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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-003-0MA03

Water resources and flood risk

MA03: Wimboldsley to Lostock Gralam

Water resources assessment

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Water resources assessment

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Department for Transport

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1 Introduction

1.1 Structure

1.1.1 This report is an appendix to the water resources and flood risk assessment. It presents the water resources assessment for the Proposed Scheme in relation to the Pickmere to Agden and Hulseheath area (MA03).

1.1.2 This appendix should be read in conjunction with:

- Volume 2, Community Area reports;
- Volume 3, Route-wide effects;
- Volume 4, Off-route effects; and
- Volume 5, Appendices.

1.1.3 The water resources and flood risk assessments include both route-wide and community area specific appendices. The route-wide appendices comprise:

- a Water Framework Directive (WFD) compliance assessment (Volume 5: Appendix WR-001-00000); and
- a Draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000).

1.1.4 For MA03, the Flood risk assessment (Volume 5: Appendix WR-005-0MA03) should also be referred to as well as the relevant Hydraulic modelling report (Volume 5: Appendix WR-006-00001).

1.1.5 Additional information relevant to this assessment is set out in Background Information and Data (BID):

- Water resources assessment baseline data (BID WR-004-0MA03)[1]; and
- WFD compliance assessment baseline data which are reported for the Proposed Scheme (BID WR-002-00001)[2].

1.2 Scope, assumptions and limitations

1.2.1 The scope, assumptions and limitations for the water resources assessment are set out in the Environmental Impact Assessment Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-00001).

1.2.2 The MA03 area covers a 13.4km long section of the Proposed Scheme. The spatial scope of the assessment is based initially on the identification of surface water and groundwater features within 1km of the route of the Proposed Scheme. However, the spatial scope in MA03 has been extended to include The Mere, Mere Site of Special Scientific Interest (SSSI), which is also a part of the Midland Meres and Mosses (Phase 1) Ramsar site. For the purposes of this assessment this spatial scope is defined as the study area.

1.2.3 The assessment considers the construction and operational features of the Proposed Scheme within this study area. These are shown on Volume 2, MA03 Map Series CT-05 and CT-06.

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water resources assessment baseline data,* BID WR-004-0MA03*.* Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

[2] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water Framework Directive compliance assessment baseline data,* BID WR-002-00001. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

1.2.4 This assessment covers the potential impacts of the Proposed Scheme on existing surface water and groundwater resources, including consideration of:

- surface waters[3];
- aquifers;
- abstractions (licensed and unlicensed) and consented discharges;
- springs and other groundwater – surface water interactions with implications for water resources; and
- water dependent habitats.

1.2.5 The route-wide WFD compliance assessment (Volume 5: Appendix WR-001-00000) provides a comprehensive review of the potential impacts of the Proposed Scheme on designated WFD surface water and groundwater bodies. The WFD compliance assessment, which involved extensive walkover surveys, informed both the value attributed to relevant receptors, such as watercourses, and the assessment of impacts and effects used in this assessment.

1.2.6 The water resources assessment considers the pollution risks associated with spillage and routine discharges of runoff from all roads within the study area that are affected by the Proposed Scheme during the construction and operational phases. Where background surface water quality data in the vicinity of the Proposed Scheme is not available to support the Highways England Water Risk Assessment Tool (HEWRAT)[4] assessment, an assumption has been made, on a precautionary basis, that there is still the potential to exceed environmental quality standards (EQS) in the receiving watercourse.

1.2.7 The risk to water resources associated with accidents or spillages from trains during the operation of the Proposed Scheme are considered on a route-wide basis within Volume 3, Route-wide effects, Section 16, Water resources and flood risk.

1.2.8 Mineral resources (operational or historical) and potential impacts to groundwater quality from existing land contamination are presented in the Land quality report, Volume 5: Appendix LQ-001-0MA03.

1.3 Study area description and key features

1.3.1 The study area is predominantly rural, although there are some villages, residential areas and farmsteads located within proximity to the Proposed Scheme, including Hoo Green, Hulseheath, Mere village and residential areas to the north of Mere village.

1.3.2 Within MA03, the Proposed Scheme will be constructed mainly as a series of cuttings and embankments. At the crossings of Arley Brook, M6, A56 Lymm Road and Peacock Lane, the Proposed Scheme will be constructed on viaduct. There are no tunnelled or ground level sections in the Pickmere to Agden and Hulseheath area (MA03).

1.3.3 The main environmental features of relevance to water resources include:

- Smoker Brook, Waterless/Arley Brook, Tabley Brook, Millington Clough, Agden Brook and associated tributaries;
- two licensed surface water abstractions;
- one potential spring features within the land required for construction of the Proposed Scheme;
- the Sherwood Sandstone Group, which is classified as a Principal aquifer;
- the Mercia Mudstone Group, which is classified as a Secondary B aquifer;
- the permeable superficial deposits, which are classified as Secondary A and Secondary (Undifferentiated) aquifers;
- two unlicensed groundwater abstractions;
- Leonard's and Smoker Wood Local Wildlife Site (LWS), and ancient woodland which is a surface water dependent habitat;
- The Mere, Mere SSSI (a part of the Midland Meres and Mosses (Phase 1) Ramsar site) and Arley and Waterless Brook Corridor LWS which are surface water and potentially groundwater dependent habitats; and

[3] Ponds are not included in the water resources assessment; these are assessed as ecological receptors in Volume 2.

[4] Standards for Highways (2020), *Design Manual for Roads and Bridges* (*DMRB) – LA 113 Road Drainage and the Water Environment Revision 1*. Available online at: https://www.standardsforhighways.co.uk/prod/attachments/d6388f5f-2694-4986-ac46-b17b62c21727?inline=true.

- Rink Wood and Round Wood LWS and ancient woodland, Bongs Wood and Rough LWS and ancient woodland, Tabley Pipe Wood LWS, Belt Wood LWS and ancient woodland, fields behind Ye Olde No. 3 LWS and Woolstencroft Farm Meadow LWS, which are potentially groundwater dependent habitats.

1.4 Stakeholder engagement

1.4.1 Discussions have been held with the following stakeholders to inform the water resources assessment:

- the Environment Agency to obtain further information regarding licensed abstractions and discharges, water dependent habitats and WFD enhancement opportunities;
- Cheshire East Council (CEC) and Warrington Borough Council (WBC) which are the Lead Local Flood Authorities (LLFA) with regard to private unlicensed abstractions and flood risk;
- the owners of private licensed and unlicensed abstractions (where access has been available) to confirm details of abstractions; and
- Natural England and local councillors for communities around The Mere, Mere (and Rostherne Mere in the Hulseheath to Manchester Airport area (MA06)), to discuss the Proposed Scheme and the councillors' knowledge of water resources and drainage in the area.

2 Site specific surface water assessments

2.1 Summary of assessment

2.1.1 Table 1 presents the potential impacts and effects related to surface water resources and features potentially affected by the Proposed Scheme. Further baseline details for these receptors are provided in Water resources assessment baseline data (BID WR-004-0MA03). Those surface water features potentially affected by groundwater interaction are described in Section 3.1.

2.1.2 The WFD compliance assessment (Volume 5: Appendix WR-001-00000) provides a comprehensive review of the aspects of the Proposed Scheme that have potential to cause permanent impacts on water bodies, or which could constrain the future achievement of water body objectives. Temporary construction impacts, defined as those which would last less than three years, may not have implications for WFD compliance, but may nevertheless result in significant effects related to water resources. Such temporary effects have therefore been considered in this assessment, as shown in Table 1.

2.1.3 Construction work sites may have substantial water demands where they are associated with design elements, such as batching plants. At these locations the construction compounds may require water abstractions to augment other supply options. Where these are required, then an assessment will include location specific engagement with the Environment Agency and other water undertakers on the availability of water at that location.

2.1.4 The draft Code of Construction Practice (CoCP) sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme to protect surface waters (see Volume 5: Appendix CT-002-00000).

2.1.5 Millington Clough is located in the Hulseheath to Manchester Airport (MA06) area. This watercourse is considered in Water resource assessment, Volume 5: Appendix WR-003-0MA06.

Table 1: Summary of potential impacts on surface water receptors

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Surface water bodies									
Tributary of Smoker Brook 1	Moderate	• Smoker Brook viaduct • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Drainage outfalls from HS2 attenuation pond and track drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include appropriate drainage design, and measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Leonards Wood Drain	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Tributary of Smoker Brook 2	Low	• Watercourse crossing by proposed access road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Watercourse crossing by proposed access road • Drainage outfall from HS2 attenuation pond	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Waterless Brook/Arley Brook 1	Moderate	None	There are no elements of the Proposed Scheme likely to impact this waterbody. Impacts possible from Pickmere embankment on groundwater – surface water interactions (see Section 3).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Tributary of Waterless Brook/Arley Brook 2	Moderate	• Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Drainage outfall from HS2 attenuation pond	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include appropriate drainage design and measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Pickmere Lane Drain	Low	• Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			supported, through the disturbance of silt or direct contamination by polluting materials.						
School Lane Drain	Low	• Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Waterless/Arley Brook	High	• Utility diversion • Arley Brook viaduct • Watercourse crossing by proposed road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Arley Brook viaduct • Watercourse crossing by proposed road • Drainage outfalls from attenuation pond and track drainage	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbon related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	Mitigation measures include avoiding the floodplain and channel. Piers are set back from the channel to avoid impacts on flow. Mitigation measures will include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tabley Brook	Moderate	• Watercourse crossing by proposed temporary road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP. Mitigation measures will include appropriate watercourse crossing by the proposed temporary road.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Drainage outfall from HS2 attenuation pond	Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor	Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (permanent)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
				Significance of effect – Minor adverse, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Tributary of Waterless Brook/Arley Brook 3	Moderate	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Waterless Brook/Arley Brook 4	Moderate	• Utility diversion • Watercourse crossing by proposed road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Watercourse crossing by proposed road	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include appropriate watercourse crossing design.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 1	Low	• Demolition of residential properties • Heyrose embankment • Utility diversion • Watercourse crossing by proposed access road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Heyrose embankment • Drainage outfall from HS2 attenuation pond	Approximately 25m of watercourse will be lost during construction of the Heyrose embankment. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	The lost part of the watercourse will be incorporated into the new scheme drainage. Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			the Proposed Scheme and associated infrastructure or from accidental spillages.						
Tributary of Waterless Brook/Arley Brook 5	Moderate	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Tabley Brook 2	Moderate	• Heyrose embankment • Realignment (108m) including Bongs Wood culvert (70m) • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Heyrose embankment • Realignment (108m) including Bongs Wood culvert (70m) • Drainage outfall from two HS2 attenuation ponds	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include realignment of watercourse to avoid embankment and appropriate drainage design. Measures to manage water quality will be adopted during the design process. Culvert lengths have been reduced during the design process and invert levels set below the bed of the watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 3	Moderate	• Heyrose embankment • Watercourse crossing by proposed access road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Heyrose embankment • Drainage outfall from HS2 attenuation pond	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			Approximately 30m of the headwaters of this watercourse will be lost during construction of the Heyrose embankment.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Water is collected from the embankment drainage to the north of the watercourse and will help to support flow. The lost part of the watercourse will be incorporated into the new scheme drainage. Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
Tributary of Tabley Brook 4	Low	• Hoo Green South embankment No.2 • M6 Mere viaduct • Realignment (95m) including an unnamed culvert north of M6 realignment (50m) • Watercourse crossing by proposed road and access road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• M6 Mere viaduct • Realignment (95m) including and unnamed culvert north of M6 realignment (50m) • Watercourse crossing by proposed road and access road • Drainage outfall from two HS2 attenuation ponds and road drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures include avoiding the floodplain and channel, where practicable. Mitigation measures will include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 5	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Tributary of Tabley Brook 6	Low	• Hoo Green South embankment No.2 • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Hoo Green South embankment No.2 • Drainage outfall from HS2 attenuation pond	Over half of this small watercourse will be partially lost during construction of the Hoo Green South embankment No.2. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Major Significance of effect – Minor adverse, not significant	The approximately 180m of lost watercourse will be incorporated into the new scheme drainage. Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 8	Low	• Hoo Green South embankment No.2 • Realignment (140m) including; – Winterbottom culvert (75m) – Unnamed culvert south of HS2 attenuation pond (10m) • Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Hoo Green South embankment No.2 • Realignment (140m) including; – Winterbottom culvert (75m) – Unnamed culvert south of HS2 attenuation pond (10m) • Drainage outfall from two HS2 attenuation ponds and route drainage	Watercourse will be partially lost during construction of the Hoo Green South embankment No.2. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Approximately 290m of the headwaters of the watercourse will be lost during construction. The watercourse will be incorporated into the new scheme drainage. Measures to manage water quality will be adopted during the design process. A minor realignment of the watercourse is included to avoid the embankment, appropriate watercourse crossing and drainage design. Culvert lengths have been reduced during the	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (permanent)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
					design process and invert levels set below the bed of the watercourse.				
Belt Wood Drains	Low	• Hoo Green South embankment No.2 • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Hoo Green South embankment No.2	Watercourse will be partially lost during construction of the Hoo Green South embankment No.2. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from realignment of the watercourse.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	The lost part of the watercourse will be incorporated into the new track drainage.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 7	Moderate	• Hoo Green North Cutting • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Tabley Brook 9	Moderate	• Watercourse crossing by proposed access road • Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Watercourse crossing by proposed access road • Drainage outfall from two HS2 attenuation ponds and road drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Mitigation measures will include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Winterbottom Lane Drains	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Hoogreen Lane Drains	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Drainage outfall from road drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Hulseheath Lane Drains	Low	• Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Chapel Lane Drain	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Millington Clough 1	Low	• Hoo Green North cutting • Hulseheath south embankment • Realignment (240m) including; – Millington Clough offline culvert No. 2 (25m)	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		– Millington Clough offline culvert No. 3 (10m) • Diversion (260m) • Watercourse crossing by proposed road and access road • Temporary works such as compounds, worksites, stockpiles and access routes							
		• Hoo Green North cutting • Hulseheath South embankment • Realignment (240m) including; – Millington Clough offline culvert No. 2 (25m) – Millington Clough offline culvert No. 3 (10m) • Diversion (260m) • Utility diversion • Watercourse crossing by proposed road and access road • Drainage outfall from one HS2 attenuation pond, one highway attenuation pond and road drainage	Approximately 230m of this watercourse will be lost during construction of the Hoo Green North cutting and Hulseheath embankment. The diversion and realignment will affect approximately 750m of the existing channel. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Mitigation measures will include diversion and realignment of watercourse to avoid embankment and cutting, and appropriate watercourse crossing and drainage design. Culvert lengths have been reduced during the design process and invert levels set below the bed of the watercourse. Mitigation measures will include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Millington Clough 2	Low	• Hoo Green North cutting • Realignment (540m) including; – Millington Clough culvert (235m) – Millington Clough offline culvert No. 1 (20m) • Utility diversion • Watercourse crossing by	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		proposed road and access road • Temporary works such as compounds, worksites, stockpiles and access routes							
		• Hoo Green North cutting • Realignment (540m) including; – Millington Clough culvert (235m) – Millington Clough offline culvert No. 1 (20m) • Watercourse crossing by proposed road and access road • Drainage outfalls from one HS2 attenuation pond, one highway attenuation pond and route drainage	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Mitigation measures will include a realignment of watercourse to avoid cutting, and appropriate watercourse crossing and drainage design. Culvert lengths have been reduced during the design process and invert levels set below the bed of the watercourse. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Kaylane Brook	Moderate	• Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Millington Clough 3	Low	• Hoo Green North cutting • Diversion (335m) including an unnamed culvert (23m) • Watercourse crossing by proposed road and access road • Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		• Hoo Green North cutting • Diversion (335m) including an unnamed culvert (23m) • Watercourse crossing by proposed road and access road	Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements. Deterioration of water quality due to contamination of surface water from both routine discharges from the Proposed Scheme and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include a realignment of watercourse to avoid cutting and appropriate watercourse crossing. Culvert lengths have been reduced during the design process and invert levels set below the bed of the watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Millington Clough 4	Low	• Hoo Green North cutting • Realignment (435m) including Millington Clough aqueduct (79m) • Utility diversion • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		• Hoo Green North cutting • Realignment (435m) including Millington Clough aqueduct (79m)	Approximately 100m of this watercourse will be lost during construction of the Hoo Green North cutting. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Part of the watercourse will be incorporated into the new scheme drainage. Mitigation measures will include appropriate drainage design. Measures to manage water quality will be adopted during the design process. Mitigation measures will include a realignment of watercourse to avoid cutting and appropriate watercourse crossing.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Froghall Lane Drains	Low	• Watercourse crossing by proposed temporary road • Temporary works such as compounds, worksites, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials. Deterioration, loss or change to the existing water environment, flow characteristics and morphology from the presence of the design elements.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP. Mitigation measures will include appropriate watercourse crossing by the proposed temporary road.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Agden Brook	Moderate	• Utility diversion • Temporary works such as compounds,	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include hydrocarbons related to fuel oils	Magnitude of impact – Minor	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		worksites, stockpiles and access routes	and high alkaline substances such as cement and concrete. Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.	Significance of effect – Minor adverse, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Surface water abstractions									
Spray irrigation – direct – Tributary of Smoker Brook 1	High	None	Located upstream of the Proposed Scheme, however abstraction is from a watercourse considered within this assessment – the abstraction has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Spray irrigation – direct – Agden Brook	High	None	Located downstream of the Proposed Scheme, however abstraction is from a watercourse considered within this assessment – the abstraction has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharges to surface water									
Discharge NPSWQD009773 Discharge 01C/31 Discharge 016891618	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge NPSWQD005447	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Located adjacent to the land required for construction of the Proposed Scheme. This area will be used for access only and no works will be undertaken in this area. Therefore, the potential for mobilisation of contaminants that could impact water quality at the discharge site is considered low.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge 01C/79	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge 01689159	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered	Magnitude of impact – Negligible	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (temporary)

Surface water feature/receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			within this assessment – the discharge has been included on a precautionary basis.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Discharge 016892421	Low	None	Located downstream of the Proposed Scheme and discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge 016890372	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge 016810082 Discharge 016892026 Discharge 016990318	Low	• Temporary works such as compounds, worksites, stockpiles and access routes	Located within the land required for construction of the Proposed Scheme. This discharge has potential to be physically impacted by construction work.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge NPSWQD004779	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Discharge 016992555 Discharge 016993011	Low	None	Located upstream of the Proposed Scheme, however discharging into a watercourse considered within this assessment – the discharge has been included on a precautionary basis.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

3 Site specific groundwater assessments

3.1 Summary of assessment

3.1.1 Table 2 presents all groundwater receptors within the study area and summarises potential impacts from the design elements of the Proposed Scheme, which are relevant to the water environment. Further baseline details for these receptors are provided in Water resources assessment baseline data (BID WR-004-0MA03). Individual impact assessments for each design element are presented in Sections 3.2 and 3.3.

3.1.2 Construction worksites may have substantial water demands where they are associated with design elements, such as batching plants. At these locations the construction worksites may require water abstractions to augment other supply options. Where these are required, then an assessment will include location specific engagement with the Environment Agency and other water undertakers on the availability of water at that location.

3.1.3 The draft CoCP sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme to protect groundwaters (see Volume 5: Appendix CT-002-00000). All above ground temporary works within construction compounds and worksites are included in design and mitigated by the draft CoCP.

3.1.4 The potential impacts of future ground investigations are considered negligible because of the measures outlined in the draft CoCP. As this assessment is applicable for all receptors it is not re-stated in Table 2.

3.1.5 In support of the groundwater impact assessment presented in Table 2, further detail is provided in Section 3.2 to Section 3.4 to demonstrate the methodology and assumptions used in relation to cuttings, viaducts and overbridges and borrow pits of the Proposed Scheme. The locations of these elements are shown in Volume 2, MA03 Map Book: Map Series CT-05 and CT-06.

Table 2: Summary of potential impacts on groundwater receptors

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Hydrogeology (aquifers)									
Alluvium – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions	The temporary works have the potential to locally affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer therefore are likely to have a negligible impact on recharge and localised impact on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct	The temporary works have the potential to locally affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of shallow groundwater flow pathways may occur around piled foundations for new viaduct piers. Due to the location and minor extent of the pier foundations within the much larger area of aquifer, the impact on groundwater flow pathways will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
River terrace deposits – Secondary A aquifer	Moderate	None	This unit is not crossed by the Proposed Scheme in this community area. Although the river terrace deposits are likely to be hydraulically connected to the alluvium and glaciofluvial sheet deposits, they are not expected to be impacted by works.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Shirdley Hill Sand Formation – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Lymm south embankment • Lymm north embankment	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary works are above ground or shallow and of small areal extent compared to the aquifer therefore are likely to have a negligible impact on recharge and localised impacts on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • A56 Lymm Road viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the piers within the much larger area of aquifer, the impact on groundwater flow pathways will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Glaciofluvial deposits – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Pickmere embankment • High Legh embankment	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and largely temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Permanent works are above ground or shallow and of small areal extent compared to the aquifer therefore are likely to have a negligible impact on recharge and/or groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (temporary)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
				Significance of effect – Moderate adverse, significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
			The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of shallow groundwater flow pathways may occur around piled foundations for viaduct piers. Due to the location and minor extent of the pier foundations within the much larger area of aquifer, the impact on groundwater flow pathways will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Glaciofluvial sheet deposits – Secondary A aquifer	Moderate	None	This unit is not crossed by the Proposed Scheme. Although the glaciofluvial sheet deposits are likely to be hydraulically connected to the Shirdley Hill Sand Formation, they are not expected to be impacted by works in proximity to the Shirdley Hill Sand Formation.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Glacial till – Secondary (Undifferentiated) aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Pickmere embankment • Heyrose embankment • Hoo Green South embankment No.2 • Hoo Green South embankment No.2 retaining wall • Hoo Green North embankment retaining wall • Lymm south embankment • Hoo Green South embankment	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Permanent works are above ground or shallow and of small areal extent compared to the aquifer, therefore are likely to have a negligible impact on recharge and/or groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct • M6 Mere viaduct • Hoo Green viaduct • A56 Lymm Road viaduct	The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting • High Legh cutting retaining wall • High Legh cutting • Agden cutting • Hoo Green South cutting retaining wall • Hoo Green (box) tunnel • Hoo Green North cutting retaining wall	The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
Mercia Mudstone Group – Sidmouth Mudstone Formation – Northwich Halite Member – Unproductive strata	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Pickmere embankment • Heyrose embankment • Hoo Green South embankment No.1 and No.3 • Lymm North embankment	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer therefore are likely to have a negligible impact on recharge and/or groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct • M6 Mere viaduct • A56 Lymm Road viaduct	Piling is not expected to occur in the Northwich Halite Member. During installation of the piles, there is a slight risk of temporary mobility of poor quality groundwater present in the Northwich Halite Member. However, the potential impacts relating to this risk are considered to be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Mercia Mudstone Group – Sidmouth Mudstone Formation – Bollin Mudstone Member – Secondary B aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hoo Green South embankment No. 2	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer, therefore are likely	Magnitude of impact – Negligible	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		• Hoo Green South embankment No.2 retaining wall • Hoo Green North embankment retaining wall • Hoo Green South embankment • Hulseheath South embankment	to have a negligible impact on recharge and only localised impacts on groundwater flow.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
		Deeper excavation (>1mbgl) including: • Hoo Green viaduct • Hoo Green North cutting • utilities diversions (new pylons) • High Legh cutting retaining wall • High Legh cutting • Hoo Green South cutting retaining wall • Hoo Green (box) tunnel • Hoo Green North cutting retaining wall	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2). Potential alteration of groundwater flow pathways may occur as a result of piling in the bedrock beneath viaduct piers and retaining walls. Due to the location and minor extent of the piling within the much larger area of the aquifer, the impact on groundwater flow pathways will be localised and negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Mercia Mudstone Group – Tarporley Siltstone Formation – Secondary B aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hulseheath South embankment • Hulseheath North embankment	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer therefore are likely to have a negligible impact on recharge and only localised impacts on groundwater flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
		Deeper excavation (>1mbgl) including: • utilities diversions (new pylons) • High Legh cutting retaining wall • High Legh cutting • M56 west overbridge • Agden cutting • Peacock Lane viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2). Potential alteration of groundwater flow pathways may occur as a result of piling in	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			the bedrock beneath viaduct piers and retaining walls. Due to the location and minor extent of the piling within the much larger area of the aquifer, the impact on groundwater flow pathways will be localised and negligible.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
		Deeper excavation (>1mbgl) including: • High Legh cutting retaining wall • High Legh cutting	The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
Sherwood Sandstone Group – Helsby Sandstone Formation – Principal aquifer	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Lymm south embankment • Lymm north embankment	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Agden cutting • A56 Lymm Road viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The permanent below ground features, including cuttings, may alter groundwater flow (see Section 3.2). Potential alteration of groundwater flow pathways may occur as a result of piling in the bedrock beneath viaduct piers. Due to the location and minor extent of the piling within the much larger area of the aquifer, the impact on groundwater flow pathways will be localised and negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Abstractions									
Well at Frog Lane Farm, Pickmere, Knutsford, Cheshire 2568003053	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Well at Heyrose Farm, Over Tabley, Knutsford	High	Above ground elements and shallow excavation (<1mbgl) including:	The temporary works have the potential to affect groundwater quality in the well, although the impact is likely to be temporary.	Magnitude of impact – Major	Implementation of measures described in the draft CoCP.	Magnitude of impact – Major	A site visit is required to assess location, value and use of this abstraction. If	Magnitude of impact – Negligible	Construction (temporary)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
2568003036		• ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Heyrose embankment		Significance of effect – Major adverse, significant		Significance of effect – Major adverse, significant	receptor is confirmed, other mitigation measures, if required, will be discussed and agreed with the owner.	Significance of effect – Negligible, not significant	
			The abstraction may be located close to or within the land required for the construction of the Proposed Scheme and, therefore, may be destroyed by the construction.	Magnitude of impact – Major Significance of effect – Major adverse, significant	None required.	Magnitude of impact – Major Significance of effect – Major adverse, significant	A site visit is required to assess location, value and use of this abstraction. If receptor is confirmed then mitigation, if required, will be discussed and agreed with the owner.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Discharges to groundwater									
Discharge 01C/31 Discharge 01C/79 Discharge 0173/2093	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Lymm South embankment • Lymm North embankment	These discharges are between 340m to 500m from any temporary construction works and are not within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on these discharges will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Groundwater – surface water interactions									
Potential spring at Clay House Farm, Flittogate Lane Potential spring north of Tableypipe Wood, Cheshire East	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	These potential springs are all over 200m from any temporary construction works and not within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on these potential springs will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Potential spring at Belt Wood east	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions	This potential spring is directly adjacent to the temporary construction works of the Proposed Scheme which have the potential to impact water quality at the feature.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • utilities diversions (new pylons)	Permanent below ground structures of the utility diversions have potential to negatively impact groundwater flow pathways to the potential spring.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	Additional field survey to confirm if spring is present.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	If a spring is present, mitigation could include re-establishing the spring flow through excavation or	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
							introduction of gravel channels to facilitate flow away from the Proposed Scheme.		
Spring at Belt Wood north	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions	This spring is over 300m from any temporary construction works and not within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on these potential springs will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The cuttings assessment (Section 3.2) shows that this feature is just outside the potential dewatering zone of influence, however it is located downgradient of the cutting and therefore some of the spring catchment may be drained by the cutting, reducing flow to the spring.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
Potential spring at Dobb Lane, Yew Tree Farm, A50	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions (removal of gas pipeline)	The potential spring has been identified as a land drain which supports an undesignated habitat. It is located within the temporary construction works of the Proposed Scheme which have the potential to impact water quality to the land drain.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The cuttings assessment (Section 3.2) shows that this feature is within the dewatering zone of influence, therefore the potential spring may receive less groundwater flow to the land drain and associated undesignated habitat.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (permanent)
Spring at Wrenshot House, Wrenshot Lane	Low	Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (Section 3.2) shows that this feature is outside the potential dewatering zone of influence, but it is located downgradient of the cutting, therefore the spring may receive a reduced groundwater flow.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Potential spring at ponds 360m north of Wrenshot House, Wrenshot Lane	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	The potential spring has been identified as a land drain which supports an undesignated habitat. The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary. Any changes to groundwater quality would affect, temporarily, the quality of the discharge water.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	This land drain is located outside of the radius of influence of the dewatering of Hoo Green North cutting, however, some of the catchment from the spring is within the radius of dewatering from the cutting and this may reduce the flow to this feature (see Section 3.2). This will impact supported habitat downstream.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Surveys have identified this feature as a land drainage outfall supporting a valuable habitat. The land drain will be incorporated into the drainage system for the Proposed Scheme and will receive flow from a new land drainage outfall in the drainage network.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Potential spring at Bowdon roundabout	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	This potential spring is not within the footprint of the Proposed Scheme or close to any below ground works and is 880m from any temporary construction work. Therefore, the impact on this potential spring will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Potential spring 25m north-east of The Meadows, Spodegreen Lane	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	This potential spring is not within the footprint of the Proposed Scheme or close to any below ground works and is 780m from any temporary construction work. Therefore, the impact on this potential spring will be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Smoker Brook 1	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Pickmere embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Smoker Brook 2	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		• Pickmere embankment							
Waterless/Arley Brook	High	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Pickmere embankment • Heyrose embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. However, due to the location and minor extent of the viaduct piers within the much larger area of the glaciofluvial deposits and glacial till, the impact on groundwater flow pathways will be negligible in the context of baseflow to the river.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Waterless Brook/Arley Brook 1 Tributary of Waterless Brook/Arley Brook 2	Low Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Pickmere embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tabley Brook	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Heyrose embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Arley Brook viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the viaduct piers within the much larger area of the glaciofluvial deposits and glacial till the impact on groundwater flow pathways will be negligible in the context of baseflow to the river.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Waterless Brook/Arley Brook 3 Tributary of Tabley Brook 1	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Heyrose embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Waterless Brook/Arley Brook 4 Tributary of Waterless Brook/Arley Brook 5 Tributary of Tabley Brook 2 Tributary of Tabley Brook 3	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Heyrose embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Tributary of Tabley Brook 4	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Heyrose embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • M6 Mere viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			extent of the viaduct piers within the much larger area of the glacial till the impact on groundwater flow pathways will be negligible in the context of baseflow to the river.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Tributary of Tabley Brook 5 Tributary of Tabley Brook 6	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • Hoo Green South embankment No.2	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • M6 Mere viaduct	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the viaduct piers within the much larger area of the alluvium and glacial till the impact on groundwater flow pathways will be negligible in the context of baseflow to the river.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 9	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hoo Green South embankment No.2 • Hoo Green South embankment No.2 retaining wall	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green viaduct • Hoo Green (box) tunnel • Hoo Green South cutting retaining wall • Hoo Green North cutting retaining wall	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (see Section 3.2) shows that this feature is just outside the potential dewatering zone of influence and a	Magnitude of impact – Moderate	Although none required, some branches of the watercourse will receive	Magnitude of impact – Minor	None required.	Magnitude of impact – Minor	Construction (temporary

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			small proportion of groundwater may be intercepted that would otherwise discharge to this watercourse.	Significance of effect – Minor adverse, not significant	flow from the drainage system of the Proposed Scheme downstream of the crossing with the Proposed Scheme. Therefore, approximately 1km of the watercourse may be affected and receive reduced baseflow.	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	and permanent)
		Deeper excavation (>1mbgl) including: • utilities diversions (new pylons)	Permanent below ground structures of the utility diversions have potential to negatively impact groundwater flow pathways to the watercourse meaning baseflow to the receiving watercourse is likely to be altered (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Although none required, parts of the watercourse will receive additional flow upstream of the new pylons from the drainage network of the Proposed Scheme, therefore mitigating any minor potential loss in baseflow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 8	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hoo Green South embankment No.2 • Hoo Green South embankment No.2 retaining wall • Hoo Green South embankment retaining wall	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green viaduct • Hoo Green (box) tunnel • Hoo Green South cutting retaining wall	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (see Section 3.2) shows that this feature is just within the potential dewatering zone of influence and a small proportion of groundwater may be intercepted that would otherwise discharge to this watercourse.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required, although water intercepted by the drainage for the cuttings will be returned to the watercourse downstream of the crossing with the Proposed Scheme. Therefore, approximately 1.2km of the 1.8km watercourse may be	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
					affected and receive reduced baseflow.				
		Deeper excavation (>1mbgl) including: • utilities diversions (new pylons) • M6 Mere viaduct	Permanent below ground structures of the piles have potential to negatively impact groundwater flow pathways to the watercourse meaning baseflow to the receiving watercourse is likely to be altered (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required, although water intercepted by the drainage for the piles will be returned to the watercourse downstream of the crossing with the Proposed Scheme.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Tabley Brook 7	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hoo Green South embankment No.2 • Hoo Green North embankment retaining wall	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The cuttings assessment (see Section 3.2) shows that this feature is within the potential dewatering zone of influence and a small proportion of groundwater may be intercepted that will otherwise discharge to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Tributary of Millington Clough 1	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hulseheath South embankment • Hulseheath North embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (Section 3.2) shows that these features are within the potential dewatering zone of influence and a small	Magnitude of impact – Moderate	Water intercepted by the drainage for the cuttings will be returned to the	Magnitude of impact – Moderate	None required.	Magnitude of impact – Moderate	Construction (temporary

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			proportion of groundwater may be intercepted that would otherwise discharge to these watercourses.	Significance of effect – Minor adverse, not significant	watercourses downstream of the crossing with the Proposed Scheme but a significant proportion of the watercourse (65%) will receive reduced baseflow.	Significance of effect – Minor adverse, not significant		Significance of effect – Minor adverse, not significant	and permanent)
		Deeper excavation (>1mbgl) including: • Peacock Lane viaduct	Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the viaduct piers within the much larger area of the aquifer the impact on groundwater flow pathways will be negligible in the context of baseflow to the watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Tributary of Millington Clough 2 Tributary of Millington Clough 3	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hulseheath South embankment • Hulseheath North embankment	The temporary construction works have the potential to affect the quality of baseflow to these watercourses.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (Section 3.2) shows that these features are within the potential dewatering zone of influence and a small proportion of groundwater may be intercepted that would otherwise discharge to these watercourses.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Water intercepted by the drainage for the cuttings will be returned to the watercourses downstream of the crossings with the Proposed Scheme.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Construction (temporary and permanent)
		Deeper excavation (>1mbgl) including: • Peacock Lane viaduct	Potential alteration of shallow groundwater flow pathways may occur around new viaduct piers. Due to the location and minor extent of the viaduct piers within the much larger area of the aquifer the impact on groundwater flow pathways will be negligible in the context of baseflow to the watercourses.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Tributary of Millington Clough 4	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hulseheath North embankment	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			The cuttings assessment (Section 3.2) shows that this tributary is within the potential dewatering zone of influence and a small proportion of groundwater may be intercepted that will otherwise discharge to this watercourse. Additionally, there may be reduced baseflow to the potential spring supporting the watercourse.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)
Agden Brook	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level route and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions	The temporary construction works have the potential to affect the quality of baseflow to this watercourse.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation (>1mbgl) including: • Hoo Green North cutting	Potential for groundwater flow to the watercourse to be intercepted by the below ground structures of the cutting (see Section 3.2).	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required though the draft CoCP will be implemented throughout construction.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)

3.2 Impact on groundwater from cuttings

3.2.1 Summary parameters for each cutting are presented below in Table 3 to Table 10.

3.2.2 Where the groundwater elevation lies above the base of the cutting the likely maximum zone of influence from dewatering of the cutting has been undertaken. In the case that the groundwater level is not known, the groundwater level is assumed to be at the surface and a detailed assessment is undertaken accordingly.

3.2.3 Assessment of the likely maximum zone of influence from dewatering of the cuttings has been made using Sichardt's formula as set out in the SMR Technical Note: Groundwater assessment.

3.2.4 Hydraulic conductivity values from the high end of the range, presented in literature, have been used in the assessment, to provide a conservative estimate of the dewatering zone of influence. Where groundwater levels are not known, the worst-case assumption, that groundwater is at ground level, has been used.

3.2.5 Cuttings are assumed to be open and any permanent works such as retaining walls or drainage measures do not form part of the quantitative assessment. Maximum drainage invert below track level is estimated at 3.15m.

3.2.6 Based on these precautionary assumptions, the zone of influence is likely to be overestimated. However, for the purpose of this preliminary assessment, this precautionary approach is considered to be appropriate.

Hoo Green viaduct (main line) and Hoo Green (box) tunnel (HS2 Manchester spur)

Table 3: Summary of the parameters for the groundwater assessment of Hoo Green viaduct and Hoo Green (box) tunnel

Box structure parameters	Parameter details
Length (m)	530
Maximum depth (m)	7.1 to top of rail (10.2 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)
Lowest level of drainage invert along track (metres above ordnance datum: mAOD)	50.9
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Potential spring at Belt Wood east Tributary of Tabley Brook 9 Belt Wood LWS and SBI

3.2.7 The Hoo Green viaduct and Hoo Green (box) tunnel are both box structures. These box structures will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and into the underlying Mercia Mudstone Group (Secondary B aquifer). There is currently no information available on groundwater elevations or depth to groundwater in this area for the superficial deposits or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.8 Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) from the box structures is estimated to extend up to 197m. This is based on a maximum cutting depth of 10.2m from ground level to the track drainage invert. The box structures will penetrate the base of the glacial till and extend into the top of the underlying Mercia Mudstone Group. The maximum zone of drawdown is not extended in the Mercia Mudstone Group aquifer compared to the glacial till as the permeability is lower than for the glacial till.

3.2.9 Permanent walls are to be built along the entire length of these structures and the proposed construction method will use secant piles, thereby significantly reducing the requirement for dewatering. The walls will fully penetrate the glacial till aquifer along most of the length of these structures giving rise to an increased risk of groundwater flooding. Land drains have been included on the upgradient side of the route of the Proposed Scheme in this area, to collect any cross flow of groundwater in this area. Volumes of groundwater flow in this area are expected to be low and therefore no other mitigation is considered necessary. The impact on the glacial till is assessed to be negligible, leading to a negligible effect which is not significant. The land drainage will ensue that the risk of groundwater flooding is negligible.

3.2.10 The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, not significant in terms of impact on the Mercia Mudstone Group

3.2.11 Tributary of Tabley Brook 9 is a watercourse comprised of several small branches and is fed by several low value land drainage outfalls. The watercourse is located within the land required for the construction of the Proposed Scheme and within the lateral extent of drawdown of Hoo Green viaduct and Hoo Green (box) tunnel. Tributary of Tabley Brook 9 may receive reduced baseflow due to the interception by the structures of

[5] On a precautionary basis, high-end sand and gravel conductivity values are assumed for glacial till to allow for potential presence of middle sands: Hydraulic conductivity from Domenico, P.A and Schwartz, F. W. (1990), *Physical and Chemical Hydrogeology*. John Wiley & Sons.

groundwater which would otherwise contribute to the baseflow. This is assessed to be a moderate impact, leading to a minor effect which is not significant. The reduction in baseflow would, however, be partially mitigated by the drainage system of the Proposed Scheme. The drainage system would discharge at the source of the branch of Tributary of Tabley Brook 9 closest to Hoo Green viaduct and Hoo Green (box) tunnel, resulting in negligible impact to the flow along the length of the watercourse downstream of the new outfall. However, the longest branch of Tributary of Tabley Brook 9 will not receive drainage discharge which could result in reduced baseflow to approximately 1km of the watercourse. For Tributary of Tabley Brook 9, the mitigation in the form of discharge from the cutting drainage network lowers the overall impact on the watercourse to a minor impact, leading to a negligible effect which is not significant.

3.2.12 Belt Wood, a potentially groundwater dependent habitat, is outside of the lateral extent of drawdown but is downgradient of the Proposed Scheme. Therefore, the structures may intercept baseflow in the groundwater catchment for the habitat. Tributary of Tabley Brook 9 passes through Belt Wood, much of which would still receive reduced baseflow despite mitigation embedded into the Proposed Scheme (see Section 4.1 for further detail).

Hoo Green North cutting (main line)

Table 4: Summary of the parameters for the groundwater assessment of Hoo Green North cutting

Cutting parameters	Parameter details
Length (km)	2.7
Maximum depth (m)	19.0 to top of rail (22.1 to drainage invert)
Strata intercepted	Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	40.8
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer) Spring at Wrenshot House, Wrenshot Lane Tributary of Millington Clough 1 Tributary of Millington Clough 2 Tributary of Millington Clough 3 Tributary of Millington Clough 4 Park Covert

3.2.13 The cutting will penetrate the glaciofluvial deposits (Secondary A aquifer) and glacial till (Secondary (Undifferentiated) aquifer) and into the underlying Sidmouth Mudstone Formation, Bollin Mudstone Member and Tarporley Siltstone Formation of the Mercia Mudstone Group (Secondary B aquifers). There is no currently available information on groundwater elevations or depth to groundwater in this area for the superficial deposits or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.14 Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is estimated to extend up to 394m. This is based on a maximum cutting depth of 22.1m from ground level to the track drainage invert. The cutting will penetrate the base of the glacial till and extend into the top of the underlying Mercia Mudstone Group. However, the maximum zone of drawdown is smaller in the Mercia Mudstone Group aquifer than in the glacial till as the permeability is lower than for the glacial till.

3.2.15 A retaining wall is to be built along the entire length of this cutting and the proposed construction method will use secant piles, thereby significantly reducing the requirement for dewatering. The retaining walls will fully penetrate the glacial till aquifer in this location giving rise to an increased risk of groundwater flooding. Land drains have been included on the upgradient side of the route of the Proposed Scheme to collect any cross flow of groundwater in this area. Therefore, the impact on the glacial till is assessed to be negligible, leading to a negligible effect which is not significant. The land drainage will ensure that the risk of groundwater flooding is negligible.

3.2.16 The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, not significant in terms of impact on the Mercia Mudstone Group.

3.2.17 The spring at Wrenshot House, Wrenshot Lane and potentially groundwater dependent habitat Park Covert are located outside of the zone of influence. The spring at Wrenshot House, Wrenshot Lane is also upgradient of the cutting. Therefore, these features are unlikely to be impacted by the cutting.

3.2.18 Potential spring at Dobb Lane, Yew Tree Farm, A50 is located within the zone of influence, therefore, the potential spring may receive less groundwater flow to the land drain and associated undesignated habitat. This is assessed as a minor impact, leading to a minor adverse effect which is not significant.

3.2.19 Tributary of Millington Clough 4 is located within the zone of influence of the cutting and thus will likely receive reduced baseflow. Part of the watercourse will be integrated into the new drainage network of the Proposed Scheme via the land drainage system. While the land drainage will provide some flow to the watercourse from runoff, it does not compensate for water intercepted by the cutting which will be diverted and discharged into Tributary of Agden Brook 1. As such, the Tributary of Millington Clough 4 downstream of the cutting will receive reduced baseflow. The reduction in baseflow will result in a moderate impact on this low value watercourse, leading to a minor effect which is not significant.

3.2.20 Tributaries of Millington Clough 1, 2 and 3 are also located within the zone of influence of the cutting, and thus likely to receive reduced baseflow. Drainage on the upgradient side of the route will discharge groundwater flow into Tributary of Millington Clough 2. Tributary of Millington Clough 1 and 3 will receive discharge from the drainage network downstream of the cutting. However, upgradient of this discharge locations baseflow in tributaries of Millington Clough 1 and 3 will receive reduced baseflow. Most notably, approximately 450m of a total length of 1.1km of Tributary of Millington Clough 1 will receive reduced baseflow. The impact on Tributary of Millington Clough 1, 2 and 3, after mitigation with the drainage discharge, is assessed to be a moderate impact, leading to a minor effect which is not significant.

High Legh cutting retaining wall and High Legh cutting

Table 5: Summary of the parameters for the groundwater assessment of High Legh cutting

Retaining wall and cutting parameters	Parameter details
Length (m)	200
Maximum depth (m)	20.6 to top of rail (23.8 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	40.1
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)

3.2.21 The cutting will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and the Bollin Mudstone Member of the Mercia Mudstone Group (Secondary B aquifer). There is no currently available information on groundwater elevations or depth to groundwater in this area for the glacial till or the Mercia Mudstone Group. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.22 As defined above, the zone of drawdown has been calculated assuming the cutting is an open cutting without retaining walls. Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for both the glaciofluvial deposits and the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is estimated to extend up to 73m in the superficial deposits. This is based on a maximum cutting depth of 23.8m from ground level to the track drainage invert. A small section of the cutting (approximately 50m) will be constructed as a retaining wall; the rest of the cutting will be constructed as an open cutting.

3.2.23 Assuming the groundwater flow direction in the glacial till and glaciofluvial deposits follows topography, groundwater will flow towards the north-east, approximately perpendicular to the alignment of the cutting. The cutting is therefore likely to form a barrier to groundwater flow over some part or possibly the whole of the cutting length, leading to local changes in groundwater level. However, taking into account the extent of the glaciofluvial deposits and glacial till aquifers, this is assumed to be a minor impact, leading to a minor adverse effect which is not significant.

3.2.24 The High Legh cutting retaining wall and cutting will fully penetrate the thickness of the glacial till and glaciofluvial deposits and will extend into the top of the underlying Mercia Mudstone Group. Assuming a hydraulic conductivity value of $1.0x10^{-5}$m/s for the Mercia Mudstone Group[6], the zone of influence from the cutting is estimated to extend up to 217m in the bedrock. Based on hydrogeological mapping[7], it is assumed the groundwater flow direction in the Mercia Mudstone is towards the north-west. The cutting may therefore form a partial barrier to groundwater flow in the area, leading to local changes in groundwater level. Taking into account the extent and depth of the Mercia Mudstone Group aquifer overall, this is assessed to be a minor impact, leading to a minor effect which is not significant.

3.2.25 There are no groundwater dependent features within the radius of influence of this cutting.

M56 West overbridge (box structure)

Table 6: Summary of the parameters for the groundwater assessment of M56 West overbridge

Box structure parameters	Parameter details
Length (m)	50
Maximum depth (m)	16.0 to top of rail (19.1 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	39.8
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer) Sherwood Sandstone Group – Helsby Sandstone Formation (Principal aquifer)

3.2.26 The box structure will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and the Mercia Mudstone Group (Secondary B aquifer). There is currently no available information on groundwater elevations or depth to groundwater in this area for the glacial till or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the box structure on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.27 There are no superficial deposits recorded in the vicinity of the M56 West overbridge. The structure is expected to penetrate directly into the Mercia Mudstone Group. Assuming a hydraulic conductivity value of $1x10^{-5}$m/s for the Mercia Mudstone Group[6], the lateral extent of drawdown from the cutting is calculated as 174m in the Mercia Mudstone Group. This is based on a maximum cutting depth of 19.1m from ground level to the track drainage invert. The structure will be constructed as a long, reinforced concrete (RC) box tunnel with secant piled walls. Based on hydrogeological mapping[7], it is assumed the groundwater flow direction in the Mercia Mudstone is towards the north to north-west and the cutting is unlikely to form a barrier to groundwater flow in the area. Taking into account the scale of the Mercia Mudstone Group aquifer overall, the impact is assessed to be a negligible, which leads to a negligible effect which is not significant. There are no groundwater dependent features within the lateral extent of drawdown of the M56 west overbridge.

[6] Based on the high-end value for bulk testing within the Mercia Mudstone Group. Hobbs, P. R. N *et al*. (2002), *Engineering geology of British rocks and soils – Mudstones of the Mercia Mudstone Group.* British Geological Survey, Research Report RR/01/02.

[7] British Geological Survey (1989), *Hydrogeological map of Clwyd and the Cheshire Basin including parts of the hydrometric areas 54, 65, 66, 67, 68 69 and 70.* Available online at: https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=11567.

Agden cutting

Table 7: Summary of the parameters for the groundwater assessment of Agden cutting

Cutting parameters	Parameter details
Length (m)	620
Maximum depth (m)	17.5 to top of rail (20.6 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer) Sherwood Sandstone Group – Helsby Sandstone Formation (Principal aquifer)
Lowest level of drainage invert along track (mAOD)	36.3
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Tarporley Siltstone Formation (Secondary B aquifer) Sherwood Sandstone Group – Helsby Sandstone Formation (Principal aquifer) Agden Brook

3.2.28 The cutting will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and the Mercia Mudstone Group (Secondary B aquifer). There is currently no available information on groundwater elevations or depth to groundwater in this area for the glacial till or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.29 Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[5] (where present), the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is estimated to extend up to 68m. This is based on a maximum cutting depth of 20.6m from ground level to the track drainage invert. The cutting will be constructed as an open cutting and at present no piling, foundations or walls are proposed.

3.2.30 The Agden cutting fully penetrates the thickness of the glacial till and extends into the underlying Mercia Mudstone and Sherwood Sandstone. Assuming that the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the north-east, approximately perpendicular to the alignment of the cutting. The cutting is therefore likely to form a permanent drain of groundwater flow over some part or possibly the whole of the cutting length, leading to local changes in groundwater level. However, taking into account the extent of the glacial till aquifer, this is assumed to be a minor impact, leading to a minor adverse effect which is not significant.

3.2.31 The zone of influence in the Mercia Mudstone Group is greater than the glacial till. Assuming a hydraulic conductivity value of $1x10^{-5}$m/s for the Mercia Mudstone Group[6], the lateral extent of drawdown from the cutting is calculated as 188m in the Mercia Mudstone Group. This is based on the cutting depths and rest water level condition as described for the glacial till. Based on hydrogeological mapping[7], it is assumed the groundwater flow direction in the Mercia Mudstone is towards the north to north-west and the cutting is unlikely to form a drain to groundwater flow in the area. Taking into account the scale of the Mercia Mudstone Group aquifer overall, the impact is assessed to be a negligible, which leads to a negligible effect which is not significant.

3.2.32 The cutting will extend into the top of the Sherwood Sandstone Group in the northern part of the cutting. However, the lateral extent of drawdown is lower in the Sherwood Sandstone Group as the cutting is shallower than in the Mercia Mudstone Group. Assuming a hydraulic conductivity value of $1.16x10^{-4}$m/s for the Sherwood Sandstone Group[8], the maximum lateral extent of drawdown is 188m. Potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, not significant in terms of impact on the Sherwood Sandstone Group.

3.2.33 Agden Brook is located outside the zone of influence of Agden cutting. However, as the watercourse is downgradient of the proposed cutting, there is potential for groundwater baseflow to the watercourse to be reduced by permanent below ground structures. The watercourse is located approximately parallel to the Proposed Scheme, over 400m to the east, and is not crossed by the route of the Proposed Scheme. The impact on Agden Brook is assessed as minor, leading to a minor adverse effect which is not significant.

[8] Geometric mean value for PT sandstone from Allen, D. J et al. *The physical properties of major aquifers in England and Wales*. British Geological Survey Technical Report WD/97/34. 312pp, Environment Agency R&D Publication 8.

Hoo Green South cutting retaining wall

Table 8: Summary of the parameters for the groundwater assessment of Hoo Green South cutting retaining wall

Cutting retaining wall parameters	Parameter details
Length (m)	360
Maximum depth (m)	6.1 to top of rail (9.2 to drainage invert)
Strata intercepted	Glacial till (Secondary Undifferentiated aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	51.2
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Tributary of Tabley Brook 8 Tributary of Tabley Brook 9

3.2.34 The cutting will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and the Mercia Mudstone Group (Secondary B aquifer). There is currently no available information on groundwater elevations or depth to groundwater in this area for the glacial till or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.35 As defined above, the zone of drawdown has been calculated assuming the cutting is an open cutting without retaining walls. Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is estimated to extend up to 182m. This is based on a maximum cutting depth 9.2m from ground level to the track drainage invert, and a rest water level at ground level. A retaining wall is to be built along the entire length of this cutting and the proposed construction method will use secant piles thereby significantly reducing the requirement for dewatering. These walls will fully penetrate the glacial till aquifer across the majority of the cutting in this location and therefore there is an increased risk of groundwater flooding. Land drains have been included on the upgradient side of the route in this area and therefore the impact on the glacial till is assessed to be negligible, leading to a negligible effect which is not significant.

3.2.36 The cutting will penetrate the base of the glaciofluvial deposits and glacial till and will extend into the top of the underlying Mercia Mudstone Group. The extent of the drawdown in the underlying Mercia Mudstone Group aquifer is less than in the glacial till due to the lower permeability of the mudstone. The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, leading to a negligible effect which is not significant on the Mercia Mudstone Group.

3.2.37 Tributary of Tabley Brook 8 is crossed by the Proposed Scheme in two locations. There may be a slight reduction in baseflow to Tributary of Tabley Brook 8 although the proportion of intercepted groundwater will be small. This is assessed to be a moderate impact, leading to a minor effect which is not significant. The cutting drainage upstream of the second (downstream) crossing with the Proposed Scheme will be discharged into Tributary of Tabley Brook 8, although baseflow may still be reduced in a 1.2km section of the 1.8km long watercourse upstream of the discharge location. While the mitigation embedded in the design lowers the impact on downstream watercourses, the impact on Tributary of Tabley Brook 8 remains as a moderate impact, leading to a minor adverse effect which is not significant.

3.2.38 Groundwater baseflow to 500m of the headwaters of Tributary of Tabley Brook 9 is located outside of the zone of influence, although the catchment area of the watercourse may be inside the zone of influence. Therefore, there is potential for baseflow to be reduced. This is assessed to be a moderate impact, leading to a minor effect which is not significant. There are several branches of the watercourse contributing to baseflow in Tributary of Tabley Brook 9, one of which will receive flow from the drainage network of the Proposed Scheme. For Tributary of Tabley Brook 9, the mitigation as discharge from the cutting drainage network lowers the overall impact on the watercourse to a minor impact, leading to a negligible effect which is not significant.

Hoo Green North cutting retaining wall (HS2 Manchester spur)

Table 9: Summary of the parameters for the groundwater assessment of Hoo Green North cutting retaining wall

Cutting retaining wall parameters	Parameter details
Length (m)	50
Maximum depth (m)	8.7 to top of rail (11.8 to drainage invert)
Strata intercepted	Glacial till (Secondary Undifferentiated aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	51.1
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Tributary of Tabley Brook 9

3.2.39 The cutting will penetrate the glacial till (Secondary (Undifferentiated) aquifer) and the Mercia Mudstone Group (Secondary B aquifer). There is currently no available information on groundwater elevations or depth to groundwater in this area for the glacial till or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.40 As defined above, the zone of drawdown has been calculated assuming the cutting is an open cutting without retaining walls. Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is estimated to extend up to 359m. This is based on a maximum cutting depth of 11.8m from ground level to the track drainage invert. The cutting will partially penetrate the base of the glacial till and will extend into the top of the underlying Mercia Mudstone Group. The maximum zone of drawdown is not increased in the Mercia Mudstone Group aquifer as the permeability is lower than for the glacial till.

3.2.41 A retaining wall is to be built along the entire length of this cutting and the proposed construction method will use secant piles, thereby significantly reducing the requirement for dewatering. As these walls will partially penetrate the glacial till aquifer in this location, there is an increased risk of groundwater flooding. Land drains have been included on the upgradient side of the route in this area and therefore the impact on the glacial till is assessed to be negligible, leading to a negligible effect which is not significant.

3.2.42 The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, not significant in terms of impact on the Mercia Mudstone Group.

3.2.43 There may be a slight reduction in baseflow to the northern branch of Tributary of Tabley Brook 9 although the proportion of intercepted groundwater will be very minor. This is assessed to be a moderate impact, leading to a minor effect, which is not significant. The drainage in this area will be discharged into a more southerly branch of Tributary of Tabley Brook 9. Baseflow to approximately 1km of the northern branch will therefore potentially be reduced. Mitigation as discharge from the cutting drainage network lowers the overall impact on the watercourse to a minor impact, leading to a negligible effect which is not significant.

Hoo Green North cutting (HS2 Manchester spur)

Table 10: Summary of the parameters for the groundwater assessment of Hoo Green North cutting

Cutting parameters	Parameter details
Length (m)	905
Maximum depth (m)	10.5 to top of rail (13.7 to drainage invert)
Strata intercepted	Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	58.9
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation, Bollin Mudstone Member (Secondary B aquifer) Tributary of Millington Clough 1

3.2.44 The cutting will penetrate the glaciofluvial deposits (Secondary A aquifer), glacial till (Secondary (Undifferentiated) aquifer) and the top of the Mercia Mudstone Group (Secondary B aquifer). There is currently no available information on groundwater elevations or depth to groundwater in this area for the glaciofluvial deposits, glacial till or the Mercia Mudstone. It has therefore been assumed that groundwater levels within the superficial and bedrock aquifers are at ground level, in order to assess the maximum likely extent for the impact of the cutting on groundwater flow. Application of the draft CoCP will ensure that materials and fluids used during construction are managed so that there is no significant adverse effect on groundwater quality.

3.2.45 Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for both the glaciofluvial deposits and the glacial till[5] and $2.72x10^{-5}$m/s for the Mercia Mudstone Group[6], the lateral extent of drawdown (also referred to as the zone of influence) from the cutting is calculated as 415m. This maximum value occurs within the glaciofluvial deposits. This is based on a maximum cutting depth of 13.7m from ground level to the track drainage invert.

3.2.46 The cutting will also pass through the unconfined Mercia Mudstone Group, although the zone of drawdown is smaller in the Mercia Mudstone Group aquifer as the permeability is lower than for the glacial till. The Mercia Mudstone Group extends more than 50m below the cutting depth and is laterally extensive. Therefore, potential local changes in groundwater level to the maximum cutting depth are assessed as negligible, not significant in terms of impact on the Mercia Mudstone Group.

3.2.47 The cutting will fully penetrate the glacial till and glaciofluvial deposits and will reduce local groundwater levels in the area. The aquifers are laterally extensive in this area and the impact on the glacial till and glaciofluvial deposits are assessed to be minor, leading to a minor adverse effect which is not significant.

3.2.48 Tributary of Millington Clough 1 is a small agricultural field ditch of low receptor value. The watercourse is crossed by the Proposed Scheme in two locations. The baseflow could be reduced in approximately 600m of Tributary of Millington Clough 1 as a result of the combined impacts of the Hoo Green North cuttings on both the HS2 WCML connection and the HS2 Manchester spur. This equates to approximately 65% of the total watercourse length. The reduction in baseflow from the Hoo Green North cuttings is assessed to be a moderate impact, leading to a minor adverse effect which is not significant. Drainage from the cutting will discharge groundwater into Tributary of Millington Clough 1, downgradient of the cutting and downgradient of Hulseheath South embankment. Despite mitigation to receive discharge from the cutting drainage network, the overall impact on the watercourse remains a moderate impact, leading to a minor adverse effect which is not significant.

3.3 Impacts to groundwater quality from viaduct, overbridge and underbridge piling

3.3.1 Piling can affect groundwater quality where the works have hydraulic connection to an aquifer or are in the aquifer itself. Potential impacts may occur from losses of circulation fluid, turbidity resulting from the breakdown of in-situ aquifer material, and possible contamination by hydraulic fluids and greases from machinery. There is likely to be a more rapid transfer of these materials through fracture or fissure flow if present. If within a catchment for a groundwater abstraction, then degraded groundwater quality may render the abstraction unsuitable for use. Catchments for groundwater abstraction are indicated by the SPZ1 and SPZ2 areas and are defined by the Environment Agency around all licenced abstraction sites.

3.3.2 Piling can impact groundwater flow in an aquifer if the capacity of pathways are reduced during the action of piling or migration of grout into the aquifer. Potential impact from piled structures depends on the spacing of piles and the aquifer type. For example, fissure flow may be impeded if a fracture pathway is intercepted by a pile but matrix flow is less likely to be impeded as groundwater will divert around the structure.

Overbridges and underbridges

3.3.3 The following overbridges are located within Pickmere to Agden and Hulseheath area (MA03):

- Tabley Inferior footpath 1/1 accommodation underbridge;
- Pickmere footpath 9/1 underbridge;
- Tabley Superior restricted bridleway 4/1 accommodation underbridge;
- Mere bridleway 1/1 accommodation underbridge;
- A50 overbridge;
- Millington Clough offline underbridge;
- Peacock Lane overbridge;
- Manchester to Liverpool Junction overbridge;
- Agden Brook Farm accommodation underbridge; and
- Millington Clough underbridge.

3.3.4 There is a possibility that groundwater quality and flow in the Mercia Mudstone and Sherwood Sandstone may be impacted by the construction of overbridge piles. The piles are not expected to extend any deeper than 20m below ground level. The potential impacts from construction piling can be mitigated using bentonite in the process to reduce fluid loss. Many methods of piling can also be facilitated by the use of temporary casing, which is generally more effective in preventing losses to immediately adjacent watercourses. Therefore, the impact from the construction of overbridges, underbridges and aqueducts is expected to be localised and temporary and of minor extent in comparison to the areal extent of the superficial and bedrock aquifers, and thus the impact is assessed as negligible leading to a negligible effect which is not significant.

Arley Brook viaduct

3.3.5 Foundations for the Arley Brook viaduct will comprise drilled concrete piles with pile caps. The piles are currently designed to be up to 27m deep and are expected to penetrate through the alluvium and glacial till and into the underlying Mercia Mudstone Group. Therefore, these piles may obstruct the flow of groundwater in the superficial deposits and an upper section of the bedrock in the immediate vicinity of the foundations for the viaduct. Any impacts are likely to be localised. The impact on the alluvium and glacial till is expected to be negligible. Taking into account the extent and depth of the bedrock aquifer, the resulting effect will be negligible.

3.3.6 Waterless/Arley Brook is present within the immediate vicinity of the Arley Brook viaduct. There is the potential for adverse impacts on baseflow to parts of Arley Brook. Any below ground structures have the potential to obstruct groundwater flow towards the watercourse. However, any groundwater intercepted by the viaduct would still discharge into Arley Brook via the drainage system of the Proposed Scheme downstream of the route. This results in a short stretch of 160m of Arley Brook possibly receiving reduced baseflow. However, on the scale of the watercourse, the permanent effects on Arley Brook would be negligible.

3.3.7 Arley and Waterless Brook Corridor is crossed by the Proposed Scheme. It is possible the construction and permanent below ground structures of the viaduct may impact groundwater flow and the quality of groundwater supporting the habitat (further information in Section 4.1).

M6 Mere viaduct

3.3.8 Foundations for the M6 Mere viaduct will comprise drilled concrete piles with pile caps. The piles are currently designed to be up to 27m deep and are expected to penetrate through the glacial till and into the underlying Mercia Mudstone Group. Therefore, these piles may obstruct the flow of groundwater in the superficial deposits and an upper section of the bedrock in the immediate vicinity of the foundations for the viaduct. Any impacts are likely to be localised. The impact on the glacial till is expected to be negligible. Taking into account the extent and depth of the bedrock aquifer, the resulting effect will be negligible.

3.3.9 Tributary of Tabley Brook 4 is crossed by the M6 Mere viaduct and Tributary of Tabley Brook 6 and 8 are present within the immediate vicinity of the M6 Mere viaduct. There is the potential for adverse impacts on baseflow to parts of these watercourses. Any below ground structures have the potential to obstruct groundwater flow towards the watercourses. However, the source of Tributary of Tabley Brook 4 is located upstream and upgradient of the Proposed Scheme so there will be no impact to the supply of the watercourse. The watercourse is then diverted under the viaduct, resulting in a negligible impact to the baseflow of the watercourse. Both Tributary of Tabley Brook 6 and 8 are located downgradient of the Proposed Scheme, but any groundwater intercepted by the viaduct would still discharge into these watercourses via the drainage system of the Proposed Scheme downstream of the route. Therefore, there is no impact to the baseflow to these watercourses thus the permanent effects on Tributary of Tabley Brook 6 and 8 would be negligible.

A56 Lymm Road viaduct

3.3.10 Foundations for the A56 Lymm Road viaduct will comprise drilled concrete piles with pile caps. The piles are currently designed to be up to 38m deep and are expected to penetrate through the Shirdley Hill Sand Formation and glacial till and into the underlying Sherwood Sandstone Group and Mercia Mudstone Group. Therefore, as these piles fully penetrate the superficial deposits and extend into the top of the bedrock, these piles may obstruct the flow of groundwater in the superficial deposits and an upper section of the bedrock in the immediate vicinity of the foundations for the viaduct. Any impacts are likely to be localised. The implementation of the draft CoCP will ensure the expected impact on the Shirdley Hill Sand Formation and glacial till will be negligible. Taking into account the extent and depth of the bedrock aquifers, the resulting effect will be negligible.

3.3.11 Tributary of Agden Brook 1 is present within the immediate vicinity of the A56 Lymm Road viaduct. There is the potential for adverse impacts on baseflow to the watercourse as below ground structures have the potential to obstruct groundwater flow towards the watercourse. However, any groundwater intercepted by the Proposed Scheme would still discharge into Tributary of Agden Brook 1 via the drainage system of the Proposed Scheme downstream of the route. This results in a short stretch of 90m of Tributary of Agden Brook 1 possibly receiving reduced baseflow. However, on the scale of the watercourse, the permanent effects on Tributary of Agden Brook 1 would be negligible.

Peacock Lane viaduct

3.3.12 Foundations for the Peacock Lane viaduct will comprise drilled concrete piles with pile caps. The piles are currently designed to be up to 21m deep. There are no recorded superficial deposits in proximity to the viaduct; the viaduct piles are expected to penetrate directly into the Mercia Mudstone Group. Therefore, these piles may obstruct the flow of groundwater in the upper section of the bedrock in the immediate vicinity of the foundations for the viaduct. Any impacts are likely to be localised. Taking into account the extent and depth of the bedrock aquifer, the resulting effect will be negligible.

3.3.13 Millington Clough is present within the immediate vicinity of the Peacock Lane viaduct. There is the potential for adverse impacts on baseflow to parts of Millington Clough. Any below ground structures have the potential to obstruct groundwater flow towards the watercourse. However, any groundwater intercepted by the viaduct would be discharged into Tributary of Millington Clough 1, an upstream tributary of Millington Clough, via the drainage system of the Proposed Scheme downstream of the route. Therefore, there is no impact to the baseflow to Millington Clough, resulting in a negligible effect. Additionally, Tributary of Millington Clough 1, 2 and 3 may also receive reduced baseflow. Due to the location and minor extent of the viaduct piers within the much larger area of the aquifer the impact on groundwater flow pathways will be negligible in the context of baseflow to the river. Intercepted flow will also be diverted by the drainage network of the Proposed Scheme.

3.4 Impacts to groundwater from borrow pits

3.4.1 There are no borrow pits within Pickmere to Agden and Hulseheath area (MA03).

4 Site specific water dependent habitats assessment

4.1 Summary of assessment

4.1.1 Table 11 summarises the potential hydrological impacts (for example, changes to flow, level, regime, or quality) related to surface water and groundwater dependent habitats. Further details of the ecology of these sites and the assessment of the local level ecological effects arising from water impacts, are provided in Ecological register of local level effects, Volume 5: Appendix EC-015-0MA03. Where there are significant effects, the ecological effects and associated mitigation are reported in Volume 2, Community Area report: Pickmere to Agden and Hulseheath (MA03), Section 7, Ecology and biodiversity.

Table 11: Summary of potential water dependent habitat impacts

Receptor	Design element	Discussion of potential impact to water receptor
Surface water dependent habitats		
Leonard's and Smoker Wood (including Smoker Brook) LWS and ancient woodland	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles, worksites and compounds	It is currently unclear if this site is supported by surface water, but it has been included on a precautionary basis. The Proposed Scheme crosses this site on a viaduct, with embankment close to the northern boundary of the site. There is the potential to alter water quality during construction. This will be mitigated through the implementation of the draft CoCP resulting in a negligible impact.
Surface water and groundwater dependent habitats		
Arley and Waterless Brook Corridor LWS	Above ground elements and shallow excavation (<1mbgl): • ground level track and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Arley Brook viaduct	The Proposed Scheme has the potential to alter surface water quality during the temporary construction works. This will be mitigated through the implementation of the draft CoCP. The mitigation measures for the permanent below ground works, such as the Arley Brook viaduct include avoiding the floodplain and channel, with piers set back to remove impacts on flows. Any discharges to the watercourse could affect water quality, however appropriate drainage design and measures to manage water quality will be adopted during the design process, and the impact is assessed to be negligible.
The Mere, Mere SSSI (part of Midland Meres and Mosses (Phase 1) Ramsar site)	Deeper excavation (>1mbgl) • Hoo Green North cutting retaining wall • Hoo Green North cutting	The cuttings assessment (Section 3.2) shows that this feature is outside of the potential dewatering zone of influence. A detailed assessment for the site is provided in Section 0. This assessment shows that there is some uncertainty around whether the Proposed Scheme could impact on groundwater flow to The Mere, Mere. However, recharge trenches are embedded into the design and this will mitigate for any impact on groundwater flow, leading to negligible impact. No impacts on the surface water flows to the site have been identified.
Groundwater dependent habitats		
Rinks Wood and Round Wood LWS and ancient woodland	Above ground elements and shallow excavation (<1mbgl): • ground level track and roads • temporary works such as stockpiles, worksites and compounds • Pickmere embankment	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. With the exception of a short section and a junction on roads close to and adjacent to the site, land required for the construction of the Proposed Scheme is over 250m from the site at the closest point. There are also limited below ground works associated with the Scheme in this area. Therefore, the impact on any groundwater discharge to the water dependent habitat (if applicable), and on the quality of the groundwater discharge, will be negligible.
Bongs Wood and Rough LWS and ancient woodland	Above ground elements and shallow excavation (<1mbgl): • ground level track and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Heyrose embankment	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The habitat is partially within land required for the construction of the Proposed Scheme and there are permanent below ground structures for pylons. The impact of the temporary construction works on groundwater quality will be mitigation through the implementation of the draft CoCP. The permanent below ground structures have the potential to impact groundwater flow. However, the majority of the habitat is up-gradient from the land required for construction and the quantity of flow impacted is considered to be minor. Therefore, the impact on any groundwater flow to the water dependent habitat (if applicable) will be negligible.
Tabley Pipe Woods LWS	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The land required for the construction of the Proposed Scheme is located adjacent to the downgradient boundary of the site. There is the potential to alter groundwater quality during construction, although this will be mitigated through the implementation of the draft CoCP. It is assessed that the impact on groundwater level and quality at this site is negligible.

Receptor	Design element	Discussion of potential impact to water receptor
	• temporary works such as stockpiles, worksites and compounds	
Belt Wood LWS and ancient woodland	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions • Hoo Green South embankment No.2 • Hoo Green South embankment No.2 retaining wall	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The habitat is within the land required for the construction of the Proposed Scheme. Therefore, the structures may intercept baseflow in the groundwater catchment for the habitat although these design elements only require shallow excavations. There is the potential to alter groundwater quality during construction; this will be mitigated through the implementation of the draft CoCP. Therefore, the impact of these design elements on groundwater level and quality at this site is negligible.
	Deeper excavation (>1mbgl): • Hoo Green North cutting • Hoo Green South cutting retaining wall • Hoo Green viaduct • Hoo Green (box) tunnel	The cuttings assessment (Section 3.2) shows that this feature is outside the potential dewatering zone of influence and therefore the water dependent habitat (if applicable) will not be affected by any permanent dewatering. Two upper reaches of the Tributary of Tabley Brook 9, which run through Belt Wood LWS, are within the potential lateral extent of drawdown of Hoo Green South and Hoo Green North cuttings. A small proportion of groundwater may, therefore, be intercepted that would otherwise discharge to this watercourse. Drainage from the Proposed Scheme will be discharged into one of the reaches upstream of Belt Wood, which may compensate for some of the flow lost. Since it is unclear at this time whether this site depends on flows in Tributary of Tabley Brook 9, this impact is assessed as minor on this site.
	Deeper excavation (>1mbgl) including: • utilities diversions (new pylons)	Permanent below ground structures for the utility diversions have potential to negatively impact groundwater flow pathways to the habitat meaning that baseflow may be altered. However, given the relatively small dimensions of the pylons compared to the size of the habitat, it is unlikely the pylons will have a significant impact on the habitat. The impact is assessed as negligible.
Park Covert ancient woodland	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads • temporary works such as stockpiles, worksites and compounds • utilities diversions	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The land required for the construction of the Proposed Scheme is located 30m west of the habitat. There is the potential to alter groundwater quality during construction, although this will be mitigated through the implementation of the draft CoCP. It is assessed that the impact on groundwater level and quality at this site is negligible.
	Deeper excavation (>1mbgl): • Hoo Green North cutting	The cuttings assessment (see Section 3.2) shows that this feature is outside the potential dewatering zone of influence and therefore the water dependent habitat (if applicable) will not be affected by any permanent dewatering.
Fields behind Ye Olde No. 3 LWS	Above ground elements and shallow excavation (<1mbgl): • Lymm north embankment • Lymm south embankment	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The land required for the construction of the Proposed Scheme is 20m from the habitat on the other side of a major road. However, there are limited below ground works in the area. Therefore, the impact on any groundwater discharge to the water dependent habitat (if applicable), and on the quality of the groundwater discharge, will be negligible.
Woolstencroft Farm Meadow LWS	Above ground elements and shallow excavation (<1mbgl): • Heatley south embankment	It is currently unclear if this site is supported by groundwater, but it has been included on a precautionary basis. The land required for the construction of the Proposed Scheme is over 500m from this site at the closest point, and there are limited below ground works in the area. Therefore, the impact on any groundwater discharge to the water dependent habitat (if applicable), and on the quality of the groundwater discharge, will be negligible.

4.2 Detailed assessment

The Mere, Mere

4.2.1 The Mere, Mere SSSI, a part of the Midland Meres and Mosses (Phase 1) Ramsar site, is located in the upper part of the catchment of Rostherne Mere Ramsar site and SSSI, shown on the map in Figure 1. The Mere, Mere site includes Little Mere which is located just downstream of the main waterbody. Little Mere and Rostherne Mere are connected by Rostherne Brook. The surface water sub-catchment boundary upstream of the outlet from Little Mere, and the downstream Rostherne Mere surface water catchment boundary, are included in Figure 1.

4.2.2 The superficial geology of The Mere, Mere SSSI sub-catchment comprises mainly glacial till and glaciofluvial deposits, as shown on Figure 2. Some alluvium is also present in low-lying wetland areas, most notably in Meremoss Wood upstream of The Mere, Mere. The substantial number of springs in and around the sub-catchment, shown on Figure 1 and Figure 2, indicates that groundwater is likely to play a major role in supporting base flows in streams particularly in dry periods, and in maintaining water levels in the meres.

4.2.3 Figure 1 shows the likely maximum zone of influence on groundwater from dewatering/drainage in the Hoo Green North and Hoo Green South cuttings to the west of The Mere, Mere. The derivation of the zone of influence is discussed in Section 3.2. The calculations for the zone of influence do not take into account the proposed construction of retaining walls and other structures in the Hoo Green cuttings just to the south of the Rostherne Mere catchment which could also affect groundwater flows and drainage. However, based on the assumptions made in the calculations, including the assumption that the groundwater level is at ground level, the zone of influence in the Rostherne Mere catchment is likely to be overestimated. A precautionary approach, taking into account the likely maximum zone of influence, is considered appropriate for the assessment at this stage.

4.2.4 The Hoo Green cuttings and associated zone of influence are located a substantial distance from the sub-catchment of The Mere, Mere, as indicated by the sub-catchment boundary in Figure 1 and Figure 2. The cuttings and the zone of influence are, however, in an area of the Rostherne Mere topographic catchment shown by the British Geological Survey (BGS) to be underlain by a band of glaciofluvial deposits. These glaciofluvial deposits extend to the east and merge into an area of glaciofluvial deposits along the western flank of The Mere, Mere sub-catchment, and also in the Rostherne Mere catchment downgradient of The Mere, Mere.

4.2.5 In the current conditions, groundwater within the zone of influence for the Hoo Green cuttings may drain down the topographical gradient to the north east towards springs that discharge to watercourses feeding Rostherne Mere. It is possible, however, that some groundwater from this area could drain through the glaciofluvial deposits towards The Mere, Mere. As the directions of groundwater flow from the area of the zone of influence cannot be confirmed at present, it is assumed, on a precautionary basis, that groundwater flow could either be to the north east or towards The Mere, Mere. Further assessment of groundwater conditions will be undertaken as part of geotechnical site investigations, prior to construction of the Proposed Scheme. The objective of the assessment will be to provide an improved understanding of the detailed hydrogeology in the Rostherne Mere catchment to the east of the Hoo Green cuttings, and the likely directions of groundwater flow.

4.2.6 If groundwater does flow towards The Mere, Mere, the discharge location could be in the area of a ditch which runs along the A5034 north-west of Little Mere as shown in Figure 1. The ditch drains from north to south along the west side of the A5034 and discharges into Little Mere. However, there are no springs shown on Ordnance Survey (OS) mapping along the course of the ditch, and no other springs indicated in the area. In addition, the section of the ditch along the A5034 was observed on two occasions in spring 2019 (in March and May), when groundwater levels should be reasonably high following winter recharge. The ditch was found to be dry on both occasions with no evidence of the presence of any groundwater discharge.

4.2.7 Alternatively, it is possible that some groundwater from the area around the Hoo Green cuttings might discharge on the western side of Little Mere. However, no springs are shown on OS mapping in the slopes or along the shoreline on the western side of Little Mere. In addition, no evidence of springs or groundwater-fed mire/fen or marsh was found along the western shoreline of Little Mere during a National Vegetation Classification (NVC) survey undertaken in August 2020.

4.2.8 Mitigation is included in the Proposed Scheme, in relation to the Hoo Green cuttings, as also discussed in the Water resources assessment, Volume 5: Appendix WR-003-0MA06. In the event that the impact of the cuttings is confirmed as affecting some groundwater discharge to The Mere, Mere, the proposed works will also provide mitigation for The Mere, Mere.

Figure 1: Location of The Mere, Mere

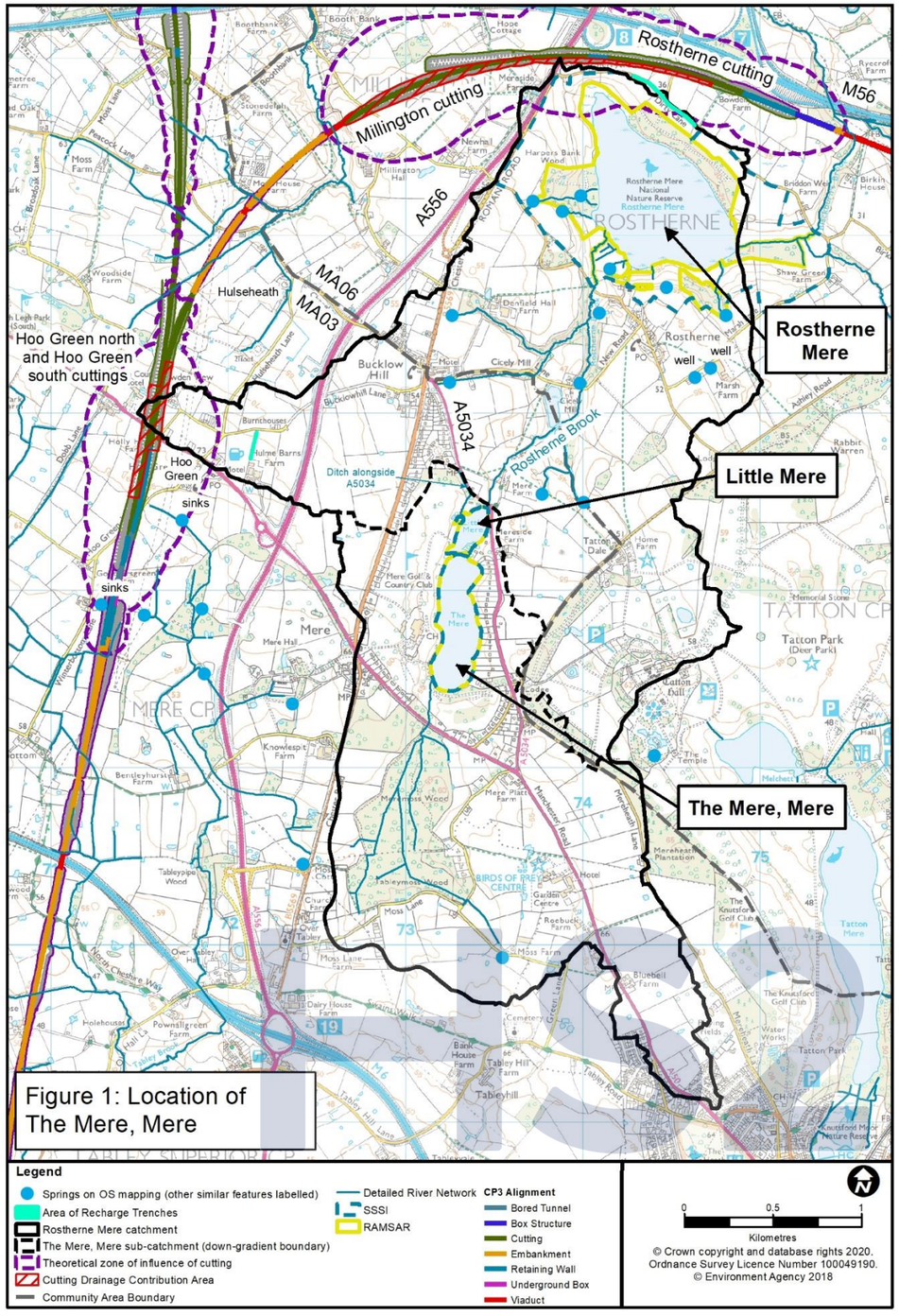
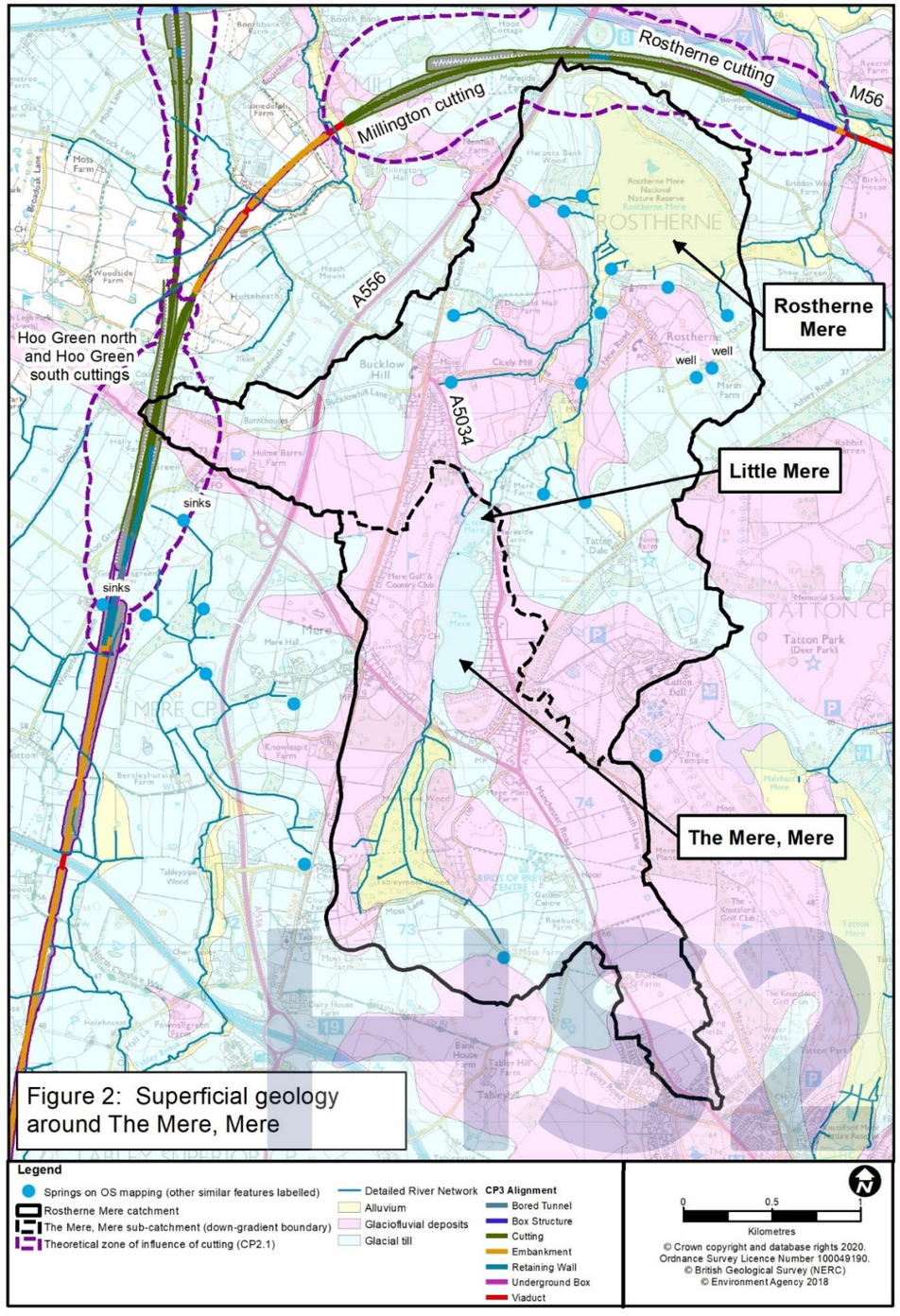


Figure 2: Superficial geology around The Mere, Mere



Mitigation

4.2.9 The mitigation will comprise drainage from an area of the cuttings extending across and outside the Rostherne Mere catchment, pumped to recharge trenches. The trenches will be located in the superficial deposits in the Rostherne Mere catchment, to the east of the zone of influence of the cuttings. The approximate sections of the cuttings contributing to the mitigation drainage scheme, and also the provisional location of the recharge trenches to which the drainage water will be discharged, are indicated on Figure 1.

4.2.10 The approximate sections of cuttings from which drainage water may be utilised for recharge were determined taking into account the varying levels of the cuttings on the Proposed Scheme main line and the HS2 Manchester spur. The geological mapping in Figure 2 indicates that glaciofluvial deposits, generally comprising permeable sands and gravels, are likely to be present at the location of the recharge trenches.

4.2.11 The trenches should produce a contribution to recharge which exceeds the natural recharge in the area of the zone of influence. If any groundwater flowing towards The Mere, Mere is intercepted by the Hoo Green cuttings, the recharge through the trenches should compensate for the reduction in groundwater flow, leading to a negligible impact. There may be differences in precise timing between recharge through the trenches and the natural groundwater throughflow in the zone of influence. However, taking into account the distance of the recharge scheme from The Mere, Mere, a slight variation in the timing of recharge should make no significant difference to the timing of any groundwater flow towards The Mere, Mere.

5 Site specific highways drainage assessments

5.1 Introduction

5.1.1 Roads are designed to drain freely to prevent the build-up of standing water on the carriageway whilst avoiding exposure to, or causing, flooding. Contaminants deposited on the road surface are quickly washed off during rainfall. Where traffic levels are high, the level of contamination increases and therefore the potential for unacceptable harm being caused to the receiving water also increases. There are many circumstances in which runoff from roads is likely to have no discernible effect, however a precautionary and best practice approach indicates the need for the assessment of the possible impact of pollutant discharges on the water environment from roads affected by the Proposed Scheme. These effects can either be through spillage and routine runoff pollution from new roads that are used during the construction and operational phases or changes in traffic movements on the existing road network.

5.1.2 The Proposed Scheme makes provision for two methods for draining new sections of highway: direct runoff to soakaway and drainage via an attenuation pond to an existing watercourse. Where changes in traffic volumes have been identified along the existing road network, steps have been taken to identify the type of drainage in place and an assessment has been made of whether the highway works proposed have implications for pollution risk within the Pickmere to Agden and Hulseheath area.

5.2 Methodology and assessment criteria

Routine runoff pollution risk

5.2.1 Where highway drainage is discharged to local watercourses, the assessment for determining whether routine runoff is likely to have a detrimental impact on water quality uses the HEWRAT[4]. Where highway realignments are to discharge to kerb side ditches which do not have a baseflow, the Groundwater Assessment (Appendix C)[4] has been used.

5.2.2 The significance of the impact of the predicted effects on surface water and groundwater receptors has been assessed in accordance with the methodology described in the SMR.

Spillage pollution risk

5.2.3 In addition to assessing the potential for adverse effects of routine surface water runoff from highways, an assessment of the potential spillage risk to water quality has been undertaken for highway realignments. The methodology for assessing spillage risk follows the Spillage Risk Assessment (Appendix D)[4].

5.3 Detailed assessment

Screening results

5.3.1 A screening exercise has not identified the need for a routine runoff and pollution risk assessment or a spillage pollution risk assessment, in the Pickmere to Agden and Hulseheath area, during the construction and operational phases.