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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-003-0MA01

Water resources and flood risk

MA01: Hough to Walley's Green

Water resources assessment

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M306

Department for Transport

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High Speed Two (HS2) Limited,
Two Snowhill
Snow Hill Queensway
Birmingham B4 6GA

Telephone: 08081 434 434

General email enquiries: HS2enquiries@hs2.org.uk

Website: www.hs2.org.uk

A report prepared for High Speed Two (HS2) Limited:

ARUP+ ERM | FOSTER + PARTNERS | JACOBS
RAMBOLL | TYPSA | COSTAIN

MWJV
Mott MacDonald | WSP

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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 Hough to Walley's Green area (MA01).

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 MA01, the Flood risk assessment (Volume 5: Appendix WR-005-0MA01) should also be referred to.

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-004-0MA01)[1]; and
- WFD compliance assessment baseline data (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 MA01 area covers a 10.8km 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, within this area the spatial scope has been extended to include the southern unit of 14 units that make up Sandbach Flashes Site of Special Scientific Interest (SSSI). This southern unit is known as 'Bottoms Flash and Groby's Flash'. 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, MA01 Map Book: Map Series CT-05 and CT-06. The route of the Proposed Scheme will connect to HS2 Phase 2a at the Crewe tunnel south portal. The Proposed Scheme will include changes to the design of HS2 Phase 2a Crewe tunnel south portal, to enable the connection between the two schemes, and these are considered in this assessment.

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];

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water resources assessment baseline data,* BID WR-004-0MA01. 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.

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

- 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 from existing land contamination on groundwater quality are presented in the Land quality report, Volume 5: Appendix LQ-001-0MA01.

1.3 Study area description and key features

1.3.1 The route passes through Crewe, and a number of small villages, hamlets and farmsteads are located within proximity to the Proposed Scheme, including Basford, Parkfield, and Walley's Green.

1.3.2 Within MA01, the Proposed Scheme will be constructed as a tunnel underneath Crewe, with a series of cuttings and embankments to the north of the tunnel. There are no ground level sections.

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

- Basford Brook, Gresty Brook, Swill Brook, Valley Brook, Hoggins Brook and their associated tributaries;
- the Mercia Mudstone Group Secondary B aquifer;
- the permeable superficial deposits Secondary A and Secondary (Undifferentiated) aquifers; and
- Sandbach Flashes SSSI, which is a surface water dependent habitat.

1.4 Stakeholder engagement

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

- the Environment Agency;
- United Utilities plc (the local water and sewerage undertaker);
- Natural England, particularly regarding Sandbach Flashes Site of Special Scientific Interest (SSSI). Natural England raised concerns about the potential impact on the SSSI of drainage discharges from the Proposed Scheme. Drainage discharge locations were changed to ensure no hydrological pathway between the SSSI and the Proposed Scheme;
- Canal & River Trust; and
- Cheshire East Council (CEC) regarding private unlicensed water abstractions.

[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.

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-004-0MA01). Those surface water features potentially affected by groundwater interactions 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 compounds may have substantial water demands where they are associated with design elements, such as concrete batching plant and tunnelling by tunnel boring machine (TBM). 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) (see Volume 5: Appendix CT-002-00000) sets out the measures and standards of work that will be applied to the construction of the Proposed Scheme to protect surface waters.

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									
Swill Brook	Moderate	• Temporary works such as compounds, 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 – 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)
Basford Brook	Moderate	• Temporary works such as compounds, 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 – 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)
Cheer Brook	Moderate	• Temporary works such as compounds, 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 – 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 Swill Brook 1	Moderate	• Crewe tunnel • Temporary works such as compounds, 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 – 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)

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
			Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.						
Tributary of Basford Brook 4	Moderate	• Temporary works such as compounds, 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 – 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 Gresty Brook 1	Moderate	• Crewe tunnel • Temporary works such as compounds, 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 – 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 Gresty Brook 3	Moderate	None	There are no elements of the route of the Proposed Scheme likely to impact this waterbody.	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)
Gresty Brook	High	• Crewe tunnel • Utility diversion • Temporary works such as compounds, 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 – 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 Gresty Brook 2	Moderate	• Temporary works such as compounds, 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 – 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)
Valley Brook	High	• Crewe tunnel	The Crewe Tunnel passes approximately 25m below the watercourse so limited potential for surface water flow and quality impacts.	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)

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
Leighton Brook	Moderate	• Temporary works such as compounds, stockpiles and access routes • Utility diversion	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 – 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)
Groby Road Drain	Low	• Temporary works such as compounds, 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 – 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)
Broughton Road Drains	Low	• Demolition of residential and commercial properties • Crewe North portal (retained cutting) • Watercourse crossing by proposed access road • Utility diversion • Temporary works such as compounds, 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)
		• Crewe North portal (retained cutting) • Watercourse crossing by proposed access road	Watercourse will be partially lost during construction of the Crewe North portal retaining wall. 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	The lost part of the watercourse will be incorporated into the new track drainage. Mitigation measures will include appropriate watercourse crossing by proposed road.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Parkers Road Drain	Low	• Coppenhall Moss south embankment • Coppenhall Moss cutting • Utility diversion	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	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)

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
		• Temporary works such as compounds, stockpiles and access routes	Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials.						
		• Coppenhall Moss south embankment • Coppenhall Moss cutting	Watercourse will be completely lost during construction of the Coppenhall Moss south embankment and Coppenhall Moss cutting.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	The watercourse will be incorporated into the new track drainage.	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 (permanent)
Tributary of Fowle Brook 1	Low	• Coppenhall Moss south embankment • Temporary works such as compounds, 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)
		• Coppenhall Moss south embankment • Drainage outfalls from HS2 attenuation pond	Approximately 80m of this watercourse will be lost due to construction of the Coppenhall Moss south embankment. Deterioration, loss or change to the existing water environment, flow characteristics and morphology.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	The reduction in flow as a result of the loss of the upper section of the watercourse which will be mitigated by the additional flow from the proposed attenuation pond. 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)
Hoggins Brook	Low	• Realignment (1.43km) including; – Footpath Crewe 29/1 offline culvert (35m) – Warmingham Moss offline culvert (10m) – Coppenhall Moss culvert (295m) • Watercourse crossing by proposed access road • 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 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
		stockpiles and access routes							
		• Realignment (1.43km) including; – Footpath Crewe 29/1 offline culvert (35m) – Warmingham Moss offline culvert (10m) – Coppenhall Moss culvert (295m) • 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 railway and associated infrastructure or from accidental spillages.	Magnitude of impact – Minor Significance of effect – Negligible, not significant	Mitigation measures will include realignment of watercourse, appropriate watercourse crossing and drainage design as a result of the proposed road. 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 River Weaver 1	Moderate	• Temporary works such as compounds, stockpiles and access routes	Uncontrolled site runoff could impact the flow dynamics and water quality of the receiving watercourse. Mobilised contaminants could typically include sediments, 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)
		• Drainage outfalls 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 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)
Discharges to surface water									
Discharge 016891954 Discharge 0168/820 Discharge 016891798 Discharge 016810413	Low	• Crewe tunnel	Works beneath the watercourse so limited potential for surface water flow and quality impacts.	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)

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
Discharge 016891918									
Discharge 01CRE0042									
Discharge 01CRE0040									
Discharge 01CRE0041									
Discharge 01CRE0036									
Discharge 01CRE0035									
Discharge 01CRE0037									
Discharge 01C/136									

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-004-0MA01). Individual impact assessments for some design elements are presented in Sections 3.2, 3.3, 3.4, 3.5 and 3.6.

3.1.2 A small area of the Crewe North rolling stock depot is located in the Hough to Walley's Green area (MA01), with the majority located in the Wimboldsley to Lostock Gralam area (MA02). All impacts of the Crewe North rolling stock depot are reported in the Wimboldsley to Lostock Gralam area report (Volume 5, Water resources assessment: Appendix WR-003-0MA02).

3.1.3 Construction compounds may have substantial water demands where they are associated with design elements, such as concrete batching plant and tunnelling by TBM. 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.

3.1.4 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. All above ground temporary works within construction compounds are included in design and mitigated by the draft CoCP.

3.1.5 The potential impacts of future ground investigations required for design development 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.

3.1.6 In support of the groundwater impact assessment presented in Table 2, further detail is provided in Section 3.2 to Section 3.6 to demonstrate the methodology and assumptions used in relation to cuttings (including tunnel portals), tunnels, and viaducts and overbridges of the Proposed Scheme. The locations of these elements are shown in Volume 2, MA01 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: • at grade track and roads; • temporary works such as stockpiles and compounds; and • utilities diversion	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 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)
		Deeper excavation (>1mbgl) including: • Cowley Way vent shaft; and • Middlewich Street vent shaft	Dewatering during construction of the vent shafts has the potential to affect groundwater flow (see Section 3.4). The vent shafts are not located in the alluvium but the alluvium and glacial till aquifers could be hydraulically connected.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of secant piles through the superficial deposits will reduce any impacts on groundwater levels in the alluvium.	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
River terrace deposits – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • utilities diversions	The temporary works have the potential to affect groundwater quality, although this is likely to be localised and temporary. No preferential flow pathways will be created so impact on groundwater flow is 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: • Cowley Way vent shaft	Dewatering during construction of the vent shaft has the potential to affect groundwater flow (see Section 3.4). The vent shaft is not located in the river terrace deposits but the river terrace deposits and glacial till aquifers could be hydraulically connected.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	The proposed use of secant piles through the superficial deposits will reduce any impacts on groundwater flow and level in the river terrace deposits	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Lacustrine deposits	Low	None	This unit is not crossed by the Proposed Scheme in this community area. It is not expected to be hydraulically connected to the surrounding glacial till, therefore no impact is expected from the Proposed Scheme.	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	None required.
Glaciofluvial deposits – Secondary A aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversion	The temporary and permanent 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)
			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 and permanent)
		Deeper excavation (>1mbgl) including: • Crewe tunnel south portal; • Crewe tunnel; and • Middlewich Street vent shaft	The tunnelling construction works will be close to the boundary between the glaciofluvial deposits and underlying bedrock at the southern end of the tunnel. Therefore, tunnelling will have the potential to impact on groundwater quality due to the introduction of bentonite and additives in circulating fluids for tunnel boring machines (TBM) prior to completion with in-situ concrete and cement grouts and associated additives 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, additives will not contain hazardous substances unless expressly agreed with the Environment Agency	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 may alter groundwater flow (see Section 3.4). The vent shaft is not located in the glaciofluvial deposits but the glaciofluvial	Magnitude of impact – Minor	The proposed use of secant piles through the superficial deposits for the vent shaft will reduce any impacts on	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
			deposits and glacial till aquifers could be hydraulically connected.	Significance of effect – Minor adverse, not significant	groundwater flow and level in the glaciofluvial deposits	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Glaciofluvial sheet deposits – Secondary A aquifer	Moderate	Deeper excavation (>1mbgl) including: • Cowley Way vent shaft	Dewatering during construction of the vent shaft has the potential to affect groundwater flow (see Section 3.4). The vent shaft is not constructed in the glaciofluvial sheet deposits but the glaciofluvial sheet deposits and glacial till aquifers could be hydraulically connected.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	The proposed use of secant piles through the superficial deposits will reduce any impacts on local shallow groundwater levels	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Glacial till – Secondary (Undifferentiated) aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversion	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary. Temporary and permanent works are above ground or shallow and of small areal extent compared to the aquifer and are therefore likely to have a negligible impact on recharge and/or groundwater flow.	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 and permanent)
		Deeper excavation (>1mbgl) including: • Cowley Way vent shaft; and • Middlewich Street vent shaft	Dewatering during construction of the vent shaft has the potential to affect groundwater flow (see Section 3.4).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed use of secant piles through the superficial deposits will reduce any impacts on local shallow groundwater levels	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: • Crewe tunnel; • Cowley Way vent shaft; • Middlewich Street vent shaft; and • Warmingham Moss viaducts and box structures	Crewe tunnel does not intercept this aquifer and has limited potential to impact on groundwater flow. The permanent below ground features (vent shafts) may alter groundwater flow and piling for viaducts may locally obstruct groundwater flow but are of small areal extent compared to the aquifer (see Section 3.5).	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: • Parkers Road Overbridge; • Crewe footpath 29/1 Overbridge; • utilities diversions (new pylons); and • Minshull Vernon footpath 8Y/1 accommodation overbridge	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)
			Piling for overbridges and new pylons are of small areal extent compared to the aquifer, therefore are likely to have a negligible impact on 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: • Crewe tunnel south portal; • Crewe tunnel north portal; • Crewe North portal (retained cutting); and • Coppenhall Moss cutting	The permanent below ground features, including the Crewe tunnel south and north portals, piling and 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 – Secondary B aquifer	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; • Coppenhall Moss south embankment; and • Coppenhall Moss 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)
			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: • Crewe tunnel and cross passages	The tunnelling construction works will be within the bedrock aquifer. Tunnelling will have the potential to impact on 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)
			Construction of cross passages will be short-term (in the order of weeks). Construction will involve ground improvements to reduce the need for dewatering.	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: • Cowley Way vent shaft; and • Middlewich Street vent shaft	Some of the excavation for the vent shafts might create a temporary pathway between aquifer layers with varying groundwater quality at different depths. The potential mixing of groundwater of varying quality could result in a temporary deterioration of water quality in some aquifer layers.	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: • Crewe tunnel south portal; • Crewe tunnel; • Cowley Way vent shaft; • Middlewich Street vent shaft; • Crewe tunnel north portal;	The permanent below ground features, including Crewe tunnel, vent shafts, piling and cuttings, may alter groundwater flow (see Sections 3.2, 3.3, 3.4 and 3.5).	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
		• Crewe North portal (retained cutting); • Coppenhall Moss cutting; • Warmingham Moss viaducts and box structures; • Parkers Road Overbridge; • Crewe footpath 29/1 Overbridge; • utilities diversions (new pylons); and • Minshull Vernon footpath 8Y/1 accommodation overbridge							
Mercia Mudstone Group – Sidmouth Mudstone Formation – Wilkesley Halite Member	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and • temporary works such as stockpiles and compounds	The Wilkesley Halite Member is considered unproductive strata and is not expected to contain significant groundwater. While the temporary works have the potential to affect groundwater quality, this is likely to be highly localised and temporary.	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)
		Above ground elements and shallow excavation (<1mbgl) including: • Crewe North rolling stock depot	The impacts of Crewe North rolling stock depot are fully assessed in the Wimboldsley to Lostock Gralam area (MA02).	–	–	–	–	–	–
Abstractions									
There are no public water supply or private abstractions from groundwater (licensed and unlicensed) in the study area.									
Discharges to groundwater									
Discharge NPSWQD008929	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and • temporary works such as stockpiles and compounds	The discharge is within an area of the glacial till deposits. It is not within the footprint of the Proposed Scheme or in proximity to any below ground works and therefore the impact on this discharge 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)
		Deeper excavation (>1mbgl) including: • Cowley Way vent shaft	Dewatering during construction of the vent shaft has the potential to affect groundwater flow (see Section 3.4).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	The proposed secant piles construction method for the vent shaft will reduce any impacts on local groundwater levels in the glacial till deposits	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 016892399	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and	The discharge is within an area of the glacial till deposits. It is not within the footprint of the Proposed Scheme or in proximity to any below ground works and therefore the impact on this discharge will be negligible.	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)

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
		• temporary works such as stockpiles and compounds		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	
Groundwater – surface water interactions									
Spring 70m east of Chorlton Bank Farm	Moderate	None	This feature is located 330m east of land required for construction of the Proposed Scheme and is outside the zone of influence of below ground works. Therefore, the spring is not expected to be impacted by the Proposed Scheme.	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 at Savoy Road, Crewe	High	Deeper excavation (>1mbgl) including: • Cowley Way vent shaft	The detailed assessment (see Section 3.4) shows that this feature is outside of the potential dewatering zone of influence. Therefore, the potential spring is not expected to be affected by any dewatering of the Mercia Mudstone.	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)
Swill Brook Tributary of Gresty Brook 2	Moderate Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; and • temporary works such as stockpiles and compounds	The temporary construction works have the potential to affect the quality of baseflow to these watercourses.	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)
Basford Brook Gresty Brook	Moderate High	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversions	The temporary construction works have the potential to affect the quality of baseflow to these watercourses.	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: • Cowley Way vent shaft	The detailed assessment (see Section 3.4) shows that these features are within the potential dewatering zone of influence and groundwater may be intercepted that will otherwise flow to these watercourses.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The proposed secant piles construction method for the vent shaft through the superficial deposits will reduce any impacts on groundwater flow to Basford Brook and Gresty Brook	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 Swill Brook 1 Tributary of Gresty Brook 1 Tributary of Gresty Brook 3	Moderate Moderate Moderate	None	No works directly adjacent to the watercourses so limited potential for any hydraulic connection to these watercourses.	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).

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
Valley Brook	High								
Leighton Brook	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversions	The temporary construction works have the potential to affect the baseflow of 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 Fowle Brook 1	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • 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 – 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: • Coppenhall Moss cutting	The cutting assessment (Section 3) shows that these features are just outside of the potential dewatering zone of influence. There is a small risk that baseflow to the watercourses could be intercepted over a 250m stretch of the 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 and permanent)
		Deeper excavation (>1mbgl) including: • Warmingham Moss viaducts and box structures	Piling works are of small areal extent compared to the aquifer, therefore are likely to have a negligible impact 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)
Hoggins Brook	Low	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversions	The temporary construction works, including construction of the watercourse diversion, 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: • Warmingham Moss viaducts and box structures	Piling works are of small areal extent compared to the aquifer and the watercourse is culverted underneath the Warmingham Moss viaducts. Therefore, the viaduct piles are likely to have a negligible impact groundwater flow. Additionally, no impact to baseflow in watercourse is expected from the watercourse diversion as it will only	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)

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
			impact a short section (approximately 1km of the total watercourse of greater than 6km) in the upper catchment only.						
Tributary of River Weaver 1	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • ground level track and roads; • temporary works such as stockpiles and compounds; and • utilities diversion	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)

3.2 Impact on groundwater from cuttings

3.2.1 Summary parameters for each cutting are presented below in Table 3 to Table 6.

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 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.

Crewe tunnel south portal

Table 3: Summary of the parameters for the groundwater assessment of Crewe tunnel south portal

Portal parameters	Parameter details
Length (m)	150
Maximum depth (m)	22.6 to top of rail (25.8 to drainage invert)
Strata intercepted	Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)
Lowest level of drainage invert along track (metres above ordnance datum: mAOD)	38.4
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 (Secondary B aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation – Wilkesley Halite Member (Unproductive aquifer) Basford Brook

3.2.7 The embedded retaining wall, which forms part of the portal, will penetrate the glaciofluvial deposits Secondary A aquifer, glacial till Secondary (Undifferentiated) aquifer and 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 superficial deposits or the Mercia Mudstone. It has therefore been conservatively assumed that groundwater levels within the superficial deposits and the Mercia Mudstone are at ground level, and that groundwater flow may be affected by the cutting for the portal. 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 glaciofluvial deposits and glacial till[5], the lateral extent of drawdown (also referred to as the zone of influence) in the glaciofluvial deposits and glacial till is estimated to extend up to 470m. This is based on a maximum depth for the tunnel portal of 25.8m from ground level to the track drainage invert, and a rest water level at ground level. The tunnel portal will penetrate through the glaciofluvial deposits and 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 glaciofluvial deposits and glacial till.

3.2.9 The tunnel portal is located close to the catchment boundary between Swill Brook to the west and Basford Brook to the east, with the cutting and retaining wall aligned approximately along the catchment. boundary Assuming the groundwater flow directions in the glaciofluvial deposits and glacial till follow topography, the cutting and retaining wall of the tunnel portal are not likely to form a barrier to groundwater flow in the area. Whilst there may be localised changes in groundwater level, the impact is assessed to be minor on the Secondary A and Secondary (Undifferentiated) aquifers, leading to a minor effect which is not significant.

3.2.10 Basford Brook is at the edge of the calculated zone of influence, however groundwater from within the catchment of Basford Brook that would otherwise discharge to this watercourse may be intercepted. There is a 550m length of the watercourse affected, therefore, the impact is considered minor for this moderate value receptor, leading to a minor effect which is not significant.

[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.

Crewe tunnel north portal

Table 4: Summary of the parameters for the groundwater assessment of Crewe tunnel north portal

Portal parameters	Parameter details
Length (m)	150
Maximum depth (m)	18.6 to top of rail (21.8 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)
Lowest level of drainage invert along track (mAOD)	30.2
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)

3.2.11 The embedded retaining wall, which forms part of the portal, will penetrate the glacial till Secondary (Undifferentiated) aquifer and 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. It has therefore been conservatively assumed that groundwater levels within the glacial till and the Mercia Mudstone are at ground level, and that groundwater flow may be affected by the cutting for the portal. 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.

3.2.12 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) in the glacial till is estimated to extend up to 515m. This is based on a maximum depth for the tunnel portal of 21.8m from ground level to the track drainage invert, and a rest water level at ground level. The tunnel portal will 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.

3.2.13 Assuming the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the north or north–east. The cutting and retaining wall of the tunnel portal are aligned in approximately the same direction and, as a result, are not likely to form a barrier to groundwater flow in the area. Whilst there may be local changes in groundwater level, on the scale of the glacial till aquifer in the area the impact is assessed to be minor on the Secondary (Undifferentiated) aquifer, leading to a minor effect which is not significant.

3.2.14 There is a tunnel drainage sump (and associated pump), with $500m^3$ capacity, located beneath the Crewe tunnel north portal to collect any surface water run-off and water generated from firefighting activities. The tank invert is located 1m below the minimum track drainage invert. The tank will be constructed within Mercia Mudstone Group Secondary B aquifer below the portal but may extend upwards into the glacial till. The tank could form a partial, localised barrier to groundwater flow in the superficial and bedrock aquifers. However, considering the scale of the tank, compared to the areal extent of the superficial and bedrock aquifers, the impact on groundwater flow is assessed as negligible, leading to a negligible effect which is not significant.

Crewe North portal (retained cutting)

Table 5: Summary of the parameters for the groundwater assessment of Crewe North portal (retained cutting)

Retained cutting parameters	Parameter details
Length (m)	590
Maximum depth (m)	14.1 to top of rail (17.2 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer)
Lowest level of drainage invert along track (mAOD)	34.1
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)

3.2.15 The cutting will only penetrate the glacial till Secondary (Undifferentiated) aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area for the glacial till. It has therefore been conservatively assumed that groundwater levels within the glacial till are at ground level and that groundwater flow within the glacial till may be affected by the cutting. 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.

3.2.16 The glacial till is almost fully penetrated by the retained cutting. 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) in the glacial till is estimated to extend up to 515m. This is based on a maximum cutting depth of 17.2m from ground level to the track drainage invert, and a rest water level at ground level. The cutting will extend into the top of the Mercia Mudstone Group however the maximum zone of drawdown is smaller in the Mercia Mudstone Group aquifer as the permeability is lower than for the glacial till. The hydraulic connection of the Mercia Mudstone Group with the glacial till is not expected to be laterally extensive. The impact on the Mercia Mudstone Group Secondary B aquifer is therefore assessed as negligible, leading to a negligible effect, which is not significant.

3.2.17 Assuming the groundwater flow direction in the glacial till follows topography, it will flow towards the north or north-east. The retained cutting is aligned in the same direction and is not likely to form a barrier to groundwater flow in the area. Whilst there may be local changes in groundwater level, on the scale of the glacial till aquifer this is assessed to be a minor impact on the Secondary (Undifferentiated) aquifer leading to a minor adverse effect, which is not significant.

Coppenhall Moss cutting

Table 6: Summary of the parameters for the groundwater assessment of Coppenhall Moss cutting

Cutting parameters	Parameter details
Length (m)	220
Maximum depth (m)	2.6 to top of rail (5.8 to drainage invert)
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer)
Lowest level of drainage invert along track (mAOD)	44.8
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer) Tributary of Fowle Brook 1 Moss Bridge Marsh Local Wildlife Site (LWS)

3.2.18 The cutting will only penetrate the glacial till Secondary (Undifferentiated) aquifer. There is no currently available information on groundwater elevations or depth to groundwater in this area for the glacial till. It has therefore been conservatively assumed that groundwater levels within the glacial till are at ground level and that groundwater flow within the glacial till may be affected by the cutting. 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.

3.2.19 Assuming a hydraulic conductivity value of $3x10^{-4}$m/s for the glacial till[4] the lateral extent of drawdown (also referred to as the zone of influence) in the glacial till is estimated to extend up to 176m. This is based on a maximum cutting depth of 5.8m from ground level to the track drainage invert, and a rest water level at ground level. The cutting will not penetrate the Mercia Mudstone Group and the hydraulic connection of the Mercia Mudstone Group with the glacial till is not expected to be laterally extensive. The potential local changes in groundwater level to the maximum cutting depth are assessed as negligible on the Mercia Mudstone Group Secondary B aquifer leading to a negligible effect, which is not significant.

3.2.20 Assuming the groundwater flow direction in the glacial till follows topography, it will flow towards the north or north-east. The cutting is aligned in the same direction and is not likely to form a barrier to groundwater flow in the area. Whilst there may be local changes in groundwater level, on the scale of the glacial till in the area, this is assessed to be a minor impact on the Secondary (Undifferentiated) aquifer leading to a minor effect which is not significant.

3.2.21 The Tributary of Fowle Brook 1 is outside of the calculated zone of influence however groundwater from within the catchment of Tributary of Fowle Brook 1 that would otherwise discharge to this watercourse may be intercepted. There is only a 250m length of the watercourse affected, therefore, the impact is considered minor for this low value receptor, leading to a negligible effect which is not significant.

3.2.22 Moss Bridge Marsh LWS, a potentially groundwater dependent habitat, is located within the radius of influence of Coppenhall Moss cutting and has the potential to be impacted. Further details are presented in Section 4.

3.3 Impact on groundwater from tunnels

3.3.1 The Crewe tunnel will comprise twin bore tunnels approximately 6.2km in length, each approximately 9m internal diameter, and will run from the Crewe tunnel south portal (constructed as part of Phase 2a) to the Crewe tunnel north portal. Tunnelling is within the Mercia Mudstone Group Secondary B aquifer. The Crewe tunnel includes cross passages, which will link the main tunnel bores.

3.3.2 The Crewe tunnel will be constructed using a TBM through the Mercia Mudstone Group Secondary B aquifer. The TBM is designed so the tunnel is lined behind the TBM as the TBM advances through the ground. The lining is fully constructed using a precast concrete unit 10m to 15m behind the face of the excavation. Cement grout is injected behind the tunnel lining to fill the annulus between the lining and the excavated ground. The 10m to 15m section between the constructed tunnel lining and the face of the excavation is protected by a 'steel can' which is effectively watertight. As the TBM advances, the excavation face in front of the tunnel will also be pressurised to balance the groundwater pressure and the soil pressure. Therefore, no dewatering is expected during construction of the Crewe tunnel by TBM. The cross passages between the twin bore tunnels will be constructed using ground improvement, where required, to reduce groundwater ingress.

3.3.3 The tunnel is designed to be watertight, although some minimal leakage is likely. This potential loss of groundwater into the tunnel is considered negligible with negligible impact to existing groundwater levels in the long term, leading to a negligible effect which is not significant.

3.3.4 Construction of the tunnel will create an extended cylinder of no flow through the Mercia Mudstone Group Secondary B aquifer. Hydraulic conductivity of the aquifer adjacent to the tunnel lining will also decrease as a result of grouting during construction. However, sandstone horizons or skerries can exist in the Mercia Mudstone Group which could contain significant groundwater flow. Each tunnel bore has a diameter of only 8.8m and the aquifer has an area of several hundred square kilometres and extends vertically below the tunnel for at least 100m. In this area the Mercia Mudstone underlies a significant thickness of glacial till and therefore no features have been identified which depend on groundwater flow in the Mercia Mudstone. Therefore, the tunnel will have negligible impact on groundwater flow. Any changes in groundwater level due to a partial barrier to flow created by the tunnel will be highly localised. The changes will have a negligible impact in the context of the Secondary B aquifer as a whole.

3.3.5 The tunnelling construction will be carried out mainly within the Mercia Mudstone Group. However, at the southern end of this area the tunnel will crosscut the boundary between the Mercia Mudstone and the overlying glaciofluvial deposits. Therefore, tunnelling will have the potential to impact on groundwater quality in the Mercia Mudstone and the glaciofluvial deposits. However, application of the draft CoCP will ensure materials and fluids used during construction are managed so that there is negligible impact on groundwater quality and associated receptors.

3.4 Impact on groundwater from vent shafts

3.4.1 Summary parameters for each vent shaft are shown in Table 7 and Table 8.

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

3.4.3 Assessment of the likely maximum zone of influence from dewatering of the vent shafts which may be below existing groundwater level (as set out above) has been made using Sichardt's formula as set out in the SMR Technical Note: Groundwater assessment.

3.4.4 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.

3.4.5 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.

Cowley Way vent shaft

Table 7: Summary of the parameters for the groundwater assessment of Cowley Way vent shaft

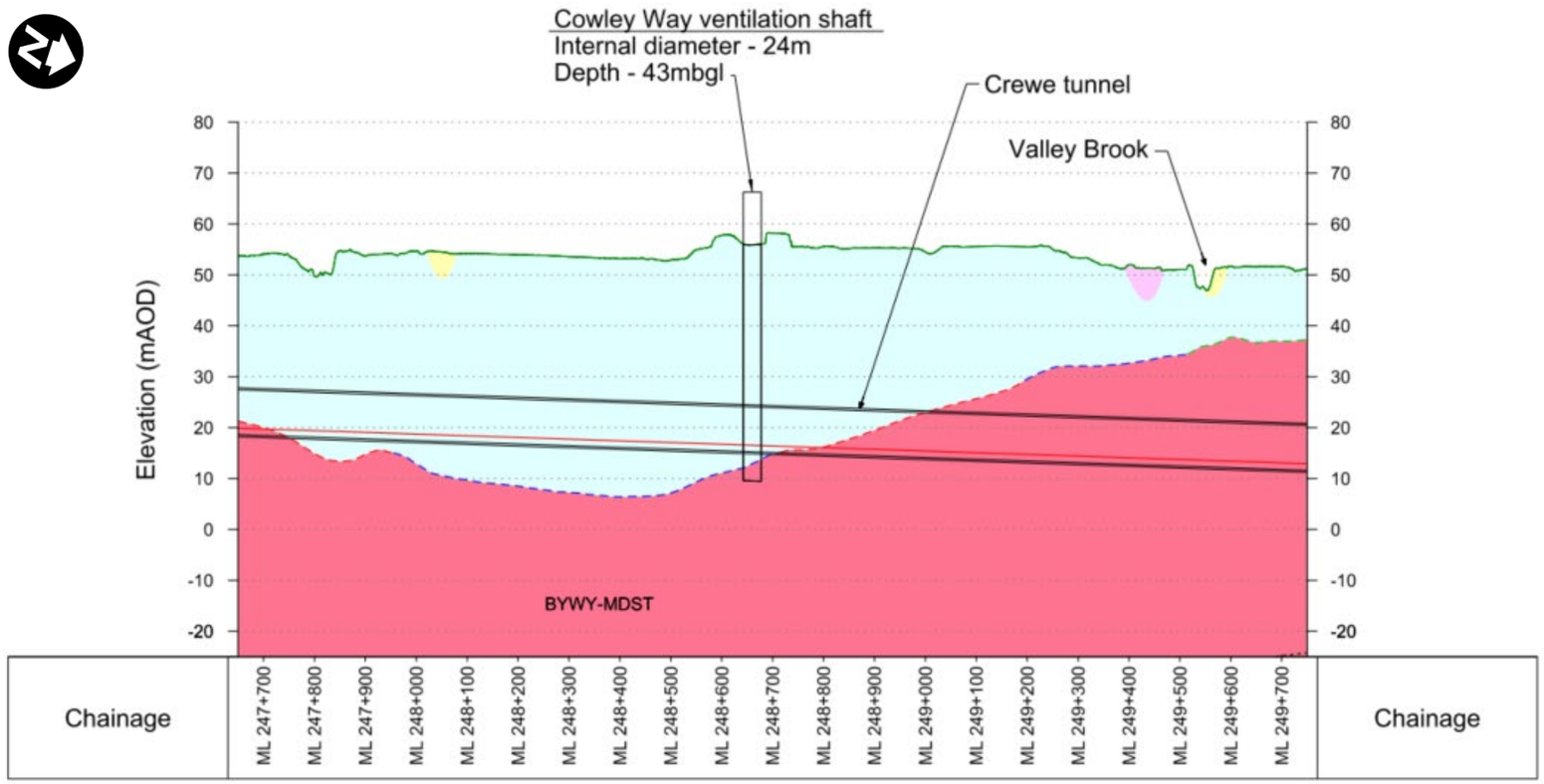
Vent shaft parameters	Parameter details
Diameter (m)	24
Maximum depth (m)	43
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Alluvium (Secondary A aquifer) River terrace deposits (Secondary A aquifer) Glaciofluvial sheet deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer) Discharge to groundwater (NPSWQD008929) Potential spring at Savoy Road, Crewe Basford Brook Gresty Brook

3.4.6 The vent shaft will be excavated in the glacial till Secondary (Undifferentiated) aquifer and will extend into the top 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 and the Mercia Mudstone Group. It has therefore been conservatively assumed that groundwater levels within the glacial till and the Mercia Mudstone Group are at ground level and that groundwater flow within the glacial till and the Mercia Mudstone Group may be affected by the vent shaft dewatering.

3.4.7 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.

3.4.8 The vent shaft will be constructed using secant piles through the glacial till and embedded into the Mercia Mudstone, if encountered. Where the vent shaft penetrates the Mercia Mudstone Group, it will be constructed using the sprayed concrete lining (SCL) method. A schematic geological cross section of the Cowley Way vent shaft is provided in Figure 1.

Figure 1: Geological cross section of the Cowley Way vent shaft



Scale H: 1:10,000, V: 1:1000. ASTM = American Society for Testing and Materials

3.4.9 The proposed methodology (construction of secant pile walls in the superficial deposits) will significantly reduce the requirement for dewatering during construction of the section of the vent shaft through the superficial deposits. Where dewatering of the Mercia Mudstone Group (Sidmouth Mudstone) Secondary B aquifer, is required then a slight, localised temporary impact may occur to groundwater levels in the overlying superficial deposits. This is due to the limited hydraulic connectivity between the mudstones and siltstones in the Sidmouth Mudstone Formation and the overlying glacial till.

3.4.10 As a result, the impact of vent shaft construction on groundwater levels and flow in the glacial till and other superficial deposits will be negligible, resulting in a negligible effect, which is not significant. Similarly, the impact on any groundwater dependent surface receptors (including potential spring at Savoy Road, Basford Brook and Gresty Brook) will be negligible, leading to a negligible effect which is not significant. Although a section of Gresty Brook is culverted, the assessment has been undertaken assuming the whole of the watercourse is unlined. The impact on the culverted section is likely to be less than for the same section of Gresty Brook, if unlined. The assessment of a negligible effect is, therefore, applicable to the whole of Gresty Brook including the culverted section.

3.4.11 If the vent shaft penetrates the base of the glacial till and extends into the top of the underlying Mercia Mudstone Group bedrock, the zone of influence is calculated as 673m assuming a hydraulic conductivity value of 2.72×10^{-5}m/s for the Mercia Mudstone Group[6]. The zone of influence calculation is also based on the assumption that the piezometric level in the Mercia Mudstone is at ground level.

3.4.12 The SCL will be installed shortly after construction and this will seal off the groundwater from the vent shaft. The cross-sectional area of the vent shaft is small in comparison with the overall aquifer dimensions in the bedrock and will extend only a few metres into the bedrock. Therefore, the temporary impact of dewatering on groundwater levels and flow in the bedrock, will be localised and short-term. As a result, the construction of this vent shaft is assessed to have a negligible impact on the Mercia Mudstone Group Secondary B aquifer, leading to a negligible effect which is not significant.

[6] Based on the high–end value for bulk testing within the Mercia Mudstone Group. Hobbs, P. R. N. Hallam, J. R, Forster, A, Entwisle, D. C, Jones L. D, Cripps, A. C, Northmore, K. J, Self, S. J and Meakin, J. L (2002), *Engineering geology of British rocks and soils – Mudstones of the Mercia Mudstone Group.* British Geological Survey, Research Report RR/01/02. 106pp.

3.4.13 Detailed geotechnical investigations will be undertaken prior to the construction of the vent shaft to assess the nature of the glacial till and the underlying Mercia Mudstone. The results of the investigation will be used to confirm the aquifer properties of the formations which will be encountered in constructing the vent shaft and provide a more detailed assessment of the potential impacts of shaft construction on groundwater levels.

Middlewich Street vent shaft

Table 8: Summary of the parameters for the groundwater assessment of Middlewich Street vent shaft

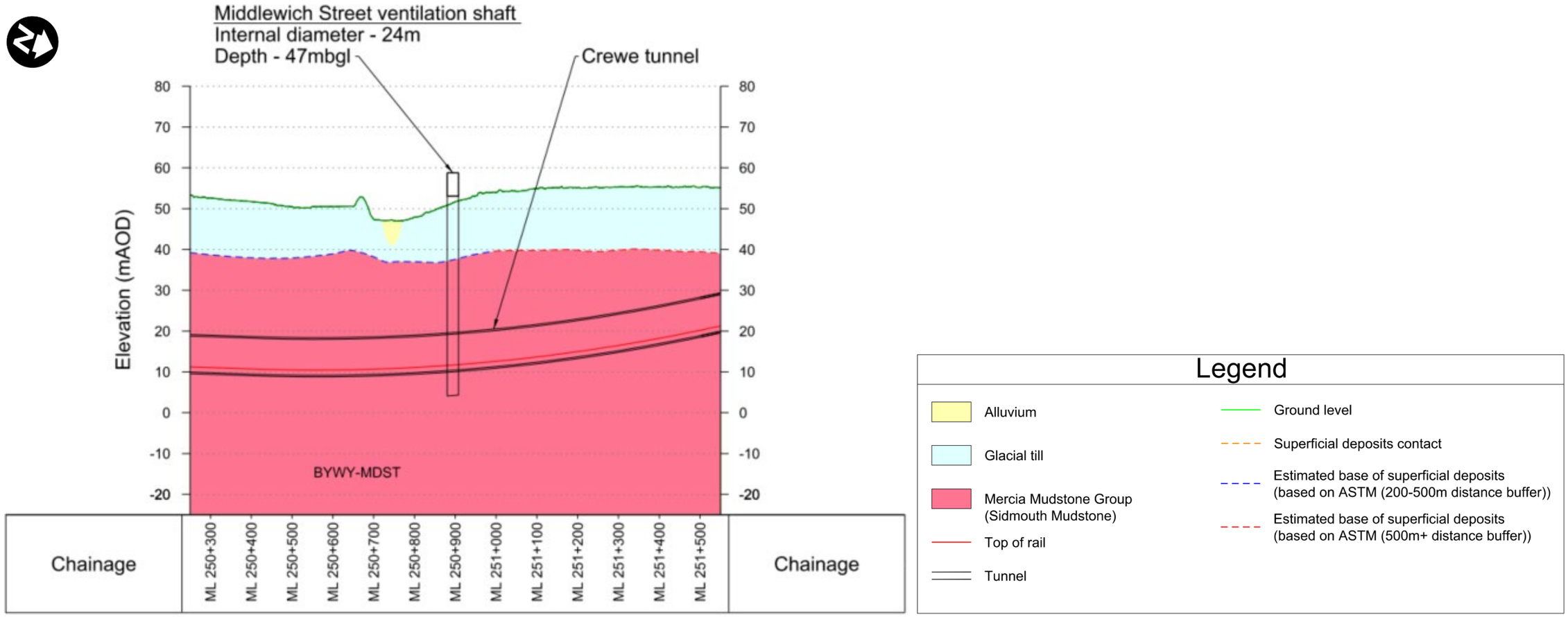
Vent shaft parameters	Parameter details
Diameter (m)	24
Maximum depth (m)	47
Strata intercepted	Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Alluvium (Secondary A aquifer) Glaciofluvial deposits (Secondary A aquifer) Glacial till (Secondary (Undifferentiated) aquifer) Mercia Mudstone Group – Sidmouth Mudstone Formation (Secondary B aquifer)

3.4.14 The vent shaft will penetrate the glacial till Secondary (Undifferentiated) aquifer and into 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 and the Mercia Mudstone Group. It has therefore been conservatively assumed that groundwater levels within the glacial till and the Mercia Mudstone Group are at ground level, and that groundwater flow within the glacial till and the Mercia Mudstone Group may be affected by the vent shaft dewatering.

3.4.15 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.

3.4.16 The vent shaft will be constructed using secant piles through the glacial till and embedded into the Mercia Mudstone. Where the vent shaft penetrates the Mercia Mudstone Group, it will be constructed using the SCL method. A schematic geological cross section of the Middlewich Street vent shaft is provided in Figure 2.

Figure 2: Geological cross section of the Middlewich Street vent shaft



Scale H: 1:10,000, V: 1:1000. ASTM = American Society for Testing and Materials

3.4.17 The proposed methodology (construction of secant pile walls in the superficial deposits) will limit significantly the requirement for dewatering during construction of the section of the vent shaft through the superficial deposits. In addition, dewatering in the Mercia Mudstone Group (Sidmouth Mudstone) Secondary B aquifer will have little impact on groundwater levels in the superficial deposits. The dewatering may give rise, temporarily, to a slight, localised change in leakage between the bedrock and superficial aquifers, thus affecting groundwater levels in the superficial deposits. However, taking into account the predominantly low permeability of the mudstones and siltstones in the Sidmouth Mudstone bedrock, and the nature of the glacial till, comprising mainly sandy silty clay, any leakage between formations is likely to be very limited. As a result, the impact on groundwater levels and flow in the glacial till and other superficial deposits will be negligible, resulting in a negligible effect, which is not significant.

3.4.18 The vent shaft is likely to extend approximately 33m into the Mercia Mudstone Group bedrock underlying the glacial till. Assuming a hydraulic conductivity value of 2.72×10^{-5}m/s for the Mercia Mudstone Group[6], the maximum zone of influence is calculated as 735m. This zone of influence calculation is based on the assumption that the water level in the Mercia Mudstone is at ground level.

3.4.19 The SCL will be installed shortly after construction and this will seal off the groundwater from the shaft. The cross-sectional area of the vent shaft is small in comparison with the overall aquifer dimensions in the bedrock. Although the vent shaft will extend approximately 33m into the bedrock the Mercia Mudstone extends over 100m below the base of the shaft in this location. Therefore, the temporary impact of dewatering on groundwater levels and flow in the bedrock, will be localised and short-term. As a result, the construction of this vent shaft is assessed to have a negligible impact on the Mercia Mudstone Group Secondary B aquifer, leading to a negligible effect which is not significant.

3.4.20 Detailed geotechnical investigations will be undertaken prior to the construction of the vent shaft to assess the nature of the glacial till and the underlying Mercia Mudstone. The results of the investigation will be used to confirm the aquifer properties of the formations which will be encountered in constructing the shaft and provide a more detailed assessment of the potential impacts of shaft construction on groundwater levels.

3.5 Impacts to groundwater from viaduct and overbridge piling

3.5.1 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 source protection zone (SPZ)1 and SPZ2 areas and are defined by the Environment Agency around all licenced abstraction sites.

3.5.2 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

3.5.3 The following overbridges are located within MA01:

- Parkers Road Overbridge;
- Crewe footpath 29/1 Overbridge; and
- Minshull Vernon footpath 8Y/1 accommodation overbridge.

3.5.4 Groundwater quality in the superficial deposits and underlying Mercia Mudstone Group may be impacted during the construction of overbridge piles, although the piles are not expected to extend any deeper than 10m below ground level. The potential impacts from construction piling can be mitigated by using bentonite in the process to reduce fluid loss, if ground investigation undertaken at the stage of detailed design shows this to be necessary. 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. The impact from the construction of overbridges 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.

Warmingham Moss viaducts and box structures

3.5.5 Foundations for the Warmingham Moss viaducts (Warmingham Moss southbound approach viaducts No.1, No.2 and connecting viaduct, Warmingham Moss northbound approach viaducts No.1 and No.2) and Warmingham Moss box structures (southbound box structure No.1 and No.2 and northbound box structure) will comprise drilled concrete piles with pile caps. The piles are currently designed to be 30m deep on average and are expected to penetrate through the glacial till and into the underlying Mercia Mudstone Group. Therefore, these piles may locally 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. Taking into account the extent and depth of the superficial and bedrock aquifers, the impact will be negligible.

3.5.6 Below ground structures have the potential to obstruct groundwater flow towards the Tributary of Fowle Brook 1 and Hoggins Brook in the vicinity of the viaducts. However, piling works are of small areal extent compared to the aquifer. As a result, permanent effects on groundwater flow into Tributary of Fowle Brook 1 and Hoggins Brook would be negligible.

3.5.7 Moss Bridge Marsh LWS, a potentially groundwater dependent habitat, is crossed by the Proposed Scheme. Spring Plantation Grassland LWS, also a potentially groundwater dependent habitat, is located within the land required for the construction of the Proposed Scheme. Both habitats are in proximity to the Warmingham Moss viaducts and box structures. It is possible that the construction and permanent below ground structures of the viaducts and box structure may affect groundwater flow and the quality of groundwater supporting the habitats (further information in Section 4).

3.5.8 The potential impacts from construction piling can be mitigated (for example by 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 useful to stop losses to immediately adjacent watercourses. Implementation of the draft CoCP will ensure that materials that may come into contact with groundwater will be selected, and method statements developed, to control any potential contaminants.

3.6 Impacts to groundwater from borrow pits

3.6.1 There are no borrow pits within Hough to Walley's Green area.

4 Site specific water dependent habitats assessment

4.1 Summary of assessment

4.1.1 Table 9 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 Volume 5, Ecological register of local level effect: Appendix EC-015-0MA01. Where there are significant effects, the ecological effects and associated mitigation are reported in Volume 2, Community Area report: Hough to Walley's Green (MA01), Section 7, Ecology and biodiversity.

Table 9: Summary of potential water dependent habitat impacts

Receptor	Design element	Discussion of potential impact to water receptor
Surface water dependent habitats		
Sandbach Flashes SSSI (Bottoms Flash and Groby's Flash)	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; • temporary works such as compounds, stockpiles and access routes; and • Coppenhall Moss south and north embankments– Drainage outfall from proposed attenuation pond.	There is potential for impacts on water quality during the construction phase, however these will be managed through the application of the draft CoCP and the impact will be negligible. Tributary of Fowle Brook 1 is within the footprint of the Proposed Scheme before it flows into Sandbach Flashes SSSI. An 80m section of the upper watercourse will be lost due to the construction of the Coppenhall Moss south and north embankments. An outfall from a proposed attenuation pond will be discharged into Tributary of Fowle Brook 1 downstream of the Proposed Scheme which will compensate for the flow lost. Therefore, the impact on any surface water dependent habitat will be negligible at this site.
Basford Brook LWS	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; and • temporary works such as stockpiles and compounds.	The land required for the construction of the Proposed Scheme is approximately 490m from this site at the closest point. The site is not located within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on any surface discharge to the water dependent habitat and on the quality of the surface discharge will be negligible.
Mere Gutter with Basford Brook LWS	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; • temporary works such as stockpiles and compounds; and • utilities diversions.	The watercourse is culverted beneath the land required for the construction of the Proposed Scheme. However, there will be a crossing associated with utilities diversions. The crossing will be constructed such that groundwater and surface water impact will be negligible.
Surface water and groundwater dependent habitats		
Moss Bridge Marsh LWS	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; and • temporary works such as stockpiles and compounds. Below ground elements and deeper excavation (>1mbgl) including: • Coppenhall Moss cutting; and • Warmingham Moss viaducts and box structures (Warmingham Moss southbound box structure).	The site will be crossed by the Proposed Scheme and at least partly removed (the impact of the partial loss of this site is covered in Volume 2, Community Area report: Hough to Walley's Green (MA01), Section 7, Ecology and biodiversity). The site is supported by surface water (rainfall and drainage channels) but may also receive groundwater from the underlying glacial till so has been included here on a precautionary basis. For the remaining habitat, the temporary works may affect water quality, but this is likely to be localised and temporary. This will be mitigated through the implementation of the draft CoCP, resulting in a negligible impact. Any secant piling associated with the retaining wall for the Warmingham Moss southbound box structures (No.1 and No.2), located approximately 400m north of Moss Bridge Marsh LWS, would not affect groundwater flow to the site. The site is located just within the zone of influence of the Coppenhall Moss cutting and may receive reduced groundwater flow. As the area is flat lying, it is possible that the catchment area for groundwater flow to the site will be reduced. A reduction in groundwater flow, as a result of drainage to the cutting, could lead to a minor localised reduction in groundwater levels at the site. If the site is found to be groundwater fed, this may lead to a minor impact.
Spring Plantation Grassland LWS	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; • temporary works such as stockpiles and compounds; • Coppenhall Moss south embankment; and • utilities diversions.	The eastern end of the site is located within land required for the construction of the Proposed Scheme and habitat is likely to be removed (the impact of the loss of part of this site is covered in Volume 2, Community Area report: Hough to Walley's Green (MA01), Section 7, Ecology and biodiversity). The site is supported by surface water (rainfall and drainage channels) but may also receive groundwater from the underlying glacial till so has been included here on a precautionary basis. For the remaining habitat, the temporary works have the potential to affect water quality, although this is likely to be localised and temporary. This will be mitigated through the implementation of the draft CoCP, resulting in a negligible impact.

Receptor	Design element	Discussion of potential impact to water receptor
	Below ground elements and deeper excavations (>1mbgl) including: • Warmingham Moss viaducts and box structures.	Piling 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 viaducts. Any impacts are likely to be localised. Taking into account the extent and depth of the superficial and bedrock aquifers, the impact will be negligible.
Worsley Covert and Polestead Wood LWS, SBI and ancient woodland	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; and • temporary works such as stockpiles and compounds.	The land required for the construction of the Proposed Scheme is approximately 180m from this site at the closest point. The site is not located within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on any groundwater discharge to the water dependent habitat and on the quality of the groundwater discharge will be negligible.
Groundwater dependent habitats		
Ridding Farm Ponds LWS	Above ground elements and shallow excavation (<1mbgl) including: • at grade track and roads; and • temporary works such as stockpiles and compounds.	The land required for the construction of the Proposed Scheme is approximately 360m west from this site at the closest point. The site is not located within the footprint of the Proposed Scheme or in proximity to any below ground works. Therefore, the impact on any groundwater discharge to the water dependent habitat and on the groundwater quality will be negligible.

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 run-off 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 MA01.

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. Where highway realignments are to discharge to kerb side ditches which do not have a baseflow, the Groundwater Assessment (Appendix C)[3] 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)[3].

5.3 Detailed assessment

Screening results

5.3.1 A screening exercise has identified the need for a routine runoff and pollution risk assessment and a spillage pollution risk assessment in MA01. This is related to David Whitby Way, during the construction phase, shown in Figure 3.

5.3.2 A screening exercise has not identified the need for a routine runoff and pollution risk assessment or a spillage pollution risk assessment, in MA01, during the operational phase.

Routine runoff pollution risk

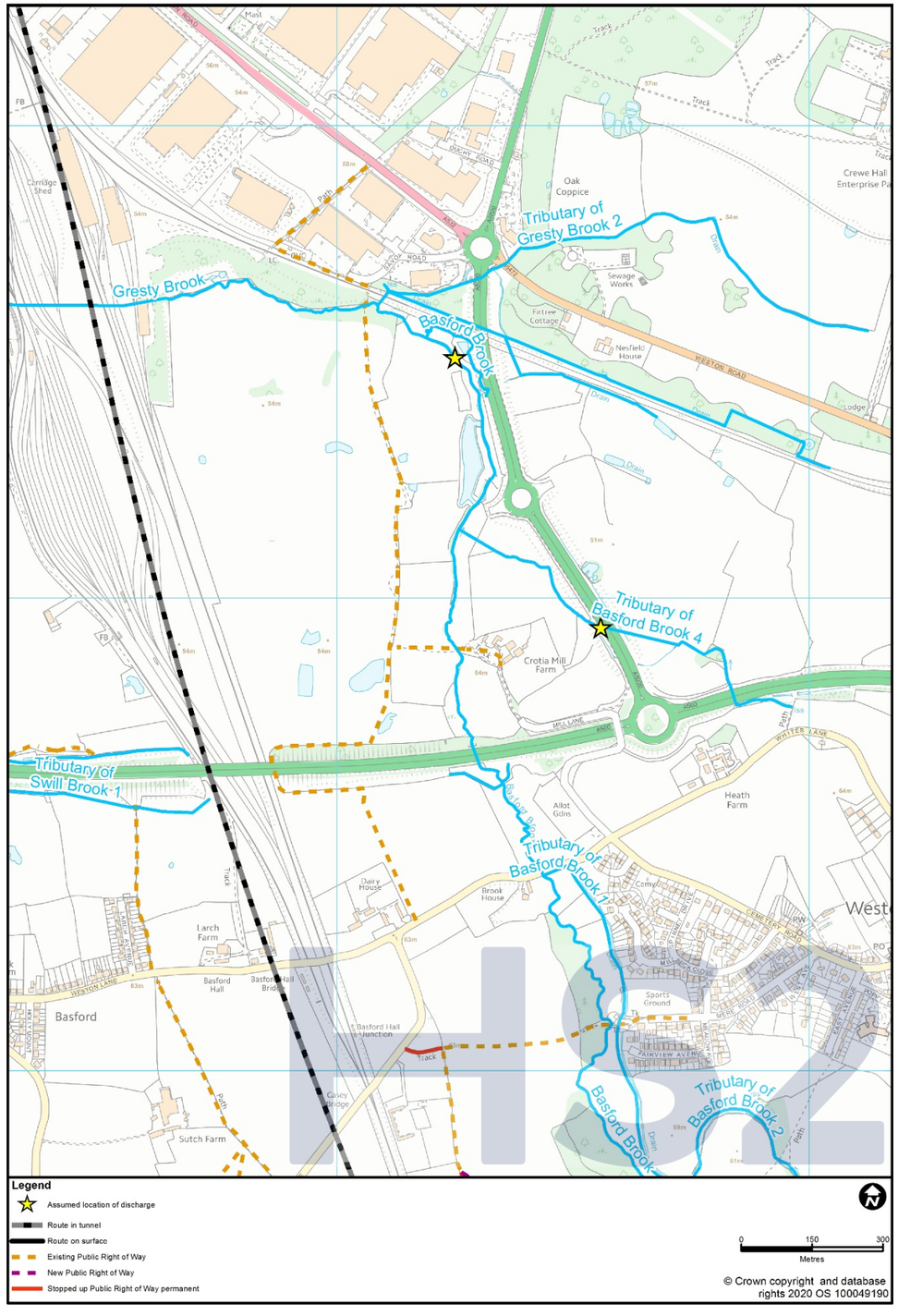
David Whitby Way

5.3.3 During the construction phase, increased traffic on the David Whitby Way is assessed. It is assumed that there is no attenuation on the existing road, with the outfalls assumed to go straight to the watercourse. For David Whitby Way, the outfalls are Basford Brook (known as outfall 1) and Tributary of Basford Brook 4 (known as outfall 2).

5.3.4 The tier 2 surface water assessment results for outfall 1 identified that both the acute soluble and sediment-bound pollutants assessments passed and there are no EQS exceedances for copper and zinc in the discharge. No data is currently available with regards to the background concentrations of copper in the watercourse (upstream of the discharge), therefore sensitivity testing has been carried out. This testing shows that if background concentrations for copper exceed 0.97µg/l the water quality in the receiving watercourse after discharge would exceed the EQS. During the passage of the hybrid Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. If mitigation is required these will be designed in consultation with the Environment Agency and other stakeholders to mitigate any significant effects on water quality. On a precautionary basis, this is assessed to be a moderate impact, on this moderate value receptor, resulting in a moderate effect which is significant.

5.3.5 The tier 2 surface water assessment results for outfall 2 identified that both the acute soluble and sediment-bound pollutants assessments passed and there are no EQS exceedances for copper and zinc. No data is currently available with regards to the background concentrations of copper in the watercourse (upstream of the discharge), therefore sensitivity testing has been carried out. This testing shows that if background concentrations for copper exceed 0.90µg/l the water quality in the receiving watercourse after discharge would exceed the EQS. During the passage of the Bill further investigations, such as monitoring and analysis of the bioavailability of metals and dilution, will be carried out, where reasonably practicable, to identify whether additional mitigation measures are required. If mitigation is required these will be designed in consultation with the Environment Agency and other stakeholders to mitigate any significant effects on water quality. On a precautionary basis, this is assessed to be a moderate impact, on this low value receptor, resulting in a minor effect which is not significant.

Figure 3: David Whitby Way



Highways spillage risk assessment

5.3.6 The evaluation of spillage risk for David Whitby Way outfall 1 is presented in Table 10[7]. The risk of a serious pollution incident occurring is identified as negligible. The highway realignment will not result in significant effects related to spillage risk and no further mitigation is required.

Table 10: Spillage risk assessment for David Whitby Way – outfall 1

	No junction	Roundabout	Notes
Water body type	Surface	Surface	
Length of road draining to outfall (km)	0.74	0.43	The length of the road was measured based on OS mapping.
Road type (A-road or motorway)	A Road	A Road	
If A road, is site urban or rural?	Urban	Urban	
Junction type	No junction	Roundabout	
Location	<20 mins	<20 mins	A response time of less than 1 hour is expected for emergency services.
Traffic flow (AADT two way)	17,065	17,065	The highest traffic flow (AADT two way) along the whole road was selected which represents a conservative approach.
% HGV	5	5	The corresponding HGV percentage value to the selected AADT value was chosen to represent the whole road. This represents a conservative approach.
Spillage factor (no/109HGVkm/year)	0.31	5.35	This spillage factor was taken from Table D.1 as presented in LA 113 Road Drainage and the Water Environment Revision 1[3].
Risk of accidental spillage	0.00007	0.00072	This represents the total annual probability of a spillage.
Risk of pollution incident	0.00003	0.00033	This represents the total annual probability of a spillage causing a pollution incident.
Is risk greater than 0.01?	No	No	This is the considered overall risk for the length of the road.
Total probability	0.0004	0.0004	
Return period (years)	2,798	2,798	

5.3.7 The evaluation of spillage risk for David Whitby Way outfall 2 is presented in Table 11. The risk of a serious pollution incident occurring is identified as negligible. The highway realignment will not result in significant effects related to spillage risk and no further mitigation is required.

[7] This table provides a summary of the spillage risk calculations carried out using the HEWRAT spillage risk spreadsheet. Available online at: http://www.hagdms.com/index.cfm?fuseaction=help.download.

Table 11: Spillage risk assessment for David Whitby Way – outfall 2

	No junction	Notes
Water body type	Surface	
Length of road draining to outfall (km)	0.17	The length of the road was measured based on OS mapping.
Road type (A-road or motorway)	A Road	
If A road, is site urban or rural?	Urban	
Junction type	No junction	
Location	<20 mins	A response time of less than 1 hour is expected for emergency services.
Traffic flow (AADT two way)	17,065	The highest traffic flow (AADT two way) along the whole road was selected which represents a conservative approach.
% HGV	5	The corresponding HGV percentage value to the selected AADT value was chosen to represent the whole road. This represents a conservative approach.
Spillage factor (no/109HGVkm/year)	0.31	This spillage factor was taken from Table D.1 as presented in LA 113 Road Drainage and the Water Environment Revision 1[3].
Risk of accidental spillage	0.00002	This represents the total annual probability of a spillage.
Risk of pollution incident	0.00001	This represents the total annual probability of a spillage causing a pollution incident.
Is risk greater than 0.01?	No	This is the considered overall risk for the length of the road.
Total probability	0.0000	
Return period (years)	139,500	