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HS2

High Speed Rail (Crewe – Manchester) Environmental Statement

Volume 5: Appendix WR-003-OR003

Water resources and flood risk

Off-route works: Annandale depot

Water resources assessment

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(Crewe – Manchester)
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Department for Transport

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1 Introduction

1.1 Structure

1.1.1 This report is an appendix to the water resources and flood risk assessment. It presents the water resources assessment for the Proposed Scheme in relation to the off-route works at Annandale depot.

1.1.2 This appendix should be read in conjunction with:

- Volume 4: Off-route effects; and
- Volume 5: Appendices.

1.1.3 The water resources assessments also comprise:

- a Water Framework Directive (WFD) preliminary compliance assessment (Volume 5: Appendix WR-001-OR003); and
- a Draft water resources and flood risk operation and maintenance plan (Volume 5: Appendix WR-007-00000).

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

- Water resources assessment baseline data (BID WR-004-OR003)[1]; and
- Water Framework Directive preliminary compliance assessment baseline data (BID WR-002-OR003)[2].

1.1.5 Maps referred to throughout this assessment are contained in the Volume 4, Off-route effects Map Books: Map Series CT-05 and CT-06.

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), adjusted to take into account the differences between the legislation in England and Scotland. The Water Environment (Controlled Activities) (Scotland) Regulations 2011[3] (CAR) and their further amendments 2013[4] and 2017[5] apply regulatory controls to activities which may affect Scotland's water environment. These activities include abstractions from surface water or groundwater (either licensed or unregistered), and discharges to surface water or groundwater. The regulations include provisions to protect surface water features, groundwater, springs and other water dependent habitats including groundwater dependant wetlands. The Water Environment and Water Services (Scotland) Act 2003 makes provision for protection of the water environment including provision for implementation of the Water Framework Directive (2000/60/EC).

[1] High Speed Two Ltd (2022), High Speed Rail (Crewe – Manchester), *Background Information and Data, Water resources assessment baseline data,* BID WR-004-OR003. 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 preliminary compliance assessment baseline data,* BID WR-002-OR003. Available online at: http://www.gov.uk/government/collections/hs2–phase–2b–crewe–manchester–environmental–statement.

[3] Natural Scotland (2011), *The Water Environment (Controlled Activities) (Scotland) Regulations 2011.* Available online at: http://www.legislation.gov.uk/ssi/2011/209/contents/made.

[4] Natural Scotland (2013), *The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2013.* Available online at: http://www.legislation.gov.uk/ssi/2013/176/contents/made.

[5] Natural Scotland (2017), *The Water Environment (Controlled Activities) (Scotland) Amendment Regulations 2017.* Available online at: http://www.legislation.gov.uk/ssi/2017/389/pdfs/ssi_20170389_en.pdf.

1.2.2 Under the CAR regulations, there are three types of authorisation:

- General Binding Rules (GBRs);
- registrations; and
- licences.

1.2.3 The general binding rules represent a set of mandatory rules which cover specific low risk activities, and do not require an application to be made to the Scottish Environment Protection Agency. Registrations allow for small-scale activities that individually pose low environmental risk but cumulatively can result in a greater environmental risk. In this case the operator registers the activity with the Scottish Environment Protection Agency and a number of conditions must be compiled with. Licences allow for site-specific conditions to be set to protect the water environmental from activities that pose a higher risk. The CAR licence requires the nomination of a 'responsible person' to be held accountable for securing compliance with the terms of the licence.

1.2.4 The works at Annandale depot cover a 5.9km 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 land required for the construction of the stabling facility. For the purposes of this assessment this spatial scope is defined as the study area.

1.2.5 The assessment considers the construction and operational features of the Proposed Scheme within this study area. These are shown on Volume 5, Water resource and flood risk Map Book, Map Series WR-01 and WR-02.

1.2.6 The off-route works WFD preliminary compliance assessment (Volume 5: Appendix WR-001-OR003) provides a comprehensive review of the potential impacts of the Proposed Scheme on designated WFD surface water and groundwater bodies.

1.2.7 No surveys have been undertaken due to land access constraints; therefore, a precautionary approach has been adopted. Where possible this assessment is based on publicly available information. In the absence of relevant data, it is assumed that potential water resources receptors may be present close to the land required for the construction of the Proposed Scheme and impact magnitude assessed accordingly. The maximum applicable value will be assigned to these potential receptors.

1.2.8 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.

1.2.9 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 4, Section 6.11, Water resources and flood risk.

1.3 Study area description and key features

1.3.1 The study area is predominantly rural, with a number of villages, hamlets and farmsteads located within close proximity to the Proposed Scheme, including Gretna Green and Kirkpatrick-Fleming. The town of Gretna is located south east of the southern extent of the Proposed Scheme.

1.3.2 Annandale depot will be constructed as a series of cuttings and embankments.

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

- Kirtle Water and associated tributaries Kirkpatrick Burn, Ewes Burn and Stand Burn;
- 16 potential spring features;
- the Sherwood Sandstone Group high productivity aquifer;
- the permeable superficial deposits high or high to moderate productivity aquifers and unclassified aquifers;
- one potential public water supply (PWS) abstraction assumed to be located in an area which might be affected by the construction of the Proposed Scheme;
- one potential private licensed groundwater abstraction;
- two potential unregistered groundwater abstractions; and

- seven nature conservation sites comprising ancient woodland which have the potential to be groundwater dependent habitats.

1.4 Stakeholder engagement

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

- Scottish Environment Protection Agency (SEPA);
- Dumfries and Galloway Council (DGC); and
- Scottish Water to confirm details of public water supply abstractions (if and where present) and associated water resource management plans.

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 affect by the Proposed Annandale depot. Further baseline details for these receptors are provided in the Water resources assessment baseline data (BID WR-004-OR003) and the WFD preliminary compliance assessment baseline data (BID WR-002-OR003).

2.1.2 The WFD preliminary compliance assessment (Volume 5: Appendix WR-001-OR003) 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 batching plant. 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 Scottish Environment Protection Agency and other water undertakers on the availability of water at that location.

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

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									
Kirkpatrick Burn	Moderate	• Works on and alongside the existing West Coast Mainline WCML	Construction work in the Kirkpatrick Burn catchment will be limited to on track works within the existing railway land. There are no new railway drainage outlets into the Kirkpatrick Burn. No impacts on Kirkpatrick Burn are anticipated.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required, although the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Tributary of Kirkpatrick Burn	Moderate	• Works on and alongside the existing WCML • Cove crossing satellite compound	Construction work in the Tributary of Kirkpatrick Burn catchment will be limited to on track works within the existing railway land and activities at the satellite compound. The works could give rise to the temporary deterioration of water quality caused by the mobilisation of contaminants in runoff.	Magnitude of impact – Minor Significance of effect – Minor, not significant	None required, although 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)
Ewes Burn	Moderate	• Southern reception tracks (cutting and piled foundations for embankment) • Realignment (800m) including a 45m surface water drainage culvert feeding into the	The two realignments on Ewes Burn of approximately 800m and 180m in length respectively, could have a permanent impact on the hydromorphology of the watercourse. The planning allocation GSTF/010 is also located over part of the Ewes Burn and could lead to additional realignments or culverting of Ewes Burn (although details are not available at this time).	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	The detailed design of these realignments will be developed in general accordance with Construction Industry Research and Information Association (CIRIA) and SEPA guidance and in consultation with SEPA specialists.	Magnitude of impact – Minor Significance of effect – Minor beneficial, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor beneficial, not significant	Construction (temporary and permanent)

Surface water feature/ receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
		headwaters of Ewes Burn • Realignment (180m) • Drainage outfalls from land drainage and from 2 holding tanks for track drainage • Temporary works such as stockpiles and compounds • Northern Reception track • Stabling sidings • Planning allocation GSTF/010[6]	Deterioration of water quality by temporary works caused by the mobilisation of contaminants by runoff from the construction area. Typically, these would include sediments, hydrocarbons related to fuel oils and high alkaline substances such as cement and concrete.	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)
			Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials. Deterioration 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 – Moderate adverse, significant	Mitigation measures will also include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
		• Wastewater treatment works	Deterioration of water quality and alteration of natural water chemistry downstream of confluence of Tributary of Ewes Burn 1, due to routine discharges from the proposed wastewater treatment works.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Mitigation measures will be designed in detail following ground investigation and monitoring of surface water flows. Mitigation could take the form of discharge of water intercepted by the cuttings to the Ewes Burn at an appropriate rate and location, to provide dilution flow in the Ewes Burn.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Operational (permanent)
Tributary of Ewes Burn 1	Moderate	• Ewes Burn access road culvert • Tributary of Ewes Burn 1 diversion (400m) including a 45m long access road culvert	The approximately 400m long diversion, (which includes a 45m long culvert) of Tributary of Ewes Burn 1 will replace approximately 400m of existing channel (which includes an 8m long culvert) will have a permanent impact on the hydromorphology of the watercourse.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP including the detailed design of the culvert will be developed in general accordance with Construction Industry Research and Information Association (CIRIA) and SEPA guidance and in consultation with SEPA specialists.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)

[6] Further details of this planning allocation can be found in Volume 5: Appendix CT-004-OR003, Planning data.

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
		• Drainage outfalls from land drainage and from holding tanks for track drainage • Temporary works such as stockpiles and compounds • Stabling sidings • Southern reception tracks	Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials. Deterioration 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 – Minor adverse, not significant	Mitigation measures will also include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
		• Wastewater treatment works	Deterioration of water quality and alteration of natural water chemistry due to contamination of surface water from routine discharges from the proposed wastewater treatment works.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Mitigation measures will be designed in detail following ground investigation and monitoring of surface water flows.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Operational (permanent)
Tributary of Ewes Burn 2	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • Northern Reception track culvert • Diversion (150m) including: – 32m northern reception track culvert; – 53m stabling sidings culvert • Discharges from track and land drainage	The 150m diversion including two culverts (32m and 53m respectively) of Tributary of Ewes Burn 2 will have a permanent impact on the hydromorphology of the watercourse.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP including the detailed design of the culvert will be developed in general accordance with Construction Industry Research and Information Association (CIRIA) and SEPA guidance and in consultation with SEPA specialists.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)
		• Drainage outfalls from land drainage and from holding tanks for track drainage • Temporary works such as stockpiles and compounds • Stabling sidings • Southern reception tracks (cutting)	Deterioration, loss or change to the existing water environment and the ecology supported, through the disturbance of silt or direct contamination by polluting materials. Deterioration 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 – Minor adverse, not significant	Mitigation measures will also include appropriate watercourse crossing and drainage design. Measures to manage water quality will be adopted during the design process.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Stand Burn	Moderate	• Wastewater treatment works discharge	Ewes Burn flows into Stand Burn and therefore there could be a deterioration of water quality and alteration of natural water chemistry due to discharges from the proposed wastewater treatment works.	Magnitude of impact – Moderate	Implementation of measures described in the draft CoCP	Magnitude of impact – Moderate	Mitigation measures will be designed in detail following ground investigation and monitoring of surface water flows. Mitigation	Magnitude of impact – Negligible	Operational (permanent)

Surface water feature/ receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
				Significance of effect – Moderate adverse, significant		Significance of effect – Moderate adverse, significant	could take the form of recirculation of water intercepted by the cutting to the Ewes Burn at an appropriate rate and location to provide dilution flow into the Ewes Burn	Significance of effect – Negligible, not significant	
Tributary of Stand Burn	Moderate	None	Watercourse is located on the opposite side of Ewes Burn and therefore there will be no impact on this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Kirtle Water	High	• Wastewater treatment works discharge	Deterioration of water quality and alteration of natural water chemistry due to discharges from the proposed wastewater treatment works is unlikely to be significant due to combined dilution effects of Ewes Burn and Stand Burn.	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 (temporary and permanent)
Tributary of Kirtle Water 1 (Irvington)	Moderate	None	Watercourse is located on the opposite side of Kirtle Water from the Proposed Scheme and there will be no impact on this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Tributary of Kirtle Water 2 (Gretna Services)	Moderate	None	Watercourse is located on the opposite side of Kirtle Water from the Proposed Scheme and there will be no impact on this watercourse.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)

2.2 Detailed assessment

Impacts to surface water from wastewater treatment works

2.2.1 The wastewater treatment works will discharge treated effluent to Tributary of Ewes Burn 1 and, as a result, could have an impact on surface water quality. Tributary of Ewes Burn 1 joins Ewes Burn north of Redhouse Cottage. Ewes Burn joins with Stand Burn down stream of the A74(M). The possible low level of dilution of the effluent in Tributary of Ewes Burn 1 and Ewes Burn could also impact the water quality of Stand Burn and Kirtle Water, although the impact is expected to be less than for Ewes Burn. There is not expected to be an impact on water quality at Kirtle Water due to dilution in the larger flow.

2.2.2 Mitigation measures will be designed in detail following ground investigation and monitoring of surface water flows and quality. Mitigation could take the form of discharge of surface water and groundwater, intercepted by drainage in the Southern reception tracks cutting or Headshunt cuttings, to Ewes Burn and tributaries. The discharge of groundwater drainage would be at an appropriate rate and location to provide dilution of the treated effluent discharge either at the same location or further downstream.

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 design elements of the Proposed Scheme, which are relevant to the water environment. Further baseline details for these receptors are provided in the Water resources assessment baseline data (BID WR-004-OR003). Individual impact assessments for each design element are presented in Section 3.2.

3.1.2 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.

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

3.1.4 In support of the groundwater impact assessment presented in Table 2, further detail is provided in Section 3.2 to Section 3.3 to demonstrate the methodology and assumptions used in relation to cuttings and embankments of the Proposed Scheme. The locations of these elements are shown in the Volume 4, Off-route effects Map Books, 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)									
Peat	Low	Above ground elements and shallow excavation (<1mbgl) potentially including: • Track and roads • Temporary works such as stockpiles and compounds • Drainage	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	None required, although 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: • Northern reception track (excavation or piled foundations) • Stabling sidings (excavation or piled foundations)	The peat deposits underlying the scheme may either be excavated or piled as part of the construction process. Due to the minor extent of peat within this area, and the unclassified aquifer status, the impact on groundwater flow pathways is likely to be negligible.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	Construction (temporary and permanent)
			Acid sulphate conditions may occur in the deep peat deposits, when oxidised. Although a very small area of peat at this location piling in this peat could lead to oxidation of these deposits, which could impact on surface watercourses flowing in this area.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Surveys should be undertaken to identify if conditions are present that could lead to acidified peat.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	If acid peat conditions exist, then aquifer protection measures should be used to ensure no pathway created to cause oxidation.	Magnitude of impact – Moderate Significance of effect – Minor adverse, not significant	Construction (temporary and permanent)
Alluvium	Moderate	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds • Northern reception track (excavation or piled foundations) • Stabling sidings (excavation or piled foundations) • Land drainage features	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be temporary only.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect - Negligible, not significant	Construction (temporary)
			The land drainage for the permanent works may reduce the recharge to the aquifer in the alluvium. Due to the very limited extent of alluvium within the study area, the impact on local water resources would be minor.	Magnitude of impact – Minor Significance of effect – Minor, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor, not significant	None required.	Magnitude of impact – Minor Significance of effect – Minor, not significant	Construction (temporary and permanent)
		Deeper excavation (>1mbgl) including: • Northern reception track (excavation or piled foundations)	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be temporary only.	Magnitude of impact – Moderate Significance of effect – Moderate	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 –	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
		• Stabling sidings (excavation or piled foundations)		adverse, significant				Negligible, not significant	
			Potential alteration of shallow groundwater flow pathways may occur if piled foundations are installed. Due to the limited extent of the alluvium within the study area the impact on local water resources is likely to be minor.	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)
Kilblane Sand and Gravel Formation	High	None	The unit is not crossed by the Proposed Scheme and, although it may be hydraulically connected to the Gretna Till Formation, it is not expected to be impacted by works in the till.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	Construction (temporary and permanent)
Plumpe Farm Sand Member Plumpe Sand and Gravel Formation River terrace deposits (Un-differentiated)	High Moderate	None	The units are not crossed by the Proposed Scheme and, although they may be hydraulically connected to the Gretna Till Formation, they are not expected to be impacted by works in the till.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	Construction (temporary and permanent)
Kerr Moraine Formation	Low	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles	The temporary works have the potential to affect shallow groundwater quality, although this is likely to be temporary only.	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)
Gretna Till Formation	Low	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds • Northern reception track (excavation or piled foundations) • Stabling sidings (excavation or piled foundations) • Wastewater treatment works • Land drainage features • Ewes Burn Culvert	The temporary works have the potential to affect shallow groundwater quality although this is likely to be localised and temporary.	Magnitude of impact – Moderate Significance of effect – Moderate adverse, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
			Temporary and permanent works are of small areal extent compared to the aquifer, therefore are likely to have a negligible impact on recharge and 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 –	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
								Negligible, not significant	
		Deeper excavation (>1mbgl) including: • Southern reception tracks cutting • Headshunt cutting • Building foundations • Piled foundations below embankments	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)
			Potential impact from cutting dewatering and drainage on groundwater levels are likely to be localised and the impact is assessed to be minor.	Magnitude of impact – Minor Significance of impact – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of impact – Minor adverse, not significant	None required.	Magnitude of impact – Minor Significance of impact – Minor adverse, not significant	Construction (temporary and permanent)
Sherwood Sandstone Group – Chester Formation – St Bees Sandstone Member	High	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds • Northern reception track • Stabling sidings	The temporary works have the potential to affect groundwater quality, although this is likely to be temporary and the bedrock is protected by a substantial thickness of superficial deposits.	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: • Southern reception tracks • Headshunt cutting • Drainage • Building foundations • Piled foundations below embankments	The construction works, including possible piling into the top of the aquifer below embankments (where located on peat). have the potential to affect groundwater quality, although this is likely to be temporary.	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)
			The southern reception tracks and the Headshunt cuttings will significantly reduce the thickness of the overlying Gretna Till Formation, reducing the pathway into the sandstone aquifer. However, the extent of the cutting is small within the much larger area of the aquifer, minimising any impact on groundwater quality.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required, although the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	Construction (temporary and permanent)
			As the cuttings do not penetrate through the superficial deposits, potential impacts from cutting dewatering and	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	None required.	Magnitude of impact – Negligible	Construction (temporary and permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
			drainage on groundwater level are assessed as negligible.	Significance of impact – Negligible, not significant		Significance of impact – Negligible, not significant		Significance of impact – Negligible, not significant	
Abstractions									
Potential PWS abstractions from the Sherwood Sandstone Group aquifer (outside of the 1km study area) in the Annan drinking water protected area	Very high	Deeper excavation (>1mbgl) including: • Southern reception tracks • Northern reception track • Headshunt cutting • Traction substation cutting	The four Annandale depot cuttings have the potential to impact on groundwater quality within the Annan drinking water protected area. British Geological Society (BGS) logs for nearby boreholes (along the A74 (M)) show that the Gretna Till Formation is approximately 14-17m thick in the area. Assuming the superficial deposits are of a similar thickness in the vicinity of the Annandale depot cuttings, the superficial deposits should minimise the impact on the Sherwood Sandstone aquifer. Therefore, the impact on groundwater quality in any public water supply boreholes is assumed to be negligible.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of impact – Negligible, not significant	Construction (permanent)
		Deeper excavation (>1mbgl) including: • Northern reception track (excavation or piled foundations) • Stabling sidings (excavation or piled foundations)	Piling works associated with the embankments and other works have the potential to impact on groundwater quality within the Annan drinking water protected area.	Magnitude of impact – Minor Significance of effect – Moderate, 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 impact – Negligible, not significant	Construction (temporary)
Potential abstraction at Lochinvar BH34 & BH35, Chapelknowe, Canonbie (CAR licence)	High	Deeper excavation (>1mbgl) including: • Southern reception tracks	Located approximately 845m east of the proposed scheme, and is 600m across hydraulic gradient from the zone of influence for the cutting (see Section 3.2).	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Well south of North Lodge (potential unregistered groundwater source)	High	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds	Removal of topsoil or shallow material, and construction activity has potential to impact on groundwater quality.	Magnitude of impact – Minor Significance of effect – Moderate, 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:	Located 780m west of the hunt shunt cutting, and therefore 450m outside the zone of influence for the cutting, and	Magnitude of impact – Negligible	None required.	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
		• Headshunt cutting	with existing drainage features between the calculated zone of influence and the well site (see Section 3.2).	Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant		Significance of effect – Negligible, not significant	and permanent)
Watchhill Well (potential unregistered groundwater source)	High	• Above ground elements and shallow excavation (<1mbgl) on eastern section of WCML	Located 840m east and across hydraulic gradient from the Proposed Scheme. Well is least 1.5km outside of the radius of influence of the southern reception track cutting.	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 (temporary and permanent)
Other potential unregistered groundwater abstraction sources	High	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds	Assume that potential unregistered groundwater abstraction sources are located close to or within areas required for construction of the Scheme. Depending on the construction of the abstraction sources, there may be potential for contamination of the abstraction during construction works.	Magnitude of impact – Moderate Significance of effect – Moderate, significant	Implementation of measures described in the draft CoCP. Site visits to check on sources and locations in relation to construction areas.	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: • Southern reception tracks • Headshunt cutting • Building foundations • Northern reception track (excavation or piled foundations) • Stabling sidings (excavation or piled foundations)	Assume that potential unregistered groundwater abstraction sources are within the calculated zone of influence for Headshunt or Southern reception tracks cuttings and that abstraction is from the Gretna Till Formation, rather than the deeper Sherwood Sandstone Group. The impact of drainage to the cutting on groundwater flow and groundwater levels in the Gretna Till Formation in the vicinity of the sites could be moderate.	Magnitude of impact – Moderate Significance of effect – Moderate, significant	Surveys and engagement to identify any unregistered abstractions which could be affected.	Magnitude of impact – Moderate Significance of effect – Moderate, significant	If any potential effect is identified, mitigation will be agreed with the abstraction operator and SEPA to ensure a continuous, reliable water supply. Mitigation might comprise lowering of pumps, deepening of sources or provision of replacement boreholes.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Discharges to groundwater									
Potential discharges to groundwater including 20 discharges at CAR licensed sites	Low	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds • Deeper excavation (>1mbgl) including Headshunt cutting	Some CAR licensed sites which are discharges to groundwater are located close to areas required for construction and within the calculated zone of influence for the Headshunt cutting. However, there is unlikely to be any disruption to these discharges due to construction work.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required, although the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	As a precaution, site visits to check on locations in relation to construction areas and need for any special mitigation measures.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary and permanent)
Groundwater – surface water interactions									
Ewes Burn	Moderate	Deeper excavation (>1mbgl) including:	Parts of the upper reaches of Ewes Burn and tributary drains are within the	Magnitude of impact –	Land drainage and track drainage will be discharged	Magnitude of impact – Negligible	None required.	Magnitude of impact –	Construction (permanent)

Receptor	Receptor value	Design element	Discussion of potential impact to water receptor	Magnitude of potential impact and effect	Avoidance and mitigation measures included in design	Magnitude of remaining impact and effect	Other mitigation measures	Residual effects	Duration of effect
Tributary of Ewes Burn 1 Tributary of Ewes Burn 2 Potential unregistered surface water abstractions from Ewes Burn	Moderate Moderate Moderate	• Southern reception tracks • Northern reception track (cutting and piled foundations for embankment) • Stabling sidings (excavation or piled foundations) • Headshunt cutting • Stabling sidings	calculated zones of influence for the cuttings. There is potential for reductions in baseflow in Ewes Burn and its tributaries from the Gretna Till Formation, as groundwater may be intercepted by the cuttings and also by embankment piling (see Section 3.2).	Moderate Significance of effect – Moderate adverse, significant	into the watercourse thereby potentially eliminating the impact on flow.	Significance of effect – Negligible, not significant		Negligible Significance of effect – Negligible, not significant	
Stand Burn	Moderate	Deeper excavation (>1mbgl) including: • Southern reception tracks • Headshunt cutting • Northern reception track (piled foundations for embankment) • Stabling sidings (excavation or piled foundations)	Parts of the upper reaches and tributary drains for Ewes Burn, which discharges into Stand Burn, are within the calculated zones of influence for the cuttings. There is potential for reductions in baseflow in Ewes Burn from the Gretna Till Formation as groundwater may be intercepted by the cuttings and also by embankment piling (see Section 3.2). Any reduction in baseflow could also affect baseflow in Stand Burn further downstream.	Magnitude of impact – Minor Significance of effect – Minor adverse, not significant	None required, although land drainage and track drainage will be discharged upstream of Stand Burn, thereby potentially eliminating the impact on flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (permanent)
Rae Burn	Moderate	Deeper excavation (>1mbgl) comprising: • Headshunt cutting	A section of a tributary drain to Rae Burn is within the calculated zone of influence for the cutting. There is potential for a reduction in baseflow from the Gretna Till Formation in the drain and, therefore, in Rae Burn. as groundwater may be intercepted by the cutting (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	None required
Black Sark	Moderate	Deeper excavation (>1mbgl) comprising: • Southern reception tracks • Headshunt cutting	The uppermost reach of a tributary drain to Black Sark is located within the calculated zone of influence for the southern reception tracks cutting. Black Sark also receives discharge from Rae Burn which may be affected by the Headshunt cutting. There is potential for a reduction in baseflow from the Gretna Till Formation in the drain and Rae Burn, and therefore in Black Sark. as groundwater may be intercepted by the cuttings. The potential impact on the flow in Rae Burn is minor, and Black Sark has a large contributing catchment upstream of the inflows from both Rae Burn and the drain potentially impacted by the southern reception tracks cutting. Therefore, the flow in Black Sark would be effectively unchanged by drainage to the cuttings (see Section 3.2).	Magnitude of impact – Negligible Significance of effect – Negligible, 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	None required

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
Kirtle Water	High	Deeper excavation (>1mbgl) comprising: • Southern reception tracks • Headshunt cutting	Any potential reduction in baseflow in Ewes Burn and Stand Burn might give rise to a reduction in baseflow in Kirtle Water. However, Kirtle Water has a large contributing catchment upstream of the Proposed Scheme and, therefore, the flow would be effectively unchanged by drainage to the cuttings.	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	None required
Potential spring 200m south of Cranberry Farm	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds Deeper excavation including (>1mbgl) • Headshunt cutting	This potential spring is located beneath or very close to the tracks for the Proposed Annandale depot and is also within the calculated zone of influence of the southern reception tracks cutting. Therefore, the spring discharge could be lost as a result (see Section 3.2).	Magnitude of impact – Major Significance of effect – Major adverse, significant.	Land drainage from the area around the potential spring will be collected and discharged into the realigned Ewes Burn.	Magnitude of impact – Major Significance of effect – Major adverse, significant.	Survey to assess the value of the potential feature. If a true expression of groundwater, and important ecological features are present mitigation measures to relocate the spring, and reinstate the discharge, will be considered in detailed design.	Magnitude of impact – Minor Significance of effect – Moderate, significant	Construction (temporary and permanent)
Potential spring 170m north east of Bensmoor Wood Potential spring 90m north of Cranberry Farm	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds	Both springs located adjacent to or just within the land required for construction of the Proposed Annandale depot. The temporary works have the potential to affect groundwater quality and flow although this is likely to be localised and temporary.	Magnitude of impact – Minor Significance of effect – Moderate, significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, significant	Construction (temporary)
Potential spring 220m west of Redhall Castle Potential spring 300m north west of Redhall Castle	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds	These features are located more than 300m down-gradient from any land required for construction of the Proposed Annandale depot. The temporary works are unlikely to affect groundwater quality and flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
		Deeper excavation including (>1mbgl) • Headshunt cutting	Outside but down-gradient of the cutting. Potential reduction in spring discharges due to the cutting intercepting groundwater flow to the springs.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	None required.	Magnitude of impact – Minor Significance of effect – Moderate adverse, significant	Survey to assess the value of the potential features. If true expressions of groundwater, and important ecological features are present, monitoring and possible mitigation measures will be	Magnitude of impact – Negligible Significance of effect – Negligible, 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
							considered in detailed design.		
Two potential springs in area south of Gretna service area Potential spring in area east of Gretna service area Potential spring 450m south east of Gretna service area Potential spring at Stand Burn ponds Potential spring at Gretna Flow Potential spring at Sheepwash east of Williamsfield Cottage	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds	These features are located more than 245m from any land required for construction of the Proposed Annandale depot. The temporary works are unlikely to affect groundwater quality and flow.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Implementation of measures described in the draft CoCP.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Potential spring at Kirkpatrick Fleming Potential spring west of Newton	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds	These features are located up-gradient of the land required for construction of the Proposed Annandale depot. They are unlikely to be hydraulically connected to the Proposed Scheme.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required although the draft CoCP will be implemented throughout construction.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	Construction (temporary)
Potential spring 150m east of Fairyrow Wood Potential spring 274m east of Irvington Potential spring 45m east of Irvington Sinks 50m east of Irvington	High	Above ground elements and shallow excavation (<1mbgl) including: • At grade track and roads • Temporary works such as stockpiles and compounds	These potential features are located on the opposite side of Kirtle Water to the land required for construction of the Proposed Annandale depot. As a result, they will not be hydraulically connected to the Proposed Scheme.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	None required.	Magnitude of impact – Negligible Significance of effect – Negligible, not significant	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 4.

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 Groundwater assessment method Technical note in the SMR.

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 is estimated to be a maximum of 2m below track level.

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.

Southern reception tracks

Table 3: Summary of the Southern reception tracks cutting parameters for the groundwater assessment

Cutting parameters	Southern reception tracks cutting parameter details
Length (km)	0.780
Maximum depth (m)	5.83
Strata intercepted	Permeable superficial deposits comprising Gretna Till Formation - Unclassified aquifer (equivalent to Secondary (Undifferentiated) aquifer), and alluvium (intercepted at the western end of the cutting) - moderate to high productivity aquifer (equivalent to Secondary A aquifers). Superficial deposits are underlain by the bedrock Sherwood Sandstone Group - highly productive aquifer (equivalent to Principal aquifer), although bedrock is not likely to be intercepted.
Lowest level of drainage invert along track (mAOD)	35.90 (assumed 7.83mbgl)
Groundwater level(s) (mAOD)	Assumed to be at ground level
Principal receptors	Gretna Till Formation Unclassified aquifer Alluvium – moderate to high productivity aquifer Sherwood Sandstone Group - highly productive aquifer Ewes Burn Stand Burn Black Sark Potential spring 200m south of Cranberry Farm Western section of Blacksike wood

3.2.7 BGS logs for boreholes constructed along the route of the A74 (M), 0.7km to 0.9km to the south of the Southern reception tracks cutting, indicate a substantial thickness of superficial deposits down to about 27mAOD to 30mAOD. Assuming superficial deposits are present down to similar levels in the vicinity of the Southern reception tracks cutting, the cutting would not extend into the bedrock underlying the superficial Gretna Till Formation (Secondary (Undifferentiated) aquifer) and alluvium.

3.2.8 BGS surface geological mapping shows an area of bedrock outcropping near Whinny Rig about 250m to the south of the cutting. However, BGS logs for boreholes about 100m from Whinny Rig (at Douglas Tanks) indicate a minimum thickness of 16m of till overlying the bedrock. A similar extent of superficial deposits as indicated by the borehole logs is, therefore, assumed in the area of the cutting.

3.2.9 There is no groundwater level data available for superficial deposits in the vicinity of the Southern reception tracks cutting.

3.2.10 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.

3.2.11 Assuming a hydraulic conductivity value of $3x10^{-4}$ m/s for the Gretna Till Formation[7] and alluvium, the zone of drawdown (also referred to as the zone of influence) is estimated to extend a maximum distance of about 237m on either side of the cutting. This is based on a maximum cutting depth of 5.83m, an assumed drainage invert depth of 7.83m, and a rest water level at ground level.

3.2.12 The cutting is not likely to penetrate through the superficial deposits and into the underlying bedrock. There may be thin groundwater bearing horizons within the Gretna Till Formation which are not laterally extensive and result in perched water levels forming both within the till and the overlying alluvium. The cutting could therefore reduce groundwater levels in the Gretna Till Formation and the alluvium in the area of the zone of influence. The impact on these moderate value formations is assessed to be minor, leading to a minor effect, which is not significant.

3.2.13 Changes in groundwater levels in the superficial deposits might, potentially, have an impact on groundwater levels in the underlying Sherwood Sandstone Group. The BGS log for a borehole located about 100m from the cutting indicates that sandstones with some mudstones and siltstones extend more than 100m below the cutting depth. The Sherwood Sandstone Group is also laterally extensive across the region. Therefore, although there might potentially be minor local changes in groundwater levels within the zone of influence of the cutting, the overall changes in groundwater level in the Sherwood Sandstone Group are assessed as negligible, leading to a negligible effect, which is not significant.

3.2.14 Assuming that the groundwater flow direction in the Gretna Till Formation follows topography, groundwater will flow towards the east or south-east. This is approximately parallel to the cutting and, as such, the cutting is unlikely to interrupt overall groundwater flow in the area.

3.2.15 Construction of the Southern reception tracks cutting will remove some of the superficial deposits along the line of the cutting. The Gretna Till Formation, which overlies the Sherwood Sandstone Group, is classified as not a significant aquifer, consisting generally of interbedded layers of low and higher permeability material. The formation would therefore be expected to restrict the vertical flow of water through the ground. The reduction in thickness of the Gretna Till Formation along the line of the cutting could potentially create a shorter pathway for surface water to discharge into the Sherwood Sandstone which, in turn, could lead potentially to a slight change in bedrock groundwater chemistry in the area.

3.2.16 The cutting is located within the Annan groundwater drinking water protection area (ground), indicating that very high value public and high value private water supply boreholes may be located in the region. However, assuming that the superficial deposits indicated in BGS logs for boreholes along the A74 (M) and near Whinny Rig are present down to similar levels in the vicinity of the Southern reception tracks cutting, then an approximate 5 to 10m thickness of Gretna Till Formation should remain below the cutting drainage. As a result, the impact on groundwater quality in the bedrock aquifer, and any public water supply or other abstraction boreholes drawing on groundwater in the aquifer, should be negligible. This negligible impact would give rise to a negligible adverse effect, which is not significant.

3.2.17 Scottish Environment Protection Agency records indicate that no sites licensed under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 are present with the calculated zone of influence of the Southern reception tracks cutting. On a precautionary basis, however, it is assumed that other unregistered groundwater abstractions could potentially be located within the calculated zone of influence. Any such abstractions are assumed to be high value receptors. A minor impact on groundwater flow and groundwater levels in the vicinity of any abstractions could result in a moderate adverse effect to these potential receptors, which would be significant.

3.2.18 If, following discussion with Scottish Environment Protection Agency and site surveys, it is confirmed that unregistered groundwater abstractions are present in or close to the zone of influence, mitigation options for the impact on groundwater flow and groundwater levels will be discussed with the abstraction owners and Scottish Environment Protection Agency. Mitigation options will be considered with a view to ensuring a continuous, reliable water supply at abstraction sources from either the superficial deposits or the bedrock. Such mitigation options might include the lowering of pumps, deepening of abstraction sources or provision of alternative boreholes.

3.2.19 The potential spring 200m south of Cranberry Farm is within the land required for the construction of the Proposed Scheme, close to the centreline of the southern reception tracks cutting and will be lost during construction. Pending a survey, on a precautionary basis, this potential spring is assumed to be a high value feature. The overall impact on this feature is assessed as major, leading to a major effect, which is significant.

3.2.20 The upper reach of Ewes Burn is located within the calculated zone of influence of the Southern reception tracks cutting over a channel length of about 230m. Ewes Burn may, therefore, receive reduced baseflow due to interception of groundwater from Southern reception tracks cutting. This is assessed to be a moderate impact on a moderate value receptor, resulting in a moderate effect, which is significant. The impact on the baseflow in Stand Burn, which is located downstream of Ewes Burn, is assessed as minor. Stand Burn is also a moderate value receptor, resulting in a minor effect, which is not significant.

[7] 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.

3.2.21 The uppermost reach of a drain in Blacksike wood is also located just within, or very close to, the calculated zone of influence. The drain discharges to a second larger drain, and then further downstream to Black Sark. If the drain in Blacksike wood is fed by groundwater, there could be an impact on the baseflow and, hence downstream, on the discharge to Black Sark. However, Black Sark has a large contributing catchment upstream of the drain and, therefore, the flow would be effectively unchanged by any drainage to the Southern reception tracks cutting. This is assessed to be a negligible impact on the flow in Black Sark, a moderate value receptor, resulting in a negligible effect, which is not significant.

3.2.22 Blacksike wood, an ancient woodland (see Table 5) is located adjacent to the existing WCML and to land required for the construction of the Proposed Scheme. It is currently unclear with this woodland is dependent on groundwater and has been included on a precautionary basis. The western section of Blacksike wood is located within the calculated zone of influence of the Southern reception tracks cutting. As already indicated, the uppermost reach of a drain in Blacksike wood is located just within, or very close to, the calculated zone of influence. If the drain is fed by groundwater and supports an important habitat in Blacksike wood, or if groundwater supports any other wetland habitats within the wood, there could be a moderate impact on the groundwater flow beneath the woodland due to drainage in the cutting.

Headshunt cutting

Table 4: Summary of the Headshunt cutting parameters for the groundwater assessment

Cutting parameters	Headshunt cutting parameter details
Length (km)	1.040
Maximum depth (m)	9.77
Strata intercepted	Permeable superficial deposits comprising Gretna Till Formation - Unclassified aquifer (equivalent to Secondary (Undifferentiated) aquifer). Superficial deposits are underlain by the bedrock Sherwood Sandstone Group - highly productive aquifer (equivalent to Principal aquifer), although bedrock is not likely to be intercepted.
Lowest level of drainage invert along track (mAOD)	38.47 (assumed 11.77mbgl)
Groundwater level(s) (mAOD)	Ground level
Principal receptors	Gretna Till Formation Unclassified aquifer Sherwood Sandstone Group - highly productive aquifer Ewes Burn Tributary of Ewes Burn 1 Tributary of Ewes Burn 2 Stand Burn Rae Burn Black Sark Three licensed discharges to groundwater Billy's Wood North Woodland east of Grahamshill Railway Cottages Mossknowe Lodge Wood

3.2.23 BGS logs for boreholes constructed along the route of the A74 (M), approximately 0.3km to the south of the Headshunt cutting, indicate a substantial thickness of superficial deposits down to about 28mAOD to 30mAOD. The BGS log for a borehole approximately 0.5km north of the proposed platforms within the stabling area indicates a similar thickness of superficial deposits. Assuming that superficial deposits are present down to approximately the same levels in the vicinity of the Headshunt cutting as in the boreholes along the A74(M), the cutting would not fully penetrate through the superficial Gretna Till Formation (Secondary (Undifferentiated) aquifer).

3.2.24 There is no groundwater level data available for superficial deposits in the vicinity of the Headshunt cutting.

3.2.25 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.

3.2.26 Assuming a hydraulic conductivity value of $3x10^{-4}$ m/s for the Gretna Till Formation[7], the zone of drawdown (also referred to as the zone of influence) is estimated to extend a maximum distance of about 357m on either side of the cutting. This is based on a maximum cutting depth of 9.77m, an assumed drainage invert depth of 11.77m, and a rest water level at ground level.

3.2.27 The cutting is not likely to penetrate through the Gretna Till Formation. There may be thin groundwater bearing horizons within the Gretna Till Formation which are not be laterally extensive and result in perched aquifers forming within the till. The cutting could therefore reduce groundwater levels in the Gretna Till Formation in the area of the zone of influence. Assuming that the groundwater flow direction in the glacial till follows topography, groundwater will flow towards the south from a topographic high just to the north of the WCML. The cutting is likely to interrupt some groundwater flow in the area. However, taking into account the proximity of the cutting to the local groundwater divide, the impact on groundwater flow in the aquifer overall is assessed as negligible, leading to a negligible effect which is not significant.

3.2.28 Changes in groundwater levels in the Gretna Till Formation might, potentially, have an impact on groundwater levels in the underlying Sherwood Sandstone Group. The BGS log for a borehole located about 1km from the cutting indicates that sandstones with some mudstones and siltstones extend more than 100m below the cutting depth. The Sherwood Sandstone Group is also laterally extensive. Therefore, although there could potentially be minor local changes in groundwater levels within the zone of influence of the cutting, the overall changes in groundwater level in the Sherwood Sandstone Group are assessed as negligible, leading to a negligible effect, which is not significant.

3.2.29 Construction of the Headshunt cutting will remove some of the superficial deposits along the line of the cutting. The Gretna Till Formation, which overlies the Sherwood Sandstone Group, is not a significant aquifer, consisting generally of interbedded layers of low and higher permeability material. The formation would therefore be expected to restrict the vertical flow of water through the ground. The reduction in thickness of the Gretna Till Formation along the line of the cutting could potentially create a shorter pathway for surface water to discharge into the Sherwood Sandstone which, in turn, could lead to a slight change in groundwater chemistry in the area.

3.2.30 The cutting is located within the Annan groundwater drinking water protection area (ground), indicating that very high value public and high value private water supply boreholes may be located in the region although not in the study area. However, assuming that the superficial deposits indicated in BGS logs for boreholes along the A74 (M) are present down to similar levels in the vicinity of the Headshunt cutting, then an approximate 8m thickness of Gretna Till Formation should remain below the cutting drainage. As a result, the impact on groundwater quality in the bedrock aquifer, and any abstraction boreholes drawing on groundwater in the aquifer, should be negligible. This negligible impact would give rise to a negligible adverse effect, which is not significant.

3.2.31 SEPA records indicate that there are no sites licensed under the Water Environment (Controlled Activities) (Scotland) Regulations 2011 comprising groundwater abstractions are present with the calculated zone of influence of the Headshunt cutting.

3.2.32 Unregistered groundwater abstractions could potentially be located within the zone of influence. All abstractions are assumed to be high value receptors. Assuming that any abstraction is from the Gretna Till Formation, rather than the deeper Sherwood Sandstone Group, then the moderate impact on groundwater flow and groundwater level could result in moderate adverse effects to any potential abstractions, which would be significant.

3.2.33 If, following discussion with the Scottish Environment Protection Agency and site surveys, it is confirmed that any groundwater abstractions are present in or close to the zone of influence, mitigation options for the impact on groundwater flow and groundwater levels will be discussed with the abstraction owners and the SEPA. Mitigation options will be considered with a view to ensuring a continuous, reliable water supply at abstraction sources from either the superficial deposits or the bedrock. Such mitigation options might include the deepening of abstraction sources or provision of alternative boreholes.

3.2.34 SEPA records indicate that three sites licensed under the Water Environment (Controlled Activities) (Scotland) Regulations 2011comprising discharges to groundwater are present with the calculated zone of influence of the Headshunt cutting. No disruption to these discharges is expected as a result of the presence of the cutting. However, as a precaution, site visits will be undertaken to check on the locations of the discharges in relation to the cutting.

3.2.35 There are no springs within the calculated zone of influence of Headshunt cutting. However, the permanent below ground features of the cutting have the potential to interrupt some groundwater flow towards the potential springs 220m east of Redhall Castle and 300m north-west of Redhall Castle. This is assessed to be a minor impact on these potential high value receptors, leading to a moderate effect, which is significant. Surveys are, however, required to confirm the nature of these features and whether they are true expressions of groundwater.

3.2.36 Ewes Burn and Tributary of Ewes Burn 1 and 2 may receive reduced baseflow due to interception of groundwater from Headshunt cutting. The potential reduction in baseflow is assessed to have a moderate impact on Ewes Burn, a moderate value receptor, resulting in a moderate effect, which is significant. The impact on the baseflow in Stand Burn, which is located downstream of Ewes Burn, is assessed as minor. Stand Burn is also a moderate value receptor, resulting in a minor effect, which is not significant.

3.2.37 A section of a tributary drain which discharges downstream to Rae Burn is located within the calculated zone of influence for the Headshunt cutting. There is potential for a reduction in baseflow from the Gretna Till Formation in the drain and, therefore, in Rae Burn, as groundwater may be intercepted by the cutting. The potential reduction in baseflow is assessed to have a minor impact on the Rae Burn, a moderate value receptor, resulting in a minor effect, which is not significant.

3.2.38 Rae Burn discharges further downstream to Black Sark and, therefore, there could potentially be a reduction in baseflow in Black Sark. However, as the impact on Rae Burn is minor, and Black Sark has a substantial contributing catchment upstream of the confluence with Rae Burn, the flow would be effectively unchanged in Black Sark by any drainage to the Headshunt cutting. This is assessed to be a negligible impact on the flow in Black Sark, a moderate value receptor, resulting in a negligible effect, which is not significant.

3.2.39 There are three woodlands (see Table 5) located either wholly or mainly within the calculated zone of influence of Headshunt cutting (Billy's Wood North, Woodland east of Grahamshill Railway Cottages and Mossknowe Lodge Wood). It is currently unknown if these woodlands contain any water dependent habitat and they have been included on a precautionary basis. If any wetland habitats are present within these woodlands, there could be a moderate to major impact on these wetland features due to the cutting drainage.

3.3 Impacts on groundwater from embankment piling

3.3.1 The northern reception track embankment and stabling sidings embankment will be partially constructed on peat over sections indicated by BGS geological mapping as about 200m to 400m in length. The method of construction will be dependent in part on the thickness of the peat. If shallow, the peat might be replaced with a suitable fill material. Otherwise the embankment could be constructed on precast concrete piles driven through the peat at close centres to a nominal depth of 10m. BGS logs for boreholes along the A74(M) to the south of the stabling area indicate that, with a depth of 10m, the piles could penetrate through the Gretna Till Formation which is likely to underlie the peat. The piles could then extend into the top few metres of the Sherwood Sandstone Group.

3.3.2 Piling can affect groundwater quality where the works have a hydraulic connection to an aquifer or are located in the aquifer itself. However, the use of driven precast concrete piles reduces substantially the potential for contamination, although impacts may still occur from contamination by hydraulic fluids and greases from machinery. Implementation of the draft CoCP will, however, ensure control of any potential contaminants.

3.3.3 The piling might also intercept some groundwater which discharges to Ewes Burn and redirect the groundwater flow to the Scheme drainage. This is assessed to be a minor impact on Ewes Burn, a moderate value receptor, resulting in a minor effect, which is not significant.

4 Site specific water dependent habitats assessment

4.1 Summary of assessment

4.1.1 Table 5 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 the Ecological register of significant effects below local level (Volume 5, Appendix EC-003-OR003) and Ecological baseline data-designated sites (Volume 5, Appendix EC-001-OR003). Where there are significant effects, the ecological effects and associated mitigation are reported in Volume 4, Section 6.5, Ecology and biodiversity.

Table 5: Summary of potential water dependent habitat impacts

Receptor	Design element	Discussion of potential impact to water receptor
Groundwater dependent habitats		
Blacksike Wood and Bensmoor Wood	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds Deeper excavation (>1mbgl) including: • Southern reception tracks cutting	This ancient woodland has the potential to be groundwater dependent. The site is located adjacent to land required for construction of the proposed Annandale depot. Any potential for impacts on water quality during the construction phase will be managed through the application of the draft CoCP. Therefore, it is assessed that there would be a negligible impact on groundwater quality at this site. The south west corner of the ancient woodland is located within the calculated zone of influence of the proposed southern reception tracks cutting. The uppermost reach of a drain in Blacksike Wood is also located within the zone of influence. If any wetland habitats are present within the ancient woodland, or are associated with the drain, there may be a minor impact on the groundwater contribution and hydrology for these features, depending on location, due to the cutting drainage.
Mossknowe Lodge Wood	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds Deeper excavation (>1mbgl) including: • Headshunt cutting	These separate parcels of ancient woodlands, located in close proximity between the A74(M) and B7076 Roman Road, have the potential to be groundwater dependant. A small section of Mossknowe Lodge Wood No. 1, adjacent to the existing B7076, is within the land required for construction of the proposed Annandale depot. The land required is likely to be for access purposes. Any potential for impacts on water quality during the construction phase will be managed through the application of the draft CoCP. Therefore, there would be a negligible impact on groundwater quality at Mossknowe Lodge Wood No. 1. The impact would also be negligible at Mossknowe Lodge Wood No.2 and No.3 which are adjacent to, but outside, the land required for construction. All three woodlands are located within the calculated zone of influence for the Headshunt cutting. If any wetland habitats are present within the three woodlands, there could be a moderate impact on the groundwater contribution and hydrology for these features due to the cutting drainage.
Ancient woodland east of Grahamshill Railway Cottages	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds Deeper excavation (>1mbgl) including: • Headshunt cutting	This ancient woodland has the potential to be groundwater dependant. It is located adjacent to land required for construction of the Proposed Annandale depot along the existing WCML. Any potential for impacts on water quality during the construction phase will be managed through the application of the draft CoCP. Therefore, it is assessed that there would be a negligible impact on groundwater quality at this site during construction. All of the ancient woodland is within the calculated zone of influence of Headshunt cutting and it may be directly impacted by groundwater level changes caused by the cutting. If any water dependent habitats are present within the ancient woodland, or are associated with a drain located adjacent to the northern boundary of the woodland, there could be a major impact on the groundwater contribution and hydrology for these features due to the cutting drainage.
Kirkpatrick Burn Wood	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds	These ancient woodlands have the potential to be groundwater dependant. They are located just over 50m down-gradient of land required for construction of the Proposed Gretna stabling facility along the existing WCML. Any potential for impacts on water quality during the construction phase will be managed through the application of the draft CoCP. Therefore, there would be a negligible impact on groundwater quality at this site during construction.
Billy's Wood	Above ground elements and shallow excavation (<1mbgl) including: • Ground level or embankment track and roads • Temporary works such as stockpiles and compounds Deeper excavation (>1mbgl) including: • Headshunt cutting	This ancient woodland has the potential to be groundwater dependant. It is located close to land required for construction of the Proposed Annandale depot along the existing WCML. Any potential for impacts on water quality during the construction phase will be managed through the application of the draft CoCP. Therefore, it is assessed there would be a negligible impact on groundwater quality at this site during construction. Billy's Wood North is within the calculated zone of influence of Headshunt cutting and may be directly impacted by groundwater level changes caused by drainage in the cutting. If any wetland habitats are present within the ancient woodland, there could be a moderate impact on the groundwater contribution and hydrology for these features.