Cottam Parkway Railway Station

Environmental Statement

Volume 2: Main Statement

Chapter: Water Environment

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11 Water Environment

ES Chapter Number	Environmental Topic	Relevant Appendices
11	Water Environment	Appendix 11.1: Flood Risk Assessment Appendix 11.2 Highways England Water Risk Assessment Tool (HEWRAT) Appendix 11.3 Water Environment Regulations (WER) Compliance Assessment Appendix 11.4 Figures

11.1 Introduction

11.1.1 This chapter presents the assessment of the Scheme in terms of the surface water environment as follows: surface water quality, surface water supply, hydromorphology, flood risk and groundwater. A brief overview of the Scheme description is provided in 11.1.8 – 11.1.9. For a full description of the Scheme, please refer to Chapter 3 'Description' in this ES.

Hydrological Setting

11.1.2 The Scheme is hydrologically situated within the Savick Brook catchment which has a total catchment area of 49.5km^2. Its source is in the village of Longridge and the catchment is predominately rural in nature before flowing through Preston city centre. The watercourse flows from east to west, approximately 500m south of the Scheme and joins the River Ribble approximately 3.0km downstream of the Scheme. Savick Brook is also

referred to as the Millennium Ribble Link as it has been canalised to form a navigable watercourse with locks; it connects the Ribble Estuary to the Lancaster Canal.

11.1.3 The Lancaster Canal is an artificial, navigable waterway that runs east to west. The canal is located approximately 350m north of the railway station building and is crossed by the access road. The canal is 67km in length and provides a navigable link between the Lancaster Canal and the River Ribble through Savick Brook (via locks on Savick Brook).

11.1.4 Three Ordinary Watercourses flow north to south through or adjacent to the Scheme:

- Lady Head Runnel flows east of the Scheme. It has three culverts upstream of the railway line and starts to flow uncovered from Lea Road south of the Fylde Line/Blackpool Branch Line.
- The middle Ordinary Watercourse is unnamed on Ordnance Survey (OS) mapping and is referred to as Central Watercourse in this chapter. This watercourse flows through the Scheme location via a culvert below the proposed station building, car park and platform structures.
- The third Ordinary Watercourse is situated approximately 350m to the west of the Central Watercourse. This watercourse is referred to as the Western Watercourse in this report.

11.1.5 Each ordinary watercourse is culverted beneath the Lancaster Canal and the Fylde Line/Blackpool Branch Line before converging and joining Savick Brook. Figure 11.1 illustrates the location of Savick Brook, the Lancaster Canal and the three identified Ordinary Watercourses in relation to the Scheme.

11.1.6 There is a watercourse to the far west of the Scheme which is a tributary of the Western Watercourse. There are also a number of ponds within the vicinity of the Scheme with no known outflow, which are assumed to have

originated as marl pits. These water bodies have been scoped out of any surface water quality and hydromorphology impact assessment because they are not hydrologically connected to the Scheme.

Scheme Description

11.1.7 The features of key relevance to the water environment are summarised below:

- a new surface water drainage system that routes surface water runoff from the access road, Railway Station and car park into attenuation storage prior to discharge into local watercourses;
- an access road bridge and associated earthworks and embankments over the Lancaster Canal;
- piling foundations for the access road bridge, footbridge, platform and overhead lines;
- excavations for both the attenuation pond for the access road and the underground attenuation storage, as well as any cuttings associated with the access road;
- construction of embankments for the access road, Railway Station and platforms;
- a new 900mm diameter culvert upstream of the Preston Fylde Junction to Blackpool North line to convey the Central Watercourse beneath the car park and Railway Station. This would replace an existing 225mm diameter culvert along the Central Watercourse and tie into the existing 975mm diameter culvert beneath the railway line;
- an extension of the existing 975mm railway culvert to enable the installation of an emergency evacuation route along the south of the railway line; and

- a culvert extension to convey Lady Head Runnel beneath a proposed emergency muster point and emergency vehicle turning head to the south-east of the Scheme.

11.2 Consultation

11.2.1 During the course of this assessment, consultation has taken place with relevant statutory and non-statutory consultees and stakeholders

11.2.2 This has been summarised in Table 11.1.

Table 11.1: Guidance from consultees

Consultee	Date	Comment
Environment Agency	14 December 2021	Protection of Groundwater Para 2.1.56 of 'Description of the Station and Summary of the Environmental Reports' (undated) states "no negative impacts to groundwater are anticipated." We would like to highlight that the site is located over a Principle Aquifer from the Sherwood Sandstone Group, in Zone 2 of the Source Protection Zone. This should be taken into consideration when designing drainage schemes, and any potential impacts on this resource must be avoided.
The Canal and River Trust (the Trust)	27 January 2022	According to our records there is a watercourse passing underneath the station which seems to be the same watercourse which connects to our culvert 6 under the canal. Based on our records it appears that the outfall side of this watercourse is on the towpath side of the canal, so the station would be downstream. We note that only a short section on drainage and this mentions attenuation ponds and the culverting of the watercourse under the station. Subject to the details on this matter and ensuring that the culverting would not increase the risk of flooding upstream (i.e. towards the canal), then we would be satisfied with this approach in principle.

11.3 Relevant Legislative, Plans, Policies and Background

11.3.1 The following sections report the key legislation, plans and policies of relevance to this chapter.

Acts of Parliament and Regulations

11.3.2 A list of the key pieces of legislation relevant to the Scheme together with a brief summary are provided in Table 11.2.

Table 11.2: Key Acts of Parliament and Regulations

Act of Parliament / Regulation	Summary
Environmental Protection Act 1990	Sets out the fundamental structure and authority for waste management, control of emissions and polluting of controlled waters.
Flood and Water Management Act 2010	This Act established Lead Local Flood Authorities (LLFA) with responsibilities to manage local sources of flooding.
Flood Risk Regulations 2009	Enacted to support the delivery of the Floods Directive requirements and outlines the requirements for flood protection and flood risk management, subsequently reflected in the Flood and Water Management Act, 2010.
The Environmental Permitting (England and Wales) Regulations 2016	The Regulations set out the guidelines for environmental permitting, the circumstances in which environmental permits are required, and compliance obligations. It is relevant to, for example, any works in rivers, dewatering, and any discharges to water

(as amended)	bodies.
The Water Environment (Water Framework Directive) (England and Wales) (WER) Regulations 2017	The provisions of WER require that environmental objectives are set for all surface and groundwater bodies to have regard for water quality standards and betterment wherever possible.
The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019	To protect and improve the water environment from various sources of pollution e.g. from agriculture and urban sources; it is also about protecting human health by preventing contamination of drinking water and bathing waters.
The Environment (Amendment etc.) (EU Exit) Regulations 2019	The Regulations amend the Environment Protection Act 1990 and other key environment legislation to ensure they continue to function properly following Brexit.

11.3.3 The following acts and regulations are also of relevance to this chapter:

- Land Drainage Act 1991 (as amended);
- Water Industry Act 1991;
- Water Resources Act 1991 (as amended);
- Environment Act 1995;
- Climate Change Act 2008;
- Water Act 2014; and,

- Town and Country Planning (Environmental Impact Assessment) Regulations 2017.

Plans and Policies

11.3.4 A list of the key plans and policies are presented in Table 11.3.

Table 11.3: Key Plans and Policies

Plan / Policy	Summary
National Planning Policy Framework 2021 (the NPPF)	The NPPF sets out the Government's planning policies for England. The NPPF is accompanied by National Planning Practice Guidance (NPPG) 'Flood Risk and Coastal Change' was published alongside the NPPF. These identify how new developments must take flood risk into account, including making allowance for climate change impacts and ensuring no increase in risk to people and property elsewhere. Regarding surface water quality, planning policies should prevent unacceptable levels of pollution adversely affecting the water environment and improve local water quality conditions wherever possible.
Preston Local Plan 2012-2026	The Local Plan (Preston City Council, 2015), adopted in 2015, aims to reduce the amount of development in high flood risk zones and help with the implementation of flood alleviation measures in high risk areas. Therefore, an assessment of the flood risk in the study area is required due to the proposed future use of the land. This plan identifies the need for directing development away from areas at high risk of flooding which is included in the site selection process. The plan encourages new developments to

	integrate sustainable drainage systems (SuDS) for surface water management which could be incorporated into the green infrastructure network.
Central Lancashire Core Strategy	The Central Lancashire Core Strategy (Preston City Council et al., 2012), encourages sustainably managed growth, whilst protecting and enhancing green spaces and access to open countryside. Key policies and objectives relevant to the Scheme include: Policy 17 relates to the design of new buildings, which states that designs that will be adaptable to climate change and adopt the principles of sustainable development including the use of SuDS. Policy 18 relates to the use of green infrastructure to manage and improve environmental resources. The policy highlights investment and improvement of the natural environment, including the Lancaster Canal into Preston and securing mitigation or compensation where development may result in the loss or damage to part of the Green Infrastructure network. Policy 29 relates to water management, and aims to improve water quality, water management and reduce the risk of flooding. The policy highlights the need to slow down runoff rates in areas of development to reduce the risk of surface water flooding and encourages the use of SuDS. Strategic Objective SO 23 focuses on the management of flood risk across the area and directing attention to the threats posed by the River

	Ribble. Strategic Objective SO 24 focuses on reducing water usage, protecting and enhancing Central Lancashire's water resources and minimising pollution of water, air and soil.

11.3.5 The following plans and policies are also of relevance to this chapter:

- Central Lancashire Biodiversity and Nature Conservation Supplementary Planning Document (Preston City Council, South Ribble Borough Council and Chorley Council, 2015);
- Ribble: Catchment Flood Management Plan (Environment Agency, 2009);
- Lancashire and Blackpool Local Flood Risk Management Strategy (Lancashire County Council and Blackpool County Council, 2013);
- Lancashire Area Preliminary FRA (Environment Agency, 2017b); and
- Central Lancashire Strategic FRA (Preston City Council, South Ribble Borough Council and Chorley Council, 2007).

11.3.6 Further details on the above plans and policies can be found in Appendix 11.1 Flood Risk Assessment (FRA) in volume 3 of this ES.

Guidance

11.3.7 The assessment has considered relevant key guidance as listed in Table 11.4.

Table 11.4: Key guidance

Guidance	Summary
Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and the Water Environment.	DMRB LA 113 (Highways England *et al*., 2020a) Provides guidance on the requirements for the assessment and management of potential environmental impacts on the water environment.
DMRB LA 104 Environmental Assessment and Monitoring.	DMRB LA 104 (Highways England *et al*., 2020b) Provides guidance on the requirements and procedures for the environmental assessment of projects, including reporting and monitoring of significant adverse environmental effects in line with the requirements of relevant Environmental Impact Assessment (EIA) legislation.
C532 Control of water pollution from construction sites (Construction Industry Research and Information Association (CIRIA, 2001).	Provides guidance on environmental good practice for control of water pollution arising from construction activities. Addresses water quality issues from the inception of a construction project through to the completion of the construction stage and beyond into decommissioning.
C753 SuDS Manual (CIRIA, 2015).	Sets out the planning, design, construction and maintenance of SuDS. Details how to maximise amenity and biodiversity benefits and deliver key

	objectives of managing flood risk and water quality.
C750 Groundwater control: design and practice (CIRIA, 2016).	Guidance on pumping methods used to control groundwater as part of the temporary works for construction projects.
C689 Culvert design and operation guide (CIRIA, 2010).	Guidance on suitable methods for culvert design. Details parameters and considerations for environmental best practice and water conveyance.

11.4 Methodology

11.4.1 The assessment methodology for this chapter is based on the following guidance:

- DMRB LA 113 (Road drainage and the water environment, Highways England *et al*., 2020a); and,
- DMRB LA 104 (Environmental assessment and monitoring, Highways England *et al*., 2020b).

11.4.2 The assessment of potential impacts of the proposed development on the attributes of the surface water environment in this chapter comprises:

- surface water quality: potential impacts on the quality of the water from construction and operational runoff of pollutants, including both acute impacts from soluble pollutants and chronic impacts from sediment-bound pollutants, and from spillage events;
- water supply: potential impacts on the quality and quantity of surface and groundwater fed water supplies;

- hydromorphology: the sensitivity of, and potential impacts upon riverine systems, including flow and sediment;
- flood risk: potential risk of flooding to the development and to third parties from all sources; and
- groundwater: potential impacts on the quality and quantity of groundwater resources, including aquifers, Source Protection Zones (SPZ), private licensed and unlicensed abstractions and discharges, Groundwater Dependent Terrestrial Ecosystems (GWDTE), and receptors which represent extents of groundwater-surface groundwater interaction.

11.4.3 The assessment is also supported by the FRA (Appendix 11.1) and Water Environment Regulations compliance assessment (Appendix 11.3).

11.4.4 Surface and groundwaters are intrinsically linked to ecological receptors, considered in Chapter 6 ;Ecology' of this ES.

11.4.5 Reference has been made to national and local policy documents, relevant British Standards, national guidance and other relevant information (outlined in Tables 11.3 and 11.4) in determining the assessment methodology and criteria to be used.

11.4.6 The assessment is based on general EIA methodology. The methodology described here sets out a list of criteria for evaluating the associated environment effects:

- the importance (sensitivity) of the resource under consideration on a scale of importance (i.e. very high, high, medium, or low);
- the magnitude of impact in relation to the resource that has been evaluated, quantified using the scale large, medium, small, or negligible; and

- the significance of effect using the scale major, moderate, minor, and negligible. For significant effects (moderate and major), additional mitigation could be required to reduce the significance of the effect.

Surface Water Quality Methodology

11.4.7 The assessment of impacts during operation to surface water quality is supported by the HEWRAT Assessment (Appendix 11.2).

FRA Methodology

11.4.8 The Flood Risk Assessment (FRA) has been undertaken in accordance with the NPPF, 2021. A conceptual desk-based assessment has been undertaken using readily available sources of flood risk information, supplemented by hydrological and hydraulic assessments undertaken by the Applicant to inform the design of the proposed culverts and surface water drainage system. Further details of this methodology are presented in the FRA (Appendix 11.1).

Groundwater Assessment Methodology

11.4.9 A conceptual review of hydrogeological processes has been undertaken. This is based on available baseline data received at the time of writing to determine how the construction and operation of the Scheme could impact on identified groundwater receptors. This understanding has been developed into a detailed Conceptual Site Model (CSM), using site-specific Ground Investigation data (where available) and quantitative assessments (where required) to refine the current understanding and further assess how these impacts could vary over time with the different phases of construction and operation.

Assessment Criteria

11.4.10 The assessment criteria outlined in Tables 11.5 to 11.7 are used to determine whether likely environmental effects are considered significant or not.

11.4.11 Importance (Table 11.5) should reflect the importance of features outlined in key policy documents and legislation which can include, amongst other things, its level of designation, or protection. Table 11.6 provides the criteria used to assess the potential magnitude of effect. Table 11.7 provides an illustration of how the significance of effects are derived by combining the magnitude of effect and an asset/resources sensitivity to that change.

11.4.12 Where the matrix indicates two alternative options (e.g. Slight/Moderate), evidence should be provided which supports the reporting of a single significance category. This would consider the importance of receptor and duration and/or extent of works.

11.4.13 For the purposes of this chapter, anything with a Moderate or above (i.e. Major) significance of effect (as outlined in Table 11.7) is considered to be significant.

Table 11.5: Water Environment Importance Criteria

Importance	DMRB LA 113 Typical Examples	Applicable Scheme Examples
Very High	**Nationally significant attribute of high importance.** **Flood Risk:** Essential infrastructure or highly vulnerable development. **Groundwater:** Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation LA 108 (Highways	**Flood Risk:** Highly Vulnerable development and Essential Infrastructure* at risk of flooding during the 1% Annual Exceedance Probability (AEP) (100-year) plus climate change (CC) event.
		Groundwater: Principal bedrock and superficial aquifers. Groundwater flow and yield associated with licensed groundwater abstractions. Groundwater quality within an SPZ1 (Inner Protection Zone) associated with licensed groundwater abstractions. Groundwater feeding GWDTEs with a high or moderate groundwater dependence, a high environmental importance and international or national value, such as Ramsar sites, Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Special Scientific Interest (SSSIs).
		Hydromorphology: WER classified water body achieving 'High' morphology status. Non-WER classified watercourses may be applicable if they demonstrate qualities such as: a channel in stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects unconstrained natural function; free from artificial modification or anthropogenic

	England, 2020c). Groundwater locally supports GWDTE. SPZ1. **Surface water:** Watercourse having a WER classification shown in a River Basin Management Plan (RBMP) and relatively high Q95 value. Site and/or species protected and/or designated under UK legislation. Widely used water supply.	influence.
		Surface Water Quality: WER Regulations classified water body achieving 'High' physico-chemical and biological elements status, 'Pass' for specific pollutants and/or priority substances. Q95 likely to be ≥ 1.0m³/s. Watercourse part of a site protected/designated under UK legislation (SAC, SPA, SSSI, Ramsar site). Non-WER Regulations classified watercourses may be applicable if part of a protected site.
		Water Supply: Water resource extensively exploited for public, private domestic and/or agricultural and/or industrial use, feeding ten or more properties.
High	**Locally significant**	**Flood Risk:** More vulnerable development* at risk of flooding during the 1% AEP (100-

attribute of high importance. **Flood Risk:** More vulnerable development. **Groundwater:** Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE. SPZ2. **Surface water:** Watercourse having a WER classification shown in an RBMP and Q95 <1.0m³/s.	year) plus CC event or at risk from the emergence of groundwater at the surface.
	Groundwater: Secondary A aquifers. Groundwater flow, yield and quality associated with extensive non-licensed private water abstractions (i.e., feeding ten or more properties or supplying large farming / animal estates). Groundwater quality within an SPZ2 (Outer Protection Zone) associated with licensed abstractions. Groundwater feeding GWDTEs of low groundwater dependence, a high environmental importance and international or national value, such as Ramsar sites, SACs, SPAs and SSSIs; or groundwater feeding highly or moderately groundwater dependent GWDTE with a national non-statutory UK Biodiversity Action Plan (BAP) priority.
	Hydromorphology: WER classified water body achieving or having established RBMP objectives (for a later RBMP cycle) to achieve 'Good' morphology status. Non-WER classified watercourses may be applicable if they demonstrate qualities such as: a channel achieving near-stable equilibrium and exhibiting a range of natural morphological features (such as pools, riffles and bars); diversity in morphological processes reflects relatively unconstrained natural function, with minor artificial modification or anthropogenic influence.
	Surface Water Quality: WER Regulations classified water body achieving or having established RBMP objectives (for a later RBMP cycle) to achieve 'Good' physico-chemical and biological elements status ('Good potential' for HMWBs), 'Pass' for specific

	Locally used water supply.	pollutants and /or priority substances. Q95 likely to be <1.0m³/s. Contains species protected under EC or UK legislation Ecology and Nature Conservation but is not part of a protected site. Non-WER Regulations classified water bodies may be applicable if protected species are present, indicating good water quality and supporting habitat.
		Water Supply: Valuable water supply resource due to exploitation for public, private domestic and/or agricultural and/or industrial use, feeding fewer than 10 properties.
Medium	**Of moderate quality and rarity.** **Flood Risk:** Less vulnerable development. **Groundwater:** Aquifer providing water for agricultural or industrial use with limited connection to	**Flood Risk:** Less vulnerable development* at risk of flooding during the 1% AEP (100-year) plus CC event or with potential for groundwater flooding at the surface. **Or,** Highly Vulnerable development, Essential Infrastructure or More vulnerable development at risk of flooding during the 0.1% AEP (1000-year) flood event.
		Groundwater: Secondary B and Secondary Undifferentiated aquifers. Groundwater flow, yield and quality associated with small scale private water abstractions (i.e. feeding fewer than ten properties). Groundwater quality within an SPZ3 (Source Catchment Protection Zone) associated with licenced abstractions; and groundwater quality associated with licensed abstractions for which no SPZ is defined. Groundwater feeding GWDTEs of low groundwater dependence with a national non-statutory UK BAP priority; or groundwater feeding highly or moderately groundwater dependent GWDTE sites with no conservation

	surface water. SPZ3. **Surface water:** Watercourses not having a WER classification shown in an RBMP and Q95 >0.001m³/s.	designation.
		Hydromorphology: Water body not classified under WER Regulations. A channel currently showing signs of historical or existing modification and artificial constraints. attempting to recover to a natural equilibrium and exhibiting a limited range of natural morphological features (such as pools, riffles and bars).
		Surface Water Quality: Water body not classified under WER Regulations. May have a number of anthropogenic pressures and/or pollutant inputs from discharges and/or surrounding land-use relative to flow volume. Q95 likely to be >0.001m³/s.
		Water Supply: Not applicable as all water supplies are always either assigned Very High or High importance
Low	**Lower quality.** **Flood Risk:** Water compatible development. **Groundwater:**	**Flood Risk:** Water-compatible development* at risk of flooding during the 1% AEP (100-year) plus CC event. **Or,** Less vulnerable development at risk of flooding during the 0.1% AEP Flood event.
		Groundwater: Unproductive strata. Very poor groundwater quality and / or very low permeability make exploitation of

	Unproductive Strata **Surface water:** Watercourses not having a WER classification shown in a RBMP and Q95 ≤0.001m3/s.	groundwater unfeasible. No active groundwater supply. Groundwater feeding GWDTEs of low groundwater dependence with no designation or groundwater that supports a wetland not classified as a GWDTE, although may receive some minor contribution from groundwater.
		Hydromorphology: Water body not classified under WER Regulations. A channel currently showing signs of extensive historical or existing modification and artificial constraints. There is no evidence of diverse fluvial processes and morphology and active recovery to a natural equilibrium.
		Surface Water Quality: Water body not having a WER Regulations classification shown in a RBMP. May have a large number of anthropogenic pressures and/or pollutant inputs from licensed discharges and/or surrounding land-use relative to flow volume. Q95 likely to be ≤0.001m³/s.
		Water Supply: Not applicable as all water supplies are always either assigned Very High or High importance

*as defined in the Flood Risk and Coastal Change Planning Practice Guidance to the National Planning Policy Framework (Department for Communities and Local Government, 2021)

Table 11.6: Water Environment Magnitude of Impact Criteria

Magnitude	DMRB LA 113 Criteria	Applicable Scheme Examples
Major adverse	Results in loss of attribute and/or quality and integrity of the attribute.	**Flood Risk:** A large adverse change in flood depth (>100mm), flood extent, velocity or peak flow that may have an impact some distance upstream or downstream. Potential to significantly change flood frequency. Potential change in risk to life. **Groundwater:** Major or irreversible change to groundwater aquifer(s) flow, water level, quality or available yield, endangering resources currently available. Irreparable impact on Groundwater resource, with a major or total loss of an existing supply or supplies. Changes to water table level or quality would result in a major or total change in, or loss of, a groundwater dependent area, where the value of a site would be severely affected. Changes to groundwater aquifer(s) flow, water level and quality would result in major changes to groundwater baseflow contributions to surface water and/or alterations in surface water quality, resulting in a major shift away from baseline conditions such as change to WER Regulations status. Dewatering effects create significant differential settlement effects on existing infrastructure and buildings leading to extensive repairs required. **Hydromorphology:** Loss of, or extensive adverse changes to the watercourse bed, banks and vegetated riparian corridor resulting in changes to existing morphological

		features and/or channel planform and cross section and/or natural fluvial processes. Impacts would be at the water body scale. For WER Regulations classified water bodies, impacts have the potential to cause deterioration on morphology status or prevent the achievement of 'Good' morphology status due to an increase in the extent of morphological pressures on the water body. **Surface Water Quality:** Construction works in-channel and/or extensive construction works adjacent to a watercourse which are therefore likely to risk a major, measurable shift from baseline water quality. Risk of adverse impacts on protected aquatic species. Construction works on multiple tributaries of a watercourse resulting in the risk of a significant cumulative impacts on water quality. Loss or extensive change to a designated nature conservation site. Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT and compliance failure with Environmental Quality Standards (EQS) values. Calculated risk of pollution from a spillage ≥2% annually (spillage assessment). For WER Regulations classified water bodies, water quality impacts have the potential to cause deterioration/reduction in WER Regulations status/classification. **Water Supply:** Long-term loss or change to water supply.
Moderate	Results in effect on integrity of attribute, or	**Flood Risk:** A moderate adverse change in flood depth (>50mm), flood extent or peak flow that may have limited impact some distance upstream or downstream. Potential for

adverse	loss of part of attribute.	some change in flood frequency. Minor changes in floodplain flow pathways that increase velocity or extent of flooding but do not lead to new areas being inundated or new flow pathways forming. **Groundwater:** Moderate long-term or temporary significant changes to groundwater aquifer(s) flow, water level, quality or available yield which results in moderate long-term or temporarily significant decrease in resource availability. Groundwater resource use/abstraction is impacted slightly, but existing supplies remain sustainable. Changes to water table level or groundwater quality would result in partial change in or loss of a groundwater dependent area, where the value of the site would be affected, but not to a major degree. Changes to groundwater aquifer(s) flow, water level and quality would result in moderate changes to groundwater baseflow contributions to surface water and/or alterations in surface water quality, resulting in a moderate shift from baseline conditions upon which the WER Regulations status rests. Dewatering effects create moderate differential settlement effects on existing infrastructure and buildings leading to consideration of undertaking minor repairs. **Hydromorphology:** Adverse changes to on the water feature bed, banks and vegetated riparian corridor resulting in changes to existing morphological features and/or channel planform and cross section and/or natural fluvial processes. Impacts would be at the reach scale. For WER Regulations classified water bodies, impacts may increase the

		extent of morphological pressures. May contribute to, but not cause a deterioration of morphology status. **Surface Water Quality:** Construction works adjacent to a watercourse which are therefore likely to risk a moderate, measurable shift away from baseline water quality. Failure of both acute-soluble and chronic-sediment related pollutants in HEWRAT but compliance with EQS values. Calculated risk of pollution from spillages ≥1% annually and <2% annually. Partial loss in productivity of a fishery. For WER Regulations classified water bodies, water quality impacts may contribute to, but not cause a reduction in water body WER classification. **Water Supply:** Temporary disruption or deterioration in a water supply.
Minor adverse	Results in some measurable change in attributes, quality or vulnerability.	**Flood Risk:** A small or very localised adverse or beneficial change in flood depth (>5mm), extent or peak flow with no perceptible impact upstream or downstream or in the floodplain. Small changes in flood frequency. **Groundwater:** Minor changes to groundwater aquifer(s) flow, water level, quality or available yield leading to a noticeable change, confined largely to the Scheme area. Changes to water table level, groundwater quality and yield result in little discernible change to existing resource use. Changes to water table level or groundwater quality would result in minor change to groundwater dependent areas, but where the value of

		the site would not be affected. Changes to groundwater aquifer(s) flow, water level and quality would result in minor changes to groundwater baseflow contributions to surface water and/or alterations in surface water quality, resulting in a minor shift from baseline conditions (equivalent to minor but measurable change within WER status). Dewatering effects create minor differential settlement effects on existing infrastructure and buildings which may need to be monitored but where repairs may be avoidable. **Hydromorphology:** Slight adverse changes to/impacts on the water feature bed, banks and vegetated riparian corridor resulting in changes to existing morphological features and/or channel planform and cross section and/or natural fluvial processes. Impacts would be at the local scale. For WER Regulations classified water bodies, impacts may result in a slight increase the extent of morphological pressures or occur where there are existing morphological pressures. Morphology status unaffected. **Surface Water Quality:** Construction works within the watercourse catchment that may result in a risk of a minor, measurable shift from baseline water quality. Failure of either acute soluble or chronic sediment related pollutants in HEWRAT. Calculated risk of pollution from spillages ≥0.5% annually and <1% annually. **Water Supply:** Not applicable as (detrimental) impacts to water supplies are only ever considered to have major or moderate adverse effects.

Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity	**Flood Risk:** Very limited potential for change. Flood level increase within model tolerances (+/- 5mm). No change in flood frequency. **Groundwater:** Very slight change from groundwater baseline conditions approximating to a 'no change' situation. Dewatering effects create no or no noticeable differential settlement effects on existing infrastructure and buildings. **Hydromorphology:** Minimal or no measurable change from baseline conditions in terms of sediment transport, channel morphology and natural fluvial processes. Any impacts are likely to be highly localised. **Surface Water Quality:** Construction works within the watercourse catchment that are not anticipated to result in a risk of a change in water quality. No risk identified by HEWRAT (pass both acute-soluble and chronic-sediment related pollutants). Risk of pollution from spillages <0.5%. **Water Supply:** Not applicable as (detrimental) impacts to water supplies are only ever considered to have major or moderate adverse effects.

Table 11.7: Significance of Effects

Magnitude Importance	Negligible	Minor	Moderate	Major
Very High	Slight	**Moderate or Large**	**Large or Very Large**	**Very Large**
High	Slight	Slight or **Moderate**	**Moderate or Large**	**Large or Very Large**
Medium	Neutral or Slight	Slight	**Moderate**	**Moderate or Large**
Low	Neutral or Slight	Neutral or Slight	Slight	Slight or **Moderate**

*Note the above matrix has been adapted from Table 3.8.1 of DMRB LA 104 and does not include a magnitude of 'No Change' or an importance of 'Negligible' as these categories are not included in DMRB LA 113.

Embedded Mitigation and Good Practice

11.4.14 The assessments presented in Section 11.7 and 11.8 of this chapter take into account embedded mitigation, which are inherent to the design, and the implementation of good practice measures.

11.4.15 An overview of the embedded mitigation measures considered relevant to the water environment are detailed prior to the assessment of construction and operation impacts in Sections 11.7 and 11.8.

11.4.16 The need for any additional discipline-specific essential mitigation identified as a result of the assessment is then set out separately in Section 11.10.

Desk-based assessment

11.4.17 The desk-based assessment considered relevant guidance (including DMRB LA 113), and legislation, as provided in Table 11.3 and 11.4.

11.4.18 In addition, the data sources outlined in Table 11.8 have informed the assessments.

Table 11.8: Data sources

Data Source	Details
British Geological Survey (BGS)	Preston 1:50,000 bedrock and drift geological map (BGS, 2012). BGS Onshore GeoIndex online application (BGS, 2020a). BGS Lexicon of Named Rock Units (BGS, 2020b). BGS Groundwater Vulnerability Dataset (BGS, 2020c).
Defra Magic Maps Online Application (Defra, 2021)	Online mapping tool containing multiple discipline-specific datasets, including: Groundwater features on OS maps Aquifer designation Designations (protected areas) Habitats and Species Features of watercourses not visited on site

	surveys (OS mapping and aerial imagery).
Enviro Insight report: Cottam Parkway (Groundsure, 2020)	Information on abstractions, discharges, groundwater flooding susceptibility and GWDTEs.
The Environment Agency (EA)	Information of abstractions and aquifer classifications (Environment Agency, 2017a). Source Protection Zones (Environment Agency, 2018). Environment Agency Flood Map for Planning (FMfP) (Environment Agency, 2021a). Environment Agency Risk of flooding from Surface Water mapping (RoFSW) (Environment Agency, 2021b). Recorded Flood Outlines. Information on WER Regulations classified water bodies, Catchment Data Explorer (Environment Agency, 2021c). The Water Quality Archive (WIMS) (Environment Agency, 2021d).
Central Lancashire Strategic FRA (Preston City Council, South Ribble Borough	Groundwater flooding events.

Council and Chorley Council, 2007)	
Factual report on Ground Investigation (GI) carried out at Preston Western Distributor Structures (IFA, 2015 and 2016)	Ground Investigation Factual Report.
Cottam Parkway Access Bridge and Road Preliminary Sources Study Report (Lancashire County Council, 2021)	Ground Investigation Report (GIR) for site including groundwater levels and monitoring with data abstracted from the Factual Report undertaken for the Preston Western Distributor Structures (IFA, 2015 and 2016).
Cottam Parkway: Access Road and Car Park Combined GIR report (Lancashire County Council, 2021a)	Ground Investigation Report (GIR) for the site, including site-specific groundwater data.
Cottam Parkway: Access Bridge and Embankment GIR report (Lancashire County Council, 2021b)	

Wallingford HydroSolutions (WHS)	Low Flow data (Q95) for water features purchased from WHS (2021).
National Library of Scotland, side by side mapping (NLS, 2021).	Historical Maps of the study area.

study area

11.4.19 The different components of the water environment assessed in this chapter have been assigned different study areas according to the requirements of the technical assessment methodology applied (Table 11.9).

Table 11.9: Summary of study areas

Discipline	Assessment Area	Justification
Surface water quality, and surface water supply	500m buffer in all directions around the provisional Scheme boundary. 1.0km downstream of proposed outfalls for Protected areas.	1.0km downstream of proposed outfalls so applicable and appropriate HEWRAT assessments can be undertaken.
Hydromorphology	500m upstream and downstream of provisional Scheme boundary.	To ensure fluvial impacts from the effects of construction and operation are identified in both the up- and downstream directions on sensitive

		receptors within watercourses.
Flood risk	500m buffer in all directions around the provisional Scheme boundary extended by up to 1.0km downstream	Whilst the focus of the assessment is the planning application boundary, and areas that are hydraulically linked, this has been extended by 500m in all directions and up to 1.0km downstream to ensure that sensitive receptors are identified.
Groundwater	1.0km buffer in all directions around the provisional Scheme boundary	Whilst the focus of the assessment is the planning application boundary, and areas that are hydrogeologically linked, this has been extended by 1.0km in all directions to ensure that sensitive receptors are identified.

Site Walkover and Surveys

11.4.20 A combined flood risk and hydromorphology site walk over survey was undertaken in April 2021.

11.4.21 The purpose of the hydromorphology survey was to identify existing hydromorphological baseline conditions of watercourses potentially impacted by the Scheme and to characterise any morphological risks and/or pressures which could impact on the Scheme.

11.4.22 The hydromorphology survey extents included observation of a 500m reach of the Central Watercourse.

11.4.23 At the time of writing, no site visits were undertaken from a specific groundwater or surface water perspective.

11.5 Assumptions and Limitations

11.5.1 Any assumptions or limitations made/encountered during the preparation of this chapter are detailed under the discipline specific heading below.

Surface Water

11.5.2 The data that have informed the HEWRAT tool are derived from several English motorways, and the tool is designed to be used where traffic volumes experienced regularly exceed 10,000 Annual Average Daily Traffic (ADDT). The traffic model provided for the Scheme details expected traffic volumes will be considerably lower than 10,000 AADT. As such, the results from the HEWRAT assessments undertaken for the Scheme are likely to be conservative. The rainfall data used within the tool are taken from the nearest available rainfall site, Warrington, SAAR 830mm, which is approximately 37km south from the Scheme.

11.5.3 The quoted SuDS treatment efficiencies taken from CIRIA (2015) and National Highways (2020b) are derived from limited studies, and do not account for the length or size of certain SuDS components.

11.5.4 Existing water quality within receiving watercourses is not directly taken into consideration in the HEWRAT routine runoff model.

11.5.5 Further limitations relating to the water quality assessments undertaken are also provided in the HEWRAT Appendix (Appendix 11.2).

11.5.6 The Western Watercourse, Lady Head Runnel and Savick Brook have limited interaction with the Scheme and were not surveyed in detail as part of the hydromorphological site survey. A desk-based study has been undertaken to provide a baseline characterisation of these watercourses using the sources outlined in Table 11.8.

11.5.7 Construction drainage outfall locations are unknown at the time of writing. It is assumed that construction drainage will be discharged to the three ordinary watercourses identified within Section 11.6 - Baseline.

Flood Risk

11.5.8 No specific limitations or assumptions have been applied to the FRA. However, this assessment is reliant on the accuracy of third-party data and information required including a hydrological and hydraulic assessment undertaken by the Applicant to inform the culvert and drainage system designed.

Groundwater

11.5.9 The impact assessment has been prepared based on the GI and laboratory results made available at the time of writing, which have been undertaken according to established protocols. It is possible that the GI and assessment carried out, whilst appropriate to comply with the agreed brief, may not indicate the full extent of conditions beneath the site. Hence, there might be areas of the site, which, if investigated further, may differ from the CSM upon which the assessment is based.

11.5.10 Multiple aspects pertaining to the outline design of the Scheme are currently unknown at this stage, and include but are not limited to:

- formation/invert levels for cuttings, subsurface earthworks, and other structures (e.g. access road bridge) and highway alignments;

- ground improvement schedule (including foundations, piles, cut-off walls, retaining walls etc.), and excavations depths/locations for each. It is presently assumed piling depths for key structures (e.g. overhead lines, platform, platform footbridge, canal bridge etc.) are no greater than 10m in depth;

- detailed temporary works information (including the need for excavations for temporary access tracks, enabling works, soil stripping etc., temporary dewatering requirements, storage areas, stockpile mounds, landscaping); and

- detailed Drainage Strategy (including the excavation depth of attenuation ponds, permanent dewatering requirements, and the need to discharge to ground etc.). It is assumed all attenuation ponds will be lined and no discharge to ground is required.

11.5.11 The outline design for the Scheme does however indicate that there is no requirement for borrow pits, and therefore no borrow pit dewatering impact assessment has been undertaken.

11.5.12 No dewatering risks assessment or foundation and piling risk assessments have been completed. Where significant effects are identified it is assumed the Contractor will undertake these based on forthcoming detailed design and ground investigation information to determine any additional mitigation that is required.

11.6 Baseline Description and Evaluation

11.6.1 This section details the Water Environment baseline for the assessment area and identifies assets where there is potential for significant effects to arise. Table 11.9 provides an overview of the study areas adopted for the Water Environment baseline and assessment. These are presented in Figure 11.1 and Figure 11.2 in Appendix 11.4.

11.6.2 No surface water supplies have been identified within the study area, therefore surface water supply is scoped out of this assessment.

Surface Waters - Overview

11.6.3 The study area consists of three minor surface water features within the Savick Brook catchment, the hydrological setting of which are detailed above in Section 11.1. The Savick Brook (also referred to as Millennium Ribble Link) catchment within the study area covers a mix of agricultural land, primarily to the west, and urbanised residential areas to the north-east and north of the Lancaster Canal.

11.6.4 Diffuse run-off may occur from land-use within the catchment and from land-use adjacent to the Lancaster Canal. The agricultural land-use may be a source of sediment, dissolved organic carbon, nutrients and biological pollutants. Run-off from urban development (from the existing road network, railway and residential areas) is likely to include suspended solids and contaminants bound to them (such as heavy metals and phosphorus); de-icing salt (chloride), oil and related compounds.

11.6.5 There are no protected areas or Nitrate Vulnerable Zones (NVZ) identified within the study area (Defra, 2021).

11.6.6 During the hydromorphology site visit, a number of existing field drains were noted discharging into the Central Watercourse, upstream of the field culvert. No extensive site surveys have been undertaken on the Western Watercourse and Lady Head Runnel. Therefore, full details of all existing outfalls, within the study area, discharging into these watercourses are not known.

Central Watercourse

11.6.7 The Central Watercourse is a minor watercourse which drains in a general north to south direction toward Savick Brook and is not designated under

WER Regulations. The catchment covers a mix of agricultural land, primarily to the west, and urbanised residential areas to the north-east and north of the Lancaster Canal. Riparian vegetation in reaches upstream of the Preston Fylde Junction to Blackpool North line culvert consists of agricultural grass. Downstream, a continuous strip of mature riparian vegetation lines the channel banks which was observed to be providing additional bank stability.

11.6.8 Within the study area, the watercourse displays a low sinuosity, straightened planform and deepened trapezoidal channel cross section, and shows extensive signs of historical modification to follow field boundaries. The realignment to follow field and property boundaries has existing modifications including three culverts. Bed material consists of silt, sand and gravels, with limited coarse material. Bank material consists of poorly consolidated silts, sands and rare gravels overlain with grassed topsoil. Bedforms and processes within the channel are homogeneous. It is likely that the channel is ephemeral during incremental dry periods. Flows within the watercourse on the day of survey were low and unenergetic.

11.6.9 The watercourse is culverted multiple times within the study area including partially below the field immediately upstream of the Preston Fylde Junction to Blackpool North line railway embankment, below the Lancaster Canal and below the Fylde Line/Blackpool Branch Line.

Table 11.10: Summary of baseline importance for the Central Watercourse

Attribute	Description Summary	Importance	Justification
Surface Water Quality	EA Overall Status: Not Classified under WER Regulations. Low flow value (Q95): 0.002m³/s*. (WHS, 2021)	Medium	Non-WER Regulations water body. Q95 > 0.001m³/s

	Anthropogenic pressures, including culverted sections, and pollutant inputs from discharges and surrounding land-use.		
Hydromorphology	Trapezoidal channel with no discernible hydromorphological features or processes. Channel realigned and modified including three culverts.	Low	Not classified under the WER Regulations. Shows extensive signs of historical modification. Lacking morphology; processes homogeneous
Flood Risk	Flood Zone 1. A hydraulic assessment confirms that the existing 975mm culvert beneath the Preston Fylde Junction to Blackpool North line has capacity to convey the 1% AEP fluvial flood flow with 70% increase due to climate change. Baseline flood risk would be driven by the	High	Flood risk to essential infrastructure during 1% AEP flood event.

	capacity of the 225mm culvert upstream of the railway, which would surcharge during the 1% AEP flood event. Flooding would likely be limited to agricultural land but may pose a risk to the railway.		

* This value was calculated by (catchment) scaling Low Flow data generated for Lady Runnel Head watercourse, provided by WHS (2021).

Western Watercourse

11.6.10 The Western Watercourse is a minor watercourse which drains from north to south discharging to Savick Brook downstream of the Scheme boundary. The watercourse is not classified under WER Regulations and receives additional flows from a minor tributary at 348500, 430864 and from the Central Watercourse at 348705, 430572.

11.6.11 The catchment consists of agricultural land. Riparian vegetation upstream of the Preston Fylde Junction to Blackpool North line culvert consists of grass. Downstream of the Fylde Line/Blackpool Branch Line and extending to the Savick Brook, a continuous strip of mature riparian vegetation lines the channel banks.

11.6.12 Within the study area, the watercourse displays a low sinuosity, straightened planform and shows extensive signs of historical modification to follow field boundaries. The realignment follows field and property boundaries, and has existing modifications including two culverts. Desk-based analysis suggests that the Western Watercourse displays a similar planform and fluvial characteristics to the Central Watercourse, where bed material is similar, with limited coarse material. Features and processes are absent.

11.6.13 The watercourse is culverted multiple times within the study area including below the Lancaster Canal and Preston Fylde Junction to Blackpool North line.

Table 11.11: Summary of baseline importance for the Western Watercourse

Attribute	Description Summary	Importance	Justification
Surface Water Quality	EA Overall Status: Not Classified under WER Regulations. Low flow value (Q95): 0.001m³/s* (WHS, 2021) Anthropogenic pressures, including culverted sections, and pollutant inputs from discharges and surrounding land-use.	Medium	Non-WER Regulations water body. Q95 ≥ 0.001m³/s
Hydromorphology	Low sinuosity over straightened channel with likely no discernible hydromorphological features. Channel realigned and modified including two culverts.	Low	Non-WER Regulations water body. Shows extensive signs of historical modification.
Flood Risk	Flood Zone 1. Fluvial flood risk has is inferred from the EA RoFSW	High	Flood risk to local transport infrastructure

Attribute	Description Summary	Importance	Justification
	mapping, which suggests the watercourse poses a risk of flooding to Sidgreaves Lane during the 3.33% AEP flood event.		during 1% AEP flood event

* This value was calculated by (catchment) scaling Low Flow data generated for Lady Runnel Head watercourse, provided by WHS (2021).

Lady Head Runnel

11.6.13 Lady Head Runnel is a minor watercourse which drains from north to south upstream of the Lancaster Canal before draining south-west downstream of the Fylde Line/Blackpool Branch Line, discharging to Savick Brook. Lady Head Runnel is not classified under WER Regulations.

11.6.14 The catchment upstream of the Lancaster Canal consists of urban land associated with residential developments and the existing Cottam Way road network. Downstream of the canal, the channel is culverted below a recreational sports ground prior to the culvert below the Fylde Line/Blackpool Branch Line and Lea Road. Downstream of the railway line, catchment land-use consists of a mix of agricultural land to the east and recreational land consisting of a golf course to the west. Mapping shows the watercourse forms the boundary between the golf course and agricultural fields.

11.6.15 Riparian vegetation in reaches downstream of the Preston Fylde Junction to Blackpool North line culvert consists of a narrow band of continuous mature deciduous trees. Within the study area, the watercourse displays a low sinuosity, straightened planform and shows extensive signs of historical modification following field boundaries. The realignment follows field and

property boundaries, and has existing modifications, including extensive culverting downstream of the canal. Downstream of Lea Road the watercourse displays a low sinuosity planform aligned to follow field boundaries.

Table 11.12: Summary of baseline importance for the Lady Head Runnel

Attribute	Description Summary	Importance	Justification
Surface Water Quality	EA Overall Status: Not Classified under WER Regulations. Low flow value (Q95): 0.001m³/s (WHS, 2021). Anthropogenic pressures, including culverted sections, and pollutant inputs from discharges and surrounding land-use.	Medium	Non-WER Regulations water body. Q95 ≥ 0.001m³/s.
Hydromorphology	Low sinuosity channel; few features/processes. Channel realigned and modified including extensive culverting south of canal.	Low	Non-WER Regulations water body. Shows extensive signs of historical modification.
Flood Risk	Flood Zone 1. Fluvial flood risk is inferred from the EA RoFSW	High	Flood risk to local transport infrastructure

	mapping, which suggests the watercourse poses a risk of flooding to Lea Road during the 3.33% AEP flood event.		during 1% AEP flood event.

Lancaster Canal

11.6.16 The Lancaster Canal is an artificial water body which runs from west to east across the study area to the north of the Scheme. The canal is crossed directly by the Scheme boundary and by the aforementioned surface water features within the study area. The canal is classified under WER Regulations as an artificial waterbody with overall Moderate ecological status. Physico-chemical quality elements are classified as High. Biological elements and specific pollutants are not assessed (EA, 2021c).

11.6.17 The canal is crossed by existing infrastructure including the Preston Western Distributor Road (PWDR) to the west.

11.6.18 As the canal is an artificial waterbody with no hydromorphological features or processes, it has been scoped out of further hydromorphological assessment.

Table 11.13: Summary of baseline importance for the Lancaster Canal

Attribute	Description Summary	Importance	Justification
Surface Water Quality	EA Overall Status: Moderate (2019). EA physico-chemical/biological	Very High	WER Regulations classified water body achieving 'High' physico-

	elements/specific pollutants status: High/ Not Assessed / Not Assessed (2019). Artificial water body and pollutant inputs from discharges and surrounding land-use.		chemical status.
Flood Risk	Records provided by the Canal and River Trust identify historical overtopping and breach events along the Lancaster Canal. However, the risk of culvert collapses and breaches adjacent to the Scheme have been assessed to be low due to Canal being in cut. Only overtopping events driven by pluvial and groundwater ingress have occurred within the vicinity of the Scheme resulting in flooding of Lea Lane and other neighbouring roads to the north of the	High	Historical flood records of floodwater overtopping canal and flooding local transport infrastructure.

	Canal.		

Surface Water Runoff and Areas of Localised Ponding

11.6.19 Environment Agency Risk of flooding from Surface Water (Environment Agency, 2021b) mapping indicates that the risk of surface water flooding across the site area is generally very low (less than 0.1% AEP). However, there are some localised areas with a medium (3.33% to 1% AEP) to high (more than 3.33% AEP) risk. These are largely restricted to isolated pockets of land associated with local depressions or existing seasonal ponds. Mapping indicates the pond features have no outflow and are unlikely to display any natural hydromorphological features or processes. They have therefore been scoped out of further hydromorphological assessment.

Table 11.14: Summary of baseline importance for surface water runoff

Attribute	Description Summary	Importance	Justification
Flood Risk	The risk of surface water flooding across the site area is generally very low (less than 0.1% AEP). However, isolated areas of surface water ponding are predicted within areas of agricultural land during the 3.33% AEP flood event.	Low	Flood risk to localised areas of Pastoral agricultural land during 3.33% AEP flood event.

Savick Brook

11.6.20 Savick Brook is a Main River watercourse forming a tributary to the River Ribble at 348125, 428822. The watercourse is located approximately 1.5km from the Scheme and receives flows from minor watercourses (Western Watercourse, Central Watercourse and Lady Head Runnel).

11.6.21 Savick Brook is designated as Heavily Modified with an overall Moderate ecological status under WER Regulations. Physico-chemical quality elements and biological elements are both classified as Moderate for 2019. There is no recent specific pollutants status available. Hydromorphological supporting elements are classed as Supporting Good but have not been accessed since 2014. RBMP Hydrological Supporting Elements for 2027 are not assessed (EA, 2021c).

11.6.22 Desk-based analysis indicates the channel forms a low sinuosity planform downstream of the study area. The watercourse supports Good hydromorphological designation suggesting it displays a range of diverse hydromorphological features and processes.

Table 11.15: Summary of baseline importance for Savick Brook

Attribute	Description Summary	Importance	Justification
Surface Water Quality	EA Overall Status: Moderate (2019). EA physico-chemical/biological elements/specific pollutants status: Moderate/ Moderate/ Not	High	Species protected under EC legislation but is not part of a protected site. Q95 </> 0.1m³/s.

	Assessed (2019). Low flow value (Q95): 0.056m³/s (WHS, 2021). Granted European Protected Species Applications (Amphibian, Bat) within catchment. No designated protected areas (Defra, 2021). Anthropogenic pressures, including culverted sections, and pollutant inputs from discharges and surrounding land-use.		
Hydromorphology	Overall Moderate Ecological Designation and Supports Good hydrological regime under WER Regulations.	High	Whilst the Scheme is located approximately 0.5km from the waterbody, impacts realised within the minor watercourses could be transferred downstream to the

			Savick Brook. The watercourse is designated as Heavily Modified with a Good overall ecological status and Supports Good hydromorphological regime. RBMP objective for hydromorphological Supporting Elements 2027 is not assessed.
Flood Risk	Whilst the Scheme is remote from flood risk from this source, the A583, Blackpool Road is within Flood Zone 3 associated within Savick Brook.	Very High	Flood risk to essential infrastructure during 1% AEP flood event.

Groundwater

Regional Geology

11.6.23 Superficial deposits of a considerable thickness overlie the bedrock geology across the entire 1.0km study area. The superficial geology local to the study area can be seen in Figure 11.3in Appendix 11.4.

11.6.24 According to BGS mapping much of the study area including the location of the railway station is underlain by glacial till deposits of Devensian age (BGS, 2020a), including impermeable clay deposits.

11.6.25 More recent deposits of Holocene age including head, lacustrine, tidal flat and alluvial deposits can be found within the study area (BGS, 2020a). Head deposits are situated in thin strips in the north and south of the study area. These deposits consist of clay, silts, sands and gravels. Lacustrine deposits are sporadically situated in the northwest of the study area, and comprise clays, silts and sands (BGS, 2020b).

11.6.26 Tidal flat deposits comprised of silt, clay and sand are found to the southwest of the study area (BGS, 2020a). Alluvial deposits are situated to the south of the study area and likely are associated with the Savick Brook. Alluvial deposits generally consist of sands, clays and gravels.

11.6.27 BGS mapping shows bedrock at the location of the study area is entirely comprised of Triassic-aged sandstones of the Sherwood Sandstone Group (BGS, 2012 and BGS, 2020a).

Site-Specific Geology

11.6.28 Two separate GIR reports have been produced as part of the Scheme with the ground investigation (GI) undertaken in March 2021, one for the Access Road Bridge and Embankment Combined Ground Investigation Report (LCC, 2021b) and the other for the Access Road and Car Park Ground Investigation Report (LCC, 2021a).

11.6.29 Both GI confirmed the presence of glacial till across the study area with thicknesses ranging from 15.3 to 17.65m, where proven. Sand layers within the glacial till were identified in both areas of GI.

11.6.30 Both GIR reports record a layer of cohesive upper glacial till, underlying the topsoil. The cohesive layers are described as sandy, slightly gravelly, silty

clays with the granular layers comprised mainly of clayey sand. In the south where the car park is proposed, layers of granular glacial till are recorded within the cohesive layer. The granular layers were found to be between 0.2 to 0.45m thick and found to be relatively shallow in nature. A summary of the geology in the Access Road and Car Park GIR (LCC, 2021a) is shown in Table 11.16.

Table 11.16: Summary of ground conditions in the south of the site

Stratum	Depth (mbgl)	Permeability data (if available)
Topsoil	0.20-0.30	NA
Upper Cohesive Glacial Till	0.20-6	6.23X10-8 m/s 4.83x10-8 m/s
Granular Glacial Till	0.75-3.10	1.41x10-7 m/s

11.6.31 In the northern GIR conducted for the access road bridge and embankment two distinctive granular glaciofluvial deposits layers have been identified between and below the upper and lower cohesive glacial till. These layers have not been identified in the south of the site, however in this area the GI did not reach the depths where the glaciofluvial deposits were recorded, so may be present at depth in the car park location. A summary of the geology identified in the Access Road Bridge and Embankment GIR (2021) can be found in Table 11.17.

11.6.32 During the GI for the access bridge and embankment the lower glaciofluvial deposits were encountered just above the bedrock. A preliminary GIR produced by Lancaster County Council for the site found that these glaciofluvial deposits were more extensive to the west in BH221 to BH224

(LCC, 2021) with depths between 16.90 to at least 20.45mbgl. More details of this Preliminary GIR can be found in Section 11.6.44.

Table11.17: Summary of ground conditions in the north of the site

Stratum	Depth (mbgl)	Permeability Data (If Available)
Topsoil	0.20-0.60	NA
Cohesive Upper glacial Till (UGT)	0.20-12.80	Not available
Granular Upper Glaciofluvial Deposits (UGD)	11.30-15.00	Not available
Cohesive Lower Glacial Till (LGT)	13.70- 16.50	Not available
Granular Lower Glaciofluvial Deposits (LGD)	16.30-17.90	Not available

11.6.33 As part of the GI for the Access Road and Car Park (LCC, 2021a) falling head tests were undertaken in the glacial till (both cohesive and granular) at three locations to determine permeability. The results show a very slow response from the glacial till indicating very low permeability, both in the cohesive and granular strata. No permeability testing was undertaken as park of the Access Bridge and Embankment GIR. The results of these tests are shown in table 11.17 above.

11.6.34 Where encountered during the GI bedrock across the study area was recorded between 15.6 and 18.15mbgl, underneath a thick layer of cohesive

glacial till containing two layers of glaciofluvial deposits. The Lower Glaciofluvial Deposits were found to be directly overlying the bedrock. The top of the sandstone where encountered is described as being lightly to heavily weathered across the site. The thickness of the bedrock was not proven during the GI. The bedrock geology local to the study area can be seen in Figure 11.4 in Appendix 11,4.

Aquifer Classification

11.6.35 The Sherwood Sandstone Group is classified as a Principal bedrock aquifer (Defra, 2021). The Principal bedrock aquifer underlies the entire study area however, it is overlain by a considerable thickness of superficial glacial deposits. This aquifer is part of the Fylde Permo-Triassic Sandstone Aquifers WER Groundwater body (Water Body ID: GB41201G100500), which has a Poor overall rating, with a Poor quantitative status but a Good chemical rating.

11.6.36 A band of Superficial Secondary A aquifer comprised of alluvium runs in a north-east to south-west orientation across the south-east corner of the study area (Defra, 2021). It is likely that the alluvium is a fluvial deposit consisting of sands and gravels of a higher permeability which are associated with both the watercourse channel and flood plain of the Savick Brook. The lacustrine deposits within the study area are also classified as a Secondary A Aquifer, which likely relates to the higher permeability sands.

11.6.37 Most of the superficial deposits across the study area are associated with impermeable glacial till. This is designated as a Secondary (undifferentiated) aquifer. Any groundwater that is present within the glacial till is likely to be perched within more permeable, discontinuous, material in which flow is restricted. The head deposits are also classified as a Secondary (undifferentiated) aquifer.

11.6.38 The tidal flat deposits are classified as being unproductive strata to the west. However, considering that these deposits within the study area are adjacent

to alluvium and follow the watercourse then it is likely that they are more sand than mud dominated due to inputs from the river. The most eastern extent of these deposits along the Savick Brook are therefore classified as a Secondary A aquifer.

11.6.39 The glacial till within the study area is of significant thickness of up to 17.75m where proven, and likely to offer considerable protection to the underlying Sherwood Sandstone Group Principal aquifer.

Groundwater Levels and Flows

Site-Specific GI

11.6.40 11.6.41 During the two 2021 Ground Investigations (LCC, 2021a; 2021b) groundwater strikes were encountered in five window samples, with groundwater levels ranging from 0.95mbgl to 4.10mbgl. Groundwater strikes were also encountered in 5 cable percussion boreholes ranging from 1.40 to 13.20mbgl. All six trial pits were terminated at 2mbgl, with all of them remaining dry. A summary of groundwater strikes encountered during the GI are shown in Table 11.18. There was little rise, if any, recorded in groundwater levels across the site after the initial strike. The groundwater seepages were encountered in localised lenses of sands, gravels and silts across the three different geologies. A location plan of these GI locations is available in Figure 11.3.

Table 11.18: Summary of groundwater strike data for the study area

Borehole ID	Water Strike Depth (mbgl)	Rose to (mbgl)	Strike Geology	Comment
WS03	1.10	NA	Sand	Slight seepage
WS05	1	NA	Sand	NA

Borehole ID	Water Strike Depth (mbgl)	Rose to (mbgl)	Strike Geology	Comment
WS06	0.95	NA	Sand	NA
WS12	4.10	NA	Clay	Slight seepage
WS14	3.5	NA	Clay	Slight seepage
CP02	13.20	NA	Sand- UGD	Slight seepage
CP03	11.70	11.70	Silt- UGD	Slightly wet sands
	12.90	12.90	Silt- UGD	Slightly wet sands
CP04	2.70	2.70	Sand- UGT	Strike
	8.30	8.10	Silt- UGT	Strike
	12.90	12.90	Sand- UGD	Strike
	16.30		Sand- LGD	
CP05	2.20	2.20	Gravel - UGT	Strike
	7.60	7.20	SAND - UGD	Strike
	12.50	12.50	SAND - UGT	Strike

Borehole ID	Water Strike Depth (mbgl)	Rose to (mbgl)	Strike Geology	Comment
CP06	1.40	1.40	SAND - UGT	Water strike in sand lens
	2.80	2.50	SAND - UGT	Strike
NB: UGD- upper glaciofluvial deposits UGT- Upper Glacial Till LGD- Lower Glaciofluvial Deposits				

11.6.41 Subsequent monitoring was undertaken in four window samples (WS05, SW09, WS15 and WS18) and four boreholes (CP01, CP03, CP04 and CP06) over a period of six months from April 2021. The results from the window samples show groundwater levels vary between 0.27-2.88mbgl, with the biggest variation observed in WS18 where a difference of 2.3m in groundwater levels was recorded. In the boreholes, groundwater levels were found to between 9.03mbgl and 13.95mbgl, with the biggest variation in CP04 where a difference of 4.44m was observed. Monitoring results from across the site are shown in Table 11.19.

11.6.42 It should be noted that site specific monitoring data are only available for six months so will not reflect any seasonal variation in groundwater levels.

Table 11.19: Summary of groundwater monitoring data for the study area

Borehole ID	Response Zone (mbgl) (mAOD)	Response Stratum	Minimum Depth (mbgl) (mAOD)	Maximum Depth (mbgl) (mAOD)
WS05	1-4 (20.60-17.60)	Clay and sand	0.27 (21.33)	1.74 (19.86)
WS09	0.5-3 (20.23-17.73)	Clay	0.33 (20.40)	1.65 (19.08)
WS14	1-6 (15.89-10.89)	Clay	0.46 (16.43)	1.47 (15.42)
WS18	0.5-3 (18.87-16.47)	Clay	0.58 (18.90)	2.88 (16.60)
CP01	1-18 (21.50-4.5)	Clay/silt/sandstone	9.03 (13.47)	11.51 (10.99)
CP03	1-16.50 (21.63 – 6.13)	Clay/silt/sandstone	13.40 (9.24)	13.95 (8.69)
CP04	1-17 (21.97-5.97)	Clay/silt/sand	9.17 (13.80)	13.61 (9.36)
CP06	1-17 (21.50-5.50)	Clay/silt/sand/sandstone	2.73 (19.52)	7.38 (14.87)

11.6.43 Parts of the Ground Investigation carried out at Preston Western Distributor Structures (IFA, 2015 and 2016) have been used as part of the Cottam Parkway Access Bridge and Road Preliminary Sources Study Report (Lancashire County Council, 2021). This study represents the subset of

investigation locations that are most relevant to the Scheme. The investigation locations used for the study relate to four cable percussion boreholes (BH221-224) and one window sample (WS227), which were drilled within the location of the proposed bridge over the Lancaster Canal.

11.6.44 The boreholes (BH221-224) were drilled to depths between 20.30mbgl (below ground level) and 22.80mbgl while the window sample (WS227) was drilled to 5.45mbgl. Within these boreholes water strikes were recorded between 12.30mbgl (8.92m AOD (Above Ordnance Datum)) and 18.20mbgl (3.19m AOD) with seepages found from 3.1mbgl (18.12m AOD) (see Table 11.20).

Table 11.20: Summary of groundwater strikes from the Preliminary Source Study Report (LCC, 2021).

Borehole ID	Water Strike Depth (mbgl)	Depth after 20 Mins (mbgl)	Comment
BH221	18.2	18.2	Strike
BH222	17.3	17.3	Seepage
BH223	13	11.3	Strike
	17.1	16.7	Strike
BH224	3.1	3.1	Seepage
	12.3	10.7	Strike
	16.9	15.1	Strike

11.6.45 Subsequently piezometers were installed in the four boreholes with the first measurements taken on the 3 December 2014 and recorded every year until 18 October 2017, and after this yearly until 30 January 2019. From

monitoring results in the Preliminary Source Study Report (LCC, 2021), groundwater levels were found to be variable within the boreholes with BH221 recording a maximum value of 4.18mbgl and a minimum of 12.76mbgl, while BH224 recorded a maximum at 0.00mbgl and a minimum of 12.72mbgl. This indicates the variable nature of the confined groundwater within the glacial till and shows that at times the groundwater could potentially reach the surface when an overlying confining clay layer is penetrated and artesian pressures are released. However, the baseline risk of groundwater flooding at the site is considered to be low and the importance of groundwater flooding as a feature of the water environment is also low.

Regional Groundwater Levels and Flows

11.6.46 In addition to the site-specific GI groundwater levels from the GI works for the Preston Western Distributor Structures (PWDS) (IFA, 2015 and 2016) have also been assessed for the purpose of this report to understand the wider more regional groundwater conditions. Out of 67 boreholes, 45 boreholes identified have monitoring installations within the glacial till and are situated within the study area (within 1.0km of the proposed station location) as presented in Figure 11.3, Figure 11.4 and Figure 11.5. The groundwater levels have been collected using a manual dip meter between the period of November 2014 to September 2018. Groundwater level data have been generally recorded monthly however, not all of the boreholes have a record which spans the entire aforementioned time period.

11.6.47 Manual dip data from the 45 boreholes collected between December 2014 and October 2018 have groundwater levels ranging between 7 and 25 mAOD. The large variability in groundwater levels suggests that there are multiple groundwater bearing horizons within the vertical profile of the glacial till in the study area.

Summary of Groundwater Levels and Flows Across the Study Area

11.6.48 The dataset in the PWDS GI (IFA, 2015 and 2016) shows water levels within the regional boreholes remain relatively consistent over the course of the monitoring period. In the more regional data, short-lived seasonal fluctuations are observed within most boreholes with water levels rising and falling, likely in relation to wetter and drier climatic periods. The more regional GI accounts for seasonal variation with longer monitoring periods than what is available for the site-specific GI.

11.6.49 The consistency of water levels in the PWDS GI (IFA, 2015 and 2016) is an indication that groundwater is located within discreet discontinuous lenses of more permeable material, confined by more impermeable silt and clay layers associated with the deposit. This was confirmed during the site-specific GI where most strikes and seepages were encountered in more permeable horizons. The subsequent monitoring on site showed no correlation in groundwater levels across the site with groundwater levels recorded between 8.69mAOD in CP03 to 21.33mAOD in WS05. Where encountered, the majority of groundwater was seepages rather than strikes, indicating limited volumes of groundwater. This supports the idea of multiple isolated groundwater bearing horizons across the site that are unlikely to be hydraulically connected to one another.

11.6.50 Given the low permeability of both the granular and cohesive glacial till, groundwater flow through glacial till is unlikely to be high, and therefore significant hydraulic gradients are not anticipated to be present. Where the upper and lower glaciofluvial deposits are present there may be a wider hydraulic connectivity within these deposits, however this is not thought to be extensive as there is no evidence of correlation in the groundwater levels found in these layers.

11.6.51 Due to the discontinuous, anisotropic nature of the glacial till, the lateral extent of identified sand horizons is unknown and difficult to categorise with the limited GI. Granular Glacial till was identified within the cohesive glacial

till to the south of the site, however this again is discontinuous in nature and was not found in every GI location. The glaciofluvial deposits were only penetrated in the six cable percussion boreholes in the north, therefore they could be present in the south at depth but this is not proven. This makes it difficult to determine the lateral extent of these glaciofluvial deposits. However, no extensive hydraulic connectivity is predicted in any of the strata at the site given the anisotropic nature of them, apart from in the bedrock. There is the potential for interactions between the bedrock and the lower glaciofluvial deposits, where more permeable layers directly overlie the bedrock, however the extent of these granular/sandy layers is unknown.

11.6.52 Groundwater levels present within a permeable horizon at one location may not exist at adjacent locations. Consequently, groundwater bearing horizons identified in boreholes proximal to the proposed station area may not extend into the area of the proposed station itself. In contrast, where connected permeable pathways exist across the site, movement of potentially significant volumes of groundwater cannot be discounted.

11.6.53 Groundwater held in permeable horizons at depth may also be pressurised and result in artesian conditions at surface when intercepted. However, no artesian conditions were identified during the various GI, but this does not mean that they are not present.

11.6.54 More regionally within the study area groundwater within the alluvium (Secondary A Aquifer) are likely to be high and in hydraulic connection with the Savick Brook. As a result of this, the alluvium is likely to provide baseflow to the watercourse along its margins. During periods of heavy rainfall, groundwater is likely to build up in these deposits and, given it is unlikely to be able to flow downwards due to vertical impediments to flow with the glacial till, will have greater propensity to emerge at ground surface.

11.6.55 In terms of groundwater flooding, higher groundwater flood risk will only occur where permeable lenses of granular glacial till are connected to ground surface, which will be limited. Such lenses are discontinuous and will

be of finite storage with little ability to transmit groundwater anywhere other than upwards. For the majority of glacial till however, it is non-groundwater bearing and therefore low to no risk to groundwater flooding.

Groundwater-Surface Water Interactions

11.6.56 The local groundwater may be connected (either directly or indirectly) to watercourses and other hydrological features as baseflow, sinks, sources, spreads, collects, issues, and springs etc. Changes to groundwater quality and levels beneath the Scheme may therefore influence water quality and/or flows in these watercourses/hydrological features, where impacts to points of groundwater-surface water interaction occur. Points of potential groundwater-surface water interaction have been identified from OS maps/historical maps within the groundwater study area.

11.6.57 Based on the review of OS mapping data via MAGIC website (Defra, 2021) and historical maps (NLS, 2021) no natural springs have been identified within the study area.

11.6.58 Within the 1.0km study area, there are five watercourses identified, three of which flow through the Scheme boundary. The Lancaster Canal is likely to be lined due to the artificial nature of it, however groundwater ingress is a known issue and therefore groundwater-surface water interactions with the Canal cannot be fully discounted. The other two channels within the Scheme boundary (Central Watercourse and Lady Head Runnel) flow across glacial till, with most of the water within the channel likely related to surface runoff and drainage of the land. Given the largely impermeable nature of the till any contributions of groundwater to baseflow are likely to be limited and localised to areas where the watercourses flow through more permeable sandy horizons.

11.6.59 Issues and sinks typically relate to drainage infrastructure (such as culvert outfalls, soakaways etc.) rather than being indicative of shallow groundwater emergence. However, as the marked ‘issues’ or ‘sinks’ have not been

surveyed as part of the current assessment, it is not possible to validate their presence or type. As a result, they have been conservatively treated as 'high' value receptors (spring discharges in this instance) until proven otherwise.

11.6.60 Five 'issues' were identified within the 1.0km study area, with one located within the Scheme boundary itself (Issue at Lady Head Runnel). This issue lies within the southern extent of the site adjacent to the proposed new station location. The locations of the issues are presented in Figure 11.3, Figure 11.4, and Figure 11.5. It should be noted that one issue, located to the north/east of the Scheme boundary is associated with an overflow for the Lancaster Canal (LLC, 2021), which subsequently flows through the site.

11.6.61 Based on the review of OS mapping data, five 'sinks' have been identified within the study area, one of which lies within the Scheme boundary at the proposed station location. The locations of the sinks are also presented in Figure 11.3, Figure 11.4, Figure 11.5.

11.6.62 A summary of all potential groundwater-surface water interactions are presented in Table 11.21.

Table 11.21: Location of receptors and their importance

Receptor Name	Distance from Scheme	Location	Importance
Issue for unnamed watercourse, eastern side of Sidgreaves Lane (Pine House)	863m north	348825 432240	High
Issue east of Brylea Caravan Park	874m north-west	348438 431998	High

Receptor Name	Distance from Scheme	Location	Importance
Issue for Central Watercourse	271m east/north	349223 431641	High
Issue for Lady Head Runnel	Within Scheme boundary	349629 431253	High
Issue at Darkinson Lane	918m south-west	348629 431026	High
Sink on Darkinson Lane	455m west	348844 431238	High
Sink within Scheme boundary, north of railway line	Within Scheme boundary	349337 431356	High
Sink north of Lancaster Canal	283m east	349225 431675	High
Sink at roundabout on Lea Road	290m north-east	349269 431862	High
Sink east of Brylea Caravan Park	923m north-west	348425 432015	High

Groundwater Abstractions

11.6.63 As shown in Figure 11.5, the entire study area is situated within an SPZ3. In this instance, the Zone 3 classification is associated with the Sherwood Sandstone Group Principal aquifer at depth, rather than the glacial till. Within 10km of the study area, there are 12 SPZ1 classifications, the closest of which is situated 2.9km to the northeast of the study area. All 12 of the SPZ1

classifications are situated within the same SPZ3 catchment that extends into the study area.

11.6.64 Groundwater abstractions fall under two categories private licensed abstractions and private unlicensed abstractions. Descriptions of both can be found below (Environment Agency, 2018).

11.6.65 Private unlicensed groundwater abstractions comprise those for quantities of less than 20m^3 per day. There is no obligation to register private water supplies however, some records of these abstractions are kept by the Local Authority if these are known. Preston City Council has confirmed there are no private unlicensed groundwater abstractions within the study area, therefore private unlicensed abstractions have been scoped out of any further assessment.

11.6.66 All groundwater abstractions over 20m^3 per day must have a valid licence authorised by the EA. Consequently, records of all private licenced groundwater abstractions are held by the EA. Five abstractions for dewatering purposes are present 1.05km south-west of the site. Another set of abstractions are located approximately 1.89km, at the closest point to the Scheme boundary, to the west of the study area at Salwick. Given the distance of these abstractions from the site, and the likelihood that they are abstracting from the Sherwood Sandstone Group Principal aquifer at depth, these abstractions have been scoped out of any further assessment.

11.6.67 This assessment has not identified the presence of any wells listed on the current OS mapping within the study area. Eleven wells have been identified on historical maps within 1.0km of the Scheme boundary, however none of these lies within the Scheme boundary itself with the closest lying 73m west. These historical wells could be indicative of either shallow groundwater abstraction associated with permeable lenses within the glacial till, or more likely groundwater abstraction from the underlying Sherwood Sandstone Group Principal aquifer. However, the status of these wells shown on the historical maps are currently unknown and aerial imagery was too poor

quality to identify any features. Therefore, for the purposes of the assessment, they have been conservatively treated as 'high' value receptors until proven otherwise.

11.6.68 A summary of all potential groundwater abstractions are presented in Table 11.22.

Table 11.22: Location of receptors and their importance

Receptor Name	Distance from Scheme	Location	Importance
Historical Well north of railway line where Sidgreaves Lane meets Darkinson Lane	73m west	349058	431336
Historical Well south of railway line on Darkinson Lane	175m west	348999	431281
Historical Well at Bryars Farm	981m west	348297	431777
Historical Well at Danes Pad	371m east	349325	431605
Historical Well at Quaker Lodge	88m north	348998	431807
Historical Well east of Lea Lane	358m north-east	349490	431614
Historical Well east of Lea Road. North of	534m east	349375	431726

Canal			
Historical Well east of cross and Lea Road	422m east	349301	431850
Historical Well at Lea House	39m north	348987	431997
Historical Well at Laburnum House	666m north	348920	432142
Historical Well south of Hoyles Lane	702m north	349052	432181

GWDTE

11.6.69 An assessment of all statutory and non-statutory ecological designations has been undertaken within the study area using the Magic Maps (Defra, 2021 application). As a result of the assessment there were found to be no statutory or non-statutory ecological designations within the 1.0km study area. In addition to this, habitat surveys completed at the site (see Chapter 6 ' Ecology') indicate that there are no GWDTEs present within the study area.

11.6.70 There are two local nature reserves located to the east of the site, Fishwick Bottom LNR and Haslam Park Preston LNR. These LNRs are located 1.2km and 1.7km east, respectively. Descriptions of these areas describe wetland habitats suggesting that GWDTEs may be present within the Local Nature Reserves, however given these are outside the study area and located upstream of the Scheme, these have been scoped out of any further assessment.

11.6.71 Newton Marsh SSSI is situated approximately 4km to the south-west of the Scheme. Due to the large distance between the study area and the SSSI it is

considered unlikely that changes to the hydrogeological regime as a result of the Scheme would have an impact upon the SSSI. Therefore, this has also been scoped out of any further assessment.

Groundwater Vulnerability

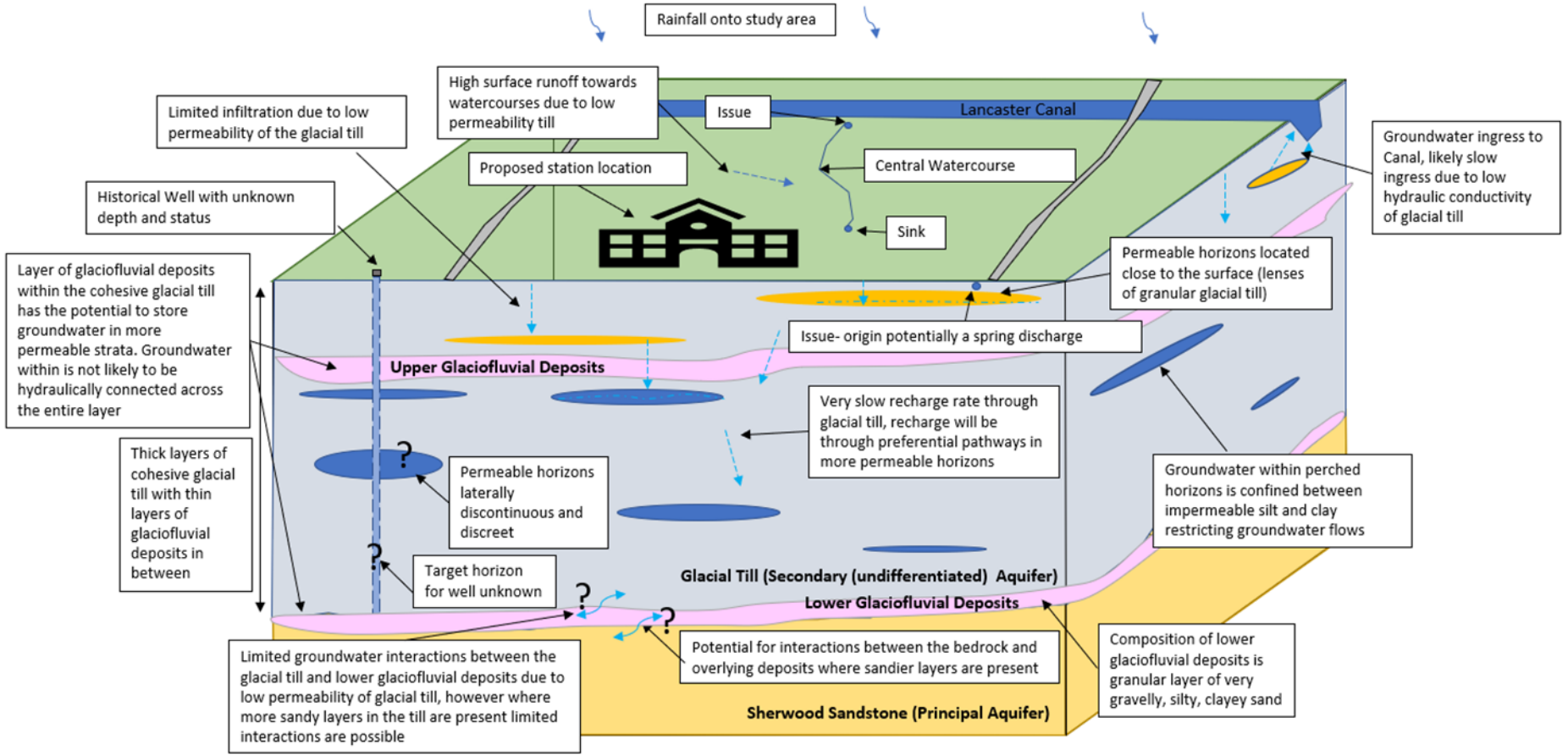
11.6.72 The groundwater vulnerability of the study area is entirely categorised as medium – low. This categorisation is based on the largely impermeable superficial glacial till deposits that underlie the study area. The glacial till is a lower priority groundwater resource that has some natural protection.

11.6.73 Given the glacial till is classified as a lower priority groundwater resource that has some natural protection; this results in a moderate to low overall groundwater pollution risk. Activities in these areas should follow good practice to ensure they do not cause groundwater pollution.

Preliminary Hydrogeological CSM

11.6.74 Based on an understanding of the underlying hydrogeological process and baseline receptor outlined above, the CSM for the site is presented in Figure 11.7.

Figure 11.7: CSM of Study Area



Water Environment Regulations (WER)

11.6.75 The Water Environment (WFD) Regulations (2017) require that all activities within, adjacent to or in the vicinity of a WER Regulations designated water body (surface water or groundwater) are assessed for compliance with WER Regulations legislative requirements. It must be demonstrated there is no deterioration or risk of deterioration to WER classification of surface or groundwater bodies.

11.6.76 The impact assessment considers potential impacts on the scoped-in WER Classification Elements for both surface and groundwater bodies arising from construction and operation. The WER Regulations compliance assessment is contained in Appendix 11.3in volume 3 of this ES.

Flood Risk – Future Baseline

11.6.77 The effects of climate change are predicted to increase the frequency and severity of flood events over the 100-year design life of the Scheme. This would increase the risk of flooding to receptors already at risk, and new receptors currently not at risk including the Preston to Blackpool railway and the local road network. Environment Agency Guidance, which details how this should be considered within FRAs, has been applied to the design and full details are in Section 4 of the FRA (Appendix 11.1). Briefly, guidance requires flood risk to be considered for all rainfall events at a level 50% greater than the predicted rainfall for a 1-100year event.

11.6.78 There is also the potential for new development to occur within the study area with potential planning applications yet to be submitted by Story Homes for the proposed Lee Road residential development north and south of the Scheme. However, assuming that management of flow conveyance and drainage (mainly comprising culverts and highways drainage) continues and that any new development follows current guidance and is designed to remain safe from future flood risk and result in no impact elsewhere then no increase in baseline sensitivity is predicted.

Groundwater – Future Baseline

11.6.79 In general, any new dewatering activities have the potential to reduce groundwater levels in the study area. Conversely, if existing dewatering regimes or abstractions cease, then groundwater levels may rise.

11.6.80 Over the medium-term and long-term, groundwater resources in the study area may be affected by climate change. However, any changes would be complex and may result in:

- a long-term decline in groundwater storage due to higher soil moisture deficits due to warmer, drier summers.
- increased frequency and severity of groundwater droughts leading to reduction in base flow to surface watercourses.
- increased groundwater flooding from high intensity storms and rainfall periods.

11.6.81 Baseline conditions for water quality could change over the anticipated lifetime of the Scheme because of land-use changes and measures to improve water bodies in line with WER Regulations objectives. It is likely that groundwater quality would generally improve as historical pollution sources are removed, and better water quality management measures are put into place.

11.6.82 However, based on currently available information, there is unlikely to be the potential for a significant change to groundwater flow and/or quality in the future. This is due to the propensity for limited amounts of groundwater to be transmissible through the glacial till, which in turn also limits vertical migration of fluids into the underlying Sherwood Sandstone Group Principal aquifer.

11.6.83 Changes to the groundwater regime brought about by climate change are unlikely to affect groundwater quality and/or flow for similar reasons to above

unless groundwater is able to emerge at the surface through permeable pathways in the glacial till, thereby increasing groundwater flooding risk.

Summary of Baseline Importance

11.6.84 Following the assessment of the baseline conditions for each aspect of the water environment, an importance level has been assigned based on the methodology outlined in Section 11.4. Table 11.23 provides a summary of the importance of each receptor that has been identified to interact with the Scheme.

Table 11.23: Summary of baseline importance

Receptor Name	Surface Water Quality	Hydromorphology	Flood Risk
Central Watercourse	Medium	Low	High
Lady Head Runnel	Medium	Low	High
Western Watercourse	Medium	Low	High
Lancaster Canal	Very High	Scoped out	High
Surface water runoff and ponding	n/a	Scoped out	Low
Savick Brook	High	High	Very High
Receptor Name	**Groundwater**		
Issue for unnamed watercourse, eastern side of Sidgreaves Lane (Pine House)	High		

Issue east of Brylea Caravan Park	High
Issue for Central Watercourse	High
Issue for Lady Head Runnel	High
Issue at Darkinson Lane	High
Sink on Darkinson Lane	High
Sink within Scheme boundary, north of railway line	High
Sink north of Lancaster Canal	High
Sink at roundabout on Lea Road	High
Sink east of Brylea Caravan Park	High
Historical Well north of railway line where Sidgreaves Lane meets Darkinson Lane	High
Historical Well south of railway line on Darkinson Lane	High
Historical Well at Bryars Farm	High
Historical Well at Danes Pad	High
Historical Well at Quaker Lodge	High
Historical Well east of Lea Lane	High
Historical Well east of Lea Road. North of	High

Canal	
Historical Well east of cross and Lea Road	High
Historical Well at Lea House	High
Historical Well at Laburnum House	High
Historical Well south of Hoyles Lane	High

11.7 Impacts – Construction (With Mitigation)

Introduction

11.7.1 This section describes the assessment of potential impacts on the surface water environment of the Scheme during construction.

11.7.2 Potential impacts on the surface water environment arising from the construction phases of the Scheme are assessed. This considers and includes embedded mitigation measures for each of the surface water quality/supply, hydromorphology, flood risk and groundwater attributes. All potential impacts reported are adverse, unless otherwise stated.

Embedded and Good Practice Mitigation

11.7.3 Embedded mitigation relevant to this chapter is summarised in Table 11.24 below.

11.7.4 In line with DMRB LA 104 (Highways England *et al*., 2020b), the significance of any potential impact is reported with embedded mitigation measures already considered.

Table 11.24: Summary of Embedded Mitigation relevant to the Water Environment during construction

Topic	Description
Construction Code of Practice (CCoP)	Good practice design and construction measures are assumed to be adequate to ensure that the magnitude of effects would be negligible. These measures would include, but are not limited to: ▪ Avoidance of areas of flood risk. ▪ Good materials management such as adding breaks into stockpiles to minimise disruption of flow. ▪ Appropriate sizing of watercourse crossings in accordance with CIRIA C786 (CIRIA, 2019). ▪ Attenuation of surface water runoff prior to discharge to the ground or to a watercourse at a rate agreed with the relevant Risk Management Authority (RMA). ▪ The design of access tracks and associated drainage to maintain natural catchments and overland flow paths and minimise the impact on floodplains. ▪ Lining of soil storage areas, ensuring that run-off is captured and there will be no infiltration to the ground. ▪ Guidance for Pollution Prevention to be followed. ▪ Development of a Construction Environmental Management Plan (CEMP) as part of Environmental Management System requirements. ▪ Limit the removal of riparian vegetation. Where removed reinstate to baseline conditions or to

	provide betterment thereof. ▪ Limit in/near channel working and the tracking of plant and machinery within the vicinity of the channel. ▪ Any work in or near channel such as culvert replacements/extensions should be undertaken during periods of low flow. ▪ Follow relevant good practice guidance on the construction of culvert replacements and extensions (CIRIA, 2010). ▪ Follow relevant good practice guidance on the construction of the operational outfalls (CIRIA, 2019). ▪ Consider green bank protection/matting during the construction of outfalls.
Pre-earthworks drainage	Pre-earthworks drainage is likely to take the form of ditches and will be constructed at the top of cuttings and the base of embankments where surface water and sub-surface pathways from adjoining land will flow towards the Scheme or other receptors, thus intercepting the flow. The purpose of the pre-earthworks drainage is to collect runoff from the natural catchments surrounding the Scheme and convey overland flow to the nearest watercourse, maintaining the existing hydrological regime of the natural catchment, where possible.

Surface Water Quality

11.7.5 Potential construction works/activities that may impact surface water features in the study area include in-channel working, and (earth) works

adjacent to the channel or within the catchment of the water features. Specific impacts may include/result in a measurable, temporary shift from baseline water quality, a decline in pollutant removal capacity and river ecosystem health, and a loss of aquatic species. These impacts, and potential causes of them, are explained in greater detail in Table 11.25. The list of potential impacts documented is not exhaustive but are examples of the most likely. The assessment of these impacts on the individual surface water features are reported in Table 11.26.

Table 11.25: Potential general impacts during construction

Type of Impact	Description
Decline in surface water quality	▪ An increase in suspended sediment concentrations in downstream water features from construction of crossing structures in-channel or on watercourse banks, soil stripping and vegetation removal, soil storage, erosion of drainage ditches and all other earthworks which could result in the mobilisation of sediment. ▪ Accidental release of oils, fuels and chemicals to the water environment from mobile or stationary plant in or near to water features, and from inappropriate refuelling and fuel storage practices. Increases in alkalinity from poor management and spillages of concrete or cement. ▪ Inputs of contaminants to the water environment could occur from disturbance of potentially contaminated land with potential drainage pathways to surface water features. Contaminated particles within suspended sediment may increase the bio-toxicity of in-channel sediment deposits. ▪ Sewage inputs to the water environment from

	accidental/uncontrolled release from sewers through damage to pipelines during service diversion or unsatisfactory disposal of sewage from site staff facilities.
Reduction in dilution capacity	▪ A reduction in the dilution capacity of a watercourse due to the decline in water quality (as described above) or diversion of sub-catchment flows.
Adverse impacts on biodiversity	▪ A decline in river ecosystem health and loss of protected aquatic species due to the decline in water quality (as described above). ▪ Excess sediment affecting the health of aquatic fauna by interfering with respiration and increasing stress levels. ▪ Releases of chemicals and concrete which can have severe or fatal consequences on freshwater ecology.

11.7.6 The Central Watercourse may be impacted by works within the catchment to the west associated with the construction of the roundabout, access road and canal crossing. In-channel works required for the proposed culvert replacement and extension associated with the new railway station, platforms, secondary means of escape (SME) and car park may also cause surface water quality impacts on the Central Watercourse, as might construction from four new outfalls.

11.7.7 The Western Watercourse runs adjacent to the Scheme and may be impacted by the construction of the roundabout, accessroad and canal crossing, which are within 250m of the watercourse, and near to in-channel works associated with four new outfalls.

11.7.8 Lady Head Runnel may be impacted by in-channel works required for the proposed culvert replacement and extension associated with the new access road may also cause surface water quality impacts on Lady Head Runnel, as might construction of a new outfall and from works within the catchment associated the SME muster area.

11.7.9 Lancaster Canal may be impacted by works in the water body associated with the new crossing and from construction works adjacent to the canal.

11.7.10 Savick Brook is located downstream of the Scheme and Western, Central and Lady Head Runnel watercourses are all tributaries of it. Therefore, the Savick Brook may be potentially impacted by all forms of construction works associated with the Scheme.

Table 11.26: Potential impacts on specific water features – Construction

Water Feature	Type of Impact	Importance	Magnitude	Significance
Central Watercourse	Decline in surface water quality. Reduction in dilution capacity. Adverse impacts on biodiversity.	Medium	Minor	Slight
Western Watercourse		Medium	Minor	Slight
Lady Head Runnel		Medium	Minor	Slight
Lancaster Canal		Very High	Minor	Moderate/Large
Savick Brook		High	Negligible	Slight

Hydromorphology

11.7.11 During the construction phase, the following activities have been identified as having the potential to impact on the hydromorphology of watercourses identified in the baseline:

- construction of three temporary site compounds (including topsoil stripping, earthworks, provision for compound drainage, and creating areas of hardstanding);
- removal and replacement of the existing field culvert on the Central Watercourse upstream of the Preston Fylde Junction to Blackpool North line;
- construction of the culvert extension downstream of the railway station building on the Central Watercourse to accommodate the SME;
- construction of the culvert extension under the emergency muster area associated turning head south of the Preston Fylde Junction to Blackpool North line;
- construction of the railway station building, footbridge over the railway line, railway station platforms and associated car park facilities;
- construction of the access road and surface water drainage systems; and
- discharge of construction drainage to watercourses.

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

- increased fine sediment input which could enter surface water features from runoff generated during construction. This can lead to the potential smothering of morphological features and alteration of hydromorphological processes within the receiving channel;

- changes to flow regime due to the discharge of external flows such as construction drainage into surface water features and over-pumping during culvert construction/extension. This could cause alterations to flow regime with subsequent changes to morphological features and processes;

- loss of riparian vegetation to facilitate construction of the design. Removal of riparian vegetation can lead to decreases in channel bank stability and increases in runoff entering surface water features; and

- disturbance of channel bed and banks through construction in or near channel. In-channel and near-channel construction (including culverts and outfalls) could lead to the removal of natural bed substrate and natural hydromorphological features, disruption and removal of lengths of natural bank and bed.

11.7.13 The potential impacts relating to the construction activities outlined above are described for each watercourse in Table 11.27 and summarised in Table 11.28.

Table 11.27: Hydromorphological impacts during construction

Type of Impact	Description
Increased sediment input	▪ Given the limited range of hydromorphological features and processes within the Central and Western Watercourses and Lady Head Runnel, and the overall distance from construction areas to the Western Watercourse, it is unlikely these watercourses would be sensitive to changes in fine sediment input. Therefore, the impact of increased sediment input would be Negligible with a Neutral significance of effect. ▪ Due to the distance from working areas, it is unlikely increases in sediment laden runoff would be realised

	on Savick Brook. Therefore, the impact of increased sediment input would be Negligible with a Neutral significance of effect.
Changes to flow regime	▪ Construction drainage discharges would likely be attenuated to green field runoff rates. ▪ Over-pumping would likely be required to facilitate culvert replacements/extensions on the Central Watercourse and Lady Head Runnel. ▪ Given that construction drainage discharges would be attenuated to greenfield runoff rates and over pumping would take place during periods of low flow the impact of changes to flow regime is reported as Minor with a Slight significance of effect. ▪ It is not anticipated construction drainage would be discharged to the Savick Brook, and no over pumping would be required therefore no impacts are anticipated.
Loss of riparian vegetation	▪ The replacement of the field culvert on the Central Watercourse will extend approx. 10m longer than the existing culvert. Current design proposals indicate that the existing culvert below the railway will be extended downstream. Lea Road culvert on Lady Head Runnel will also be extended downstream. All culvert extensions would require the removal of mature riparian vegetation ▪ Construction of operational outfalls (OF2, OF3a and OF3b) on the Western Watercourse would require riparian vegetation removal. ▪ It is likely riparian vegetation is contributing to bank

	stability on the Central Watercourse downstream of the railway, on Lady Head Runnel downstream of the Lea Road culvert and on the Western Watercourse around the proposed outfall locations. Therefore, the impact of loss of riparian vegetation related to culvert extensions and outfall construction would be Minor with a Slight significance of effect on these watercourses. ▪ No works will take place within the vicinity of Savick Brook and therefore no impacts are anticipated.
Disturbance and loss of natural bed and banks	▪ Culvert replacements/extensions and the construction of operational outfalls would involve the over-pumping of the watercourses to provide a dry working area, tracking of plant and machinery along the watercourse banks and the removal of natural channel bed and bank to facilitate the new/extended culverts. ▪ On the Western Watercourse operational drainage outfalls (OF2, OF3a and OF3b) would be constructed. OF6 would be constructed within the extended culvert Lead Road culvert on Lady Head Runnel – therefore no impacts are anticipated from the construction of this outfall however impacts from the culvert extensions still remain. ▪ Given that the channel bed and banks are easily erodible in locations where outfalls and culvert extension/replacements are required the impacts would be Minor, with a Slight significance of effect on the Central and Western Watercourses and Lady Head Runnel.

	▪ No works will take place within the vicinity of Savick Brook and therefore no impacts are anticipated.

Table 11.28: Summary of hydromorphological construction impacts

Water Feature	Type of Impact	Importance	Magnitude	Significance
Central Watercourse	Increased sediment input	Low	Negligible	Neutral – not significant
	Changes to flow regime		Negligible	Neutral – not significant
	Loss of riparian vegetation		Minor	Slight – not significant
	Disturbance and loss of natural bed and banks		Minor	Slight – not significant
Western Watercourse	Increased sediment input	Low	Negligible	Neutral – not significant
	Changes to flow regime		Negligible	Neutral – not significant
	Loss of riparian vegetation		Minor	Slight – not significant
	Disturbance and loss of natural bed and banks		Minor	Slight – not significant
Lady Head	Increased sediment	Low	Neutral – not	Neutral – not

Runnel	input		significant	significant
	Changes to flow regime		Slight – not significant	Slight – not significant
	Loss of riparian vegetation		Slight – not significant	Slight – not significant
	Disturbance and loss of natural bed and banks		Slight – not significant	Slight – not significant
Savick Brook	Increased sediment input	High	Negligible	Neutral– not significant
	Changes to flow regime		No impacts anticipated	n/a
	Loss of riparian vegetation		No impacts anticipated	n/a
	Disturbance and loss of natural bed and banks		No impacts anticipated	n/a

Flood Risk

11.7.14 The FRA (Appendix 11.1) includes a full assessment of the potential impacts of the Scheme on flood risk as shown in Table 11.29. A summary of construction works impacts are shown in Table 11.30.

11.7.15 It is anticipated that the overall magnitude of impact on Flood Risk from the effects associated with the construction phase works would be negligible

resulting in a significance of neutral. No additional essential mitigation is therefore required.

Table 11.29: Potential general impacts during construction

Type of Impact	Description
Loss of floodplain storage	▪ The location of site compounds and the storage of construction materials and equipment on site could potentially reduce floodplain storage and divert flood flow routes. ▪ The location of construction compounds within Flood Zone 1 and in areas remote from flooding associated with Ordinary Watercourses would ensure that the impact of this potential effect would be negligible.
Temporary flow constrictions during culvert construction	▪ The construction of the new culvert is likely to require the installation of a cofferdam or similar structure along with over-pumping to create a dry working area. Temporary work located within or adjacent to watercourses could affect the frequency, depth, extent, and duration of fluvial flooding. However, the timing of these works to avoid periods of wet weather together with the design of the works that would be approved by the Local Lead Flood Authority through the environmental permitting process would ensure that the impact on flood risk is negligible.
Increase in surface water runoff rate	▪ The majority of proposed features would be located on open areas that have permeable surfaces. The compaction of soil and the creation of impermeable surfaces associated with the proposed compounds and construction access tracks, have the potential

	to increase the rate of surface water runoff. This has the potential to result in impacts on local surface water flood risk and/or fluvial flood risk within the receiving watercourse. ▪ Embedded mitigation in the form of site drainage would ensure that the magnitude of this impact is negligible at the compound locations and in receiving waterbodies.
Changes in groundwater levels	▪ The groundwater assessment has concluded there is possibility that ground works may create barriers perpendicular to localised groundwater flow pathways leading to mounding of groundwater and possible emergence on up-gradient side and reduction in baseflow on down-gradient side. This would need to be confirmed at detailed design stage based on further GI and confirmation of finalised piling depths; in the meantime moderate magnitude impacts cannot be discounted.
Potential damage to canal structures	▪ The Scheme includes a new three-span design access road bridge (see Section 3.1.3) west to the existing Quaker's Bridge. Construction works could damage the canal structure itself, which could impact potential canal flood mechanism. ▪ Good practice mitigation including the design and construction of the bridge following detailed ground investigation and consultation with the Canal and River Trust would ensure that there is a very low likelihood of adverse impacts to the canal and the magnitude of impacts has been assessed to be negligible.

Table 11.30: Summary of flood risk construction impacts

Water Feature	Type of Impact	Importance	Magnitude	Significance
Central Watercourse	Loss of floodplain storage	High	Negligible	Slight – not significant
Western Watercourse	Temporary Flow constrictions during culvert construction	High	Negligible	Slight – not significant
Lady Head Runnel		Very High	Negligible	Slight – not significant
Surface water runoff	Increase in surface water runoff rate	High	Negligible	Slight – not significant
Savick Brook		Low	Negligible	Slight – not significant
Lancaster Canal	Potential damage to canal structures	High	Negligible	Slight – not significant
Groundwater flooding	Changes in groundwater levels	Low	Moderate adverse	Moderate - significant

Groundwater

11.7.16 During construction it is considered likely that potential impacts to groundwater features (including superficial and bedrock aquifers, and associated groundwater receptors, such as points of groundwater-surface water interaction, private licensed and unlicensed abstractions, SPZs, etc.) could arise from the following:

- during construction, there is a risk of groundwater contamination from the accidental spillage of fuels, lubricants, cementitious materials, hydraulic fluids, or other harmful substances. These could be stored and used throughout the Scheme, although the main storage areas would be in the construction compounds. Leaks and spills of these materials could migrate from the surface into aquifers and subsequently to secondary receptors such as groundwater abstractions and points of groundwater-surface water interactions;

- physical contamination of groundwater from ground disturbance such as soil stripping, construction of cuttings, and foundations for embankments), bridge abutments/gantries, other excavations required (for attenuation ponds for example), and piling, leading to the potential for increased sediment in groundwater reaching key receptors. The pollution risk to groundwater bodies, from the disturbance of contaminated ground specifically, is covered in Chapter 10: 'Soils, Geology and Hydrogeology' of this ES;

- the construction of cuttings, foundations, excavations for attenuation ponds, and piling activities could create vertical pathways for contaminated groundwater to migrate between aquifers. Even if groundwater is not contaminated, there is potential for mixing of different groundwater chemistries, which could be significant for WER Regulations groundwater body status, as well as for sensitive groundwater receptors, including groundwater abstractions and points of groundwater-surface water interaction;

- impedance of groundwater flow from temporary below ground structures, and the potential corresponding impact on groundwater levels and/or quality;

- local groundwater drawdown as a result of temporary dewatering. This may be required to construct any sub-surface structures, such as cuttings, foundations, and other excavations required (such as attenuation ponds) that intercept the groundwater table. Drawdown

impacts on groundwater levels, flows, and quality may be experienced in areas outside of the works area. Discharges from dewatering may also impact on receiving surface water or groundwater bodies; and

- interception of overland flows through the introduction of impervious structures or compaction of soils, and the movement and storage of earth materials within the study area, potentially disrupting local groundwater recharge. The working area for construction is likely to be relatively small in comparison to the scale of the majority of aquifer(s) being crossed.

11.7.17 Based on the receptors outlined in the baseline section, a summary of the significance of impacts relating to construction activities associated with the Scheme are summarised in Table 11.31. A full description of the temporary construction impacts of each activity to support the magnitude of impact and significant effects assessment scoring is presented in Appendix of this chapter.

Table 11.31: Summary of potential impacts to groundwater receptors

Receptor	Activity	Importance	Magnitude	Significance
Glacial till Secondary (undifferentiated) aquifer	Piling/ foundations of canal bridge, footbridge and staircase and station platform.	Medium	Moderate Adverse	Moderate
Sherwood Sandstone Group Principal aquifer		Very High	Negligible	Slight
SPZ 3		Medium	Negligible	Neutral
Issue for Lady Head Runnel	Sheet pile wall extending along the canal for full length of the proposed bridge.	High	Negligible	Slight
Issue for Central Watercourse		High	No Impact	n/a
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway line		High	No Impact	n/a
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	Negligible	Slight

Receptor	Activity	Importance	Magnitude	Significance
Lancaster Canal, Lady Head Runnel and central watercourse		High	Negligible	Slight
Western Watercourse and Savick Brook		High	No Impact	Slight
Glacial till Secondary (undifferentiated) aquifer	Excavation of attenuation pond for the new road and roundabout, and underground attenuation pond.	Medium	Moderate Adverse	Moderate
Sherwood Sandstone Group Principal aquifer		Very High	No Impact	n/a
SPZ 3		Medium	No impact	n/a
Issue for Lady Head Runnel	Excavation of cutting for road at bridge.	High	Minor Adverse	Moderate
Issue for Central Watercourse		High	Negligible	Slight
Three issues (outside study area)		High	No Impact	n/a

Receptor	Activity	Importance	Magnitude	Significance
Sink north of railway line	Culvert extension.	High	Minor Adverse	Moderate
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	Negligible	Slight
Lancaster Canal, Lady Head Runnel and central watercourse		High	Moderate	Moderate
Western Watercourse and Savick Brook		High	No Impact	n/a
Glacial till Secondary (undifferentiated) aquifer	Embankments.	Medium	Minor Adverse	Slight
Issue for Lady Head Runnel		High	Minor Adverse	Slight
Issue for Central Watercourse		High	Negligible	Slight

Receptor	Activity	Importance	Magnitude	Significance
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway line		High	Minor Adverse	Slight
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	Negligible	Slight
Lancaster Canal, Lady Head Runnel and central watercourse		High	Minor Adverse	Slight
Western Watercourse and Savick Brook		High	Minor Adverse	Slight
Glacial till Secondary (undifferentiated) aquifer	Compound area and access routes construction and material storage areas- including vegetation clearance, topsoil	Medium	Minor adverse	Slight
Issue for Lady Head Runnel		High	Major	Very Large

Receptor	Activity	Importance	Magnitude	Significance
Issue for Central Watercourse	stripping and compaction.	High	Minor Adverse	Slight
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway line		High	Moderate Adverse	Moderate
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	Negligible	Slight
Lancaster Canal, Lady Head Runnel and central watercourse		High	Minor Adverse	Slight
Western Watercourse and Savick Brook		High	Negligible	Slight

11.8 Impacts – Operation (With Mitigation)

Introduction

11.8.1 This section describes the assessment of potential impacts, on the surface water environment, of the Scheme during operation.

11.8.2 Potential impacts on the surface water environment arising from the operational phases of the Scheme are assessed, considering and inclusive of embedded mitigation measures, separately for each of the surface water quality/supply, hydromorphology, flood risk and groundwater attributes. All potential impacts reported are adverse, unless otherwise stated.

Embedded and good practice mitigation

11.8.3 In line with DMRB LA 104, the significance of any potential impact is reported with embedded mitigation measures already considered. Embedded mitigation relevant to this assessment are summarised in Table 11.32.

Table 11.32: Summary of Embedded Mitigation relevant to the Water Environment (Operation)

Topic	Description
Drainage design including SuDS	The Scheme drainage includes six drainage outfalls discharging to three water features. Where SuDS are included, they are designed to treat pollutants and attenuate runoff to acceptable levels before discharging to the water environment. Engineering and environmental factors were considered to confirm the drainage design and the types and locations of SuDS features. Specific SuDS and attenuation features for individual catchments are as follows:

	▪ Catchment 1: Surface water runoff, piped to attenuation pond through existing Cottam Link drainage system. ▪ Catchment 2: Surface water runoff piped to attenuation pond and discharged to watercourse; ▪ Catchment 3: Filter catch pits to Western Watercourse; ▪ Catchment 4: Stored in attenuation tank and oversized pipes to manhole on culvert extension; ▪ Catchment 5: Stored in oversized pipes to manhole on culvert extension; ▪ Catchment 6: Stored in oversized pipes to Lady Head Runnel; ▪ Catchment 7: Piped and discharged into headwall; and ▪ Catchment 8: piped to and stored in an attenuation tank to manhole on culvert extension. Further detail is also provided Appendix 11.2 'HEWRAT Assessment'.
Routine Maintenance	Routine maintenance of drainage systems that include but are not limited to: ▪ inspect inlets, outlets, banksides, structures and pipework for any blockage and/or structural damage and remediate where appropriate; ▪ regular inspection and removal of accumulated sediment, litter and debris from inlets, outlets,

	drains and ponds to avoid sub-optimal operation of SuDS; and, ▪ adherence to the maintenance plans specific to each SuDS component type as detailed within The SuDS Manual (CIRIA, 2015b).
Outfall structures	In relation to outfall structures efforts should be made to: ▪ provide sufficient energy gradient differential for maintenance of flow and hydraulics from outfall locations; ▪ outfalls should be positioned so that discharges are directed towards the centre of the channel to follow the natural flow of water in the channel and not towards the opposite banks; and ▪ provision of scour protection where required i.e., at outlet headwall. Green protection should be used in preference to grey protection where appropriate.
Riparian Vegetation	▪ ensure re-planting of vegetation around outfall structures, tying in with natural vegetation. The planting of trees, if removed, is of particular importance for bank stability; ▪ banks should be re-graded to replicate existing bank conditions, where practicable. Bank slopes of at least 1 in 2 are typically considered to be stable. Reinstated banks should be further stabilised with biodegradable geotextile and re-planted with suitable riparian vegetation where applicable; and, ▪ incorporate fence-lines to protect banks and establish planting where required.

Culvert replacement / extensions	In relation to culvert extension/replacements efforts would be made to: ▪ maintain natural channel width and bed gradient through the culvert where possible. Avoid sharp changes in culvert gradients; ▪ culverts should be designed using appropriate CIRIA guidance. Preliminary designs should be completed through detailed design which should undergo consultations with the required statutory consultees.
Monitoring and Maintenance	In relation to new and extended culverts post project appraisal, including an operational management and maintenance plan would be developed. The plan should include monitoring of culvert replacements/extensions for sediment and debris clearance, riparian vegetation management, and structure repair or maintenance.

Surface Water Quality

11.8.4 Potential impacts that may affect surface water features in the study area during operation include road runoff discharges associated with operation, changes in channel morphology and impacts of new culverts. These impacts may lead to a measurable, temporary or prolonged shift from baseline water quality, a decline in pollutant removal capacity and river ecosystem health and a loss of aquatic species. These impacts, and potential causes of them, are explained in greater detail in Table 11.33 (Potential general impacts during operation). The list of potential impacts documented is not exhaustive but are examples of the most likely. The assessment of these impacts on the individual surface water features are reported in Table 11.33 and Table 11.34.

Table 11.33: Potential general impacts during operation

Type of Impact	Description
Decline in surface water quality	▪ Increased pollutant loading from the operation of the Scheme, comparative to the pollutant loading from the existing road network, could reach surface water features from accidental spillages via outfalls or other surface water pathways. This could include suspended solids and contaminants bound to them (such as metals and phosphorus); biodegradable organic materials (such as debris and grass cuttings); diffuse sources with high levels of nutrients (nitrogen and phosphorus); de-icing salt (chloride); and oil and related compounds. ▪ Changes to channel morphology (refer to Hydromorphology operational impacts) could have an associated effect on water quality by mobilising suspended solids and releasing previously 'locked' contaminants into the water column. ▪ New or extended culverts could cause oxygen sags due to the lack of light, restricting aquatic plant photosynthesis and rapid microbiological degradation of biodegradable matter. Typically, longer structures would have greater impacts on water quality. Any reduction in surface area through culverts would also likely reduce atmospheric oxygenation of the water. ▪ Changes in turbulence could also affect atmospheric oxygenation of the water.
Reduction in	▪ A reduction in dilution capacity due to the decline

dilution capacity	in water quality.
Adverse impacts on biodiversity	▪ A decline in ecosystem health due to the decline in water quality.

11.8.5 Western Watercourse and Central Watercourse will receive operational discharges from mainline drainage as well as from traffic free or low traffic catchments. These two watercourses have been subject to two assessments, routine runoff and accidental spillage risk, using HEWRAT (National Highways, 2019). Full details of these assessments and results are reported in Appendix 11.2 'HEWRAT Assessment' Lady Head Runnel will receive operation discharges from the from the SME and SME access road (traffic free).

11.8.6 Lancaster Canal and Savick Brook will not receive any operation drainage directly from outfalls associated with the Scheme.

11.8.7 The HEWRAT routine runoff assessments for proposed drainage were undertaken in accordance with LA 113 (Highways England *et al*., 2019a). All input data and results are fully detailed along with the assessment method in Section 25 Appendix 11.2: 'HEWRAT Assessment'.

11.8.8 All single and cumulative assessments undertaken pass all aspects of the HEWRAT routine runoff assessment at the Step 2, prior to mitigation, including EQS compliance for Copper and Zinc. An ‘Alert’ warning is associated with the Pass results for the sediment-bound pollutant aspect of the assessment for single outfalls 2 and 4 on the Western and Central Watercourses, and cumulative outfalls 1 and 2 on the Western watercourse. This is due to the presence of a culvert within 100m downstream of the respective proposed outfall locations that may reduce velocity and result in accumulation of sediments.

11.8.9 At Step 3 after mitigation all assessments passed for all HEWRAT aspects, this equates to a Negligible impact of operational drainage for the Western and Central Watercourses. This demonstrates the betterment of water quality delivered within the receiving watercourses from the proposed outfalls from the Scheme.

11.8.10 For all applicable drainage catchments, associated outfalls and receiving watercourses throughout the Scheme, spillage risk assessment results are deemed to be within acceptable limits in accordance with DMRB LA 113, even when compared to the most sensitive annual probability threshold (0.5% or return period >200 years). All spillage risk results represent a negligible environmental impact (see Appendix 11.2 for detailed results).

11.8.11 As Lady Head Runnel only receives discharges from a traffic free catchment, and Savick Brook and Lancaster Canal do not receive and direct discharges, the impact of operational drainage on these watercourses is considered to be Negligible.

Table 11.34: Summary of potential operation impacts on surface water quality.

Water Feature	Type of Impact	Importance	Magnitude	Significance
Central Watercourse	Decline in surface water quality Reduction in dilution capacity Adverse impacts on	Medium	Negligible	Neutral
Western Watercourse		Medium	Negligible	Neutral
Lady Head Runnel		Medium	Negligible	Neutral
Lancaster Canal		Very High	Negligible	Neutral

Savick Brook	biodiversity	High	Negligible	Neutral

Hydromorphology

11.8.12 During the operation phase, the following activities have been identified as having the potential to impact on the hydromorphology of watercourses identified in the baseline:

- operation of replacement and extended culverts;
- operation of outfalls structures and associated discharges; and
- changes to flow paths and catchment areas relating to the operation of the design.

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

- loss of hydromorphological features including natural bed and banks, changes in channel gradient and potential channel adjustment related to culvert extensions/replacements. This could impact flows, sediment regime and the lateral and longitudinal connectivity of the watercourse and alter fluvial process;
- changes in flow regime due to alteration of overland flow paths related to new infrastructure. This could potentially lead to the interruption of natural fluvial processes (although these are limited), including sediment transport, which has an overall effect on the watercourse's equilibrium and natural diversity; and
- operational discharges to watercourses have the potential to cause changes in flow regime within the vicinity of the outfall, erosion of the channel bed and banks due to increased discharge velocities. Changes in flow regime may lead to changes in existing fluvial process.

11.8.14 The assessment of these impacts on the individual surface water features are reported in Table 11.35 and Table 11.36.

Table 11.35: Summary of hydromorphological impacts during operation

Type of Impact	Description
Operation of new and extended culverts	▪ Potential for alteration of existing fluvial processes and loss of existing channel bed and banks upstream by increasing culverted length by approximately 10m. No morphological features currently exist upstream. ▪ The new culvert on the Central Watercourse would be larger in diameter and could also alter channel gradient leading to potential channel adjustment downstream as the watercourse establishes a new equilibrium. Adjustment could include increases in erosion due to increased flow volumes from the larger culvert during high flow events. ▪ The culvert extensions/replacements downstream of the station building on the Central Watercourse and downstream of Lea Road on Lady Head Runnel may also lead to deposition within the culverts during low flows due to possible reductions in the channel gradients. Increased flow velocities and decreased roughness from the culvert could further alter sediment entrainment and morphologic behaviour within these channels, though this may not be significant. ▪ No discernible hydromorphological features or processes are observed on the Central Watercourse. Desk-based analysis would suggest this is also the case for Lady Head Runnel. The

	banks surrounding the culvert outlet downstream of the railway line on both watercourses are currently vegetated with a mature continuous riparian strip. Should this be retained, it would aid in reducing bank erosion through increased flows through the culvert during high flow events. Therefore, the impact is reported as Minor, with a Slight significance of effect for the Central Watercourse and Lady Head Runnel. ▪ No culverts will be required on the Western Watercourse or Savick Brook therefore no impacts related to culvert extensions/replacement are anticipated.
Changes to flow regimes and disturbance to channel bed and banks from operational drainage discharges	▪ Operational outfalls OF4 and OF8 would discharge directly into the replaced field culvert before entering the Central Watercourse. Operational outfalls OF5 and OF7 would discharge into the extended railway culvert on the Central watercourse downstream of the station building. Therefore, the discharge of flows in these locations would not directly impact on natural bed and banks but could increase flows within the culverts. ▪ Given that operational discharges would likely be discharged at greenfield runoff rates, the impact is reported as Negligible with a Neutral significance of effect. ▪ Operational outfalls OF2, OF3a and OF3b would discharge to the Western Watercourse and OF6 would discharge to the extended culvert below Lea Road on Lady Head Runnel. Operational drainage discharges would likely be attenuated to greenfield

	runoff rates. Therefore, any impact on flow regimes or to the channel bed and banks of the Western Watercourse and Lady Head Runnel would be Minor with a Slight significance of effect. ▪ No operational discharges are anticipated on Savick Brook and therefore no impacts are anticipated.
Changes in flow regime related to changes in overland flow paths	▪ The operation of the Scheme may lead to changes in overland flow paths through alteration of local catchment topography due to new structures and embankments associated with the design. ▪ Additionally, an operational surface water drainage system would capture overland flows and divert them to treatment prior to release to surface water features at an attenuated rate. This has the potential to limit the volume of water entering the Central and Western Watercourses and Lady Head Runnel potentially leading to changes in fluvial process and features. ▪ The Central Watercourse was observed to lack discernible hydromorphological features and process and is possibly ephemeral. Desk-based assessment indicates limited hydromorphological features and processes on the Western Watercourse and Lady Head Runnel. ▪ Therefore, the impact on the Central and Western Watercourses and Lady Head Runnel would be Minor with a Slight significance of effect.

Table 11.36: Summary of hydromorphological operation impacts

Water Feature	Type of Impact	Importance	Magnitude	Significance
Central Watercourse	Operation of new and extended culverts	Low	Minor	Slight – not significant
	Changes to flow regime and bed/bank disturbance related to operation of outfalls		Negligible	Neutral – not significant
	Changes in flow regime related to changes in overland flow paths		Minor	Slight – not significant
Western Watercourse	Changes to flow regime and bed/bank disturbance related to operation of outfalls	Low	Minor	Slight – not significant
	Changes in flow regime related to changes in overland flow paths		Minor	Slight – not significant
Lady Head Runnel	Operation of new and extended culverts	Low	Minor	Slight – not significant
	Changes to flow regime and bed/bank disturbance related to operation of outfalls		Minor	Slight – not significant

	Changes in flow regime related to changes in overland flow paths		Minor	Slight – not significant
Savick Brook	No Impacts anticipated	High	n/a	n/a

Flood Risk

11.8.15 The FRA (Appendix 11.1) includes a full assessment of the potential impacts of the Scheme on flood risk. Potential general impacts during operation are provided in Table 11.37. A summary of operational works effects are provided in Table 11.38.

11.8.16 It is anticipated that the overall magnitude of impact on Flood Risk from the effects associated with the operational phase works would be negligible resulting in a significance of neutral. No additional essential mitigation is therefore required.

Table 11.37: Potential general impacts during operation

Type of Impact	Description
Change in flow regime through operation of new culverts	▪ The Scheme includes the replacement of the existing 225mm culvert upstream of the railway culvert with a larger 900mm culvert that would tie into the existing 975mm railway culvert. This would be designed to convey the 1% AEP + 30% design event. This would reduce the risk of fluvial flooding upstream of the proposed railway station and car park.

	▪ The replacement of the existing culvert with one with larger diameter would however have the potential to increase pass forward flows, which could increase the risk of flooding downstream. However, at present, flood flows that exceed the capacity of the existing 225mm culvert would still be able to enter the 975mm railway culvert as these are not continuous. Therefore, the existing 225mm culvert would have a limited throttling effect on flows. ▪ A residual risk of blockage or failure of the culvert would remain. However, this is an existing risk and management and maintenance as part of the proposed development is likely to reduce this residual risk albeit by a negligible magnitude. ▪ The Lidar data and the RoFSW mapping indicate that the channel of the Central Watercourse downstream of the railway is deeply incised with a narrow floodplain. Therefore, any minor increase in peak flow through the culvert may increase flood depths in the channel but is unlikely to increase the extent of flooding. Also, the land-use downstream of the railway comprises golf courses and farmland with no highly vulnerable receptors identified. Therefore, any minor changes in flood extent would have a negligible consequence and the impact on flood risk would be negligible. ▪ The proposed new culvert across Lady Head Runnel to enable the construction of the emergency area would be designed in accordance with CIRIA C786 and would convey the 1% AEP

	flow event including allowance for climate change. Therefore, the impact on fluvial flows would be negligible. ▪ The proposed crossing downstream of the railway would have equal or greater capacity compared to the upstream culvert, the magnitude of the impact would therefore be negligible.
Changes in surface water runoff rate	▪ To manage the potential impacts of the increase in impermeable surfaces on surface water and fluvial flooding, a drainage strategy has been prepared to manage surface water runoff prior to discharge. This includes discharge to local ordinary watercourses at the greenfield runoff rate of 6.5l/s/ha. ▪ With this drainage strategy in place, any residual impacts would be limited to flood flows during rainfall events that exceed the capacity of the drain or in the event that the drainage system becomes blocked. A programme of maintenance and inspection would help to reduce the risk of blockages. Therefore, with the proposed drainage strategy in place, the magnitude of effects on fluvial and surface water flooding would be negligible and no additional mitigation is recommended.
Changes in Groundwater levels	The construction of foundations has the potential to disrupt groundwater flow and displace groundwater storage. However, due the limited groundwater held within the underlying strata and the limited extent of deep foundations, the magnitude of this potential impact has been assessed to

	be negligible.

Table 11.38: Summary of flood risk operation impacts.

Water Feature	Type of Impact	Importance	Magnitude	Significance
Lady Head Runnel	Change in flow regime through operation of new culverts	High	Negligible	Slight – not significant
Central Watercourse		High	Negligible	Neutral - not significant
Savick Brook	Changes in surface water runoff rate	Very High	Negligible	Slight – not significant
Lady Head Runnel		High	Negligible	Slight – not significant
Central Watercourse		High	Negligible	Slight – not significant
Western Watercourse		High	Negligible	Slight – not significant
Surface water runoff		Low	Negligible	Neutral - not significant
Groundwater flooding	Changes in groundwater levels	Low	Negligible	Neutral - not significant

Groundwater

11.8.17 During operation, it is considered likely that potential general impacts to groundwater features could arise from the following:

- increased pollution risks from routine runoff during the operational life of the Scheme where it is not captured and discharged to in accordance with, or differing to, the drainage strategy. Potential substances would primarily consist of silts, hydrocarbons, and dissolved heavy metals, which may migrate to groundwater bodies. Of particular importance are natural drainage features which also may attenuate routine run-off, such as issues and sinks, which may be present and active in or near designated areas, or licensed and unlicensed groundwater abstractions;

- increased pollution risks from accidental spillages of fuels and chemicals during the operational phase, for example due to road traffic accidents;

- there is potential for the embankments proposed to result in groundwater stored in pore spaces in the superficial deposits (where present), to be squeezed out, causing the ground beneath the embankment to compress. Groundwater levels, flows, and quality in the superficial deposits, both underneath the embankment, and in its vicinity, could therefore be altered;

- changes to groundwater levels, flows and quality, due to the presence of permanent below ground structures, such as foundations for bridge abutments and sheet piles, resulting in barriers to sub-surface flows, and/or providing new pathways for groundwater migration. This could lead to subsequent changes to groundwater levels, flows, quality, and locations of discharge points, for example to surface watercourses;

- potential ongoing dewatering effects from subsurface structures that require permanent drainage. This may cause the groundwater table to

fall, impacting on groundwater receptors, as well as surface water flows and users; and

- permanent reduction in recharge rates due to the increased surface area of impermeable ground. However, the increased area of impervious surfaces is likely to be relatively small in comparison to the scale of most aquifer(s) being crossed.

11.8.18 Based on the receptors outlined in the baseline section, a summary of the significance of impacts relating to operational activities associated with the Scheme are summarised in Table 11.39. A full description of the permanent construction/operational impacts of each activity to support the magnitude of impact and significant effects assessment scoring is presented in Appendix A. of this chapter

Table 11.39: Summary of operational impacts on groundwater receptors

Receptor	Activity	Importance	Magnitude	Significance
Glacial till Secondary (undifferentiated) aquifer	Sheet piling/piling/foundations of canal bridge, footbridge and staircase and station platform.	Medium	Minor Adverse	Slight
Sherwood Sandstone Group Principal aquifer		Very High	Negligible	Slight
SPZ 3		Medium	No Impact	n/a
Issue for Lady Head Runnel		High	Negligible	Slight
Issue for Central Watercourse		High	No Impact	n/a
Three issues (outside study area)		High	No Impact	n/a

Receptor	Activity	Importance	Magnitude	Significance
Sink north of railway line		High	Negligible	Slight
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	No Impact	n/a
Lancaster Canal, Lady Head Runnel and central watercourse		High	Negligible	Slight
Western Watercourse and Savick Brook		High	Negligible	Slight
Glacial till Secondary (undifferentiated) aquifer	Permanent drainage associated with excavations for attenuation ponds and	Medium	Minor Adverse	Slight

Receptor	Activity	Importance	Magnitude	Significance
Sherwood Sandstone Group Principal aquifer	cuttings.	Very High	No Impact	n/a
SPZ 3		Medium	No Impact	n/a
Issue for Lady Head Runnel		High	Minor Adverse	Slight
Issue for Central Watercourse		High	No Impact	n/a
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway line		High	Minor Adverse	Slight
Four sinks (outside study area)		High	No Impact	n/a

Receptor	Activity	Importance	Magnitude	Significance
Historical wells (outside study area)		High	No Impact	n/a
Lancaster Canal, Lady Head Runnel and central watercourse		High	Minor Adverse	Slight
Western Watercourse and Savick Brook		High	No Impact	n/a
Glacial till Secondary (undifferentiated) aquifer	Permanent construction of embankments.	Medium	Minor Adverse	Slight
Issue for Lady Head Runnel		High	Minor Adverse	Slight
Issue for Central Watercourse		High	No Impact	n/a

Receptor	Activity	Importance	Magnitude	Significance
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway line		High	Minor Adverse	Slight
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	No Impact	n/a
Lancaster Canal, Lady Head Runnel and central watercourse		High	Minor Adverse	Slight
Western Watercourse and Savick Brook		High	Minor Adverse	Slight

Receptor	Activity	Importance	Magnitude	Significance
Glacial till Secondary (undifferentiated) aquifer	Accidental spillages associated with highways/traffic/car park/railway movements.	Medium	Minor Adverse	Slight
Sherwood Sandstone Group Principal aquifer		Very High	No Impact	Slight
SPZ 3		Medium	No Impact	n/a
Issue for Lady Head Runnel		High	Minor Adverse	Slight
Issue for Central Watercourse		High	No Impact	n/a
Three issues (outside study area)		High	No Impact	n/a
Sink north of railway		High	Minor Adverse	Slight

Receptor	Activity	Importance	Magnitude	Significance
line				
Four sinks (outside study area)		High	No Impact	n/a
Historical wells (outside study area)		High	No Impact	n/a
Lancaster Canal, Lady Head Runnel and central watercourse		High	Minor Adverse	Slight
Western Watercourse and Savick Brook		High	Minor Adverse	Slight

11.9 Cumulative Effects

Surface Water Quality

11.9.1 Relevant cumulative effects and impacts of surface water quality have been assessed via HEWRAT routine runoff assessments. Road runoff discharging into the Western Watercourse from both the Scheme and the PWDR have been assessed using a cumulative assessment. Once mitigation measures are considered, either proposed or currently in place, all aspects of HEWRAT are passed and the overall magnitude of impact of operational discharge on surface water quality is Negligible resulting in an overall Neutral significance of effect, i.e. non-significant with relevance to EIA Regulations.

Hydromorphology

11.9.2 With the inclusion of embedded mitigation measures as detailed within this chapter, no significant cumulative effects are anticipated as a result of the Scheme.

Flood Risk

11.9.3 A review of planning applications submitted, identifies that residential development are currently proposed by Story Homes adjacent to the Central Watercourse immediately north of the Scheme. These applications are currently at screening stage and no details of drainage design are available. However, any proposed developments would need to comply with the requirements of national and local policy with regard to flood risk. As such any developments within the study area would have a neutral impact on flood risk throughout their development life and therefore, there would be no potential for significant cumulative effects.

Groundwater

11.9.4 A review of planning applications submitted has been undertaken to determine the potential for cumulative groundwater impacts to be caused in the future. With the exception of the PWDR/East West Link Road and nearby housing development proposed by Story Homes, it is considered that there are no cumulative impacts when taking into account the proposed additional developments. This is due to distance of the proposed developments from the Scheme and the widespread presence of glacial till. The widespread presence of glacial till across the sites suggests the developments are unlikely to be in hydraulic continuity due to the perceived lack of significant groundwater pathway linkages. Consequently, all impacts related to the Scheme are anticipated to constrained to the immediate environments of the Scheme boundary.

11.9.5 The PWDR/East West Link Road is located directly north of the Scheme. However, given the presence of glacial till and lack of perceived shallow pathways this road development is also not expected to result in cumulative impacts to the water environment.

11.9.6 In contrast, the development proposed by Story Homes has a boundary which overlaps with the Scheme boundary. It is not envisaged that the housing development would require deep foundations or excavations that would impact the groundwater environment in the same way as currently indicated for the Scheme. Any impacts to the groundwater caused by the Scheme are also likely to equilibrate reasonably quickly, which subject to timing of the housing development construction should not be enhanced by, or damaging to the adjacent works. However, depending on the timing of construction, localised dewatering/de-pressurisation may result in the potential for differential settlement effects to extend between the sites, and such effects would need to be managed by the site developer(s) based on their understanding or the perceived risks and local ground conditions. If construction is concurrent, steps should be taken by both developers to ensure direct and/or indirect discharges to groundwater are law abiding and

suitably mitigated through complimentary material management and water management plans.

11.10 Mitigation

Construction

11.10.1 Mitigation is most effective if considered as an integral part of the Development design to avoid, reduce, or offset any adverse effects on the water or wider environment.

Surface Water Quality

11.10.2 No impacts of Moderate or above have been identified from the surface water quality impact assessment detailed in Section 11.7 for the construction phase should all embedded mitigations be adhered too.

Hydromorphology

11.10.3 The assessment of effects in Section 11.7 considers the application of both embedded mitigation and good practice measures. This assessment identified that all predicted impacts would be either neutral or slight. These are not considered to be significant and therefore no additional mitigation is necessary, and no residual impacts are predicted.

Flood Risk

11.10.4 The assessment of effects in Section 11.7 considers the application of both embedded mitigation and good practice measures. This assessment identified that all predicted impacts would be either neutral or slight with the exception of impacts on groundwater flooding during the construction phase. These negligible or slight impacts are not considered to be significant and therefore no additional mitigation is necessary and no residual impacts are predicted. The impacts on groundwater flooding are considered to be

potentially significant and essential mitigation relating to the management of groundwater during construction is detailed in Table 11.40.

Groundwater

11.10.5 Where piling is required for the construction of any structures, such as bridges and platforms, then a piling risk assessment in line with Environment Agency guidance (Environment Agency, 2006) would be required to confirm that preferential flow paths would not be created that lead to unacceptable impacts to Controlled Waters. Other below-ground works should also be considered and would need to be risk assessed in a similar way, prior to construction.

11.10.6 If temporary dewatering is required in order for construction activities to take place, such as for cuttings, embankment/bridge foundations, or excavations for attenuation ponds, a dewatering risk assessment should be undertaken to confirm acceptability of approach and any necessary additional mitigation, for example by following the hydrogeological impact appraisal for dewatering abstractions (Environment Agency, 2007).

11.10.7 A site walkover by the Contractor should be undertaken to determine the nature of the groundwater features identified in Table 11.40 to determine groundwater dependency. In conjunction with reviewing the detailed design for the Scheme and any ground investigation information, the Contractor should revise the impact appraisal by undertaking a hydrogeological risk assessment to determine whether any further additional mitigation is required to reduce significant effects to acceptable levels. In areas where a direct impact upon the groundwater receptors are predicted extra measures such as avoiding topsoil stripping in that area and erecting fencing around the feature should be considered based on the outcome of the site walkover. Local diversions of surface water flow paths sourced from groundwater may also need to be implemented.

11.10.8 The drainage design should take into consideration the presence of a Principal Aquifer and SPZ3 at depth across the study area when designing the drainage. Avoiding discharges to ground will reduce the risk of contaminants infiltrating into the groundwater.

11.10.9 Subject to the above additional mitigation being completed, the residual significance of the effects that require additional mitigation to be applied should reduce to slight and/or neutral.

Operation

Surface Water Quality

11.10.10 No impacts of Moderate or above have been identified from the surface water quality impact assessment detailed in Section 11.8 for the operation phase should all embedded mitigations be adhered too.

Hydromorphology

11.10.11 The assessment of effects in Section 11.8 considers the application of both embedded mitigation and good practice measures. This assessment identified that all predicted impacts would be either neutral or slight. These are not considered to be significant and therefore no additional mitigation is necessary and no residual impacts are predicted.

Flood Risk

11.10.12 The assessment of effects considers the application of both embedded mitigation and good practice measures. This assessment identified that all predicted impacts during the operational phase would be either neutral or slight. These negligible or slight impacts are not considered to be significant and therefore no additional mitigation is necessary and no residual impacts are predicted.

Table 11.40: Summary of essential mitigation measures

Mitigation Item Reference	Approximate Location	Timing of Measure	Responsible Party for Implementation	Description	Mitigation Purpose/ Objective	Specific Consultation or Approval Required	Monitoring Measure for the Suggested Mitigation
W1	Throughout	Construction	Main Contractor	Implementation of CEMP to include embedded mitigations detailed in Section 11.7	Protect the water environment during construction	Environment Agency	A suitably qualified and experienced Environment Clerk of Work shall be appointed by the Contractor to oversee the implementation of mitigation and monitoring of the water
W2	At proposed bridge and station location	Construction	Main Contractor	Piling risk assessment	Protect groundwater from contamination	Environment Agency	
W3	At proposed attenuation	Construction	Main Contractor	Dewatering risk	Protect groundwater	Environment	

	pond and underground storage area and areas of cuttings			assessment	features	Agency	environment.
W4	Throughout, where groundwater features have been identified	Construction	Main Contractor	Site walkover to determine nature of any groundwater features and undertaking a hydrogeological risk assessment	Protect groundwater features	Environment Agency	

11.11 Summary

Surface Water Quality

11.11.1 No significant effects on surface water quality are anticipated during the construction and operational phases, provided prescribed mitigation is adhered to.

Hydromorphology

11.11.2 No significant effects on hydromorphology are anticipated during the construction and operational phases, provided prescribed mitigation is adhered to.

Flood Risk

11.11.3 A FRA identified that the Scheme would need to consider flood risk from and impacts to fluvial flooding, surface water, groundwater, and canals. However, it the development has been located within Flood Zone 1 after a sequential approach to site selection has been applied and is generally at low risk from other sources identified. As the Scheme would be classified as Essential Infrastructure, its location within Flood Zone 1 is considered to be appropriate within planning practice guidance.

11.11.4 Embedded mitigation and good practice including the appropriate design of a new culvert to convey the Central Watercourse beneath the new station and a surface water management system based on SuDS would ensure the Scheme is safe from flooding without increasing the risk of flooding elsewhere. Therefore, it would comply with the requirements of the NPPF and with the requirements of local planning policies and guidance.

Groundwater

11.11.5 No residual significant effects to groundwater are anticipated during the construction and operational phases, provided embedded and additional mitigation is implemented.

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Appendix A: Groundwater Assessment

Table A.1 Temporary Construction Significant Effect Assessment

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Glacial till Secondary (undifferentiated) aquifer	Medium	Piling/ foundations of canal bridge, footbridge and staircase and station platform.	Due to low permeability of glacial till and absence of defined water table the works are unlikely to intersect a water table, therefore ground flow or quality is unlikely to be impacted. However, where discrete horizons of groundwater bearing material occur in vertical sequence it might be that piling could breach the aquitard(s) and connect two previously discrete aquifers. However, such horizons are unlikely to be laterally extensive/continuous with significant resource value, or providing baseflow to rivers. Where sheet piling is proposed there is possibility	Moderate Adverse	Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			for barriers to created perpendicular to localised groundwater flow pathways leading to mounding of groundwater and possible emergence on up-gradient side and reduction in baseflow on down-gradient side. This would need to be confirmed at detailed design stage based on further GI and confirmation of finalised piling depths; in the meantime moderate impacts cannot be discounted. Due to absence of known contamination there is unlikely to be a risk of migration of contaminants along the annulus of the pile in the temporary condition. However, application of CCoP embedded mitigation should ensure the impacts of such activities are not significant.		

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Excavation of attenuation pond for the new road and roundabout, and underground attenuation pond. Excavation of cutting for road at bridge. Culvert extension.	Due to low permeability of glacial till and absence of defined water table the works are unlikely to intersect a water table, therefore ground flow or quality is unlikely to be impacted. However, where discrete horizons of groundwater bearing material occur there is a possibility that any excavations could intercept these groundwater bearing layers. Where this this is the case there is the potential risk for groundwater inflow into shallow foundations and the excavation base. Groundwater held in permeable horizons at depth may also be pressurised and result in artesian conditions at surface when penetrated. Groundwater control may therefore be necessary in some construction locations. However, due to the fact that groundwater bearing horizons are	Moderate Adverse	Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			likely to be localised, there is unlikely to be any far-reaching implications for the aquifer resource in terms of groundwater quality and/or flow when dewatered/depressurised. This would need to be confirmed at detailed design stage based on further GI and confirmation of final excavation depths; in the meantime moderate impacts cannot be discounted. Where groundwater exists and if intercepted by excavations there is a risk of accidental leaks and spills from the works could enter groundwater, failing that indirectly through infiltration. However, application of the CoCP embedded mitigation should ensure the impacts of such activities are not significant.		

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Construction of embankments.	Compaction effects are a result of material build up for the embankments could reduce storage within the aquifer. Local infiltration and recharge could also be reduced by such activities. However, as the glacial till is unlikely to be significantly groundwater bearing such that any impacts are considered to be minor.	Minor Adverse	Slight
		Compound area and access routes construction and material storage areas- including vegetation clearance,	Disturbances could occur to groundwater flow from temporary below ground structures and/or shallow excavations that do not required dewatering (e.g. topsoil stripping). This could also impact groundwater levels and/or quality locally due to changes in recharge. However, due to the low permeability of the glacial till and the absence of a defined water table there is less propensity for shallow groundwater bearing horizons to be	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		topsoil stripping and compaction.	present. Any impacts to the aquifer from the construction and laydown areas as well as access roads is also likely to be isolated with no far-reaching implications to the aquifer resource as a whole. The material storage areas and the movements of heavy plant vehicles have the potential to reduce the pore space and change the magnitude and direction of flow in any underlying shallow groundwater bearing horizons. However, this is also likely to be localised due to the discontinuous nature of permeable deposits. Where shallow groundwater exists and if intercepted by the temporary works there is a risk of accidental leaks and spills from the works could enter groundwater, failing that indirectly through		

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			infiltration. However, application of the CoCP embedded mitigation should ensure the impacts of such activities are not significant.		
Sherwood Sandstone Group Principal aquifer	Very High	Piling/ foundations of canal bridge, footbridge and staircase and station platform. Sheet pile wall extending along the canal for full length of the proposed bridge.	It is assumed that piling will be shallow and should not intersect the Principal aquifer, which is > c.30m below ground level. Therefore the ability for potential pollutant pathways to be created should be avoided as piling shall remain above the groundwater bearing zone. Furthermore, as the piling will not intersect the Principal aquifer the ability to connect discrete groundwater bearing horizons within the glacial till with the underlying sandstone should be avoided thereby avoiding any changes to groundwater flow and/or quality within the Principal aquifer.	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Excavation of attenuation pond for the new road and roundabout, and underground attenuation pond. Culvert extension.	It assumed that any excavations will be shallow and not intersect confined groundwater within the Sherwood Sandstone Group. Consequently, groundwater control in the Principal aquifer will not be required.	No Impact	n/a
SPZ 3	Medium	Piling/ foundations of canal bridge, footbridge and staircase and	As above for Sherwood Sandstone Group Principal aquifer.	Negligible	Neutral

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		station platform. Sheet pile wall extending along the canal for full length of the proposed bridge.			
		Excavation of attenuation pond for the new road and roundabout, and underground attenuation	As above for Sherwood Sandstone Group Principal aquifer.	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		pond Excavation of cutting for road at bridge Culvert extension			
Issue for Lady Head Runnel	High	Piling for footbridge and staircase.	Considering the nature of the groundwater within the glacial till, any impacts from piling is likely to be localised to the area surrounding the piles and therefore is highly unlikely to impact the issue.	Negligible	Slight
		Excavations for attenuation ponds and	Excavations for the underground attenuation pond could require dewatering therefore the issue could be impacted by this due to its location nearby.	Minor Adverse	Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		cuttings. Culvert extension.	Extension of the culvert may also result in a reduced flow at the issue while construction is ongoing.		
		Construction of embankments	Compaction from the construction of embankments may affect baseflow towards the issue although this is not likely to be significant given the low permeability of the glacial till. Given the unknown nature of this sink minor impacts cannot be discounted.	Minor Adverse	Slight
		Compound area and access routes construction and material storage areas-	Considering the direct nature of the works at this location it is likely that the issue will be directly impacted by the construction of the construction and laydown areas as well as access roads. Any groundwater emergence may need to diverted in the temporary conditions to ensure any receiving	Major	Very Large

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		including vegetation clearance, topsoil stripping and compaction.	downstream water receptors are not impacted. **This would need to be confirmed at detailed design stage based on further GI and confirmation of finalised excavation depths; in the meantime minor impacts cannot be discounted.** Where shallow groundwater exists and if intercepted by the temporary works there is a risk of accidental leaks and spills from the works could enter groundwater, failing that indirectly through infiltration. However, application of the CoCP embedded mitigation should ensure the impacts of such activities are not significant.		
Issue for Central	High	Piling	Considering the nature of the groundwater within the glacial till, any impacts from piling is likely to be	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Watercourse			localised to the area surrounding the piles and therefore is highly unlikely to impact the issue.		
		Excavations for attenuation ponds and cuttings.	This issue is located far enough from the works that no impacts from excavations or embankments are expected due to the impermeable nature of the glacial till, which creates limited opportunities for impacts to be far reaching from their source.	Negligible	Slight
		Construction of embankments		Negligible	Slight
		Compound area and access routes construction and material storage areas- including	The site is located adjacent to the issue therefore the receptor could experience minor impacts to groundwater flow and/or quality during construction of the construction and laydown areas as well as access roads, albeit this is not likely to be significant due to the low permeability of the glacial	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		vegetation clearance, topsoil stripping and compaction	till. Where shallow groundwater exists and if intercepted by the temporary works there is a risk of accidental leaks and spills from the works could enter groundwater, failing that indirectly through infiltration. However, application of the CoCP embedded mitigation should ensure the impacts of such activities are not significant.		
Three issues	High	All activities	The issues are located outside the Scheme boundary and significantly far from the proposed construction activities. Consequently, they are considered unlikely to be impacted from the Scheme.	No Impact	n/a
Sink north of	High	Piling	Considering the nature of the groundwater within the glacial till, any impacts from piling is likely to be	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
railway line			localised to the area surrounding the piles. Given the distance of the sink from the proposed piling no impacts are expected at the sink location.		
		Excavations for attenuation ponds and cuttings.	This sink is located within the Scheme boundary and proximal to these works. Where dewatering associated with the excavations is required then the sink could be impacted by a reduction in groundwater level or flow.	Minor Adverse	Moderate
		Construction of embankments	Compaction from the construction of embankments may affect baseflow towards the sink although this is not likely to be significant given the low permeability of the glacial till. Given the unknown nature of this sink minor impacts cannot be discounted.	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Compound area and access routes construction and material storage areas- including vegetation clearance, topsoil stripping and compaction	There is the potential for the sink to be blocked during construction which could lead to a build-up of surface water that impacts the construction and logistic operation. Given the unknown nature of this sink and relationship to a range of construction activities, moderate impacts cannot be discounted at this stage. This would need to be confirmed at detailed design stage based on further GI and confirmation of finalised excavation depths; in the meantime minor impacts cannot be discounted. Where shallow groundwater exists and if intercepted by the temporary works there is a risk of accidental leaks and spills from the works could enter groundwater, failing that indirectly through infiltration. However, application of the CoCP	Moderate Adverse	Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			embedded mitigation should ensure the impacts of such activities are not significant.		
Four sinks	High	All activities	The sinks are located outside the Scheme boundary and significantly far from the proposed construction activities. Consequently, they are considered unlikely to be impacted from the Scheme.	No Impact	n/a
Historical wells	High	Piling	All historical wells are located outside the Scheme boundary but within 1.0km of the site. It is likely that all historical wells draw groundwater from the underlying Sherwood Sandstone Group principal aquifer, or from discrete horizons with the glacial till that are unlikely to connected to the temporary site construction activities. Consequently all	Negligible	Slight
		Excavations for attenuation ponds and cuttings.			
		Construction of			

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		embankments	activities are likely to result in negligible impacts.		
		Compound area and access routes construction and material storage areas- including vegetation clearance, topsoil stripping and compaction			
Lancaster Canal, Lady Head Runnel and Central	High	Piling	The contribution of groundwater as baseflow is unknown. Any impacts from piling are likely to be localised to the area surrounding the piles however considering that sheet piling is proposed within the	Negligible	Slight
		Excavations for attenuation		Moderate	Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Watercourse		ponds and cuttings.	canal impacts to baseflow could occur as groundwater is known to ingress into the Canal. The installation of sheet piling may create a low permeability barrier to groundwater therefore could reduce the baseflow contributions to the Lancaster Canal. However, given the extent of the piling compared to the length of the canal any impacts will be negligible. Other piling within the site is likely to have localised impacts contained to the area surrounding the piles and therefore given the distance of the watercourses from the piling, any impacts to groundwater should equilibrate before the watercourse is reached. The contribution of groundwater as baseflow is unknown. However, given the propensity for the		

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			glacial till to transmit limited quantities of groundwater, then baseflow contributions are likely to be small. However, any potential dewatering from the excavations has the potential to limit the baseflow in the watercourses if it lies within the zone of influence, which in turn could reduce the flow and/or quality in the surface water features. **This would need to be confirmed at detailed design stage based on further GI and confirmation of finalised excavation depths; in the meantime moderate impacts cannot be discounted.**		
		Construction of embankments.	Compaction from the construction of embankments may affect baseflow towards the watercourse although this is not likely to be significant given the low permeability of the glacial till. Given the	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			unknown baseflow connection minor impacts cannot be discounted.		
		Compound area and access routes construction and material storage areas- including vegetation clearance, topsoil stripping and compaction	The contribution of groundwater as baseflow is unknown. However, given the propensity for the glacial till to transmit limited quantities of groundwater, then baseflow contributions are likely to be small. There are unlikely to be any deep excavations associated with construction and laydown areas/ access roads. Therefore any impacts to groundwater are expected to be limited.	Minor Adverse	Sight
Western Watercourse and Savick	High	Piling	The contribution of groundwater as baseflow is unknown. Any impacts from piling is likely to be localised to the area surrounding the piles. Given	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Brook			the distance of the watercourses from the piling no impacts are expected.		
		Excavations for attenuation ponds and cuttings.	The contribution of groundwater as baseflow is unknown, however considering the nature of the glacial till any input from groundwater is likely to be limited. Any dewatering from the excavations has the potential to limit the baseflow in the watercourse if it lies within the zone of influence, which in turn could reduce the flow in the river. Given the distance of these watercourses from the site impacts from dewatering are expected to equilibrate before the rivers.	No Impact	n/a
		Construction of embankments.	Compaction from the construction of embankments may affect baseflow towards the watercourse although this is not likely to be significant given the low permeability of the glacial till. Given the	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			unknown baseflow connection minor impacts cannot be discounted.		
		Compound area and access routes construction and material storage areas- including vegetation clearance, topsoil stripping and compaction	The contribution of groundwater as baseflow is unknown, however considering the nature of the glacial till any input from groundwater is likely to be limited. There are no deep excavations associated with the compound construction therefore given the distance of these watercourse from the site negligible are expected.	Negligible	Slight

Table A.2 Permanent Construction and Operation Significant Effect Assessment

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Glacial till Secondary A aquifer	Medium	Sheet piling/ piling/ foundations of canal bridge, footbridge and staircase and station platform.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. Under such circumstances groundwater flow paths could be impacted. Interaction with piles/sheet piles may also cause localised changes in water quality. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to be minimal. Where groundwater exists, this is likely to be in discrete horizons, which would equilibrate reasonably quickly following installation of piles/ sheet piles and unlikely to have far-reaching implications for groundwater flow and/or quality,	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			as such pathways should not exist. However, due to the uncertainties and lack of GI, minor impacts cannot be discounted.		
		Excavation of attenuation pond for the new road and roundabout, and underground attenuation pond.	The presence of the attenuation pond could result in reduced storage and localised water level changes to facilitate movement of groundwater around the pond. Under such circumstances groundwater flow paths could be impacted. If unlined there is the potential for interactions between any groundwater bearing horizons within the glacial till and the content of the attenuation pond which could change the chemistry of the groundwater. However, due to the discrete nature of groundwater bearing horizons any changes would not have any far-reaching implications as such pathways should not exist.	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			Long-term drainage of excavations could change groundwater flow and draw in contamination from spillages which has a knock-on effect to watercourses, although due to low permeability of the glacial till far reaching drainage effects (where present) are not anticipated.		
		Permanent construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised.	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Highways/ traffic/ car park/ railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could directly impact the underlying aquifer, given the direct nature of this minor impacts to groundwater quality could arise. However, given the localised nature of the groundwater in more permeable horizons any contamination would be isolated.	Minor Adverse	Slight
Sherwood Sandstone Principal aquifer	Very High	Piling/sheet piling/ foundations of canal bridge, footbridge and staircase and station platform.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, given the depth of the Sherwood Sandstone Principal aquifer and the protection offered by the overlying glacial till, negligible impacts are predicted as piles are not expected to intercept the sandstone.	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Excavations for attenuation ponds and cuttings.	Given the depth of the Sherwood Sandstone Principal aquifer, no long-term impacts are expected from the installation of underground attenuation storage, as this will be located within the overlying glacial till.	No Impact	n/a
		Highways/ traffic/ car park/ railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase are unlikely to reach the Sherwood Sandstone Principal aquifer given its depth underneath the glacial till and the lack of vertical pathways.	No Impact	n/a
SPZ 3	Medium	Piling/ sheet piling/ foundations of canal bridge, footbridge and staircase and	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, given the depth of the Sherwood Sandstone Principal aquifer and the	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		station platform.	protection offered by the overlying glacial till, negligible impacts are predicted as piles are not expected to intercept the sandstone which the SPZ relates.		
		Excavations for attenuation ponds and cuttings.	Given the SPZ relates to groundwater abstraction in the Sherwood Sandstone Principal aquifer, no long-term impacts are expected from the installation of underground attenuation storage as this will be located within the overlying glacial till.	No Impact	n/a
		Highways/ traffic/ car park/ railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase are unlikely to reach the SPZ given its depth underneath the glacial till which will offer sufficient protection.	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Issue of Lady Head Runnel	High	Piling for footbridge and staircase.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to be localised and reach equilibrium with surrounding receptors quickly. The piling is unlikely to have far-reaching implications for groundwater flow and/or quality, as such pathways should not exist, therefore the quality of groundwater at the issue should not be impacted.	Negligible	Slight
		Excavations for attenuation ponds	Long-term drainage of excavations could change the groundwater flow and draw in	Minor	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		and cuttings.	contamination from spillages. Given the close proximity of the issue to the proposed station changes to groundwater flow and quality at the issue could be observed if a pathway is present which in turn would impact the watercourse, however any such impacts are likely to be minor.	Adverse	
		Permanent construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised. Given the close proximity of this issue impacts cannot be	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			discounted, but not expected to be significant.		
		Highways/ traffic/ car park/ railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the issue given its close proximity to the road.	Minor Adverse	Slight
Issue of Central Watercourse	High	Piling.	Given the distance of the issue from the Scheme boundary no long-term impacts are predicted due to the localised nature of any piling impacts.	No Impact	n/a
		Excavations for attenuation ponds and cuttings.	Given the distance from the Scheme boundary, no long-term impacts are expected.	No Impact	n/a
		Permanent construction of	Given the distance from the Scheme boundary, impacts from embankments are likely to	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		embankments.	equilibrate before the issue is reached.		
		Highways/traffic/car park/railway movements.	Given the distance from the works, no increased pollution risks are predicted at these locations.	No Impact	n/a
3 issues	High	Piling	Given the distance from the Scheme boundary, no long-term impacts are expected.	No Impact	n/a
		Excavations for attenuation ponds and cuttings			
		Permanent construction of embankments.			
		Highways/traffic/car park/railway			

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		movements.			
Sink north of railway line	High	Piling	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to be localised and reach equilibrium with surrounding receptors quickly. The piling is unlikely to have far-reaching implications for groundwater flow and/or quality, as such pathways should not exist, therefore the quality of groundwater at the sink should not be impacted.	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Excavations for attenuation ponds and cuttings	Long-term drainage of excavations could change the groundwater flow and draw in contamination from spillages. Changes to groundwater flow and quality at the sink could be observed if a pathway is present, however any such impacts are likely to be minor.	Minor Adverse	Slight
		Permanent construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised, but not expected to be significant.	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Highways/traffic/car park/railway movements	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the sink, but this is not anticipated to be significant due to the low permeability of the glacial till.	Minor Adverse	Slight
4 sinks	High	Piling	Given the distance from the Scheme boundary, no long-term operational impacts are expected.	No Impact	n/a
		Excavations for attenuation ponds and cuttings			
		Permanent construction of embankments.			
		Highways/traffic/car park/railway			

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		movements			
All historical wells	High	Piling	Given the distance from the Scheme boundary, no long-term operational impacts are expected.	No Impact	n/a
		Excavations for attenuation ponds and cuttings			
		Permanent construction of embankments.			
		Highways/traffic/car park/railway movements			
Lancaster Canal, Lady Head Runnel	High	Piling	Given that the sheet piling is located along the canal sides there could be very slight alterations to baseflow contributions from the piling.	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
and Unnamed watercourse through centre of site (tributary to Savick Brook)			However, given the extent of this sheet piling compared to the length of the watercourse these impacts are expected to be negligible.		
		Excavations for attenuation ponds and cuttings	Long-term drainage of excavations could change the groundwater flow and draw in contamination from spillages, which in turn may have minor impacts to watercourse flowing through the Scheme boundary. However, due to the low permeability of glacial till and lack of groundwater flow pathways, such impacts are not expected to be significant.	Minor Adverse	Slight
		Permanent construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised, but not expected to be significant.		
		Highways/traffic/car park/railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the station, hence impacting the quality of the baseflow. However, given the lack of pathways and low permeability of the glacial till any impacts would likely equilibrate before the watercourses are reached.	Minor Adverse	Slight
Western Watercourse and Savick	High	Piling.	Given that the sheet piling is located along the canal sides there could be very slight alterations to baseflow contributions from the piling,	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Brook			however given the extent of this sheet piling compared to the length of the watercourse these impacts are expected to be negligible.		
		Excavations for attenuation ponds and cuttings.	Long-term drainage of excavations could change the groundwater flow and draw in contamination from spillages. The attenuation ponds are located far enough from the watercourses that no impacts are expected to propagate as far reaching as the watercourses therefore any groundwater baseflow contributions will not be impacted.	No Impact	n/a
		Construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised, but not expected to be significant.		
		Highways/traffic/car park/railway movements.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the station, hence impacting the quality of the baseflow. However, given the lack of pathways and low permeability of the glacial till any impacts would likely equilibrate before the watercourses are reached.	Minor Adverse	Slight

Table A.3 Assessment of operational impacts on groundwater receptors

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Glacial till Secondary A aquifer	Medium	Sheet piling/piling/foundations of canal bridge, footbridge and staircase and station platform.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. Under such circumstances groundwater flow paths could be impacted. Interaction with piles/sheet piles may also cause localised changes in water quality. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to be minimal. Where groundwater exists, this is likely to be in discrete horizons, which would equilibrate reasonably quickly following installation of piles/sheet piles and unlikely to have far-	Minor Adverse	

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			reaching implications for groundwater flow and/or quality, as such pathways should not exist, however due to the uncertainties and lack of GI minor impacts cannot be discounted.		
		Excavation of attenuation pond for the new road and roundabout, and underground attenuation pond.	The presence of the attenuation pond could result in reduced storage and localised water level changes to facilitate movement of groundwater around the pond. Under such circumstances groundwater flow paths could be impacted. If unlined there is the potential for interactions between any groundwater bearing horizons within the glacial till and the content of the attenuation pond which could change the chemistry of the groundwater. However, due to the discrete nature of groundwater bearing horizons any changes	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			would not have any far-reaching implications as such pathways should not exist. Long-term drainage of excavations could change groundwater flow and draw in contamination from spillages which has a knock-on effect to watercourses.		
		Permanent construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised.	Minor Adverse	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could directly impact the underlying aquifer, given the direct nature of this minor impacts to groundwater quality could arise, however given the localised nature of the groundwater in more permeable horizons any contamination would be isolated.	Minor Adverse	Slight
Sherwood Sandstone Principal aquifer	Very High	Piling/sheet piling/foundations of canal bridge, footbridge and staircase and station platform.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, given the depth of the Sherwood Sandstone Principal aquifer and the protection offered by the overlying glacial till, negligible impacts are predicted as piles	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			are not expected to intercept the sandstone.		
		Excavations for attenuation ponds and cuttings and presence of embankments.	Given the depth of the sandstone, no long-term impacts are expected from the installation of underground attenuation storage, as this will be located within the overlying glacial till	No Impact	n/a
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase are unlikely to reach the Sherwood Sandstone given its depth underneath the glacial till and the lack of vertical pathways.	No Impact	n/a
SPZ 3	Medium	Piling/sheet piling/foundations of canal bridge, footbridge and	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable	Negligible	Neutral

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		staircase and station platform.	structures. However, given the depth of the Sherwood Sandstone Principal aquifer and the protection offered by the overlying glacial till, negligible impacts are predicted as piles are not expected to intercept the sandstone which the SPZ relates.		
		Excavations for attenuation ponds and cuttings.	Given the depth of the SPZ, no long-term impacts are expected from the installation of underground attenuation storage, as this will be located within the overlying glacial till.	No Impact	n/a
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase are unlikely to reach the SPZ given its depth underneath the glacial till which will offer sufficient protection.	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
Issue of Lady Head Runnel	High	Piling for footbridge and staircase.	The introduction of piles in the ground may reduce groundwater storage and could result in water level changes to facilitate movement of groundwater around these impermeable structures. However, due to low permeability of the glacial till and given its areal extent is much greater than the proposed works, any impacts on groundwater flow and/or quality is likely to equilibrate before the issue is reached. The piling is unlikely to have far-reaching implications for groundwater flow and/or quality, as such pathways should not exist, therefore the quality of groundwater at the issue should not be impacted.	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Construction of embankments.	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised but given the close proximity of this issue impacts cannot be discounted.	Minor Adverse	Slight or Moderate
		Excavations for attenuation ponds and cuttings.	Long-term drainage of excavations could change the groundwater flow and draw in contamination from spillages. Given the close proximity of the issue to the proposed station	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			changes to groundwater flow and quality at the issue could be observed if a pathway is present which in turn would impact the watercourse, however any impacts are likely to be negligible.		
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the issue given its close proximity to the road.	Negligible	Slight
Issue of Central Watercourse	High	Piling.	Given the distance of the issue from the Scheme boundary no long-term impacts are predicted due to the localised nature of any piling impacts	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Excavations for attenuation ponds and cuttings and construction presence of embankments.	Given the temporary nature of the dewatering, no long-term impacts are expected. Given the distance from the Scheme boundary, impacts from embankments are likely to equilibrate before the issue is reached.	Negligible	Slight
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the issue however given the lack of pathways and low permeability of the till any impacts would likely equilibrate before the issue is reached.	Negligible	Slight
		Piling.	Given the distance of these issues from the Scheme boundary no long-term impacts are predicted due to the localised nature of any	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			piling impacts.		
		Excavations for attenuation ponds and cuttings. Presence of embankments.	Given the distance from the Scheme boundary, no long-term impacts are expected.	No Impact	n/a
		Highways/traffic/car park.	Given the distance from the works, no increased pollution risks are predicted at these locations.	No Impact	n/a
Sink north of railway line	High	Piling.	Given the distance of the sink from proposed piling works negligible long-term impacts are predicted due to the localised nature of any piling impacts.	Negligible	Slight
		Excavations for attenuation ponds and	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could	Negligible	Slight

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		cuttings.	impact groundwater quality within the vicinity, however given the lack of pathways and low permeability of the till any impacts would likely equilibrate before the sink is reached.		
		Presence of embankments	The presence of the embankments could cause consolidation of the materials underneath the embankment, which may cause the ground beneath the structure to compress affecting groundwater storage, pore-water pressure distribution, and magnitude and direction of groundwater flow within the groundwater bearing horizons. However, such horizons are unlikely to be laterally extensive and continuous therefore any impacts will be localised but given the close proximity impacts of compression on the sink cannot be discounted.	Minor Adverse	Slight or Moderate

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		Highways/traffic/car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality at the sink given its location underneath the proposed car park.	Negligible	Slight
Four sinks	High	Piling	Given the distance of these sinks from the Scheme boundary no long-term impacts are predicted due to the localised nature of any piling impacts.	No Impact	n/a
		Excavations for attenuation ponds and cuttings. Presence of embankments	Given the distance of the sink from the site, no long-term impacts are expected from the site.	No Impact	n/a
		Highways/traffic/car park.	Given the distance from the works, no increased pollution risks are predicted at	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			these locations.		
All historical wells	High	Piling	Given the distance of the historical wells from the Scheme boundary, no long-term impacts from piling are predicted.	No Impact	n/a
		Excavations for attenuation ponds and cuttings. Construction of embankments	Given the distance of the historical wells from the site, no long-term impacts are expected at the wells. The lack of groundwater pathways through the glacial till means that any impacts from the site will remain localised and given the closest well is 73m from the Scheme boundary, any impacts to flow/quality are unlikely to be that far reaching.	No Impact	n/a
		Highways/traffic/car park.	Given the distance from the works, no increased pollution risks are predicted at the well locations. Given that the wells likely abstract from depth and limited vertical	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			pathways exist it is highly unlikely that any increase pollution would infiltrate to the depth of abstraction		
Lancaster Canal, Lady Head Runnel and Unnamed watercourse through centre of site (tributary to Savick Brook)	High	Piling.	Given that the sheet piling is located along the canal sides there could be very slight alterations to baseflow contributions from the piling, however given the extent of this sheet piling compared to the length of the watercourse these impacts are expected to be negligible.	Negligible	Slight
		Excavations for attenuation ponds and cuttings. Construction of embankments.	Long-term drainage of excavations could change the groundwater flow and draw in contamination from spillages. The attenuation ponds are located far enough from the watercourses that no impacts are expected to propagate as far reaching as the watercourses therefore any groundwater	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
			baseflow contributions will not be impacted.		
		Highways/traffic car park.	Increased pollution risks from routine runoff and accidental spillages of fuels and chemicals during the operational phase could impact groundwater quality within the vicinity of the station, hence impacting the quality of the baseflow. However given the lack of pathways and low permeability of the till any impacts would likely equilibrate before the watercourses are reached.	No Impact	n/a
Western watercourse and Savick Brook	High	Piling.	Given the distance of these watercourse from the Scheme boundary no long-term impacts are predicted due to the localised nature of any piling impacts.	No Impact	n/a
		Excavations for attenuation ponds and	Given the temporary nature of the dewatering,	No Impact	n/a

Receptor	Importance	Design Element/ Activity	Impact Description	Magnitude	Significance
		cuttings. Construction of embankments.	no long-term impacts are expected.		
		Highways/traffic/car park.	Given the distance of these watercourses from the works, no increased pollution risks are predicted at these locations.	No Impact	n/a