BANWELL BYPASS

Environmental Statement

HIF Banwell Bypass and Highways Improvements Project

Environmental Statement Chapter 9 - Geology and Soils

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Contents

9 Geology and Soils

9.1 Introduction

9.1.1 This chapter reports the potential effects from the construction and operation of the Scheme (as detailed in ES Volume 1 - Chapter 2 – Scheme Description) on geology and soils following the methodology set out in Design Manual for Roads and Bridges (DMRB) LA 109 Geology and soils.

9.1.2 This chapter details the methodology followed for the assessment, summarises the regulatory and policy framework related to geology and soils, and describes the existing environment in the area surrounding the Scheme. Following this, the mitigation and residual effects of the Scheme are discussed, along with the limitations of the assessment.

9.1.3 The existing environment in the area surrounding the Scheme is considered with regard to:

a) Bedrock geology and superficial deposits (including geological designations and sensitive/ valuable non-designated features)

b) Soil resources

c) Effects of potential land contamination on human health, surface water and groundwater, associated ecological receptors, and properties.

9.1.4 This chapter sets out a baseline conceptual site model with respect to soil and groundwater contamination and identifies plausible contaminant linkages formed due to the construction or operational phases of the Scheme.

9.1.5 The effects on geomorphology, associated with landforms, are described in ES Volume 1 - Chapter 7 - Landscape. Effects on geomorphology, associated with hydromorphology, are described in ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Effects on archaeological artefacts are considered in ES Volume 1 - Chapter 6 - Cultural Heritage.

9.1.6 The effects on mineral deposits as a resource and the suitability for reuse of soils are described in ES Volume 1 - Chapter - 10 Material Assets and Waste.

9.1.7 The effects on agricultural land holdings and development land and businesses are described in ES Volume 1 - Chapter 12 - Population and Human Health.

9.1.8 This chapter describes the potential effects of land contamination on groundwater and surface water quality. The potential effects on groundwater, hydrogeology and surface water as a result of drainage and discharge associated with the construction and operation of the Scheme are considered in ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.

9.1.9 The following appendices support this chapter, as presented in ES Volume 3:

a) Appendix 9.A - Preliminary Sources Study Report
b) Appendix 9.B - Factual ground investigation information
c) Appendix 9.C - Interpretive ground investigation report
d) Appendix 9.D - Agricultural land classification report.

9.1.10 The assessment of cumulative effects of this chapter topic both in-combination with other technical assessments on specific receptors and with other relevant developments have been assessed and are reported in the Cumulative Effects chapter, ES Volume 1 Chapter 15.

Scheme Overview

9.1.11 The following section provides a brief description and overview of the Banwell Bypass and Highways Improvements Project.

9.1.12 The Scheme comprises the following distinct elements:

a) a bypass of the village of Banwell (referred to as the “Banwell Bypass”);
b) a route connecting the A371 at Castle Hill and the A368 at East Street (referred to as the “Southern Link”); and
c) Mitigation and enhancement measures, which broadly consist of the following:

- Environmental mitigation and enhancement measures

in connection with the Banwell Bypass and the Southern Link, examples of which include (but are not limited to) flood compensation areas, planting and habitat creation, attenuation basins etc.

- Placemaking improvements within Banwell, comprising mitigation and enhancement measures to the public realm; and

- Traffic mitigation in connection with the Banwell Bypass and the Southern Link, including Improvements to the wider local road network.

9.1.13 Together, these elements comprise the "Scheme". Each element as listed is described in more detail below.

Banwell Bypass

9.1.14 The Banwell Bypass would be located within the administrative area of North Somerset. The village of Banwell is located approximately 8km east of Weston-super-Mare. The Banwell Bypass would primarily consist of:

a) signalisation and capacity improvements to the Summer Lane/ Wells Lane junctions on the A371;

b) a 40mph single carriageway Banwell Bypass, connecting the existing A371 (east of Summer Lane) to A368 (west of Towerhead Farm);

c) a 3 metre wide shared use path provided along the majority of the Banwell Bypass providing a link from Weston-super-Mare to Sandford;

d) Banwell West Junction - a three arm roundabout located east of Knightcott Industrial Estate at the western end of Banwell;

e) Wolvershill Road Junction – a traffic signalised junction, providing access for all users to the west, east, and north. Access to the south would be restricted to public transport and walking, cycling and horse-riders, and limited agricultural access only;

f) Banwell River Bridge – an overbridge across Riverside and the River Banwell. There would not be a direct connection between Riverside and the Banwell Bypass;

g) Moor Road to Riverside Link - a side road connection between Riverside and Moor Road; and

h) Banwell East Junction - A three-arm traffic signalised junction, with dedicated turning lanes from the bypass towards the Southern Link.

Southern Link Road

9.1.15 The Southern Link will provide the new primary route south to Winscombe, as Castle Hill and Dark Lane are proposed to be stopped up. The Southern Link would be a 30mph single carriageway, connecting the A368 (East Street) to the A371 at Castle Hill. The Southern Link would be located within the Mendip Hills AONB. The Southern Link would link into the Banwell Bypass at the Banwell East Junction. A T-junction located along the Southern Link would provide access into the east of Banwell (at East Street).

Mitigation Measures

Environmental mitigation and enhancement measures in connection with the Banwell Bypass and the Southern Link.

9.1.16 The Scheme would include mitigation measures which are provided to offset the impact of the Banwell Bypass proposal. These include (but are not limited to):

a) flood mitigation to ensure that the Banwell Bypass does not increase flood risk for third-party properties;

b) land for essential mitigation, such as ecology and landscape mitigation;

c) sustainable urban drainage systems (e.g. attenuation basins and swales), and additional groundwater mitigation, to prevent adverse water quality impacts (including the Source Protection Zone); and

d) replacement land to mitigate the impact of the scheme on Banwell Football Club.

Placemaking improvements within Banwell

9.1.17 As a result of the Banwell Bypass, there would be a reduction in traffic through Banwell. The reduction in traffic (and resulting reduction in congestion) through the village could result in higher traffic speeds without mitigation.

9.1.18 A reduced 20mph speed limit through Banwell would discourage vehicles from travelling at higher speeds, whilst also discouraging the use of the road as a through route (instead of the Banwell Bypass).

9.1.19 The reduction of traffic through Banwell due to the provision of the Banwell Bypass provides the opportunity to make improvements to the existing road and public spaces within Banwell to enhance the historic and urban setting of the village. These improvements would include, but are not limited to:

a) Alteration to the road and footways including resurfacing, widening, and narrowing (which would encourage drivers to comply with the posted 20mph speed limit);
b) Incorporation of active travel measures;
c) Soft landscaping and ecological improvements; and
d) Street signage improvements.

Improvements to the wider local road network

9.1.20 Improvements to the local road network and junctions including the surrounding villages of Churchill, Sandford and Winscombe are proposed to mitigate increases in traffic as a result of the Banwell Bypass and Southern Link. These mitigation measures would consist of:

a) Lowered speed limits:
    - 20mph: A368 through Churchill, A368 through Sandford, A371 through Winscombe.
    - 30mph: A368 between Churchill and Sandford Villages.
b) Gateway Features when entering and exiting the villages of Sandford, Churchill and Winscombe;
c) Non-physical traffic calming measures through and between villages (e.g. road markings and speed signage);
d) Capacity improvements to the Churchill Junction (A38/ A371);
e) Provision of new/ improvements to existing pedestrian and cycling crossings;
f) Active travel measures along the A368, with improved footway/ cycleway access from Churchill and Langford to Churchill Academy;

g) Improvements to footways, shared pedestrian, and cycleway; and

h) Soft landscaping, native planting, rewilding, and ecological enhancements.

Context

9.1.21 North Somerset Council's (NSC) Housing Infrastructure Fund (HIF) proposal supports potential housing sites (subject to the emerging Local Plan 2038).

9.1.22 A business case was submitted to Homes England to secure funding for a package of infrastructure improvements in February 2019 and a successful funding announcement was made at the end of October 2019.

9.1.23 The Banwell Bypass would provide a highway connection to enable potential housing sites that may be allocated in the emerging Local Plan and alleviate the anticipated impact of further traffic growth upon the already congested Banwell village.

9.1.24 NSC appointed Alun Griffiths (Contractors) Ltd, with Arup and TACP (the 'AGC Team') as their technical and environmental advisors, to develop a solution including optioneering, design and planning support of the proposed HIF Banwell Bypass and Highways Improvements Project Stage 1 (the "Scheme"). Stage 1 of the project includes: optioneering; preliminary design; Environmental Impact Assessment (EIA); planning permission; Statutory Processes. Stage 2 of the project is the detailed design and construction phase, following planning determination and land acquisition.

Environmental Context

9.1.25 The Scheme crosses the North Somerset Levels which are characterised by flat open landscape of arable land divided by hedgelined ditches and rhynes. These have been inhabited and exploited for thousands of years. Much of the area lies within a designated flood zone.

9.1.26 Banwell lies to the immediate north of the Mendip Hills Area of Outstanding Natural Beauty (AONB). The Southern Link lies

within the boundary of the AONB and within a groundwater Source Protection Zone. Whilst the Mendip Hills AONB is not a designated International Dark Sky Reserve (IDSR), it is well known for its dark sky environment.

9.1.27 There are five Scheduled Monuments in the vicinity of the Scheme, the closest of which is a Romano-British villa. There are numerous Grade I, II* and II listed buildings within Banwell and its vicinity. The centre and east of Banwell is designated as a Conservation Area.

9.1.28 The North Somerset and Mendip Bats Special Area of Conservation (SAC), which includes ancient woodland, lies adjacent to the A368 and the eastern junction of the Scheme. The Banwell Ochre Caves and Banwell Caves Sites of Special Scientific Interest (SSSI) are designated for their geology and overlap with the North Somerset and Mendip Bats SAC, providing hibernation sites for Greater Horseshoe bats. The wider area provides habitat for a variety of protected and notable species including dormouse, grass snakes, otter, badger, kingfisher and several species of bat.

9.1.29 The Scheme is dissected by the River Banwell which flows northwards along Riverside. It is classified as a main river and is the source of the River Banwell Estuary.

9.1.30 There is an extensive Public Right of Way (PRoW) network in and around Banwell which includes well-used bridleways. To the east of Banwell, north of the A368 (Towerhead Road) lies a 7.2 MW photovoltaic power station (Banwell Solar Farm).

Scheme objectives

9.1.31 NSC's overall objectives for the Scheme are to deliver, within cost, quality, and programme targets:

a) Improve the local road network to deal with existing congestion issues.

b) Improve and enhance Banwell's public spaces by reducing traffic severance and improving the public realm.

c) Provide the opportunity to increase active and sustainable travel between local villages and Weston-super-Mare.

d) Deliver infrastructure that enables housing development (subject to Local Plan).

e) Ensure the development respects the local area and minimises visual impact upon the surrounding countryside and Mendip Hills Area of Outstanding Natural Beauty (AONB).

f) Innovative and efficient in reducing and offsetting carbon from the design and construction of the infrastructure.

g) Ensure the development provides the opportunity to increase Biodiversity Net Gain by at least 10%.

h) Proactively engage with stakeholders in a way that is both clear and transparent.

9.2 Competent Expert Evidence

9.2.1 The geology and soils lead is a Chartered Engineer and Member of the Institution of Civil Engineers. They have a MEng (Hons) degree in Environmental Engineering from the Wrocław University of Technology, Poland, and BSc (Hons) degree in Applied Sciences from the University of Glamorgan, Wales.

9.2.2 The geology and soils reviewer is a Chartered Geologist and Fellow of the Geological Society of London. They have a BSc (hons) in Geology from the University of Liverpool and an MSc in Applied Environmental Geology from Cardiff University.

9.3 Legislation and Policy Framework

9.3.1 The following sub-sections present the wider legislation and policy relevant to the assessment of geology and soils.

Legislation

Geology

9.3.2 Geological sites of national importance are principally afforded protection under the Wildlife and Countryside Act 1981 or the National Parks and Access to the Countryside Act 1949 by designation as a Site of Special Scientific Interest (SSSI) or National Nature Reserve (NNR). In addition, the Joint Nature Conservation Committee (JNCC) have carried out a Geological Conservation Review (GCR) and Earth Science Conservation Review (ESCR) to identify the best and most representative earth science sites in Great Britain, with a view to their long-term conservation. Although GCR/ ESCR identification does not itself give any statutory protection, many GCR/ ESCR sites have been notified as SSSIs.

Contaminated land

9.3.3 Environmental legislation and regulation provide separate drivers to manage contaminated land. The main legislative drivers for managing risks to human health and the environment from land contamination are:

a) Part 2A of the Environmental Protection Act 1990 (the Contaminated Land Regime)
b) The Contaminated Land (England) Regulations (2006)
c) The Environment Act 1995
d) The Environmental Permitting (England and Wales) Regulations 2016.

9.3.4 Under Part 2A of the Environmental Protection Act 1990, sites are identified as 'contaminated land' if they are causing, or if there is a significant possibility of causing significant harm to identified receptors including human health, ecological ecosystems or significant pollution of controlled waters, as defined by Section 104 of the Water Resources Act 1991. In general terms, the legislation advocates the use of a risk assessment approach for

the assessment of contamination and remedial requirements.

9.3.5 The Environment (Amendment etc.) (EU Exit) Regulations 2019 came into force in accordance with the European Union (Withdrawal) Act 2018 on 31st December 2020. Part 2 amends the following primary legislation relevant to this chapter:

a) The Environmental Protection Act 1990.

b) The Environment Act 1995.

9.3.6 Part 3 of the Environment (Amendment etc.) (EU Exit) Regulations 2019 amends The Contaminated Land (England) Regulations 2006.

9.3.7 The amendments in these regulations make no changes to policy and the instruments will continue to operate substantively as they did prior to 31 December 2020.

9.3.8 Additional key legislation considered relevant to the assessment for geology and soils relating to contamination include:

a) The Water Resources Act 1991.

b) The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017.

c) Department for Environment Food and Rural Affairs (Defra)The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015.

d) The Environmental Damage (Prevention and Remediation) Regulations 2009.

National policy

9.3.9 This chapter considers the National Planning Policy Framework (NPPF) [9.1] and relevant Planning Practice Guidance [9.2] , which emphasises the need for sustainable development in terms of the resources used, the maintenance of the environment, the economic use of land and consideration of society in the general area. The importance for the restoration of derelict and contaminated land is stated.

9.3.10 In relation to conserving and enhancing the natural environment, Section 15 of the NPPF states that impacts on geodiversity should be reduced by preventing harm to geological conservation interests.

9.3.11 In the UK, geological sites are afforded consideration at a local level by designation, including:

a) GCR sites (England, Scotland, Wales).
b) Geoparks.
c) Regionally Important Geological and Geomorphological Sites (RIGS).
d) Locally Important Geological and Geomorphological Sites
e) Sites of Importance for Nature Conservation.

9.3.12 Regarding development on land affected by contamination, Paragraphs 183 and 184 of the NPPF emphasises the requirement to understand the ground risks, and on the development of appropriate remediation to make ground hazards material considerations during the planning process.

9.3.13 Paragraph 174 of the NPPF states that planning policies and decisions should contribute to and enhance the natural and local environment by preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of land instability.

9.3.14 Paragraph 183(a) of the NPFF also states that planning policies and decisions should ensure that a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation).

Local policy

9.3.15 The North Somerset Council Development Plan sets out Core Strategy [9.3] with respect to objectives and strategic planning policies for North Somerset up to 2026.

9.3.16 The following policies are of relevance to the Scheme:

a) CS1: Addressing climate change and carbon reduction – promotes the re-use of previously developed in preference to the loss of green field sites.
b) CS3: Environmental impacts and flood risk assessment – states that development that would result in air, water or other

environmental pollution or harm to amenity, health or safety will only be permitted if the potential adverse effects would be mitigated to an acceptable level. This includes contamination and land instability.

c) CS12: Achieving high quality design and placemaking – identifies geology as one of the key features of a character making of a place. The recognition, protection and enhancement of these features are essential ingredients to creating environments that provide people with a connection to history and support a social identity.

Guidance and standards

9.3.17 This Chapter has been undertaken with due consideration of the following:

a) Geotechnics, General Information, Managing Geotechnical Risk, CD 622 [9.4] .

b) DMRB LA 104 Environmental assessment and monitoring [9.5].

c) DMRB LA 109 Geology and soils [9.6].

d) Contaminated Land Statutory Guidance, Department for Environment, Food and Rural Affairs (Defra), 2012 [9.7] .

e) Land contamination: risk management [9.8] (replacing Model Procedures for the Management of Land Contamination (CLR11) Defra and Environment Agency)

f) CIRIA R132: A Guide for Safe Working on Contaminated Sites [9.9] .

g) CIRIA SP73: Roles and Responsibility in Site Investigations [9.10] .

h) BS 5930: 2015 + A1:2020: Code of Practice for Site Investigations [9.11] .

i) BS 10175:2011 + A2 2017: Code of Practice for Investigation of Potentially Contaminated Sites [9.12] .

j) Groundwater protection guidance [9.13] , including The Environment Agency's approach to groundwater protection [9.14] .

k) CIRIA C552: Contaminated Land Risk Assessment, A guide to good practice [9.15] .

l) CIRIA C681: Unexploded ordnance (UXO) A guide for the construction industry [9.16] .

m) CIRIA C733: Asbestos in soil and Made Ground: a guide to understanding and managing risks [9.17] .

n) CIRIA C765: Asbestos in soil and Made Ground: good practice site guide [9.18]

o) Eurocode 7 (BS EN 1997-1 [9.19] and EN 1997-2 [9.20]) and all relevant normative guidance.

p) Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention (Environment Agency) [9.21]

q) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Defra) [9.22] .

r) Agricultural Land Classification: protecting the best and most versatile agricultural land (Natural England) [9.23] .

9.3.18 Whilst the environmental impact of certain ground risks, such as contaminated land, are considered within this chapter, the assessment and management of risk associated with land instability are excluded from this chapter in accordance with DMRB LA 109 Geology and soils, which states; “Risks associated with geotechnical hazards and land stability are assessed in CD622, Managing geotechnical risk.” Ground risks are considered as part of the geotechnical design as presented in the Interpretive Ground Investigation Report (GIR), presented in ES Volume 3 - Appendix 9.C - Ground Investigation Report.

9.4 Assessment Method

General approach

9.4.1 LA 109 Geology and soils require the baseline scenario to be informed by desk study information presented in a preliminary sources study report and existing survey data, where available. In accordance with this methodology, assessment process follows the following key stages:

a) Undertake desk-based review and historical information review.

b) Establish outline study area and baseline scenario.

c) Establish the potential for significant effects based on the scoping questions in LA 109 Geology and soils.

d) Where likely significant effects are identified, complete a detailed baseline scenario.

e) Finalise study area based on the Scheme design and baseline scenarios.

f) Establish design and mitigation measures.

g) Undertake assessment of likely significant effects.

h) Undertake monitoring where significant effects are reported.

9.4.2 The assessment of cumulative effects of this chapter topic both in-combination with other technical assessments on specific receptors and with other relevant developments have been assessed and are reported in the Cumulative Effects chapter, ES Volume 1 Chapter 15.

i)

Study area

9.4.3 The study area for the geology and soils assessment incorporates the footprint of the Scheme temporary and permanent land take of the Banwell Bypass and the Southern Link including the environmental mitigation and enhancement measures in connection with the Banwell Bypass and the Southern Link. A further 250m buffer zone beyond the temporary and permanent land take has also been considered in relation to impact on human health from potential sources of contaminated land. This distance has been established using professional judgement and is also referenced in Best Practice documents [9.24] and is typical at the hazard identification stage of an assessment. The extent of the 250m buffer zone is shown in ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan.

9.4.4 In order to consider potential impacts to sensitive controlled waters receptors (surface water and groundwater), the buffer around the land take has been increased up to 500m for consideration of general licensed abstractions and up to 1.5km for sensitive public water supplies. No significant contamination migration is expected beyond these distances. These distances have been established using professional judgement. The extent of the 500m and 1.5km buffer zones is shown in ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints Plan.

9.4.5 In addition, the study area includes the footprint of areas of placemaking improvements within Banwell and improvements to the wider local road network in Sandford, Churchill and

Winscombe. These are detailed in ES Volume 1 - Chapter 2 - Scheme Description.

Identification of baseline conditions

9.4.6 The identification of baseline conditions for geology and land contamination is primarily based on desk study information included within the Preliminary Sources Study Report (PSSR) presented in ES Volume 3 - Appendix 9.A - PSSR and the Scheme specific factual ground investigation information presented in ES Volume 3 - Appendix 9.B - Factual ground investigation information (a Phase 1 & b Phase 2) and with interpretation presented in ES Volume 3 - Appendix 9.C - Ground Investigation Report. The completed ground investigations are summarised below.

9.4.7 The identification of baseline conditions for soils is primarily based on the Agricultural Land Classification (ALC) survey information included within ES Volume 3 - Appendix 9.D - Agricultural land classification report.

9.4.8 The baseline studies are summarised in Table 9-1 and graphically presented in ES Volume 2 - Figures 9.1 to 9.5.

Table 9-1 Baseline studies

Topic	References
Geology	WSP (2021). Banwell Bypass, Statement of Intent & Preliminary Sources Study Report. (Ref 70072083-PSSR-02), included as ES Volume 3 - Appendix 9.A - PSSR. British Geological Survey (BGS) 1:50,000 scale geological map of Wells (Solid and Drift) Sheet 280 [9.25] . BGS 1:50,000 scale digital geological map, available on the 'Onshore GeoIndex' viewer [9.26] . BGS Bristol and Gloucester regional geology guide, 3rd edition [9.27] . Geology of the Cirencester district: BGS memoir for 1:50,000 geological sheet 280 [9.28] . MAGIC Maps [9.29] . Factual information from the recent Scheme specific ground investigations included in ES Volume 3 - Appendix 9.B - Factual ground investigation information (a Phase 1 & b Phase 2) with interpretation presented in ES Volume 3 - Appendix 9.C - Ground Investigation Report. Findings from site walkover carried out in October 2021, reported in ES Volume 3 - Appendix 9.C - Ground Investigation Report. Historical borehole records available from BGS Onshore GeoIndex [9.26] including

Topic	References
	• ST35NE55 located at Banwell Spring, approximately 500m west of the Scheme • ST35NE18 located at Old Brewery Yard in Banwell, approximately 500m west of the Scheme • ST36SE1 and ST36SE184 located at pumphouse, near Banwell Moor, approximately 1km north of the Scheme.
Current and historical land use	Envirocheck report for Banwell Bypass. Reference 176751735, prepared by Landmark Information Group prepared August 2018 included as part of the PSSR, ES Volume 3 - Appendix 9.A - PSSR. Findings from a site walkover carried out in April 2017 by WSP, reported in ES Volume 3 - Appendix 9.A.- PSSR
Soil survey	Natural England 1:250,000 Agricultural Land Classification Map South-West Region (ALC006) [9.30] Reading Agricultural Consultants (2022) Agricultural Land Classification and Soil Resources at Banwell, North Somerset, included as ES Volume 3 - Appendix 9.D - Agricultural land classification report.
Ground investigations	Factual information from the recent Scheme specific ground investigations included in ES Volume 3 - Appendix 9.B - Factual ground investigation information (a Phase 1 & b Phase 2) with interpretation presented in ES Volume 3 - Appendix 9.C - Ground Investigation Report. Exploratory hole locations are shown in ES Volume 2 - Figure 9.5 - Completed Ground Investigation Locations. **NSC Ground Investigation** The fieldworks of the NSC GI were completed in January 2021 and comprised 12 boreholes and 13 trial pits. Four groundwater level and ground gas monitoring visits were then undertaken in the period from March to June 2021. The installations were monitored for gas flow and then tested for methane, carbon dioxide, oxygen, hydrogen sulphide and carbon monoxide. The NSC GI were carried out at the optioneering stage meaning that the exploratory holes were spatially located for Option 2 (refer to ES Volume 1 - Chapter 2 - Scheme Description for background information on previously considered options), which although taken forward as the chosen option, is not an exact match with the current alignment. **AGC Ground Investigation** The AGC GI was carried out between October and November 2021 with the groundwater and ground gas monitoring of both NSC and AGC installations following directly after the fieldworks until January 2022. The investigations comprised 34 boreholes, 13 trial holes and three trial trenches excavated along the selected Scheme option. Geo-environmental and geotechnical samples were recovered for laboratory testing.

Land contamination assessment

9.4.9 Land contamination is regulated under several regimes including environmental protection, pollution prevention and control, waste management, planning and development control, and health and safety.

9.4.10 Paragraph 184 of the NPPF places responsibility on the developer of the land for ensuring that development is safe and suitable for use for the purpose for which it is intended which includes dealing with historical contamination of the ground to the satisfaction of the local authority and Environment Agency. The NPPF defines site investigation information as including a risk assessment of land potentially affected by contamination. It states that all investigations of land potentially affected by contamination should be carried out in accordance with established procedures.

9.4.11 The UK framework for the assessment of contaminated land endorses the principle of a "suitable for use" approach to contaminated land, where remedial action is only required if there are unacceptable risks to health or the environment, considering the use of the land and its environmental setting. For land to be determined as contaminated and require remediation (or possibly a change to less sensitive use), all three elements of a source, pathway, and receptor (SPR) 'plausible contaminant linkage' (PCL) must be present.

9.4.12 Guidance on the risk assessment of contaminated land within the UK is afforded under Land Contamination Risk Management (LCRM) framework [9.8] .

9.4.13 In accordance with LCRM: Stage 1 risk assessment, the assessment has been undertaken following a tiered approach:

a) Tier 1: Preliminary Risk Assessment (Tier 1: PRA)
b) Tier 2: Generic Quantitative Risk Assessment (Tier 2: GQRA), and/ or
c) Tier 3: Detailed Quantitative Risk Assessment (Tier 3: DQRA).

9.4.14 Should any unacceptable risks be identified from the Tier 1: PRA (e.g., greater than overall moderate risk), Tier 2: GQRA followed on by Tier 3: DQRA may be required.

Conceptual site model

9.4.15 The assessments are underpinned by Conceptual Site Model (CSM) developed for the Scheme development. Contaminated Land, as defined in Part IIA of Environmental Protection Act 1990, is assessed through the identification and assessment of contaminant linkages (contaminant-pathway-receptor

relationships). Implicit in the guidance is the application of risk assessment to assess whether potential contaminant linkages may be significant. The meanings of the components are:

a) Contaminant - a contaminant or pollutant that is in, on or under the land and that has the potential to cause harm or pollution.

b) Pathway: a route by which a receptor is or could be affected by a contaminant.

c) Receptor: a target that could be adversely affected by a contaminant, for example a person, controlled waters (in this case surface water or groundwater), an organism, property or an ecosystem.

9.4.16 In accordance with CIRIA 552 guidance [9.15], for a potential risk to either environmental or human receptors to exist, a plausible contaminant linkage involving each of these components (i.e., source – pathway- receptor) must exist. If one of the components is absent then a contaminant linkage, and thereby potentially unacceptable risk, is also unlikely to exist. Where all three components are or may be present, a potentially complete contaminant linkage can be considered to exist. This does not automatically imply the presence of unacceptable risk, but further investigation of the potential contaminant linkages is required.

Tier 1 Preliminary Risk Assessment (Tier 1: PRA)

9.4.17 The risk assessment comprises a tiered approach, commencing with a Tier 1: PRA. This involves the identification of potential contaminant linkages, the determination of hazards (hazard identification) and subsequent hazard assessment, as well as risk estimation and risk evaluation of the posed hazard identified in the CSM.

9.4.18 The CSM is based on the baseline studies and have been informed by available ground investigations and extensive desk-based information for the site.

9.4.19 In relation to the potential impacts of construction, the CSM has been developed with consideration of the construction processes that are anticipated to be required – i.e. to allow construction of the Scheme. This includes the following proposed works:

a) Construction of earthworks (including earth embankments and excavations).
b) Piled structure foundations.
c) Ground improvement beneath embankments in areas of soft ground including band drains (primary option), Controlled Modulus Columns (CMCs; secondary option), or local dig and replace.
d) Installation of drainage (highway) and culverts.

9.4.20 Any contaminant linkages deemed to pose a 'moderate' risk or greater at Tier 1: PRA, in accordance with best practice guidelines CIRIA C552, have been subjected to further risk assessment in the form of a Tier 2: GQRA.

Tier 2: GQRA methodology

9.4.21 In this assessment, soil, groundwater and ground gas data gathered through intrusive ground investigations have been screened against published guideline values based on the relevant receptors considered in the CSM. The following sections set out detailed methodology for controlled waters, ground gas and human health risk assessments.

Controlled waters

9.4.22 Where a potential contaminant linkage is identified in relation to controlled waters a Tier 2: GQRA is undertaken on available data. Where impact of groundwater onto surface waters is being assessed, this is achieved by screening available water chemical testing results against the Environmental Quality Standards (EQS) for annual average inland surface water (freshwater) values. Assessing the impact on drinking water resources is achieved by screening available water chemical testing results against UK Drinking Water Standards. Impacts from hazardous leachable contaminants on the underlying groundwater are assessed by comparing minimum reporting values against measured concentrations.

9.4.23 Where the EQS are dependent on bioavailability, which is the case for copper, lead, manganese, nickel and zinc, the bioavailable fractions have been derived using the UKTAG Metal

Bioavailability Assessment Tool.

Ground gas

9.4.24 Where a potential contaminant linkage is identified in relation to ground gas, an initial screening exercise was undertaken based on a review of the potential for ground gas generation undertaken in accordance with CIRIA C665 and CL:AIRE RB17. Based on this initial assessment the requirement for further intrusive ground gas monitoring was derived.

9.4.25 Due to the nature of the Scheme, i.e. no new buildings are included within the development, the assessment involves only derivation of Gas Screening Values (GSVs) based on recorded maximum concentrations of methane and carbon dioxide, and the measured maximum gas flow. The derived GSV is then compared to GSV thresholds to obtain a risk classification.

Human health

9.4.26 Where a potential contaminant linkage is identified in relation to human health a Tier 2: GQRA is undertaken on available data. This is done by screening available soil chemical test results against published generic assessment criteria for a suitable land use scenario, such as Defra Category 4 Screening Levels, and where these are not available, the Land Quality Management / The Chartered Institute of Environmental Health Suitable 4 Use Levels. The considered land use scenarios are based on the CSM and include open public space (park), residential without plant uptake and commercial end-use generic scenarios.

9.4.27 The applied assessment criteria, as per paragraph above, have been derived using the Environment Agency Contaminated Land Exposure Assessment model. This model defines age classes for receptors within a number of generic end use scenarios.

Assessment of likely significant effects

9.4.28 The process for assessment of likely significant effects is outlined as follows:

a) Step 1: assess the value (sensitivity) of receptors, shown in Table 9-2, as per Table 3.11 in LA 109 Geology and soils.

e) Step 2: assess the magnitude of impact on receptors, shown in Table 9-3, as per Table 3.12 in LA 109 Geology and soils.

f) Step 3: derive impact significance from receptor value and magnitude of impacts, shown in Table 9-4, as per Table 3.8.1 in LA 104 Environmental assessment and monitoring.

9.4.29 The significance of effect is determined by comparison of the identified value (sensitivity) of the receptors with the magnitude of the effect. For the purpose of this assessment, values of moderate adverse and above have been defined as significant effects, and mitigation measures are necessary.

Table 9-2 Environmental value (sensitivity) and descriptions of receptors

Receptor value (sensitivity)	Receptor type	Description
Very high	Geology	Very rare and of international importance with no potential for replacement (e.g. UNESCO World Heritage Sites, UNESCO Global Geoparks, SSSIs and GCR where citations indicate features of international importance). Geology meeting international designation citation criteria which is not designated as such.
	Soils	Soils directly supporting an EU designated site (e.g. Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar), and/ or ALC grade 1 and 2 or Land Capability for Agriculture (LCA) grade 1 and 2.
	Contamination	Human health: very high sensitivity land use such as residential or allotments. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
High	Geology	Rare and of national importance with little potential for replacement (e.g. geological SSSI, Area of Special Scientific Interest (if in Northern Ireland), NNR). Geology meeting national designation citation criteria which is not designated as such.
	Soils	Soils directly supporting a UK designated site (e.g. SSSI), and/ or ALC grade 3a, or LCA grade 3.1.
	Contamination	Human health: high sensitivity land use such as public open space. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.

Receptor value (sensitivity)	Receptor type	Description
Medium	Geology	Of regional importance with limited potential for replacement (e.g. RIGS). Geology meeting regional designation citation criteria which is not designated as such.
	Soils	Soils supporting non-statutory designated sites (e.g. Local Nature Reserves (LNR), Local Geological Sites (LGS), Sites of Nature Conservation Importance (SNCI)), and/ or ALC grade 3b or LCA grade 3.2.
	Contamination	Human health: medium sensitivity land use such as commercial or industrial. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
Low	Geology	Of local importance/ interest with potential for replacement (e.g. non-designated geological exposures, former quarries/ mining sites).
	Soils	ALC grade 4 and 5 or LCA grade 4.1 to 7, and/ or Soils supporting non-designated notable or priority habitats.
	Contamination	Human health: low sensitivity land use such as highways and rail. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
Negligible	Geology	No geological exposures, little/ no local interest.
	Soils	Previously developed land formerly in 'hard uses' with little potential to return to agriculture.
	Contamination	Human health: undeveloped surplus land/ no sensitive land use proposed. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.

Table 9-3 Magnitude of impact and typical descriptions

Magnitude of impact (change)	Receptor type	Typical description
Major	Geology	Loss of geological feature/ designation and/ or quality and integrity, severe damage to key characteristics, features or elements.
	Soils	Physical removal or permanent sealing of soil resource or agricultural land (>20ha).

Magnitude of impact (change)	Receptor type	Typical description
	Contamination	Human health: significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels) with potential for significant harm to human health. Contamination heavily restricts future use of land. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
Moderate	Geology	Partial loss of geological feature/ designation, potentially adversely affecting the integrity; partial loss of/ damage to key characteristics, features or elements.
	Soils	Permanent loss/ reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource.), including: Physical removal or permanent sealing of 1ha-20ha of agricultural land. permanent loss/ reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
	Contamination	Human health: contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g. category 4 screening levels). Significant contamination can be present. Control/ remediation measures are required to reduce risks to human health/ make land suitable for intended use. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
Minor	Geology	Minor measurable change in geological feature/ designation attributes, quality or vulnerability; minor loss of, or alteration to, one (maybe more) key characteristics, features or elements.
	Soils	Temporary loss/ reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
	Contamination	Human health: contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels). Significant contamination is unlikely with a low risk to human health. Best practice measures can be required to minimise risks to human health. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.

Magnitude of impact (change)	Receptor type	Typical description
		Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
Negligible	Geology	Very minor loss or detrimental alteration to one or more characteristics, features or elements of geological feature/ designation. Overall integrity of resource not affected.
	Soils	No discernible loss/ reduction of soil function(s) that restrict current or approved future use.
	Contamination	Human health: contaminant concentrations substantially below levels outlined in relevant screening criteria (e.g. category 4 screening levels). No requirement for control measures to reduce risks to human health/ make land suitable for intended use. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
No change	Geology	No temporary or permanent loss/ disturbance of characteristics, features or elements.
	Soils	No loss/ reduction of soil function(s) that restrict current or approved future use.
	Contamination	Human health: reported contaminant concentrations below background levels. Surface water: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment. Groundwater: refer to ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.

Table 9-4 Significance matrix

Environmental value (sensitivity)	No change	Negligible	Minor	Moderate	Major
Very high	Neutral	Slight	Moderate or large	Large or very large	Very large
High	Neutral	Slight	Slight or moderate	Moderate or large	Large or very large
Medium	Neutral	Neutral or slight	Slight	Moderate	Moderate or large
Low	Neutral	Neutral or slight	Neutral or slight	Slight	Slight or moderate
Negligible	Neutral	Neutral	Neutral or slight	Neutral or slight	Slight

9.5 Assessment Assumptions and Limitations

9.5.1 The assessment undertaken for geology and soils has been based on the collation and evaluation of available documentation listed in Table 9-1.

9.5.2 Professional judgement has been applied where necessary in assignment of sensitivity and magnitude of effects in line with definitions provided in Table 9-2 and Table 9-3.

9.5.3 The completed investigations provide only preliminary information on ground conditions and detailed information to be obtained at detailed design stage.

9.5.4 This is in line with standard practice, where the preliminary investigations are undertaken to create a ground model and identify the required mitigation measures. This is considered sufficient at the initial design stage and to inform the environmental impact assessments. Further detailed ground investigations are typically undertaken on confirmation of the design. The information obtained during these investigations would form the basis for a detailed design of the Scheme.

9.5.5 The completed investigations primarily covered the areas of the proposed Banwell Bypass and the Southern Link. No investigations have been undertaken in the wider mitigation areas covering the placemaking and improvements to the widder road network. Considering the nature of these elements (i.e. primarily involving surfacing works and introduction of signage within an existing highway corridor with very limited or no ground breaking activities), no intrusive investigations were considered necessary at this stage to inform the baseline conditions or assessments.

9.5.6 Notwithstanding the limitations, sufficient information has been available for the completion of the assessment of geology, geomorphology and contaminated land.

9.6 Consultation

9.6.1 A range of consultation and engagement has been undertaken between statutory and non-statutory consultees, landowners,

relevant organisations, community groups and the general public with respect to the Scheme detailed in ES Volume 1 – Chapter 1 - Introduction.

9.6.2 The Scoping Report has been issued to the Environmental Liaison Group that has been set up for the Scheme, which comprises a range of key Statutory Consultees. Comments have been received as summarised in Table 9-5.

9.6.3 Consultations with the Environment Agency and North Somerset Council during Environmental Liaison Group meetings have also informed the development of the geology and soils assessment.

Table 9-5 Scoping responses summary

Consultee	Response date	Response	Assessments response
Natural England	03 August 2021	**Geology** Identifies Banwell Caves SSSI and Banwell Ochre Caves SSSI as designated sites adjacent to the development site. Asks for regionally and locally important sites to be considered in the assessments through engagement with the local wildlife trust, geoconservation group or local sites body in this area.	Both designated and non-designated sites of geological interest have been considered in the baseline and assessments.

Consultee	Response date	Response	Assessments response
		Soil and Agricultural Land Quality Impacts from the development should be considered in light of the Government's policy for the protection of the best and most versatile (BMV) agricultural land. AGC team also recommend that soils should be considered in the context of the sustainable use of land and the ecosystem services they provide as a natural resource. The following to be considered in the ES: 1. The degree to which soils are going to be disturbed/ harmed as part of this development and whether 'best and most versatile' agricultural land is involved. 2. If required, an agricultural land classification and soil survey of the land should be undertaken. 3. The ES should provide details of how any adverse impacts on soils can be minimised. Further guidance is contained in the Defra Construction Code of Practice for the Sustainable Use of Soil on Development Sites.	The ALC surveys have been undertaken and considered within the assessments. Guidance on Construction Code of Practice for the Sustainable Use of Soil on Development Sites has been considered.
Environment Agency	29 July 2021	**Groundwater protection** Full Hydrogeological Risk Assessment is required to identify the risk and potential mitigation measures for the Bristol Water Banwell Spring Public Water Supply and associated Source Protection Zone, and any other private water abstractions in the area.	The impact assessment on hydrogeology has been prepared and is presented in ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment.
		Environment Management Prevention of pollution during construction to include details of containment of silt/ soil contaminated run-off and disposal of contaminated drainage including water pumped from excavations.	The Outline Environmental Management Plan has incorporated measures following industry good practice with respect to pollution prevention.

9.7 Baseline Conditions

Geology

9.7.1 The immediate land use surrounding the Banwell Bypass and Southern Link is predominately agricultural with the Mendip Hills to the south. The route is along the northern flank of the Mendips and sits on a narrow, discontinuous ridge of Carboniferous Limestone, which forms the steeply dipping northern limb of the Blackdown Pericline [9.31] . The placemaking improvements within Banwell and to the wider local road network are located within developed urban areas.

Made Ground

9.7.2 'Artificial ground' is a term used by the BGS for those areas where the ground surface has been significantly modified by human activity. The term includes:

a) Made ground — man-made deposits such as embankments and spoil heaps on the natural ground surface.

b) Worked ground — areas where the ground has been cut away such as quarries and road cuttings.

c) Infilled ground — areas where the ground has been cut away then wholly or partially backfilled.

d) Landscaped ground — areas where the surface has been reshaped.

e) Disturbed ground — areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

9.7.3 For the purpose of this assessment, artificial ground is referred to as made ground.

9.7.4 The study area is predominantly agricultural land in which made ground is rarely found. Made ground associated with the existing road carriageways and in urban areas may be present.

9.7.5 At the approximate chainage Ch. 2+000 of the Banwell Bypass immediately southeast of Muddle End village, there is a historical landfill, which is likely to contain a variety of materials and is known to have accepted waste between 1919 and 1985. A

licence was obtained for disposal of inert industrial and licenced waste (i.e. hazardous waste) in 1979 after 60 years of uncontrolled disposal. The licence ether lapsed or was surrendered. The engineering measures, if any, are unknown.

9.7.6 The completed GI, as detailed in Table 9-1 and presented in ES Volume 2 - Figure 9.5 - Completed Ground Investigation Locations, has encountered made ground that has been interpreted as the landfill material (typically a soft to firm gravelly clay with gravel and frequent fragments of glass, plastic, porcelain, metal, brick, limestone and concrete) to a depth of 2.5m outside the historical landfill boundaries, as marked in ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. This suggests that the landfill limits are larger than anticipated. As part of the archaeological investigations a magnetometer survey was conducted in 2021 (refer to ES Volume 3 - Appendix 6.E - Results of Geophysical surveys) that shows a magnetic disturbance over Area 15 that covers the paddock of the landfill. This suggests that the landfill material could cover this wider extent proven by the GI.

9.7.7 There is a second landfill approximately 170m to the west of the Southern Link. This is at the former location of the Banwell Quarry. Based on the records presented in the Envirocheck report (ES Volume 3 - Appendix 9.A - PSSR) waste was deposited there since 1968 (commercial waste) and from 1984 it was licenced to accept inert and non-hazardous (non-toxic) waste comprising of excavation arisings (natural materials), demolitions and construction wastes. Last waste was accepted in 1988. The licence ether lapsed or was surrendered.

9.7.8 Four further historical quarries are located around Knightcott [9.32] though only one is within the study area and sits approximately 150m to the east of the Banwell Bypass at Ch. 0+300 of at the end of Whitecross Lane. It is depicted in 1814 and 1902 mapping. It now appears to have been infilled and the field it sits in seems to be used to store discarded materials from Stonebridge Farm and/ or the caravan park.

9.7.9 No made ground has been identified within the historical borehole records and no areas are shown on BGS GeoIndex Onshore [9.26] . However, the completed ground investigations have encountered made ground, primarily associated with the

historical landfill at approximate Ch. 2+000 of the Banwell Bypass and existing roads. This is detailed in Sections 9.7.43.

Superficial Deposits

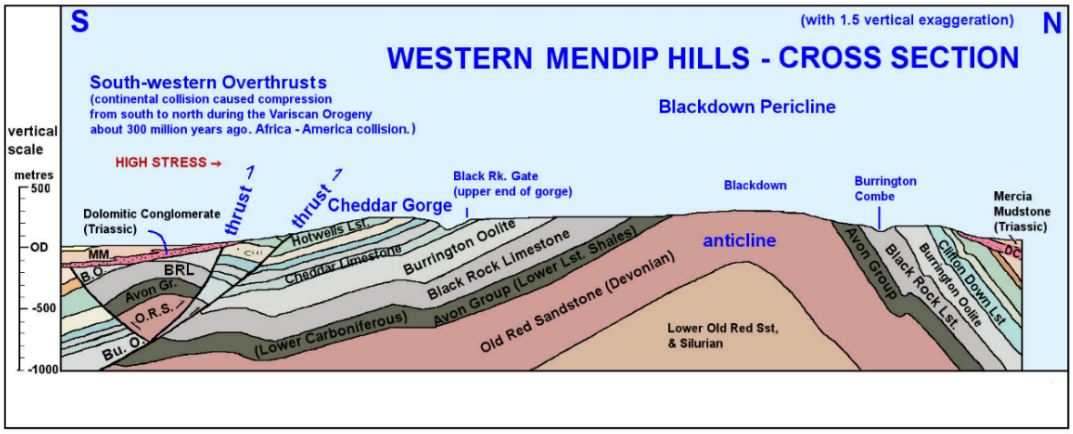
9.7.10 Superficial deposits within the study area predominantly comprise Tidal Flat Deposits (TFD) of clay, silt and sand, and also peat. These deposits form the low lying Somerset Levels to the north of the Mendips, typically at approximately 6m Above Ordnance Datum (AOD), which corresponds with mean high-water mark [9.27] . These deposits underly the eastern part of the study area, to the north and northeast of Banwell. Published geology maps show no recorded superficial deposits west of the Banwell Bypass chainage Ch. 0+940. To the east of this chainage up to a chainage of approximately Ch. 2+700, TFD underlie the Scheme. Refer to ES Volume 2 - Figure 9.2 - Published Superficial Geology.

9.7.11 No superficial deposits are expected to be found beneath the Southern Link. Head deposits comprising clay, silt, sand and gravel are shown to underlie the placemaking and road improvements in Winscombe as well as Churchill.

Bedrock Geology

9.7.12 The Scheme is underlain by several bedrock geological groups. The bedrock geology underlying the Scheme is presented in ES Volume 2 - Figure 9.1 - Published Bedrock Geology. Descriptions of the bedrock units are summarised below. The study area overlies the northern limb of the Blackdown pericline. The sandstones of the Portishead Beds form the core of the pericline. These are overlaid by Carboniferous Limestones of the Pembroke Limestone Group (Burrington Oolite Subgroup, Black Rock Limestone Subgroup, Clifton Down Limestone Formation). The limestone units within the study area generally dip around 70º towards the north. Unconformably over the limestones lie Triassic mudstones of the Mercia Mudstone Group (Blue Anchor Formation, Mercia Mudstone Group (MMG) and MMG- Marginal Facies) and Westbury Formation and Cotham Member, and Jurassic mudstones and limestones (Charmouth Mudstone Formation, Langport Member and Blue Lias Formation). Refer to

Image 9-1 below for a simplified cross section.



SIMPLIFIED CROSS-SECTION OF THE BLACKDOWN PERICLINE OF THE WESTERN MENDIP HILLS.
This is based on a BGS cross-section but has been completely redrawn with some simplification and with stratal units having been given colour emphasis. This asymmetrical structure is a response to severe northward pressures of the powerful Variscan Orogeny. One other effect of this is that the oolitic limestones here are not like Portland Oolite but have lost most of their inter-ooid porosity at a very early stage. They do not look so obviously oolitic in the field. In general, the Carboniferous Limestone here probably has low intergranular permeability and this may favour water-flow through cave systems. Go to BGS maps and publications for more details. Ian West © 2018.

Image 9-1 Idealised conceptual model of the geology in the West Mendip area [9.33] . (Approximate Scheme location is marked by an arrow).

9.7.13 As shown on ES Volume 2 - Figure 9.1 - Published Bedrock Geology presenting the published bedrock geology map, the Banwell Bypass area is underlain, in a general sequence from youngest to oldest, by rocks of the:

a) Charmouth Mudstone Formation– Jurassic aged mudstones with limestone and sandstone beds. The Charmouth Mudstone Formation presents as dark grey laminated shales, and dark, pale and bluish grey mudstones; locally concretionary and tabular limestone beds; abundant argillaceous limestone, phosphatic or ironstone (sideritic mudstone) nodules in some areas; organic-rich paper shales at some levels; finely sandy beds in lower part in some areas.

b) Langport Member and Blue Lias Formation (undifferentiated) - Jurassic aged grey to black mudstones with subordinate limestones and sandstones, formed of fine-grained limestones (Langport member) and conglomerates which are underlain by the Rhaetic Bone Bed containing marine bones and teeth. Blue Lias Formation, regularly alternating thin, hard limestone and dark mudstone beds and is generally poorly exposed. The limestones generally weather out. The whole succession is highly fossiliferous. In some areas, intervening mudstone units with relatively few limestone beds. Also includes littoral limestone facies of the Radstock Shelf - Mendip area and South Wales.

c) Westbury Formation and Cotham Member (undifferentiated) - Late Triassic aged grey to black mudstones formed of organic-rich black shale with thin beds of mudstones to calcareous mudstones with distinctive Cotham Marble towards the top.

d) Blue Anchor Formation - Late Triassic aged pale grey-ge mudstones and siltstones with thin lenses and a few thin, commonly discontinuous beds of hard, dolomitic, pale yellowish-grey, porcelaneous mudstone and siltstone, contain marine microfossils.

e) Mercia Mudstone Group (MMG)- formed during the erosion of the Mendips during the Triassic Period dominantly red (less commonly green-grey) mudstones, subordinate siltstones. Thin beds of gypsum/ anhydrite widespread; sandstones are also present.

f) MMG - Marginal Facies - conglomerate deposits occur at the edges of MMG outcrops, is described as being variable, typically consisting of conglomerate and/ or breccia with clasts derived locally from rocks lying immediately below the unconformable base of these deposits. The matrix generally consists of finer-grained rock fragments or, less commonly, siltstone, sandstone or micritic limestone. Where these deposits overlie Carboniferous limestones, such as in the Bristol and Mendip areas, both the matrix and limestone clasts are commonly dolomitized (formerly known as "Dolomitic Conglomerate"). Individual clasts can range up to several cubic metres in size.

g) Burrington Oolite Subgroup is categorised as massive pale grey ooidal limestones and ooidal/ crinoidal limestones. Beds of coarse crinoidal limestone in lower part and calcite mudstones in uppermost part. Locally dolomitised in lowermost part.

h) Black Rock Limestone Subgroup can be described as Thin- to thick-bedded, dark grey to black, foetid, fine- to coarse-grained skeletal [mainly crinoid] packstones with subordinate thin beds of shaly argillaceous skeletal packstone and mudstone. Widespread burrowing. Tractional structures and silicified limestones characterise the lowermost part of the Subgroup. Tuffs developed in the lower part of the Subgroup in the Weston super Mare areas [Middle Hope Volcanic Member]. Subgroup represents deposition in an inner to mid ramp setting with local ooid shoal development

i) Clifton Down Limestone Formation is splintery dark grey calcite and dolomite mudstones, pale grey oolitic, dark grey bioclastic and oncolitic limestones and some mudstones. Scattered cherts and silicified fossils in lower half. Sandy limestone at base in Bristol area. Deposited in a barrier/ back

barrier/ shelf lagoon setting. Limestones, thin to thick bed, dark grey to black, foetid, fine to coarse-grained skeletal packstones with subordinate thin beds of shaly argillaceous skeletal packstone and mudstone. Tuffs developed in the lower part of the Subgroup in the Weston Super Mare area.

j) Portishead Beds – Late Devonian red-green mudstones and marls, red siltstones and red-yellow, hard, fine-grained quartzose sandstones, with conglomerate locally.

9.7.14 The Southern Link is underlain by MMG and conglomerates of the Marginal Facies variation of the MMG with the southern tip of the alignment underlain by the Black Rock Limestone Subgroup. The wider mitigation measures are all underlain by MMG.

Subsurface features

9.7.15 The Coal Authority records [9.34] show a designated Surface Coal Resource Area at the northern extent of the Banwell Bypass alignment. A linear negative gravity anomaly to the north of Blackdown Pericline is interpreted to be caused by a small occurrence of Coal Measures [9.35] . However, published geology plan [9.25] does not show coal seams or outcrops within geological units underlying the Scheme. The Carboniferous Coal Measures, which in a geological sequence overlie the Carboniferous Limestones, are coal bearing. These can be found in area to the east of the Mendips, outside the study area. In addition, there is no evidence that mining activities has taken place within the Scheme footprint. Therefore, it is considered that finding outcropping coal seams within the study area is highly unlikely.

9.7.16 To the northwest of the Scheme there is a small fault line, which sits within 250m of the slip road joining the Banwell Bypass with Wolvershill Road, as shown on ES Volume 2- Figure 9.1 - Published Bedrock Geology.

9.7.17 Two man-made cavities associated with the extraction of iron ore have been recorded in close proximity to the Banwell Bypass. The closest feature has been recorded 32m to the west of the eastern extent of the site. Refer to ‘Geologically designated sites’ section for details.

9.7.18 A number of naturally formed cavities (vadose, phreatic, spring outlets and solution widened fissures) have been identified within

the surroundings of the Scheme. The closest of which are the Banwell Ochre Caves located at the eastern end of the Banwell Bypass, as shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. Detailed description is provided in sections below. Other caves are located in the wider area of the Scheme, including the Banwell Caves such as 'Banwell Bone Cave' and 'Banwell Stalactite Cave', which are located approximately 500m to the south of the Scheme, outside the study area. Refer to ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan for their locations. There is no evidence that caves are located within the Scheme footprint.

Geologically designated sites

9.7.19 The eastern end of the Banwell Bypass (approximately at Ch. 3+100) slightly encroaches on Banwell Ochre Caves SSSI, also designated as North Somerset and Mendip Bats SAC [9.29] . This comprises five caves and two pits. The caves are summarised below in Table 9-6 and the location is shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. The nearest cave is located approximately 40m south of the Scheme. These caves contain bones from "Lapus Angelicus H" [9.36, 9.37], which is a type of extinct hare, fossilised bird nests, "specimens of lead ore and unusual ochreous formations," and pottery amongst other findings.

Table 9-6 Banwell Ochre Caves SSSI – caves and pits summary [9.38]

Cave	Grid ref	Description	
Banwell Ochre Cave 1	ST40605904	L: 62m x D: 12m Altitude:43m AOD Former mine	A low entrance passage leads into roomy upper and lower galleries. This mine was once used to store the empty mining drams and there are rails and stemples still in situ.
Banwell Ochre Pit	ST4062159193	L: 7m x D: 5m Altitude:45m AOD Former mine	A blind vertical Ochre Pit
Banwell Ochre Cave – 2 (also known as Big Cave, The Ochre Cave, Banwell Ochre	ST40665923	L: 154m x D: 25m Altitude:54m AOD Cave	This cave, discovered in 1937, consists of two large parallel passages accessible from three entrances. Fossilised bird's nests of mud, probably of martins,

Cave	Grid ref	Description	
Cave, Mud Slide Mine)			were found on the ledges surrounding the Upper Entrance. Immediately above the Upper Entrance lies the High Series, an apparently separate working, but with a choked connection back to Big Cave. Inside, a roomy tunnel can be followed for over 20m passing a short blind extension to the right.
Banwell Ochre Cave – 3 (also known as Middle Series)	ST40675927	L: 92m x D: 15m Altitude:40m AOD Cave	This cave consists of upper and lower galleries, connected by climbs and pitches. The ochreous earth in this cave is locally overlain by up to 2m of fine-grained, wind-blown quartz sand.
Banwell Ochre Cave – 4 (also known as Main Entrance)	ST40735926	L: 62m x D: 9m Altitude:46m AOD Cave	A roomy entrance cutting leads to a series of irregular strike galleries excavated on one level.
Banwell Ochre Cave - 5	ST40755925	L: 31m x D: 6m Altitude:52m AOD Cave	The working consists of a simple gallery, with a step-up to the left into a passage which emerges at a second entrance immediately adjacent to the first.
Alco Hole	ST40665883	L: 6m x D: 4m Altitude:70m AOD Mine	Narrow mined ochre rift choked with rocks and bottles at a depth of 4m.

9.7.20 Notes published during the explorations of the caves in 1956 [9.36, 9.37] describe the caves as being “at no great depth below the surface” with most of the encountered passages and shafts described as directed towards the northwest, in the direction of the Scheme. Modern mapping shows these caves’ entrances to lie between 40 and 70m AOD, higher than the Scheme which varies between 5 – 20m AOD. It is therefore unlikely that there are caves that would extend into the footprint of the Scheme.

9.7.21 No Regionally or Locally Important Geological Sites (RIGS/ LICS) have been identified within the Study Area.

Hydrology and Hydrogeology

9.7.22 The hydrological and hydrogeological baseline conditions are described in full in ES Volume 1 - Chapter 13 - Road Drainage

and the Water Environment. The key features relevant to this chapter are as follows:

a) Surface water features – River Banwell, Old Yeo Rhyne and Towerhead Brook, which have northerly flows, interconnect with the various rhynes and drainage network. The Banwell Bypass crosses the River Banwell at the approximate chainage Ch. 1+950 and the Yeo Rhyne at approximately Ch. 1+800. The Yeo Rhyne splits into the West Moor Rhyne north of the Scheme, which then flows into the River Banwell. Key surface watercourses are marked on ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints Plan.

b) Groundwater aquifers – the MMG underlies the TFD and forms the low lying land at the margin of the Mendips Hills, part of the Somerset Levels. They support secondary aquifers. The Jurassic and Triassic mudstones also support Secondary aquifers. The Mendip Hills are formed by Carnoniferous Limestones supporting a Principal aquifer. Groundwater flow through the limestones is dominated by secondary porosity pathways and tertiary (karstic) porosity features. Secondary porosity features include joints and bedding planes within the rock mass. The west Mendips are renowned for their caves including the Banwell Caves, which indicate very well-developed karstic systems. Marginal Facies of MMG form part of that aquifer. Aquifer designations are shown on ES Volume 2 - Figures 13.4 and 13.5.

c) Artesian groundwater conditions - the completed ground investigations have encountered groundwater within the mudstones confined by the TFD, at or near artesian pressures. It is considered that this is driven by the recharge from the Mendips Hills through the conglomerate aquifer, which underlie the MMG. The groundwater conditions encountered through intrusive investigations are described in more detail in Section 9.7.26.

d) Springs - The Mendips Hills drain through large springs along the foot of the Mendips. The main spring in the west Mendips area is the Banwell Spring, located approximately 400m to the north of the Southern Link and 500m west of the main alignment, as shown on ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints Plan. The Banwell Spring forms headwaters of the Banwell River.

Water abstractions and Source Protection Zones

9.7.23 Water abstractions and associated source protection zones are detailed in ES Volume 3 - Appendix 13.D - Hydrogeological Impact Assessment and their locations are marked in ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints

Plan.

9.7.24 In summary, a number of water abstractions are present within the study area with the Banwell Spring Bristol Water public supply and its source protection zone being the most prominent feature.

Ground investigations

9.7.25 The Banwell Bypass and the Southern Link elements of the Scheme have been subject to two phases of ground investigations, NSC GI and AGC GI, as detailed in Table 9 - 1. In addition, historical borehole logs have been reviewed as summarised Table 9 - 1. The locations of the exploratory holes are shown in ES Volume 2 - Figure 9.5 - Completed Ground Investigation Locations. No intrusive investigations were undertaken in the proposed placemaking and wider road improvement areas, as stated in Section 9.5.

Encountered Ground Conditions

9.7.26 The encountered ground and groundwater conditions based on published, historical and completed ground investigations are presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report and summarised in Table 9-7. The locations of the completed investigations are shown in ES Volume 2 – Figure 9.5 - Completed Ground Investigation Locations. The detailed interpretation of the hydrogeological baseline is presented in ES Volume 3 - Appendix 13.D - Hydrogeological Impact Assessment.

9.7.27 For ease of reference and based on underlying geology, the Banwell Bypass and the Southern Link elements of the Scheme have been split into distinctive areas:

a) Western that includes the road alignment chainage (Ch)0 to Ch700.
b) Central - Ch1480 to Ch2700.
c) Eastern - Ch2700 to Ch3100.
d) Southern Link Road.

9.7.28 The alignment chainage is shown on ES Volume 2 - Figure 9.1 -

Published Bedrock Geology.

9.7.29 Findings showed that the majority of the investigated Scheme area is underlain by natural soils as expected within an agricultural land area. Natural soils comprised up to 0.3m of topsoil over either weathered bedrock (typically described as firm to stiff either silty or gravelly clay) or TFD (typically described as soft to very soft sandy clay with bands of peat) within the area of the floodplain.

9.7.30 Discrete areas of made ground were encountered across the Scheme. Detailed descriptions and evidence of contamination is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report. In summary, generally made ground (encountered outside the historical landfill) was described to contain anthropological inclusions such as brick or concrete. Clinker was encountered as part of the gravel in BH108 located near Moor Road. Made ground within the area of the historical landfill was described to contain metal, glass, plastic, porcelain, brick and concrete. Strong chemical odour was also recorded in BH305.

Table 9-7 Summary of encountered ground conditions (Banwell Bypass and Southern Link)

Extent (Alignment Chainage)	Summary of ground conditions			
	Strata	Typical description	Depth to top (m)	Thickness (m)
Western (Ch0 to Ch700)	Made Ground	Soft to firm slightly gravelly clay with gravel of limestone (possible reworked material) (TP205 only)	0	1.8m
	Bedrock (Various)	Weathered Bedrock Firm to stiff brown to orange brown and brown grey to dark grey slightly sandy slightly gravelly silty clay. The gravel component is angular to subangular fine to coarse of mudstone and limestone. (Ch0-1060) Very stiff fissured blue grey clay to gravelly clay to gravel of mudstone and limestone (Ch1060-Ch1480)	0.15-0.4	0.8 - 3

Extent (Alignment Chainage)	Summary of ground conditions			
	Strata	Typical description	Depth to top (m)	Thickness (m)
		Intact Bedrock Weak to moderately weak thinly to thickly laminated grey to dark grey mudstone (Ch0-Ch700) with bands of medium strong limestone and sandstone (Ch700-Ch1060)	1.1 - 3.6	unproven
Central (Ch1480 to Ch2700)	Made Ground	Soft to firm brown slightly sandy slightly gravelly silty clay with gravel of brick, limestone, siliceous material, mudstone, sandstone and rare ceramic. (BH108 and 109)	0	1.0
	Made Ground – landfill	Soft to very soft slightly sandy gravelly clay with gravel of brick, concrete, ceramic, glass, plastic, limestone (BH305, BH306, TP406, TP408, CPT503)	0-0.5	0.7-2.4
	Tidal Flat Deposits	Soft to very soft blue grey mottled brown slightly sandy clay with rare to frequent brown fibrous plant remains. Occasional partly decomposed fragments and peaty secondary components were recorded	0.15-2.3	2.0-11.0
		(Pseudo fibrous to amorphous peat (not consistently encountered in all holes) within the TFD)	(1.8-4.3)	(0.6-3.0)
	Mercia Mudstone Group	Weathered Bedrock Firm to stiff reddish brown slightly gravelly silty clay. The gravel component is angular fine to medium mudstone lithorelicts. Within CPTs upper 0.5m to 1m logged as dense sand to clayey sand	1.6-8.1	1-7.3
		Intact Bedrock Extremely weak to weak thinly laminated reddish	3.4-11	unproven

Extent (Alignment Chainage)	Summary of ground conditions			
	Strata	Typical description	Depth to top (m)	Thickness (m)
		brown locally mottled green grey mudstone		
Eastern (Ch2700 to Ch3100)	Made Ground	Soft dark brown slightly sandy slightly gravelly silty clay with gravel of brick, concrete, siliceous materials, wood, limestone and/ or ceramic. (BH309 and TP409)	0	0.4-0.8
	Mercia Mudstone Group	Weathered Bedrock Firm reddish brown slightly sandy slightly gravelly clay with gravel of mudstone	0-0.3	1.6-5.4
		Intact Bedrock extremely weak friable thinly laminated reddish brown mottled green grey mudstone (Encountered in BH111)	2.8	unproven
Southern Link Road	Mercia Mudstone Group	Weathered Bedrock Firm red brown slightly gravelly clay. The gravel component is mudstone	0.1-0.3	2.0-6.0
		Intact Bedrock extremely weak to weak thinly laminated reddish brown locally mottled green grey mudstone.	2.1-6.4	Proven 8.2m in BH310
	Marginal Facies of MMG	1m very strong breccia of limestone, mudstone overlying 2.1m very strong siltstone overlying extremely strong limestone (Encountered in BH310)	12.1	unproven

Encountered groundwater conditions

9.7.31 The encountered groundwater conditions are described in detail in ES Volume 3 - Appendix 13.D - Hydrogeological Impact Assessment and summarised below. During the completed ground investigations, groundwater was encountered across the majority of the investigated Scheme areas. In the floodplain area, shallow groundwater strikes were recorded within the TFD, as shown in ES Volume 2 - Figure 9.2 - Published Superficial Geology, given the low-lying nature of the land at typically between 0.5 and 1.6m bgl (5.2 – 3.2m AOD). In the areas of

higher ground, groundwater strikes were noted between 0.7 and 8m bgl (22.9 – (-3)m AOD) in the mudstones. No groundwater was found in the Marginal Facies MMG.

9.7.32 During the AGC GI, artesian groundwater conditions were encountered within the MMG that is confined by TFD. The recorded artesian strikes were concentrated in the central extent of the Scheme, in the thicker areas of TFD, near the Banwell River, with thickest TFD encountered in BH307, as shown in the GIR in ES Volume 3 - Appendix 9.C - Ground Investigation Report. The groundwater levels above ground level were measured between 0.7 and 1.1m (5.4 and 6.2m AOD). As discussed in ES Volume 1 - Chapter 13 - Road drainage and water environment, the encountered artesian conditions are likely to be associated with the recharge of the mudstone aquifer by the Carboniferous Limestones aquifer where the groundwater driving head is at higher level than the floodplain area.

9.7.33 Groundwater monitoring was undertaken across the Banwell Bypass and Southern Link alignments and targeting the range of strata and depths as follows:

a) TFD at 0.3 to 0.6m bgl (4.4 to 4.8m AOD)
b) weathered MMG at 0.2m to 0.47m bgl (6.3m to 6.6m AOD)
c) MMG in Central Extent at 0.2 to 0.6m bgl (5.3m to 5.7m AOD)
d) MMG in Eastern Extent at 3.9m to 5.8m bgl (19.1m to 17.1m AOD)
e) MMG in Southern Link Road at 7.1 and 9.5m bgl (14.1m and 11.7m AOD)
f) bedrock in Western Extent 0.5m to 6m bgl.

Soil resources

9.7.34 Agriculture land of varying land classifications is the main land use within the areas surrounding the Banwell Bypass and Southern Link. The placemaking and road improvements to wider road network are all located within an existing highway corridor and therefore outside agricultural land.

9.7.35 The principal physical factors influencing agricultural production are climate, site and soil. These factors together with interactions between them form the basis for classifying agricultural land into

one of five grades; ALC grade 1 land being of excellent quality and ALC grade 5 land of very poor quality. ALC grade 3 land is divided into two subgrades designated 3a being of very good quality and 3b being of moderate quality.

9.7.36 An ALC survey was undertaken between October and November 2021, to determine the ALC of soil resources within the study area. The result of the ALC survey is presented in ES Volume 3 - Appendix 9.D - Agricultural land classification report and provides accurate information on the agricultural grade of the land. The ALC of soils resources is graphically presented in drawing ref. RAC/9196/2 within ES Volume 3 – Appendix 9.D – Agricultural land classification report.

9.7.37 The total area of agricultural land that would be permanently affected by the construction of the Scheme has been estimated to be approximately 46.7ha, as shown in Table 9-8.

Table 9-8 Agricultural land affected by the construction of the Scheme (permanent land take)

ALC grade	Description	Area (ha)
		Total Scheme
Subgrade 1	Excellent (BMV)	-
Subgrade 2	Very good quality (BMV)	-
Subgrade 3a	Good quality (BMV)	4.4
Subgrade 3b	Moderate quality	17.8
Grade 4	Poor quality	24.5
Grade 5	Very poor quality	-
Total agricultural land affected		46.7

9.7.38 The Scheme would also require temporary land take estimated at approximately 8.3ha.

Contamination Site history

9.7.39 Site history is presented in the PSSR, enclosed in ES Volume 3 - Appendix 9.A - PSSR and summarised below. Key features identified below are presented in ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan.

9.7.40 The site has historically undergone little change along most of the proposed Banwell Bypass route which remains undeveloped

agricultural land. The growth of the villages of Banwell and Stonebridge, which is 200m southwest of the Banwell Bypass chainage Ch. 1+500 at its closest point, occurred predominantly between 1930 and 1985 with little change before or following these dates. The road network through Sandford, Churchill as well as Winscombe as shown on the early historical plans (late 1880s) mirrors current road network.

9.7.41 Stonebridge has continued to expand slowly since with a couple of “courts,” “homesteads,” and “lodges,” appearing between 1985 and 1996, but Banwell has remained relatively unchanged since 1985 mapping.

9.7.42 Knightcott at the start of the alignment has undergone very little change with most of its extent already present on the earliest 1884 mapping. A caravan park (current Summer Lane Park Homes), 200m to the west of the Banwell Bypass at Ch. 0+100 appears on mapping after 1973. Towerhead to the east of the end of the alignment has similarly changed little since 1884 though several additional farm buildings have appeared to the north and south of the original buildings. The farms on Catworthy Lane adjacent to the tie-in at the end of the Scheme appear on mapping from 1999.

9.7.43 A historical landfill is located at approximate chainage Ch. 1+900 of the Banwell Bypass, immediately southeast of Muddle End, as shown in ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan, which accepted waste between 1919 and 1985. At the west of the site now sits a “Welding and Fabrications” workshop and the landfill has been infilled. Banwell Quarry, 100m west of the Southern Link was no longer shown on mapping after 1985 having been labelled from 1885. Knightcott Quarry was infilled in the 1970s and the land is now industrial buildings including Aspire Stone Fabrications and Weston Trade Frames.

9.7.44 There was a gas works 100m south of the Banwell Bypass alignment crossing the River Banwell at approximately Ch. 1+950. This was no longer shown by 1930s mapping and the land is now occupied by residential properties.

9.7.45 A historical limekiln is recorded to the west of the Banwell Bypass alignment at an approximate chainage of Ch. 0+600. It is no longer shown on mapping after 1903. A second is shown

attributed to the Banwell quarry in the vicinity of the southern link and is no longer shown after the 1930s mapping.

9.7.46 In the 1930s the exploration of the Ochre Caves begun, where ochre was mined until 1948. The Ochre Caves are located to the south-east of the eastern end of the Scheme, with the nearest cave situated approximately 40m to the south. Refer to Table 9 - 6 for details of the Ochre Caves.

9.7.47 The Aquila Capital Solar Farm which is directly to the east of the Banwell Bypass between the chainages of Ch. 2+300 to Ch. 2+800 was constructed in 2015.

Unexploded ordnance (UXO)

9.7.48 A preliminary UXO assessment is presented in the PSSR enclosed in ES Volume 3 - Appendix 9.A - PSSR. In summary, the findings indicate that the area is low risk for UXO and no detailed assessment is considered necessary.

Current land use

9.7.49 Current land use and site description is presented in ES Volume 1 - Chapter 2 – Scheme Description. Additional, features relevant to this chapter are described below. The key features are marked on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan.

9.7.50 There are ‘tank’ features associated with the water works to the west of the Southern Link road, as shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. Multiple similar structures are present across the undeveloped farmland, which based on historical and current land use and their location, are likely to be associated with agricultural irrigation, or livestock/ farm use.

9.7.51 The Welding and Fabrications workshop, located within the footprint of the central extent of the Banwell Bypass (at approximate Ch. 1+800), has on-site storage facilities containing unknown materials.

9.7.52 Knightcott Motors, where the alignment ties into the existing

Knightcott Road, contains storage for tyres and also may have fuel storage. This is part of the wider Knightcott Industrial Estate to the southwest of the Scheme.

9.7.53 A complete list of potentially contaminating land uses is presented within Table 9-10 of the potential sources section of this chapter.

Regulatory data

9.7.54 The regulatory data is based on the Envirocheck report included in the PSSR, enclosed in ES Volume 3 - Appendix 9.A - PSSR.

9.7.55 No active pollution prevention and controls are within the study area.

9.7.56 There is one recorded pollution incident to controlled waters which occurred in 1996 with regards to algae which was a Category 3 incident. This occurred on Dark Lane approximately 150m from the Southern Link. Locations of pollution incidents are presented in ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints Plan.

9.7.57 At the west end of the Banwell Bypass there is a water discharge consent associated with Stonebridge Farm and another one is located 30m from the Wolvershill Road/ Wolvershill Park junction. In the centre of the Scheme, there is a further discharge consent, which is associated with the works on Moor Road and two others are present on Riverside. Towards the east, along Eastermead Lane, there are two discharge consents with another one by Towerhead Solar Farm. Locations of active discharge consents are presented in ES Volume 2 - Figure 9.4 - Hydrological and Hydrogeological Constraints Plan.

9.7.58 Two historical landfill sites have been identified within the study area, a historical landfill ‘adjacent to Bow Farm’, recorded to accept inert and industrial waste, and Banwell Quarry, recorded to accept inert, industrial (excavation, demolition and construction) waste. The location of the landfills is shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. The Banwell Bypass encroaches on the ‘Bow Farm’ landfill site at approximate Ch. 1+900, whereas the Banwell Quarry site is located approximately 100m to the west of the Southern Link.

Refer to Sections 9.7.5to 9.7.7 for details.

Environmental designations

9.7.59 There is one SSSI and SAC adjacent to the south of the Banwell Bypass between approximate chainages Ch. 3+000 to Ch. 3+200. This is also to the east of the Southern Link, as shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan

Potential baseline sources

9.7.60 The Conceptual Site Model is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report and with potential baseline sources listed in Table 9-9 and potential baseline receptors in Table 9-10.

Table 9-9 Summary of potential baseline sources

Potential Sources
On-site **S1:** Agricultural Land Use particularly farmyards, barns, and other storage areas historical and current. Potential storage of heating oil. **S2:** Made ground associated with existing road network **S3:** Made ground associated with landfill site **S4:** Limekiln **S5:** Groundwater impacted by off-site sources **S6:** Peat and organic materials
Off-site **S7:** Made ground / Infilled ground **S8:** Iron reach soils (ochre) **S9:** Current industrial works (Electrical Engineers / Metal Finishing Services, Rubber and Plastic Manufacturers, Wrought Iron Works) **S10:** Vehicle Dealers **S11:** Domestic Cleaning **S12:** Historical Gas Works **S13:** Electrical substation **S14:** Discharge consents/ pollution incident

Table 9-10 Summary of potential baseline receptors

Potential Receptors (sensitivity)
R1: Occupants of neighbouring residential properties and the caravan park (off-site, locally within 100m of the Scheme) (very high) **R2:** Workers including agricultural fields and commercial (off-site) (medium) **R3:** River Banwell (very high) and rhynes (low) **R4:** Principal aquifers (Clifton Down Limestone Formation, Burrington Oolite Subgroup, Black Rock Limestone Subgroup) (very high) **R5:** Secondary A aquifers (Langport Member and Blue Lias Formation) (medium) **R6:** Secondary B aquifers (MMG, Westbury Formation, Cotham Member, and Blue Anchor Formation) (medium) **R7:** Source Protection Zone 1c (on-site) and Zone 1 to the south associated with potable water abstraction at Banwell Spring (very high) **R8:** Groundwater abstraction wells within 500m of the Scheme and public water supplies within 1.5km (high)

9.8 Predicted Environmental Effects

9.8.1 The Scheme has the potential to affect geology and soils during construction and operation of the Scheme, both beneficially and adversely. This section presents assessment of predicted significant environmental effects.

Embedded mitigation

9.8.2 Mitigation measures incorporated in the design of the Scheme are reported as embedded mitigation. Mitigation measures incorporated in the construction of the Scheme are reported as essential mitigation in Section 9.9 Proposed mitigation and enhancement measures. The following embedded mitigation has been included as part of the Scheme.

9.8.3 The Scheme has been designed, to avoid and prevent adverse effects on the geology and soils environment through the process of design development and consideration of good design principles.

Soil resources – embedded mitigation

9.8.4 The Scheme footprint has been reduced and designed to avoid best and most versatile land and to reduce impacts on soil resources. However, the impact cannot be completely removed due to the nature and location of the Scheme.

9.8.5 Potential impacts specific to contamination impacting on soil resources would be mitigated through the following measures to be incorporated into the EMP, as part of a Soil Management Plan, to be prepared by the contractor, as detailed in 'Land contamination' section below. In addition, measures contained within the EMP would be designed to limit the possibility for spread of weeds. These would include:

a) Works would be undertaken in compliance with the Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites [9.22] .

b) The source of imported topsoil and subsoil would be investigated carefully with respect to its suitability for the intended use.

c) Should imported soils be required, these would require verification prior to use within the Scheme.

d) The Soil Management Plan would detail the areas and type of topsoil/ subsoil to be stripped, stripping method, haul routes and the management of the soil stockpiles. This would ensure high standards in the handling, storage and reinstatement of soils during construction.

e) Topsoil would be handled only in the appropriate conditions of weather and soil moisture, and with suitable machinery in line with the Defra Construction Code of Practice for the Sustainable Use of Soils on Construction Sites.

f) Topsoil excavated from areas of known high quality agricultural land would be stored separately and, where possible, reused on-site in areas that would be returned to agricultural use.

g) The stockpiling of soils would be avoided whenever possible. Where stockpiling is unavoidable, heaps would be tipped loosely and the surface firmed and shaped to shed water. Where soils are to be stockpiled for more than six months the surface would be seeded with a grass/ clover seed mix.

h) Where possible, topsoil would be re-used on site as applicable.

i) The movement of traffic would be confined to designated haul routes to reduce the amount of heavy machinery going over soil materials which could cause compaction of soil materials. Such routes would exclude areas of proposed landscaping.

9.8.6 An outline EMP is presented in ES Volume 3 - Appendix 16.A - Outline CEMP.

9.8.7 Following the completion of construction activities, agricultural land taken on a temporary basis would be restored and returned to the landowner for unrestricted agricultural use in the same agricultural condition (ALC grade) that currently exists. This would require monitoring as set out in the Soil Management Plan.

9.8.8 With the adoption of appropriate mitigation for the handling and restoration of soils, as part of the outline CEMP presented in ES Volume 3 - Appendix 16.A - Outline CEMP, most soils would be able to continue their various ecosystem functions on or off site.

Contamination– embedded mitigation

9.8.9 The Scheme within the historical landfill area comprises an approach embankment to the Banwell River Bridge (Ch. 1+940),

which requires a piled foundation and then transitions into an embankment. It is proposed that the piled embankment stretches across the extent of the deposited waste. This would avoid installation of band drains in the area of deposited waste and avoid potential cross contamination.

9.8.10 Only soils that are suitable for reuse would be retained on site as part of the Scheme. Geotechnical and chemical acceptability criteria would be established for any soils proposed for reuse and would be protective of the identified receptors, with soil samples tested and screened against the acceptability criteria as the work progresses. This would ensure that the acceptability of soils for reuse is demonstrated and verified. Any soils that do not meet the chemical acceptability criteria would be treated or disposed of to a suitably licenced facility. Any imported soils would also require verification prior to use within the Scheme. This approach to soil sampling, testing and assessment would be defined in an earthworks specification for the construction works that would be prepared in accordance with the Specification for Highway Works Series 600 Earthworks – that is applicable for the Scheme.

9.8.11 Construction activities would be undertaken in line with current best practice and guidance in accordance with the EMP. Construction-related receptors and sources would be managed to negate their impact on the environment. The commitments incorporated in the EMP, in addition to those to be incorporated into a Soils Management Plan, include but are not limited to:

a) Management of construction-related waters.

b) Environmental monitoring including surface water and ground water monitoring.

9.8.12 Following the completion of construction groundwater monitoring observation boreholes may be decommissioned. The decommissioning of the boreholes would be done in such a way that the material placed in the observation well mimics the annulus construction.

9.8.13 Potential impacts specific to contamination impacting on soil resources would be mitigated through measures to be incorporated into the EMP, as part of a Soil Management Plan, to be prepared by the contractor. Measures contained within the EMP would be designed to limit the possibility for dispersal and accidental releases of potential contaminants and uncontrolled

run-off during construction. These would include:

a) Any soils that do not meet chemical acceptability criteria would be treated or disposed of to a suitably licenced facility – refer to Section 9.8.15.

b) A watching brief would be developed to enable unexpected ground conditions or contamination to be addressed if or when encountered on site, particularly in areas of potential contaminated land or groundwater (by a suitably qualified and experienced person).

c) A discovery strategy would be developed to enable unforeseen ground conditions to be addressed if or when encountered. An Action Plan for safely dealing with unexpected contamination.

9.8.14 An outline EMP is presented in ES Volume 3 - Appendix 16.A - Outline CEMP.

9.8.15 Measures to ensure that contamination is addressed during construction and unacceptable risks with respect to human health and controlled waters are mitigated (including testing for reuse and import of materials) would be captured in the Earthworks Specification derived for the Scheme and presented in the EMP as part of the Soils Management Plan, as detailed above. The EMP would establish procedures for dealing with unexpected soil or groundwater contamination that may be encountered.

9.8.16 Piled foundation, or ground treatment (if undertaken) design will incorporate Foundation Works Risk Assessments (FWRA) to identify appropriate piling techniques. This would be completed at the detailed design stage.

9.8.17 The Scheme design incorporates assessments of ground aggressivity with respect to concrete allowing for selection of appropriate concrete class to prevent concrete degradation.

Construction

Construction effects on geology

9.8.18 The construction activities of the Banwell Bypass may encroach on the area of the Banwell Ochre Caves SSSI designated geological site (see ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan). However, this would have no impact on

the caves, which lie at higher elevation (40-70m AOD) than the Scheme which varies between 5 – 20m AOD. It is therefore unlikely that there are cave shafts that would extend into the footprint of the Scheme resulting in no change to the designated features.

9.8.19 Construction of the Banwell Bypass and Southern Link road requires earthworks including placement of fill materials, with limited excavation of soils. This would result in burying or removal of shallow superficial deposits or bedrock. In addition, piling, band drains and/ or soil stabilisation measures are likely to be required to allow for construction of structures and embankments. These construction activities would primarily impact superficial deposits or weathered bedrock with an overall minor magnitude of impact. The value of geology beneath the Banwell Bypass and Southern Link road is negligible. The effect of these Scheme elements on geology is therefore assessed as *permanent slight adverse* that is not significant.

9.8.20 The place making and the wider mitigation as described in 9.1.12would involve primarily surfacing works and introduction of signage within the existing highway corridor with very limited or no ground breaking activities and therefore would have negligible impact on the underlying ground. The value of geology beneath the placemaking and wider road improvements is negligible. The effect of these Scheme elements on geology is therefore assessed as *neutral* that is not significant.

Construction effects on soil resources

9.8.21 With regard to soil resources, construction has the potential to result in the following adverse impacts:

a) The temporary and permanent loss of BMV agricultural soils through land-take.

b) Degradation of soil resources (including damage to soil structure, reduced biological function, mixing of soil types) resulting from soil compaction due to heavy construction vehicle movements, and the exacerbation of soil erosion through handling and storage of soils.

c) Change to the function or quality of soil as a resource, including the deposition of dust on sensitive land uses, disruption to drainage, irrigation and water supply systems, unintentional pollution of soil and water courses, and spread of injurious weeds to adjacent agricultural land from soil and

material stockpiles. This could lead to the generation of waste soils that cannot be reused elsewhere on the Scheme, requiring off-site disposal as waste.

9.8.22 Construction has the potential to result in beneficial impacts to soil through a reduction in soil erosion through improved drainage.

9.8.23 The construction of the Scheme would affect ALC grade 3a (BMV) land, which is a high-value receptor, in addition to ALC grade 3b and ALC grade 4 land which are medium- and low-value receptors respectively. There may also be some impacts on land not used for agriculture or urban/ developed areas which have a negligible sensitivity value.

9.8.24 The construction of the mainline carriageway would require the permanent acquisition of 4.4ha of BMV agricultural land (ALC grade 3a) as shown in ES Volume 3 - Appendix 9.D - Agricultural land classification report. This would lead to a moderate magnitude of impact on that land given the permanent sealing of the soil resource (1 - 20ha). Given the permanent nature of the effect, the loss of BMV land cannot be mitigated and this therefore leads to an overall effect on the soil resource (BMV ALC grade 3a agricultural land of high value), which is *permanent large adverse* and significant. The effect is assessed as 'large' as it cannot be mitigated and the effect is on BMV agricultural land.

9.8.25 The permanent loss of 17.8ha of ALC grade 3b agricultural land would also result in a moderate magnitude of impact given the permanent sealing of 1- 20ha of the soil resource. Given the permanent nature of the effect, the loss of agricultural land cannot be mitigated, and this therefore leads to an overall effect on the soil resource (ALC grade 3b agricultural land of medium value), which is *permanent moderate adverse* and significant. This effect is assessed as 'moderate' given the loss is of grade 3b land which is not BMV.

9.8.26 The permanent loss of 24.5ha of ALC grade 4 agricultural land would result in a major magnitude of impact given the permanent sealing of over 20ha of the soil resource. Given the lower sensitivity of this receptor (low), the significance would be *permanent slight adverse* and not significant. This effect is assessed as 'slight' given the loss is of grade 4 land which is not

BMV.

9.8.27 The construction also requires temporary use of land which would take soil out of agricultural use for the period of construction. Following completion of construction, all temporary facilities would be removed, and the soil reinstated in accordance with the agreed end use for the land. The agricultural soil temporarily displaced by the Scheme would, after land restoration, generally be able to fulfil its primary soil functions on-site. This would be managed through the Soil Management Plan to be developed by the contractor as part of the Environmental Management Plan (EMP, outlined in ES Volume 3 - Appendix 16.A - Outline CEMP) and would ensure the soil is returned to its current ALC grade.

9.8.28 The temporary loss of 8.3ha of agricultural land would result in a minor impact given the temporary loss of soil function. Given proposal to manage soils during construction and return the land to agriculture, combined with the high to low value of impacted land, the effect would lead to a *temporary slight adverse* effect which is not significant.

Construction effects on contamination

9.8.29 The Scheme construction would result in introduction of new receptors such as construction workers and new pathways, resulting in a number of plausible contaminant linkages, as detailed in Section 9.7. In the event of disturbance of contaminated soils or groundwater during construction, and in the absence of any mitigation measures, there is a potential for the identified receptors to be affected, and for ground conditions to impact on the design of the Scheme. In relation to potentially contaminative land uses, the following adverse impacts could potentially arise as a result of construction of the Scheme:

a) Mobilising existing contamination in soil and groundwater as a result of ground disturbance during construction, particularly in areas of known and unexpected contamination.

b) Increasing the potential for contaminants in unsaturated soils to leach to groundwater in open excavations during construction.

c) Increasing the potential for contaminated surface run-off to migrate to surface water and groundwater receptors as a result of leaching from uncovered stockpiles.

d) Introducing new sources of contamination, such as fuels, chemicals and oils used during construction activities, and also imported construction materials.

e) Increasing the potential of construction workforces (from handling, storage and exposure) to existing contamination in soil and groundwater (both known and unexpected).

f) Creating preferential pathways for the migration of soil and groundwater contamination, for example along new below ground service routes, service ducts, new piled foundations, stabilised soil and/or new band drains.

9.8.30 Construction has the potential to result in beneficial impacts such as the removal or treatment of contaminated soil, with the effect that existing adverse effects on receptors are removed.

Conceptual Site Model (construction)

9.8.31 The Conceptual Site Model is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report and for construction scenario is summarised in Table 9-11.

Table 9-11 Summary of potential sources, pathways and receptors at construction

Potential Sources	Potential Pathways	Potential Receptors (*sensitivity*)
Baseline sources **S1 to S14**, as set out in Table 9 - 9 **S15:** Fuels/ oils / construction materials leakages and spillages in compound storage areas and within construction corridor	**P1:** Direct contact with soil and dust, ingestion of soil and dust, inhalation of dust and fibres **P2:** Inhalation of soil gas, migration via diffusion and preferential pathways **P3:** Direct contact with groundwater including ingestion, dermal contact and inhalation **P4:** Leaching of soils and migration of soil leachate **P5:** Contaminant migration via groundwater	Baseline receptors **R1 to R8**, as set out in Table 9 -10 **R9:** Construction workers (*medium*)

Tier 1: PRA (construction)

9.8.32 The Tier 1: PRA has been completed in accordance with best practice guidance CIRIA C552: Contaminated Land Risk Assessment 9.15 . The overall classification of the magnitude of risk, which is based on the relationship between the risk probability and consequence of the given risk, has been defined in line with the guidance. The Tier 1: PRA is presented in the

GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report with plausible contaminant linkages at construction presented in Table 9-12.

Table 9-12 Tier 1: PRA – PCLs during construction

Source	Pathway	Receptor	Classification and risk estimation (without mitigation)			Plausible contaminant linkage (PCL), where further mitigation is required
			Probability	Consequence	Risk	
S1 – S4: Baseline sources	**P1:** During construction direct contact with soil and dust, ingestion of soil and dust, inhalation of dust and fibres	**R3:** Construction workers	Likely	Minor	Low	**PCL 1:** During construction works, it is likely that construction workers would come into contact with subsurface materials in areas of storage or during placement. Although the majority of the ground conditions across the alignment are natural materials from surface level (greenfield), there is the potential to come into contact with contaminated materials during the works within the areas of identified sources, e.g. during construction works such as piling through the historical landfill. By law, the Contractor is obliged to implement safe systems of work that would mitigate the risk and therefore minor consequence of risk has been applied.
		Scheme neighbours **R4:** Residential properties/ caravan park **R5:** Workers	Low probability	Mild	Low	**PCL 2:** During construction works dust is likely to be generated and may migrate towards properties/ premises located in the Scheme vicinity. The identified potential sources of contamination are localised areas and therefore dust generation from these areas is likely to be spatially limited and temporary.

Source	Pathway	Receptor	Classification and risk estimation (without mitigation)			Plausible contaminant linkage (PCL), where further mitigation is required
S5: Groundwater	**P3:** During construction direct contact with groundwater including ingestion, dermal contact and inhalation	**R9:** Construction workers	Likely	Minor	Low	**PCL 3:** During construction works, it is likely that in areas of excavation works, construction workers would come into contact with groundwater that may be locally impacted by off-site sources. By law, the Contractor is obliged to implement safe systems of work that would mitigate the risk and therefore minor consequence of risk has been applied.
S3: Made ground (inert historical landfill)	**P2:** During construction inhalation of soil gas, migration via diffusion and preferential pathways	**R9:** Construction workers	Likely	Minor	Low	**PCL 4:** The historical landfill is known to accept inert industrial waste up to 1985. Historically due to lack of regulation such sites may have accepted non-inert waste. Therefore, in accordance with BS 8576:2013, there is a high potential for landfill gas generation. Depending on the nature of the construction activities within the landfill, construction workers may be exposed to landfill gases. This includes a risk of asphyxiation and explosive risk. By law, the Contractor is obliged to implement safe systems of work that would mitigate the risk and therefore minor consequence of risk has been applied.
S6: Peat and organic materials	**P2:** During construction inhalation of soil gas, migration via diffusion and preferential pathways	**R9:** Construction workers	Likely	Minor	Low	**PCL 5**: Elevated concentrations of ground gases may be released from peat/ organic materials during construction activities e.g. piling or band drains. Depending on the nature of the construction activities construction workers may be exposed to ground gases. This includes a risk of explosion. By law, the Contractor is obliged to implement safe systems of work that would mitigate the risk and therefore minor consequence of risk has been applied.

Source	Pathway	Receptor	Classification and risk estimation (without mitigation)			Plausible contaminant linkage (PCL), where further mitigation is required
S1-S4: Baseline sources	**P4:** During construction leaching of soils and vertical/ lateral migration of soil leachate **P5:** Migration via groundwater	**R3 to R8:** Groundwater and surface water receptors	Likely	Medium	Moderate	**PCL 6:** Although contamination is not anticipated across the majority of the Scheme, the alignment crosses isolated areas of local sources (baseline sources S1-S4) and due to the shallow groundwater level, contaminants from this have the potential to mobilise as a result of the Scheme construction leach directly into groundwater or discharge into surface water receptors through surface run-off.

Tier 2: GQRA (construction)

9.8.33 Tier 2: GQRA has been undertaken to quantify risks identified for PCLs, as detailed above. The Tier 2: GQRA is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report. The assessments considered results of chemical testing completed on soil and groundwater samples obtained during the completed NSC GI and AGC GI as presented in ES Volume 3 - Appendix 9.B - Factual ground investigation information (a Phase 1 & b Phase 2). This identified the following:

Human health (PCL 1, PCL 2 and PCL 3)

9.8.34 Localised areas of made ground materials were encountered within the Banwell Bypass alignment. These were particularly present in a vicinity of the historical landfill site at Ch. 1+750 to Ch. 1+950 (Central Extent of the Banwell Bypass) and the solar plant at Ch. 2+300 to Ch. 3+200.

9.8.35 Made ground materials encountered in the vicinity of the historical landfill were found to contain elevated concentrations of polycyclic aromatic hydrocarbon (PAH) compounds as well as metals such as arsenic and lead, in relation to the applied assessment criteria (residential without plant uptake end-use generic scenario). Evidence of hydrocarbon contamination described as ‘strong chemical odour’ was recorded in borehole BH305 at between 1.1 and 2.35m below ground level. The nature of the made ground encountered in BH305, BH306 and TP408 suggests potential overspill of deposited waste outside the landfill boundaries shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan, as discussed in Section 9.7.6.

9.8.36 Made ground encountered within the fields bordering the solar power plant, did not exhibit evidence of contamination with only one exceedance of the applied assessment criterion for arsenic.

9.8.37 No asbestos was identified within analysed samples. However, there is still a risk of asbestos being present within the deposited waste.

9.8.38 The elevated concentrations may pose a risk to the identified receptors, the construction workers and the Scheme neighbours (residents, workers). Therefore PCL 1 and PCL 2 remain plausible.

9.8.39 Groundwater sampling and testing did not identify evidence of hydrocarbon contamination. Therefore, groundwater is unlikely to pose a significant risk to construction workers. It needs to be highlighted however, that limited groundwater monitoring was undertaken in the vicinity of the historical landfill. This was due to encountered artesian pressures, which prevented from installation of monitoring wells in that area. Although the nearest monitoring point, BH108 located 85m west of the landfill boundary, has not indicated significant contamination of the groundwater, based on the recorded evidence of contamination in BH305, there is a potential for the perched water to have been impacted by contamination. Therefore, PCL 3 remains plausible contaminant linkage for the area of the historical landfill site.

Ground gas (PCL 4 and PCL 5)

9.8.40 The gas monitoring results indicated relatively low levels of ground gas with higher methane concentrations measured within the floodplain area where TFD with bands of peat are present. Due to high groundwater levels in the area of the flood plain, the obtained readings are likely to represent concentrations of dissolved gas released from groundwater rather than the soil atmosphere. High groundwater levels and impermeable nature of the superficial deposits inhibit ground gas migration from the potential sources (such as peat, landfill or made ground). However, direct disruption of these sources e.g. due to excavation or piling may result in a gas release and provide a preferential flow path. This may pose a risk to the construction workers. Therefore PCL 4 and PCL 5 remain plausible.

Controlled waters (PCL 6)

9.8.41 The completed risk assessment has indicated that the encountered made ground (outside the historical landfill area) are unlikely to pose a significant risk to controlled waters.

9.8.42 One soil leachate sample was shown to contain leachable cadmium and sulphate at elevated concentrations (in relation to applied EQS and Drinking Water Standards (DWS), respectively) in two samples obtained in the vicinity of the historical landfill (CPT503 and BH305 respectively). In addition, evidence of contamination was recorded in BH305 (‘strong chemical odour’). These indicate that the made ground encountered in the vicinity of the historical landfill has a potential to pose a risk to controlled waters. Therefore PCL 6 remain plausible for made ground

materials located in the vicinity of the historical landfill.

9.8.43 The assessment of effects on land contamination resulting from the construction of the Scheme is presented below.

Human health

9.8.44 The Tier 1: PRA identified construction workers and Scheme neighbours (nearby residents and workers) as primarily receptors of the identified sources of contamination during construction as a result of direct exposure to soils and dust generated during ground breaking activities.

9.8.45 The Tier 2: GQRA for the construction scenario identified elevated concentrations of PAH compounds and metals. This may pose a risk to construction workers (PCL 1) and Scheme neighbours (PCL 2). These elevated concentrations were measured primarily in the vicinity of the historical landfill (location marked on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan), where the scheme is to run on a piled embankment. The nearest residential areas are approximately 160m to the north and south. Therefore, the construction works are unlikely to be impacting these properties due to the distance. There are however commercial premises adjacent to the Scheme and approximately 25m to the north. Therefore, the workers of these premises may be exposed to potentially contaminated dust migrating from the construction site.

9.8.46 Workers of commercial premises and construction workers are receptors of medium sensitivity. Construction works within the area of historical landfill may result in a moderate magnitude of impact albeit temporary as constraints by the duration of intrusive works at that location. Therefore, the effect of the Scheme on risks from contamination on human health during construction is assessed *temporary moderate adverse* and significant. Therefore, mitigation measures are required.

Controlled waters

9.8.47 The Tier 1: PRA identified both groundwater and surface water within the study area and its vicinity as potential receptors of the identified sources of contamination. Construction activities may result in that contamination mobilisation and migration towards these receptors or in direct discharge of contaminants to

groundwater or surface water, resulting in pollution. The Scheme may also introduce new pathways for contamination migration along new drainage or deep foundations.

9.8.48 The Tier 2: GQRA identified elevated concentrations of leachable cadmium and evidence of contamination in the soils in the vicinity of the historical landfill, which may pose a risk to groundwater and/ or surface water receptors during construction as a result of contamination mobilisation during intrusive works e.g. excavation, soils storage, ground stabilisation or piling, as a result of increased rainfall infiltration or surface run-off (PCL 6).

9.8.49 The identified controlled water receptors within the area of the historical landfill include groundwater within the superficial deposits, which is of medium sensitivity (secondary undifferentiated aquifer), and the rhynes - low sensitivity and the Banwell River - high sensitivity. The effect of construction works on controlled waters is likely to be temporary moderate adverse. Therefore, the effect of the Scheme on risks from contamination identified in the area of the historical landfill on controlled waters during construction is assessed as *temporary moderate adverse* and significant.

Operation

Operation effects on geology

9.8.50 No impact on geology from the Scheme operation is anticipated. The operation of the Scheme would result in no change to geology resources resulting in a *neutral* effect which is not significant.

Operation effects on soil resources

9.8.51 Following the opening of the Scheme, soils adjacent to the road may be affected by spray or airborne contaminants generated during routine maintenance and operation of the road (including vehicle emissions) or released during road accidents/ emergency situations. However, considering that the Scheme would be elevated on an embankment with the Scheme boundary away from the carriageway, this is unlikely to affect soils outside the Scheme.

9.8.52 No further impacts are anticipated beyond those occurring during the construction phase. No additional mitigation measures are required.

Operation effects on contamination

9.8.53 During operation of the Scheme, road users, and the road infrastructure maintenance workers would be introduced as new receptors. Any contamination deemed by risk assessment to have posed a significant risk to the Scheme, would have been removed or remediated during the construction phase. Previous risk assessment and any subsequent mitigation measures would have already been undertaken to satisfactorily close out any residual risks identified as part of the construction phase.

9.8.54 During the Scheme operation there is also a potential for soils used within the Scheme (both site-won and imported) to pose a risk to controlled waters and human health. Rainwater infiltration contaminated materials in areas of landscaping may result in mobilisation of contaminates and migration into the underlying groundwater and subsequently towards the surface water receptors.

9.8.55 The assessment of risks from contamination on human health and controlled waters during Scheme operation is reported in ES Volume 3 - Appendix 9.C - Ground Investigation Report. The assessment includes the development of a CSM during operation of the Scheme, qualitative Tier 1: PRA and a Tier 2: GQRA of available results. This is summarised below.

Conceptual Site Model (operation)

9.8.56 The Conceptual Site Model is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report and for the operational phase is summarised in Table 9-13.

Table 9-13 Summary of potential sources, pathways and receptors at operation

Potential Sources	Potential Pathways	Potential Receptors (*sensitivity*)
Baseline sources **S1 to S14**, as set out in Table 9 - 10 **S16:** Reused materials in Scheme construction	**P6:** Direct exposure of construction materials to aggressive ground **P7:** Leaching of soils and migration of soil leachate **P8:** Contaminant migration via groundwater **P9:** Preferential pathways created by the installation of band drains	Baseline receptors **R1 to R8**, as set out in Table 9 -11 **R10:** Pedestrians/ road users (*low*) **R11:** Building fabric

Tier 1: PRA (operation)

9.8.57 The Tier 1: PRA has been completed in accordance with best practice guidance CIRIA C552: Contaminated Land Risk Assessment [9.15] . The overall classification of the magnitude of risk, which is based on the relationship between the risk probability and consequence of the given risk, has been defined in line with the guidance. The Tier 1: PRA for operation phase is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report with plausible contaminant linkages presented in Table 9-14.

Table 9-14 Tier 1: PRA – PCLs during operation

Source	Pathway	Receptor	Classification and risk estimation (without mitigation)			Plausible contaminant linkage (PCL), where further mitigation is required
			Probability	Consequence	Risk	
Baseline sources **S1-S5**	**P6:** During operation direct exposure of construction materials to aggressive ground	**R11:** Building fabric	Likely	Minor	Low	**PLC 7:** Materials used in construction of the piled foundations of the embankment and structures in area of identified potential sources may be subjected to aggressive environment, which may impact the integrity of the foundations.
Baseline sources **S1-S5** **S9:** Reused materials	**P7:** During operation leaching of soils and vertical/ lateral migration of soil leachate (e.g. along piles, stabilised ground) **P8:** Migration via groundwater	**R3 to R8:** Groundwater and surface water receptors	Low likelihood	Medium	Moderate/ low	**PCL 8:** Majority of the Scheme is supported by embankments, which would remove the pathway for rainwater infiltration through baseline sources, resulting in a beneficial impact. In areas of cut, earthworks would result in removal of materials, which would be reused within the Scheme construction. However, following construction of the road, the surface of the embankments is likely to be covered with vegetated topsoil and with the highway hardstanding significantly reducing rainwater infiltration and surface run-off. However, the Scheme is likely to introduce preferential flow paths for contamination migration e.g. through piling or stabilised ground (subject to applied stabilisation method). Although contamination is not anticipated across the majority of the Scheme, the alignment crosses baseline sources S1 to S4 (including a landfill). Artesian groundwater pressures have been encountered in the Central Extent of the Scheme and therefore downward migration is unlikely due to upward hydraulic gradient.

Source	Pathway	Receptor	Classification and risk estimation (without mitigation)			Plausible contaminant linkage (PCL), where further mitigation is required
S1-S5: Baseline sources	**P9:** Preferential pathways created by the installation of band drains	**R6:** Surface water receptors	Low likelihood	Medium	Moderate/ low	**PCL 9:** The construction of band drains within the floodplain, which may be required to allow for controlled ground settlement that would occur as a result of embankments construction. During the settlement process the pore water would be forced out of the ground resulting in upward groundwater flow, which would be collected in the drainage blanket beneath the embankment and be eventually drained into the nearest surface water course.

Tier 2: GQRA (operation)

9.8.58 Tier 2: GQRA has been undertaken to quantify risks identified for PCLs, as detailed above. The Tier 2: GQRA is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report. The assessments considered results of chemical testing completed on soil and groundwater samples obtained during the completed NSC GI and AGC GI as presented in Volume 3 - Appendix 9.B - Factual ground investigation information (a Phase 1 & b Phase 2). This identified the following:

Building fabric (PCL 7)

9.8.59 The assessment of ground properties and identification of appropriate concrete class has been completed and is presented in the GIR, ES Volume 3 - Appendix 9.C - Ground Investigation Report.

Controlled waters (PCL 8 and PCL 9)

9.8.60 The completed risk assessment has indicated that the encountered made ground (outside the historical landfill area) are unlikely to pose a significant risk to controlled waters.

9.8.61 One soil leachate sample was shown to contain leachable cadmium and sulphate at elevated concentrations in two samples obtained in the vicinity of the historical landfill (CPT503 and BH305 respectively). In addition, evidence of contamination was recorded in BH305 (‘strong chemical odour’). These indicate that the made ground encountered in the vicinity of the historical landfill has a potential to pose a risk to controlled waters. Therefore PCL 8 remain plausible for made ground materials located in the vicinity of the historical landfill.

9.8.62 Based on the hydrogeological model derived for the Scheme, as detailed in ES Volume 1 - Chapter 13 - Road Drainage and the Water Environment, three groundwater bodies underlie the Scheme contained in the TFD (flood plain), bedrock (Western Extent) and MMG (Central and Eastern Extent, and Southern Link Road).

9.8.63 Groundwater quality assessment identified a number of exceedances of criteria for dissolved metals such as arsenic, nickel and zinc. The measured concentrations are largely similar within the three groundwater bodies and as such are considered

indicative of general background groundwater quality.

9.8.64 Elevated concentrations of ammoniacal nitrogen, chromium and manganese were also identified within the analysed samples. Chromium and manganese were found elevated particularly in groundwater samples obtained from TFD. It is possible that this is due to the Scheme being located within an area where mainly agricultural activities take place (due to use of fertilizers).

9.8.65 No hydrocarbon compounds were measured above the laboratory levels of detection.

9.8.66 As the shallow groundwater within the flood plain is likely to be in continuity with the surface water system, the discharge of groundwater collected through the Scheme drainage is unlikely to have a significant impact on the surface water quality. This is with the exception of the historical landfill and its vicinity, where the groundwater quality was not monitored due to artesian pressures. As the made ground was shown to constitute a potential source of contamination PCL 9 remains valid for the area of the historical landfill.

9.8.67 The assessment of effects on land contamination resulting from operation of the Scheme is presented below.

Human health

9.8.68 The Tier 1: PRA did not identify plausible pollution pathways with respect to end site users or the Scheme neighbours. Therefore, no Tier 2: GQRA has been required. Therefore, overall the effect of the Scheme on risks from contamination on human health during operation is assessed *neutral*, which is not significant.

Controlled waters

9.8.69 The Tier 1: PRA identified site won soils reused within the Scheme as a new potential source of contamination with respect to both groundwater and surface water within the Scheme and its vicinity. Rainwater through these materials may mobilise contaminants and result in contamination migration towards these receptors resulting in pollution (PLC 8). Through embedded mitigation, reuse of site won materials would be controlled to ensure that only materials that do not pose a significant risk to sensitive receptors would be used within the construction of the Scheme. The Scheme may however

introduce preferential flow paths along e.g. piles or band drains towards controlled water receptors (PLC 8 and PLC 9).

9.8.70 The Tier 2: GQRA indicated that leachable metals within made ground as well as hydrocarbon contamination identified in the vicinity of the historical landfill site may pose a risk to surface and groundwater receptors, if made ground is reused in landscaped areas or close proximity to surface water receptors. As mentioned above, only acceptable materials would be reused within the Scheme and therefore reuse of materials in the Scheme construction is unlikely to result in a detrimental impact on the controlled waters quality. The impact on the deep groundwater aquifers from piling in the area of the historical landfill is unlikely due to the artesian groundwater conditions and an upward hydraulic gradient, which would largely limit downward migration of contamination. As set out in the embedded mitigation, piling design would involve an assessment of risks through a FWRA, which would assess the risks specific to the proposed piling methodology(ies) and identify appropriate mitigation measures, if necessary.

9.8.71 The aquifer classification in the area of the Scheme ranges from of medium (a secondary undifferentiated aquifer) to very high sensitivity (a Principal aquifer supporting public water supply), whereas the surface water system is of low (rhynes) to high (Banwell River) sensitivity. The magnitude of impact of the Scheme operation on controlled waters is likely to be negligible adverse. Therefore, the effect of the Scheme on risks from contamination on groundwater during operation is assessed as localised *permanent slight adverse* and not significant. For surface water this is assessed as localised *permanent slight adverse* and therefore not significant.

9.9 Proposed Mitigation and Enhancement Measures

9.9.1 A number of essential mitigation measures have been identified to reduce, remediate or compensate likely significant adverse environmental effects.

Geology – mitigation during construction

9.9.2 No significant effects have been identified and therefore no essential mitigation measures are necessary.

Soil resources – mitigation during construction

9.9.3 Although significant effects have been identified due to the loss agricultural land, the effect cannot be mitigated.

Contamination– mitigation during construction

9.9.4 The completed assessments identify potential risks associated with made ground materials encountered in the vicinity of the historical landfill containing elevated levels of contamination. Construction of the Scheme may result in significant effects on construction workers and surface water receptors, if disturbed. As detailed in Section 9.7.6, the nature of the encountered made ground indicates that waste was deposited outside the boundaries shown on ES Volume 2 - Figure 9.3 - Solid Features and Constraints Plan. However, the deposited waste is likely to be highly heterogeneous and therefore levels of contamination may vary within the works area. Therefore, the required mitigation measures include further investigations and specific risk assessments to better characterise the source and its extent within the Scheme footprint, to confirm the risks and to design appropriate control measures. These investigations would include groundwater sampling and ground gas monitoring. This can be undertaken during a detailed design or construction stages. In addition, a foundation works risk assessment would be required to ensure that piling works do not result in unacceptable risks to the receptors. These mitigation measures have been outlined in the EMP (ES Volume 3 - Appendix 16.A - Outline CEMP).

9.9.5 Potential impacts on human health receptors including off-site receptors would be addressed through the adoption of the following measures, which are included in EMP, as outlined in ES Volume 3 - Appendix 16.A - Outline CEMP:

a) Dust control – to include the damping of ground with water.

b) Sheeting of lorries transporting spoil off site and the use of dust suppression equipment on plant.

c) Adequate fuel/ chemical storage facilities e.g. bunded tanks, hard standing and associated emergency response spillage control procedures.

d) Well maintained plant and associated emergency response/ spillage control procedures.

e) Any temporary onsite storage of contaminated material would be stored on sheeting and covered to minimise the potential for leachate and run off from the stockpile being generated.

f) Health and safety training and provision of suitable welfare facilities.

g) Provision and use of Personal Protective Equipment (PPE).

Essential mitigation for operation

9.9.6 The embedded and essential mitigation measures such as design modifications in the area of the deposited waste in the historical landfill, which would remove the need for use of band drains as well as completion of FWRAs, as set out in Section 9.9, would prevent the pollution of controlled waters during the Scheme operational phase and therefore no additional mitigation measures are considered necessary.

Enhancement measures

9.9.7 No enhancement measures are proposed.

9.10 Residual Environmental Effects (following mitigation)

Construction

Construction residual effects on geology

9.10.1 The effect remains *neutral* and *permanent slight adverse* and not significant as no mitigation measures were deemed necessary.

Construction residual effects on soil resources

9.10.2 The effects remain *permanent large adverse* due to the loss of

ALC grade 3a soil resource and *permanent moderate adverse* due to the loss of ALC grade 3b soil resource, and significant. These effects cannot be mitigated. The effect also remains *permanent slight adverse* due to the loss of ALC grade 4 soil resource and not significant.

9.10.3 The effect of temporary loss of soil resources remains *temporary slight adverse* and not significant.

Construction residual effects on contamination

9.10.4 Following the implementation of mitigation measures (including EMP), the magnitude of any impacts of land contamination on human receptors during construction in the area of the historical landfill (workers of commercial premises and construction workers) as well as a result of encountering unexpected contamination in other parts of the Scheme is reduced to negligible. Therefore, the significance of effect would be reduced to *temporary slight adverse* and not significant. With respect to controlled waters (the Banwell River and the rhynes), on implementation of mitigation measures, the impact of construction works in the area of the historical landfill is also reduced to negligible. Therefore, the significance of effect would be reduced to *temporary slight adverse* and not significant.

Operation

Operation residual effects on geology

9.10.5 The effect from operation on geology remains *neutral* and not significant as no mitigation measures were deemed necessary.

Operation residual effects on soil resources

9.10.6 No further impacts are anticipated beyond those occurring during the construction phase. No additional mitigation measures are required.

Operation residual effects on contamination

9.10.7 The effect from operation on human health from land contamination remains *neutral* and not significant as no mitigation measures were deemed necessary.

9.10.8 The effect from operation on controlled waters from land contamination remains *slight adverse* and not significant as no mitigation measures were deemed necessary.

Potential affects due to Climate Change

9.10.9 Potential effects which could arise due to impacts from the Scheme in combination with future projected climate conditions, as presented in ES Volume 1 - Chapter 14 - Climate include:

a) Increasing frequency and severity of precipitation and storms may accelerate the erosion of soil and engineered slopes, and result in increased runoff of sediments.

b) Increasing frequency and intensity of drought periods may result in increased soil erosion, surface cracking and the formation of infiltration pathways into slopes.

c) Increased temperatures and occurrence of heat waves may enhance breakdown of organic matter resulting in increased ground gas production rate (but this may be ameliorated by lower moisture content associated with dry weather) and increased volatility of organic compounds, if present, causing unpleasant odours locally.

d) Increasing repeated cycles of drying and re-wetting may result in increased fracture propagation within the bedrock.

e) Increasing frequency and intensity of drought periods may increase the frequency of shrink-swelling of the soils, potentially leading to significant volume reductions and differential settlement.

f) Increasing long spells of hot weather and wildfires may result in soils developing water repellence, which may reduce or temporarily impede water infiltration, leading to preferential flow and increased surface runoff.

g) The effect on BMV agricultural land would occur as a one-off impact during the enabling and construction of the Scheme and the identified effect would not be altered by climate change. Climate change could however affect the ongoing functioning of soils on the site and their continued ability and effectiveness in meeting the various ecosystem functions identified for them in the scheme design, such as the storage of water and carbon, and acting as a medium for plant growth.

h) The specific impacts of climate change on soil resources are difficult to predict but may include such effects as increased susceptibility to wind erosion through drier periods, and increased susceptibility to waterlogging and development of

anaerobic conditions throughout wetter periods, which will subsequently impact on biological and chemical attributes of the soil.

i) Soil resources which are disturbed and displaced by the Scheme would have lower resilience to these potential impacts of climate change than undisturbed soil resource. This is due to such factors as the structural integrity of soil potentially being lost or reduced during handling, and disturbance of the micro- and macro-biology, should soils stored within bunds develop anaerobic conditions. The soils would be managed in accordance with the Soils Management Plan and the design of green infrastructure within the site would take account of these potential climate change impacts on the soils and ensure their resilience in the long term.

9.10.10 While the impacts of climate change are likely to affect geology and soils in general terms, no significant in-combination effects with the Scheme have been identified, and no mitigation is proposed.

9.11 Monitoring

9.11.1 No significant effects have been identified, therefore no monitoring is proposed.

9.12 Summary and Conclusions

9.12.1 The completed assessments indicate that on application of mitigation measures the Scheme is unlikely to result in significant effects on geology or land contamination. The permanent loss of soil resources leads to significant effects, which cannot be mitigated due to the location and nature of the Scheme.

9.12.2 The scheme is compliant with all relevant legislation and policy for Geology and Soils.

9.12.3 The assessments have been summarised in Table 9-15 for the construction phase and Table 9-16 for the operational phase.

Table 9-15 Summary of effects on geology, soil resources and land contamination during construction

Feature	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
During Construction						
Geology						
Superficial deposits and bedrock	Negligible	Permanent burying or removal of superficial deposits and bedrock	Minor	None required	Minor	Slight adverse
Soil resources						
ALC Grade 3a	High	Permanent sealing of the soil resource	Moderate	None	Moderate	Large adverse
ALC Grade 3b	Medium		Moderate	None	Moderate	Moderate adverse
ALC Grade 4	Low		Major	None	Major	Slight adverse
ALC Grade 3a, 3b and 4	Low to High	Temporary loss of the soil resource	Minor	EMP	Negligible	Slight adverse
Land contamination						
Construction workers	Medium	Temporary impact during earthworks from exposure/ mobilisation	Moderate	EMP	Negligible	Slight adverse
Scheme neighbours	Medium		Moderate	EMP	Negligible	Slight adverse

Feature	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
Controlled waters (surface water and groundwater receptors)	Low to medium	and migration of contamination	Moderate	EMP	Negligible	Slight adverse

Table 9-16 Summary of effects on geology, soil resources and land contamination during operation

Feature	Sensitivity of receptor	Description of impact	Magnitude of impact without mitigation	Proposed Mitigation	Magnitude of impact with mitigation	Significance of impact following mitigation
During Operation						
Geology						
Superficial deposits and bedrock	Negligible	No further impact				
Soil resources						
ALC Grade 3a, 3b and 4	Low to High	No further impact				
Land contamination						
Controlled waters (surface water and groundwater receptors)	Low to high	Leaching of contaminants and migration through preferential pathways (e.g. piling)	Negligible	None	Negligible	Slight adverse

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