Haweswater Aqueduct Resilience Programme - Proposed Bowland Section

Proposed Bowland Section

Environmental Statement Volume 2

Chapter 11: Soils, Geology and Land Quality

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11. Soils, Geology and Land Quality

11.1 Introduction

1) This chapter presents an assessment of the likely significant effects of the Proposed Bowland Section on soils, geology and land quality.

2) The chapter begins by discussing the scoping and consultation work undertaken to support the assessment and then presents a review of the legislation, guidance and planning policies relevant to soils, geology and land quality. The nature, value and sensitivity of the existing baseline environment are then identified before an assessment is made of the potential effects on soils, geology and land quality for the Proposed Bowland Section. Embedded and good practice mitigation measures relevant to soils, geology and land quality are summarised in Section 11.4.4 and have been taken into account in the assessment in Section 11.6.

3) The soils, geology and land quality topic is broken down into the following sub-topics:

- Land contamination, comprising the receptor types of human health and infrastructure (land contamination effects in relation to controlled waters are discussed in Chapter 7: Water Environment)
- Geologically designated sites
- Ecologically designated sites (where relevant to Soils, Geology or Land Quality)
- Mineral resources
- Soil quality.

4) The assessment area generally comprised the construction compound and tunnel development envelopes with a further 250 m buffer applied beyond the planning application boundaries. The minerals assessment applied a 500 m buffer to allow for any expansion of mineral or quarry operations. It should be noted that the assessment area includes the route of the proposed tunnel due to the subsurface nature of soils, geology and land quality.

5) This chapter uses data from various technical reports, and as a result includes reference to chainages (Ch.) as a way of identifying the location of a feature or a point of interest as these are used within the technical reports. The chainage is the distance in metres from the northern extent of the Proposed Bowland Section (e.g. Ch. 2+500 is 2,500 m from the start of the section). Chainages are shown in the figures within Appendix 11.1: Site Briefing (Desk Study) Report, specifically Appendix A of this document.

6) This chapter is supported by the following technical appendices and figures:

- Appendix 11.1: Geotechnical and Geo-environmental Site Briefing ('Desk Study') Report, Replacement Tunnel Section TR3 (the Proposed Bowland Section)
- Appendix 11.2: Soils, Geology and Land Quality Baseline
- Figure 11.1: Bedrock Geology
- Figure 11.2: Superficial Geology and Artificial Ground
- Figure 11.3: Agricultural Land Classification
- Figure 11.4: Geological Designation and Resources.

11.2 Scoping and Consultations

11.2.1 Scoping

7) A soils, geology and land quality chapter was included within the Environmental Impact Assessment Scoping Report which was submitted to the relevant planning authorities for comment in October 2019 followed by a Scoping Addendum submitted in February 2021 due to design changes and refinements.

Scoping Report responses were provided by both the local planning authorities, and the October 2019 Scoping Report responses have been reviewed and incorporated into the assessment. Scoping comments and responses are outlined in Appendix 4.1.

11.2.2 Consultation

8) During the course of the assessment, consultations took place with relevant statutory and non-statutory consultees, stakeholders and third parties, through written correspondence, meetings and by telephone. Full details of consultations are included in Appendix 4.1. Stakeholders contacted in connection with this work were:

- Human health (in relation to land contamination) – Lancaster City Council and Ribble Valley Borough Council
- Geologically designated sites – GeoLancashire
- Mineral resources – Lancashire County Council.

11.2.3 Scoping Update

9) An initial assessment of the environmental baseline information for the identified sub-topics within soils, geology and land quality was completed to refine the scope of assessment. Upon review of this information, the following sub-topics have not been considered further:

- Infrastructure (in relation to land contamination): no significant infrastructure of relevance to soils, geology and land quality was identified within the assessment area
- Geologically designated sites: no geologically designated sites were identified within the assessment area. The nearest was identified at Boarsden Quarry, approximately 330 m south-west of the Newton-in-Bowland Compound (refer to Appendix 11.2C)
- Ecologically designated sites: no ecologically designated sites of relevance to soils, geology and land quality were identified.

10) The sub-topics taken forward for impact assessment therefore were land contamination, in relation to human health, mineral resources and soil quality.

11.3 Key Legislation and Guidance

11) Table 11.1 introduces relevant soils, geology and land quality legislation and guidance.

Table 11.1: Soils, Geology and Land Quality Key Legislation and Guidance

Applicable Legislation or Guidance	Description
National Planning Policy Framework[1] – Section 15 'Conserving and Enhancing the Natural Environment'	Paragraph 170(b) – requires planning authorities to consider the economic and other benefits of the best and most versatile (BMV) agricultural land.
	Paragraph 170(e) – requires that planning decisions should consider the potential impacts of pollution or land instability issues to ensure that a development is appropriate for its intended location.
	Paragraph 178(a-c) – requires that decisions should ensure that a site is suitable for use with regards to ground conditions (including land contamination) and land instability; that after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and that

[1] Ministry of Housing, Communities and Local Government (2019) *National Planning Policy Framework*. London: HMSO

Applicable Legislation or Guidance	Description
	adequate site investigation information is presented in support of a development.
National Planning Policy Framework – Section 17 'Facilitating the sustainable use of minerals'	Paragraph 204(c) – requires planning policies authorities to safeguard mineral resources by defining Mineral Safeguarding Areas; and adopt appropriate policies so that known locations of specific minerals resources of local and national importance are not sterilised by non-mineral development.
	Paragraph 204(d) requires policies to encourage the prior extraction of minerals, where practical and environmentally feasible, if it is necessary for non-mineral development to take place.
	Paragraph 206 - states that planning authorities should not normally permit other development proposals in Mineral Safeguarding Areas if it might constrain potential future use for mineral working.
Part 2A of the Environmental Protection Act 1990[2]	This legislation sets out the contaminated land regime for the UK and requires land to be determined as contaminated if it poses an unacceptable risk to human health, controlled waters or the environment.
Land Contamination Risk Management[3]	This guidance presents best-practice guidance for the assessment of land contamination in the UK.
Planning and Compulsory Purchase Act 2004[4]	This legislation introduced the requirements for mineral planning authorities to prepare a local plan or unitary development plan to set out policies and proposals against which planning application and appeals are determined. These are to allow consideration of mineral policy within the context of planning with due consideration for the requirements of environmental and local amenity protection, minerals supply, control of workings and unnecessary sterilisation of resources.

11.4 Assessment Methodology and Assessment Criteria

11.4.1 Assessment Methodology

12) Reference has been made to national and local policy documents, national guidance and other relevant information in determining the assessment methodology and criteria to be used.

13) The methodology was agreed with relevant stakeholders as outlined above in Section 11.2. The general approach is as per the overview provided in Chapter 4: EIA Methodology, whereby the significance of effects is determined from a combination of the sensitivity (or 'value') of the baseline conditions, and the potential magnitude of change due to the development.

[2] Environmental Protection Act 1990. [Online] Available from: https://www.legislation.gov.uk/ukpga/1990/43/contents
[3] Environment Agency (2020) *Land Contamination Risk Management*. [Online] Available from: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm [Accessed: 22-10-2020]
[4] Planning and Compulsory Purchase Act 2004. [Online] Available from: https://www.legislation.gov.uk/ukpga/2004/5/contents

11.4.2 Assessment Criteria

14) Table 11.2 sets out the criteria that have been used to determine the sensitivities of the identified receptors.

15) Sensitivity is determined principally by a receptor's level of designation or protection and its susceptibility to or ability to accommodate change.

Table 11.2: Soils, Geology and Land Quality Sensitivity Criteria

Sensitivity	Receptor Type	Examples of Receptors
Very high	Human health (from land contamination)	Construction workers Residential gardens and allotments
	Mineral resources	Agricultural land classification (ALC) Grades 1 and 2 (Best Most Versatile (BMV) agricultural land)
	Soil quality	Future site users and maintenance workers Residential without gardens, schools and playing fields, children's nurseries, nursing homes or residential homes for the elderly
High	Human health (from land contamination)	Construction workers Residential gardens and allotments
	Mineral resources	Probable mineral reserve or indicated mineral reserve
	Soil quality	ALC Subgrade 3a agricultural land (BMV)
Medium	Human health (from land contamination)	Commercial / industrial land use
	Mineral resources	Inferred mineral resource or reconnaissance mineral resource
	Soil quality	ALC Subgrade 3b agricultural land
Low	Human health (from land contamination)	Users of adjacent land No built development but land is open to public access
	Soil quality	ALC Grades 4 and 5 agricultural land
Negligible	Human health (from land contamination)	No access to land
	Mineral resources	No mineral occurrences / prospects
	Soil quality	Previously developed land formerly in 'hard uses' with little potential for return to agriculture

16) In respect of soil quality, the sensitivity criteria applied were based on ALC grade which assigns a value to soil by its ability to support agricultural uses. The ALC grade was used as a proxy to assign the sensitivity of soil quality in the assessment.

17) The criteria used to help determine the magnitude of change on the identified receptors are set out in Table 11.3. In determining magnitude, changes are considered in the context of other factors such as spatial extent, likelihood of occurrence and duration.

Table 11.3: Magnitude of Change for Soils, Geology and Land Quality Receptors

Magnitude	Receptor Type	Negative Effect
Major	Human health	Significant harm as defined by Part 2A of the Environment Act
	Mineral resources	Total sterilisation of reserve / resource
	Soil quality	Previously re-usable soils rendered totally unsuitable for re-use
Moderate	Human health	Effects on health occur (less than significant harm under Part 2A of the Environment Act)
	Mineral resources	Permanent loss of part (<50 %) of resource Total temporary loss of all or significant part (>50 %) of resource
	Soil quality	Previously re-usable soils rendered unsuitable for re-use without remediation / treatment
Minor	Human health	n/a
	Mineral resources	Permanent loss of minor part (<15 % of resource) Temporary loss of part (<50 %) of resource
	Soil quality	High quality soils (suitable for use in residential / open space areas) rendered suitable for use in commercial / industrial areas only
Negligible	Human health	n/a
	Mineral resources	Temporary loss of a negligible (<15 %) part of the resource
	Soil quality	n/a
No Change	All receptors	n/a

11.4.3 Assessment of Significance

18) Table 11.4 provides an illustration of how the significance of effects is assessed, by forecasting the magnitude of change and a receptor's sensitivity to that change.

19) For the purposes of this assessment, anything with a moderate or greater effect was considered to be significant in the context of the EIA Regulations.

Table 11.4: Significance of Effects

		Magnitude				
		No change	Negligible	Minor	Moderate	Major
Sensitivity	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	Slight or 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

11.4.4 Embedded and Good Practice Mitigation

20) The assessment of likely significant effects in Section 11.6 takes into account the application of both embedded and good practice mitigation measures. Embedded mitigation is inherent to the design, and good practice mitigation measures are those which are standard industry practice used to manage commonly occurring environmental effects. These measures are set out in full within the Construction Code of Practice (CCoP) – Appendix 3.2, but the main measures of relevance to this chapter can be summarised as follows.

Land Contamination (Human Health)

- Land contamination would be assessed and managed in accordance with *Land Contamination Risk Management*[5]. This would include ground investigation, followed by human health risk assessment and remediation where required, which would be agreed with the relevant local authorities and the Environment Agency
- Tunnelling operations and machinery would be of a bespoke design to mitigate potential risks to construction workers from asphyxiant or explosive atmospheres, and robust risk assessment procedures would be required to provide protection in accordance with relevant legislation
- A plan dealing with unexpected occurrences of contamination would be in place to deal with unforeseen contamination, including measures to manage immediate risks to human health and prevent the further spread of contamination
- A construction environmental management plan would be developed with pollution prevention measures and environmental controls detailed to prevent the creation of any new contamination during works.

Soil Quality

- Suitably qualified and experienced persons would be employed to oversee the management of soil during stripping, handling, storage and reinstatement

[5] Environment Agency (2020) *op. cit.*

- The contractor would follow guidance within *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*[6] and *Good Practice Guide for Handling Soils*[7] with regards to soil management
- Soil resource surveys would be undertaken and a soil resource plan produced incorporating the results of these surveys
- The full depth of topsoil would be stripped from areas to be disturbed by construction, such as where haul roads, compounds and subsoil stockpiles would be located, and from areas where topsoil would otherwise be sealed by development
- Subsoils would be stripped as required for restoration in agricultural land and landscaping, where the designs necessitated subsoil stripping, or the suitably qualified and experienced person determined it to be necessary to mitigate impacts on the resource during construction.

11.4.5 Assumptions and Limitations

21) The following topic-specific assumptions and data/information source limitations apply to the assessment:

- The Site Briefing (Desk Study) Report (refer to Appendix 11.1) has provided the baseline for geology and the initial ground model for the Proposed Bowland Section
- Ground investigation and monitoring data were limited to historical borehole data available from the British Geological Survey (BGS) and information from the construction of the existing Haweswater Aqueduct. At the time of writing, the ground investigation programme was ongoing within the Proposed Bowland Section, and factual and interpretative reporting for these works had not been completed
- Due to the status of the ongoing ground investigation, uncertainties remain regarding the assessments that require ground data such as soil or groundwater chemical condition, or soil and rock physical characteristics. These uncertainties will be addressed via the ongoing ground investigation and further risk assessment as required.

11.5 Baseline Conditions

22) This section details the soils, geology and land quality baseline for the assessment area and identifies receptors where there is potential for significant effects to arise.

23) Baseline data were collated from a variety of desk-based and field studies data sources available at the time of writing. Detailed technical reviews of the baseline conditions are presented in Appendix 11.1 and Appendix 11.2, with summaries presented in the following paragraphs.

24) The baseline conditions presented below are those taken forward for assessment following the scoping update as discussed in Section 11.2.3.

11.5.1 Land Contamination (Human Health)

25) A review of historical mapping shows that the Lower Houses Compound and the proposed tunnel alignment have not been significantly developed beyond construction of the existing Haweswater Aqueduct and small-scale agricultural buildings and farmhouses. The earliest available maps from 1847 show that small areas surrounding the Newton-in-Bowland Compound were quarried for limestone. Five small-scale historical limestone quarries were identified within 250 m of the Proposed Bowland Section towards the southern end of the proposed alignment. There are a limited number of historical features

[6] Department for Environment, Food & Rural Affairs (2009) *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites*. [Online] Available from: https://www.gov.uk/government/publications/code-of-practice-for-the-sustainable-use-of-soils-on-construction-sites [Accessed: 26-10-2020]

[7] Ministry of Agriculture, Fisheries and Food (2000) *Good Practice Guide for Handling Soils*. [Online] Available from: https://webarchive.nationalarchives.gov.uk/20090317221756/http://www.defra.gov.uk/farm/environment/land-use/soilguid/index.htm [Accessed 26-10-2020]

identified within 250 m of the proposed route alignment that could present potential risks to human health receptors, namely:

- Historical made ground associated with the construction of the existing Haweswater Aqueduct
- Unspecified mound and pits
- Five historical landfill sites which received inert, industrial, household and commercial wastes prior to 1976
- Potential mine spoil and infilled ground from mineral extraction activities including coal and lead mining in the surrounding areas (25 possible historical small-scale quarries, mines and pits have been identified)
- Contaminants associated with agricultural land use such as animal burials, and disposal of farm wastes including agrichemicals and asbestos-containing materials.

26) Two historical stockpiles from the construction of the existing Haweswater Aqueduct have also been identified adjacent to the land required for the Lower Houses (Ch. 0+050) and Newton-in-Bowland Compounds (Ch. 16+300). These are likely to comprise tunnel arisings, but the presence of other construction waste such as from temporary worker accommodation demolition waste materials or other related waste material cannot be discounted.

27) Potential Contaminants of Concern (PCoC) include a broad range of metals, inorganic compounds, hydrocarbon fuels/ oils and asbestos (including asbestos containing materials). Contaminants associated with agricultural land use such as animal burials and disposal of farm wastes could include pathogens, agrichemicals and asbestos-containing materials. Ground gases beneath the site, including radon, methane, carbon dioxide, hydrogen sulphide and carbon monoxide, have been identified as a potential source of contamination for human health receptors. Of particular note is the potential risk to construction personnel working in confined spaces such as the shafts and tunnel. The assessment area is underlain by potential methane-generating geologies, including the Bowland Shale Formation. For further detail on sources of contamination and PCoC, reference should be made to the Site Briefing (Desk Study) Report in Appendix 11.1.

28) The assessment area passes through five radon classes as described by the BGS and Public Health England, varying from radon class 1 (0 to 1 % of homes are above the action level for radon) in the north, to radon class 5 (10 % to 30 % of homes are above the action level for radon) in the south.

29) The Site Briefing (Desk Study) Report presents an initial conceptual model for the Proposed Bowland Section.

30) No significant sources of potential groundwater contamination which may have the potential to affect human health were identified within the Proposed Bowland Section. For further information on groundwater in the area refer to Chapter 7: Water Environment.

11.5.2 Geology and Ground Model

31) A summary of the geology and ground model for the Proposed Bowland Section is presented below, with the mapped geology summarised on Figure 11.1 and Figure 11.2. For further information, reference should be made to Appendix 11.1: Site Briefing (Desk Study) Report.

Artificial Geology

32) BGS 1:50,000 mapping records small areas of made ground (artificial geology) east of the proposed tunnel alignment at Ch. 10+320 and Ch. 13+800. A small area described as 'worked ground – void' is recorded approximately 1.4 km east of the development at Ch. 10+350. Given the undeveloped landscape of the region, any other made ground deposits are likely to be localised and associated with the construction of the existing Haweswater Aqueduct, minor roads or agricultural development. Any made ground would be expected to be limited in lateral and vertical extent. There is potential for unrecorded animal burial pits, such as those associated with mass culls of farm animals during the two

outbreaks of foot and mouth disease that post-dated construction of the existing Haweswater Aqueduct, or other farm-scale burials.

Superficial Geology

33) BGS maps indicate that there are large areas where superficial deposits are absent, suggesting that the bedrock is at, or close to, ground level. Elsewhere, superficial deposits are mapped as follows:

- Peat is present across central sections of the proposed tunnel alignment, notably at higher elevations, discontinuously recorded between approximately Ch. 6+430 and Ch. 12+270, and in smaller areas towards the northern end of the proposed tunnel
- Head deposits, comprising clay, silt, sand and gravel, are identified at several locations along the proposed tunnel alignment, typically associated with steep slopes and valleys and discontinuously recorded between approximately Ch. 2+875 and Ch. 14+235
- Alluvium is recorded adjacent to the watercourses along the proposed tunnel alignment between Ch. 3+180 and Ch. 3+230, and between Ch. 14+150 and Ch. 14+175
- Glacial till is anticipated to be encountered where the proposed tunnel sections have low cover, particularly in the north and south, as well as underlying areas where there are proposed surface works relating to the proposed compound areas and shaft construction; it is mapped broadly between Ch. 0+000 and Ch. 4+180, and between Ch. 13+830 and Ch. 16+460.

Bedrock Geology

34) There are three main geological groups that the Proposed Bowland Section tunnel would cross:

- The Bowland High Group (comprising the Chatburn Limestone Group and base of the Worston Shale Group)
- The Craven Group (comprising the Bowland Shales Group and the majority of the Worston Shale Group)
- The Millstone Grit Group.

11.5.3 Soil Quality

35) To assess which soil types may be affected by the Proposed Bowland Section, national soil map data[8] were obtained, which provide the location of 297 soil associations (types) at a 1:250,000 scale. From these mapped data, it was found that the Proposed Bowland Section traverses the following soil associations:

- Brickfield 3 – Lower Houses Compound. This soil association comprises slowly permeable seasonally waterlogged fine loamy over clayey soils
- Wilcocks 1 – Lower Houses Compound. This soil association comprises slowly permeable, seasonally waterlogged fine loamy and fine loamy over clayey upland soils with a peaty surface horizon
- Brickfield 2 – Newton-in-Bowland Compound. This soil association comprises slowly permeable seasonally waterlogged fine loamy soils. Associated with fine loamy soils with only slight waterlogging and some deep well-drained fine loamy soils
- Fladbury 3 – Newton-in-Bowland Compound with associated construction access. This soil association comprises seasonally wet stoneless clay, fine silty and fine loamy soils affected by groundwater.

[8] Cranfield University (2020) *National soil map data*. [Online] Available from: https://cranfield.blueskymapshop.com/ [Accessed: 22-10-2020]

36) To evaluate the agricultural value of the soils, provisional ALC data produced by Natural England were reviewed.[9] [10] It was found that the Lower Houses Compound and the majority of the Newton-in-Bowland Compound lie within land mapped as ALC Grade 4. Grade 3 land is mapped for the southernmost tip of the Newton-in-Bowland Compound. Subgrades 3a and 3b are not differentiated in the Provisional ALC data, so to make a conservative assessment it has been assumed that this is Subgrade 3a land. The majority of the soil underlain by the proposed tunnel is mapped as Grade 5 and non-agricultural land.

37) For further detail on soil quality, reference should be made to Appendix 11.2A and Figure 11.3. For further information on the severance of agricultural land holdings reference should be made to Chapter 14 Communities and Health.

11.5.4 Mineral Resources

38) Mineral resources were primarily identified via Lancashire County Council (2020)[11] and BGS (2006)[12] information.

39) Lancashire County Council Mineral Safeguarding Areas (MSA) for sand and gravel deposits, and limestone, have been identified within western and northern areas of the Newton-in-Bowland Compound.

40) There are no operational mineral extraction activities or extant minerals applications within 500 m of the Proposed Bowland Section. At the time of writing, Waddington Fell Quarry is an operational hard rock quarry, located approximately 3 km south-east of the Newton-in-Bowland Compound. Its current permit to operate is due to expire prior to construction of the Proposed Bowland Section. It is proposed that surplus tunnel arisings from the Proposed Marl Hill and Bowland Sections would be used by the quarry for the purposes of implementing a revised and enhanced restoration scheme (subject of a separate planning application to Lancashire County Council). On this basis, it is not further considered within this chapter

41) For further detail on mineral resources, reference should be made to Appendix 11.2B and Figure 11.4.

11.6 Assessment of Likely Significant Effects

42) The following section describes the effects of the Proposed Bowland Section on soils, geology and land quality during the enabling works, construction, commissioning and operational phases. Identified effects take into account both embedded and good practice mitigation measures, as set out in Section 11.4.4.

11.6.1 Enabling Works Phase

43) Enabling works are those works required to prepare the site for the main tunnelling and shaft construction phase of works, such as soil stripping, earthworks, rock breaking, forming access routes and providing worker facilities.

44) The potential for temporary adverse impacts on soils, geology and land quality to arise during the enabling works phase of the Proposed Bowland Section is discussed in the following sections.

[9] Natural England (2020) *Provisional Agricultural Land Classification (ALC)*. [Online] Available from: https://data.gov.uk/dataset/952421ec-da63-4569-817d-4d6399df40a1/provisional-agricultural-land-classification-alc [Accessed: 26-10-2020]
[10] Natural England (2020) *Agricultural Land Classification (ALC) Grades – Post 1988 Survey (polygons)*. [Online] Available from: https://data.gov.uk/dataset/c002ceea-d650-4408-b302-939e9b88eb0b/agricultural-land-classification-alc-grades-post-1988-survey-polygons [Accessed: 26-10-2020)
[11] Lancashire County Council (2020) *Maps and Related Information Online MARIO*. [Online] Available from: http://mario.lancashire.gov.uk/agsmario/default.aspx [Accessed: 24-10-2020]
[12] British Geological Survey (2006) *Mineral Resource Information in Support of National, Regional and Local Planning: Lancashire (comprising Lancashire and Boroughs of Blackpool and Blackburn with Darwen)*. [Online] Available from: https://www2.bgs.ac.uk/downloads/start.cfm?id=2585 [Accessed: 26-10-2020]

Land Contamination (Human Health)

45) The disturbance of land contamination during enabling works could result in risks to construction workers and adjacent land users via acute exposure to land contamination. Relevant exposure pathways include accidental ingestion, dermal contact and / or inhalation of soil particles (following airborne dispersion for adjacent land users).

46) Construction workers are considered to have a very high sensitivity. Users of adjacent land are considered to have a low sensitivity.

47) However, the presence of land contamination across the Proposed Bowland Section is considered unlikely. Any existing contamination which is present should be identified by the ongoing ground investigation and subsequent risk assessment, with appropriate remedial measures undertaken as required as per Section 11.4.4. Should unforeseen contamination be encountered during enabling works, any potential risks to human health would be mitigated by implementation of the unexpected contamination plan held within the CCoP (refer to Section 5.6). Radon is not considered to represent a viable risk to receptors during enabling works due to the nature of activities proposed in this phase (i.e. soil stripping, earthworks, rock breaking, forming access routes and worker facilities).

48) Therefore, no effects are predicted to occur on construction workers (high sensitivity) or adjacent land users (low sensitivity) during the enabling works.

Soil Quality

49) The soil quality at the Lower Houses Compound and the majority of the Newton-in-Bowland Compound was identified as ALC Grade 4 (poor quality); therefore, the soils are considered as having a low sensitivity.

50) Soil quality could be affected by sealing beneath hardstanding e.g. compounds; compaction and smearing during trafficking, handling and storage; or degradation through mixing with soils of poorer quality of other materials.

51) However, implementation of the measures summarised in Section 11.4.4 would mitigate the potential for these effects to occur, through careful planning and consideration of soil resources.

52) Therefore, no effects are predicted to occur on soil quality (low sensitivity) during the enabling works.

Mineral Resources

53) Western and northern areas of the Newton-in-Bowland Compound lie within Lancashire County Council MSA for sand and gravel deposits and limestone. However, given that there are no operational mineral extraction activities or known planning applications in process for workings within 500 m of the Proposed Bowland Section, the sensitivity / value of the mineral safeguarding areas was considered to be medium.

54) It is considered that the enabling works would have no discernible effect on the mineral safeguarding areas as they would pose only minor temporary access restrictions, if any.

11.6.2 Construction Phase

55) During the main construction phase of the Proposed Bowland Section, the principal activities that could affect soils, geology and land quality receptors relate to tunnelling, shaft construction and open-cut trenching.

56) The potential for temporary adverse impacts on soils, geology and land quality to arise during the construction phase of the Proposed Bowland Section is discussed in the following sections, and identified effects are summarised in Table 11.5.

Land Contamination (Human Health)

57) The disturbance of land contamination during construction works is considered to be less likely than during the previous enabling works phase. During the construction phase, it is anticipated that shallow

groundworks will have been largely completed during the enabling works phase, and the likelihood of construction workers and adjacent land users being exposed to land contamination would be very low. This judgement is also made taking account of the mitigation measures set out in Section 11.4.4, such as prior ground investigation and risk assessment and implementation of an unexpected contamination plan.

58) Exposure pathways to construction workers within the tunnel associated with potentially asphyxiant or explosive ground gases would be largely mitigated by bespoke design measures and risk assessment procedures, as set out in the CCoP, as referenced in Section 11.4.4. It is not anticipated that potential displacement of ground gases into properties by the tunnelling operations would be a viable pathway for adjacent land users. Radon is not considered to represent a viable risk to any receptors during construction.

59) Therefore, no effects are predicted to occur on construction workers (high sensitivity) or adjacent land users (low sensitivity) during the construction phase.

Soil Quality

60) The soil quality within the Proposed Bowland Section ranges from ALC Grade 5 (very poor quality) to ALC Grade 3 (assumed to be Subgrade 3a, good quality soil), and therefore the soils are considered as having low to high sensitivity.

61) As noted above, shallow groundworks should largely be complete prior to the construction phase. Therefore, taking into account the mitigation measures set out in Section 11.4.4, no effects are predicted to occur on soil quality during the construction phase.

Mineral Resources

62) As per Section 11.6.1, the sensitivity / value of the MSAs at the Newton-in-Bowland Compound is considered to be medium.

63) The magnitude of change on the MSAs is considered to be negligible on the basis that the Proposed Bowland Section would impact on a very limited footprint of the resources during construction.

64) Accordingly, the significance of effect of the Proposed Bowland Section on mineral resources was assessed as neutral or slight.

Table 11.5: Summary of Construction Phase Effects

Environmental / Community Asset	Value / Sensitivity	Magnitude of Change	Nature of Effect	Significance of Effect (Pre-Mitigation)
Mineral resource				
Lancashire County Council mineral safeguarding area for sand and gravel	Medium	Negligible	Temporary loss of a negligible (<15 %) part of the resource	Neutral or slight
Lancashire County Council mineral safeguarding area for high purity limestone	Medium	Negligible	Temporary loss of a negligible (<15 %) part of the resource	Neutral or slight

11.6.3 Commissioning Phase

65) The only commissioning phase activity of relevance to soils, geology and land quality receptors would be land reinstatement. However, with respect to land contamination, any contamination present would likely have been encountered and dealt with during the enabling and construction works phases, whilst the CCoP (refer to Section 5.6) would mitigate the potential for effects from unforeseen contamination.

66) No effects on mineral resources would occur during the commissioning phase.

67) With regards to soil quality, any potential adverse impacts on soils during handling and reinstatement would also be mitigated by implementation of the measures set out within the CCoP and summarised in Section 11.4.4.

68) As such, there are no commissioning phase effects identified in relation to Soils, Geology and Land Quality.

11.6.4 Operational Phase

69) The operational phase accounts for the permanent presence and operation of the constructed infrastructure.

70) The potential for adverse impacts on soils, geology and land quality to arise during the operation of the Proposed Bowland Section is discussed in the following sections.

Land Contamination (Human Health)

71) There is the potential that following construction, any land contamination remaining within the Proposed Bowland Section could present risks to future site users, or site workers and ground workers during asset maintenance. Relevant exposure pathways include accidental ingestion, dermal contact and / or inhalation of soil particles.

72) Maintenance workers and future site users beyond the operational area (but within the former construction area) are considered to have a high sensitivity.

73) However, it is considered unlikely that any land contamination would be encountered across the Proposed Bowland Section and that any contamination identified would be managed during the enabling and construction works; therefore, contamination sources are unlikely to remain into the operational phase.

74) As such, no effects are predicted to occur on future site users during the operational phase. Furthermore, for maintenance workers, who have a greater potential for exposure during ground-breaking activities, operatives would work under appropriate risk assessments and method statements, such that no effects are predicted to occur.

75) No operational impacts on human health from the tunnel are identified on the basis that there would be no access during routine operations. Health and safety measures for future entry during maintenance or future outages are not considered relevant to this assessment.

Soil Quality

76) It is not anticipated that there would be any activities during the operational phase that could affect soil quality and no effects, therefore, are predicted on soils.

Mineral Resources

77) Following construction of the Proposed Bowland Section, operational impacts on mineral resources would be unlikely. Although there are Lancashire County Council MSAs for sand and gravel, and high purity limestone, of medium sensitivity / value within the footprint of the Newton-in-Bowland Compound, it is considered highly unlikely that the Proposed Bowland Section would significantly impede future mineral workings at a regional level.

78) Therefore, no effects are predicted to occur on mineral resources during operation.

11.7 Mitigation and Residual Effects

79) Embedded and good practice mitigation measures were taken into account in determining the significance of potential effects in Section 11.6. No effects were identified in Section 11.6 for any phase of the Proposed Bowland Section requiring additional mitigation.

11.8 Cumulative Effects

80) The following section provides an overview of the potential cumulative effects from different proposed developments and land allocations, in combination with the Proposed Bowland Section (i.e. inter-project cumulative assessment). Data on proposed third party developments and land allocations contained in development plan documents were obtained from various sources, including local planning authority websites, online searches, and consultations with planning officers. Proposed development data were then reviewed with a view to identifying schemes or land allocations whose nature, scale and scope could potentially give rise to significant environmental effects when considered in combination with the likely effects arising from the Proposed Bowland Section.

81) Intra-project cumulative impacts, i.e. two or more types of impact acting in combination on a given environmental receptor, property or community resource, are considered in Chapter 14: Communities and Health.

82) It is important to note that future growth on the local road network was taken into account in the traffic modelling described in Chapter 16: Transport Planning. For this reason, the potential cumulative effects of future traffic growth between the Proposed Bowland Section and other proposed developments are embedded into predicted road traffic-related impacts on highways capacity, air quality and noise.

83) The over-arching cumulative effects of the Proposed Programme of Works i.e. the five proposed replacement tunnel sections in combination, are considered in Chapter 19: Cumulative Effects. In addition, Chapter 19 examines the cumulative effects associated with the outcomes from Volume 2 (delivery and operation of the main construction compounds, tunnel, and construction traffic routes), Volume 5 (proposed off-site highways works and satellite compounds), and Volume 6 (Proposed Ribble Crossing).

84) Based on professional judgement, it was concluded that there are no proposed third party developments or land allocations in local development plan documents which could potentially give rise to likely significant cumulative effects. No cumulative assessment was therefore undertaken in connection with soils, geology or land quality.

11.8.1 Highways Works

85) As described in Volume 5 there are no likely significant effects anticipated in relation to soils, geology or land quality in relation to the proposed off-site highways works.

11.8.2 Ribble Crossing

86) As described in Volume 6 there are no likely significant effects anticipated in relation to soils, geology or land quality in relation to the Proposed Ribble Crossing.

11.9 Conclusion

87) This chapter considered the potential soils, geology and land quality impacts associated with enabling works, construction, commissioning and operational phases along the route of the Proposed Bowland Section.

88) In line with the EIA Scoping Reports and Scoping Opinions received, assessment of infrastructure (in relation to land contamination), geologically designated sites and ecologically designated sites from the soils, geology and land quality topic were excluded from this assessment. The sub-topics taken forward for impact assessment were human health (in relation to land contamination), mineral resources and soil quality.

89) Embedded and good practice mitigation measures for soils, geology and land quality were identified for inclusion within the CCoP and are summarised in this chapter.

90) The baseline conditions at the site were established through a review of desk-based information, consultation responses and data provided by United Utilities. Assessments were undertaken to

determine the environmental impact of the Proposed Bowland Section during all phases of construction and operation.

91) The potential for adverse impacts to arise on soils, geology and land quality receptors was considered, but taking into account the embedded and good practice mitigation measures set out within the CCoP, no adverse effects were identified requiring additional mitigation.

92) Based upon the assessment presented in this chapter, and provided that the measures detailed in the CCoP would be applied, no significant adverse effects on soils, geology and land quality receptors are predicted.

11.10 Glossary and Key Terms

93) Key phrases and terms used within this technical chapter relating to Soils, Geology and Land Quality are defined within Appendix 1.2: Glossary and Key Terms.