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Network Rail

Oxford Corridor Phase 2 Capacity Improvement Scheme

Environmental Impact Assessment – Environmental Statement: Chapter 7 – Geology and Soils

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7. GEOLOGY AND SOILS

7.1 Introduction

7.1.1 This chapter of the Environmental Statement reports the potential effects resulting from the construction and operation of the Scheme on geology and soils. The assessment has taken the following approach:

- identification of relevant baseline conditions;
- details of relevant mitigation embedded within the Scheme and construction management measures;
- assessment of potential geology and soils effects from the Scheme;
- proposals for appropriate additional mitigation measures if possible; and
- conclusions on the likely significant residual effects of the Scheme for geology and soils.

7.1.2 A full description of the Scheme is given in Chapter 2 – Description of the Scheme. All technical terms used in this chapter are explained within Appendix 1.5 – Glossary and Acronyms.

7.1.3 The geology and soils assessment considers the following:

- geology, including sites of geological importance;
- soils, including the impacts on agricultural soil quality, sensitive and vulnerable soils with regards to contamination, soil and agricultural land loss, erosion or compaction and degradation of soil quality;
- land contamination, including the potential for the Scheme to disturb areas of ground, groundwater contamination, and the potential impacts of encountering contamination on the environment and human health during the operation and construction phases; and
- controlled waters.

7.1.4 This chapter is supported by the following:

<u>Volume 3</u>

- Figure 7.1 – Geology Baseline for the Scheme; and
- Figure 7.2 – Historical Ground Investigation Locations.

Volume 4

- Appendix 7.1 – Geology and Soils Baseline Conditions; and
- Appendix 7.2 – Preliminary Risk Assessment.

7.2 Legislation, Policy and Guidance

7.2.1 The following section outlines the relevant national legislation, regional and local planning policies and guidance relevant to this assessment.

7.2.2 Table 7.1 sets out the relevant legislation for geology and soils; Table 7.2 sets out relevant planning policy for geology and soils whilst Table 7.3 provides a summary of relevant guidance for this geology and soils assessment. Professional judgement has also been applied to this assessment.

7.2.3 The legislation, policies and guidance listed have been taken into account in the assessment of the likely significant effects on geology and soils as a result of the Scheme. Appropriate mitigation measures have been developed as a result.

Table 7.1: Legislation relevant to geology and soils

Legislation	Description in relation to geology and soils	Relevance to the Scheme
Part 2A of the Environmental Protection Act (EPA) 1990 (Defra, 2012)	Part 2A of the EPA sets out the legislative framework for dealing with historically contaminated land including the requirement to take action where there are "unacceptable risks to human health and the environment", based on the "suitable for use" approach.	Risks to human health and the environment have been assessed to determine whether action is required to deal with past land contamination.
Water Framework Directive (WFD) (2000/60/EC) (WFD, 2015)	The WFD is a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. It includes guidance on management of risks arising from contamination.	Contamination risks to controlled waters have been assessed to determine whether action is required to deal with past land contamination or future contamination arising during construction and operation of the Scheme.
Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009	The Act regulates pollution, water quality, flood defence and discharges to controlled waters in England and Wales.	Contamination risks to controlled waters have been assessed to determine whether action is required to deal with past land contamination or future contamination arising during construction and operation of the Scheme.
Control of Pollution (Oil Storage) (England) Regulations 2001 (gov.uk, 2001)	The Control of Pollution (Oil Storage) Regulations set the design standards for oil storage facilities, with the aim of reducing the number of oil-related water pollution incidents.	The requirements of the Control of Pollution (Oil Storage) Regulations have been used to inform the construction management measures as described in Section 7.5 of this chapter and Appendix 2.1 – Mitigation Register.
Environmental Damage (Prevention and Remediation) Regulations 2015 (gov.uk, 2015)	These Regulations apply in relation to the prevention and remediation of environmental damage. Environmental damage is damage, as specified in this regulation, to protected species, natural habitats, sites of special scientific interest, surface water, groundwater, marine waters or land.	The requirements of the Environmental Damage (Prevention and Remediation) Regulations 2015 have been used to inform the construction management measures as described in Section 7.5 of this chapter and Appendix 2.1 – Mitigation Register.

Table 7.2: Planning policy relevant to geology and soils

Policy Document	Description in relation to geology and soils	Relevance to the Scheme
National		
National Planning Policy Framework (Ministry of Housing, Comunities and Local Government, 2019)	The National Planning Policy Framework sets out the government's planning policies for England and how they are expected to be applied by local planning authorities. The relevant national planning policy and associated guidance with respect to contaminated land are presented in the section on ground conditions and pollution. Paragraph 178 states "*Planning policies and decisions should ensure that:* *a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination.*"	An assessment of the risks from contamination has been undertaken by means of desk studies and ground investigation works. The effects of pollution have been assessed based on the findings. These effects have been taken into account in the the proposed mitigation measures so that the Scheme can be developed safely.
National Policy Statement for National Networks (Department for Transport, 2014)	The National Policy Statement for National Networks sets out the criteria on national need, benefits and impacts of significant road and rail infrastructure projects in England. Applications for development are assessed using these criteria. Paragraph 4.15 states that all proposals for projects that are likely to have significant effects on the environment must be accompanied by an Environmental Statement which should identify, describe and assess effects on humans, fauna and flora, soil, water, air, climate, the landscape, material assets and cultural heritage, and the interaction between them.	This geology and soils chapter reports the effects on soil and water from the Scheme.
Local		
Oxford City Local Plan 2001 – 2016 (Oxford City Council , 2005)	This Local Plan sets out the policies and proposals for future development and land use in Oxford for the period 2001 to 2016. The Plan's objective is to promote positive measures to improve the local environment and to meet the needs of local communities. The Plan needs to control development, that might harm the environment, and also needs to encourage remedial action where damage has already occurred.	Contaminated soil and landfills are present within and in proximity to the Scheme. Risks to human health and the environment are assessed and mitigation actions identified where they need to be addressed.

Policy Document	Description in relation to geology and soils	Relevance to the Scheme
Oxford City Local Plan 2016 – 2036 (Oxford City Council, 2018)	Policy RE7: Managing the impact of Development. Planning permission will only be granted for development that provides mitigation measures where necessary. The factors the City Council will consider in determining compliance with the above elements of this policy include impacts of the construction phase, including the assessment of these impacts within the Construction Management Plans; contaminated land; and impact upon water and wastewater infrastructure. Policy RE9: Land quality. Planning applications where proposals would be affected by contamination or where contamination may present a risk to the surrounding environment, must be accompanied by a report. This should detail the investigations that have been carried out to assess the nature and extent of contamination. It should also cover the possible impacts it may have on the development and its future users, biodiversity, the natural and built environment and set out detailed mitigation measures to allow the development to go ahead safely and without adverse effect. This should include, as appropriate: removing the contamination; treating the contamination; protecting and/or separating the development from the effects of the contamination; and validation of mitigation measures.	Contaminated soil and landfills are present within and in proximity of the Scheme. Risks to human health and the environment are assessed and mitigation actions identified where they need to be addressed.

Table 7.3: Guidance relevant to geology and soils

Guidance Document	Description in relation to geology and soils
Design Manual for Roads and Bridges (DMRB) guidance documents LA 109 Geology and Soils (Highways England , 2019)and LA 104 Environment Assessment and Monitoring (Highways England, 2020)	LA 109 sets out the requirements for assessing and reporting effects on geology and soils. LA 104 sets out the requirements for environmental assessment, including reporting and monitoring of significant adverse environmental effects.
Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance	This statutory guidance was issued by the Secretary of State for Environment, Food and Rural Affairs (Defra) in accordance with section 78YA of the Environmental Protection Act 1990. Section 57 of the Environment Act 1995 created Part 2A of the Environmental Protection Act 1990. This establishes a legal framework for dealing with contaminated land in England. The guidance is intended to explain how local authorities should implement the regime, including how they should go about deciding whether land is contaminated land in the legal sense of the term. It also elaborates on the remediation provisions of Part 2A, such as the goals of remediation and how regulators should ensure that remediation requirements are reasonable.
Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Defra, 2009)	This guidance gives advice on good practice for maintaining soil quality and structure during construction.
Contaminated Land: Applications in Real Environments (CL:AIRE) definition of waste: development industry code of practice	This guidance sets out good practice on a site-specific basis for assessing whether excavated materials are classified as waste or not, and when treated excavated waste ceases to be waste for a particular use. It can be used to demonstrate suitability for re-use of excavated materials on site.
The EA's approach to groundwater protection (CL:AIRE, 2018 (Version1.2))	This document contains position statements which provide information about the Environment Agency's approach to managing and protecting groundwater. It details how the Environment Agency delivers government policy for groundwater and adopts a risk-based approach where legislation allows.

Guidance Document	Description in relation to geology and soils
Planning Practice Guidance for Land Affected by Contamination (Ministry of Housing, Comunities & Local Government, 2019)	This guidance provides guiding principles on how planning can deal with land affected by contamination.
Agricultural Land Classification of England and Wales: revised guidelines and criteria for grading the quality of agricultural land (Ministry of Agriculture, Fisheries and Food, 1988)	This document provides the revised guidelines and criteria for grading the quality of agricultural land. This is used to assess potential impacts from the Scheme on agricultural land.
Model Procedures for the management of land contamination: Land contamination: risk management (LCRM) (Environment Agency, 2020)	This guidance sets out a UK risk-based approach for the management of land contamination and is built upon the principles of the Model procedures for the management of land contamination – contaminated land report (CLR11) published by the Environment Agency in 2004.
Guidance on Oil Storage Regulations for businesses (Environment Agency & Defra, 2015)	This guidance sets out the secondary containment measures to contain leakage of oil.

7.3 Methodology

Introduction

7.3.1 The approach outlined below has been followed in preparing this Chapter. It reports the consultation undertaken, defines the study area, temporal scope, the sources of baseline data, and the methodology and significance criteria. The limitations and assumptions of the study are also described.

Consultation

7.3.2 The scope and method of assessment for this geology and soils assessment was presented in the Environmental Impact Assessment Scoping Report (Network Rail, 2020). Oxford City Council issued a Scoping Opinion in response to the Scoping Report in January 2021. The Scoping Opinion included a requirement for geology and soils to be included in the EIA and gave further direction on the content of the assessment.

7.3.3 An overview of consultation undertaken on the Scheme is summarised in Chapter 4 – Approach to Environmental Impact Assessment.

7.3.4 In relation to the geology and soil assessment there has been engagement with the following stakeholders:

- Oxford City Council; and
- Environment Agency.

7.3.5 Table 7.4 summarises the consultation responses received regarding the scope and methodology to be applied in the EIA and indicates how the assessment has been revised in response (where appropriate).

Table 7.4: Summary of EIA Scoping Report consultation responses for geology and soils scope and methodology

Consultee	Issues raised in response to the Scoping Report	Summary of the response to issues raised
Oxford City Council	Impact on contaminated land needs to be considered as part of the human health section as well as geology and soils.	The impact on contaminated land has been assessed and is reported in Section 7.6 of this chapter.
Natural England	Natural England as the statutory consultee have requested further information should feature in the Environmental Statement in relation to biodiversity and geology (including the impact on site of special scientific interest (SSSI), and special area of conservation (SAC), air quality, climate change adaption, cumulative and in-combination effects).	No designated geological sites of interest have been identified within the study area (Ref: Natural England Website and Thames Valley Environmental Record Centre (TVERC) - Local Geological Sites Website),. Therefore, geodiversity assessment has been scoped out
	Natural England has confirmed that the Oxford Meadows SSSI is outside of the scope of the EIA in respect to Geology and Soils due to its location outside of the 500m buffer study area.	Effects on the Oxford Meadows SSSI have not been assessed within this EIA and are not reported on in the Environmental Statement.
	Natural England has requested that the impact on contaminated land needs to be considered as part of the human health section as well as geology and soils.	Effects due to contaminated land have been assessed in the Environmental Statement including effects to human health within Section 7.6 and also within Chapter 13.

Study Area

7.3.6 The study area for this assessment comprised a 500m buffer zone around the red line boundary.

7.3.7 The red line boundary has been modified as a result of the development of the design of the Scheme and therefore the study area covered in the Scoping Report may slightly differ in some places from the area covered in this assessment.

7.3.8 The study area is shown in Figure 7.1.

Temporal Scope

7.3.9 Baseline conditions are described using available data sources, including consideration of how this baseline may change from present day to the year of construction (i.e. the future baseline in the absence of the Scheme).

7.3.10 The temporal scope of this assessment was:

- baseline year: 2019
- future baseline year (first year construction): 2022; and
- future baseline year (first year operation): 2025

Baseline Data

7.3.11 The geology and soils baseline has been derived using the following sources of information:

- Groundsure Reports no. 6552685, 6552686 and 6552687,14 Jan 2020 (Groundsure, 2020);
- Multi Agency Geographic Information for the Countryside website (MAGIC) (Defra, 2021);
- Phase 1 and 2 ground investigation report (THJV, 2014)
- Contaminated Land Risk Assessment (THJV, 2014);
- Oxford Corridor Roger Dudman Way Factual Ground Investigation Report (THJV, 2017)
- Oxford Corridor Down Carriage Sidings Contaminated Land Study Report (THJV, 2018)
- historical reports (Volume 4 – Appendix 7.1); and
- site walkover (Volume 4 – Appendix 7.1).

Assessment Methodologies

7.3.12 The assessment follows the general methodology outlined in the Scoping Report (Network Rail, 2020) and described in Chapter 4 – Approach to Environmental Impact Assessment. It considers whether potential effects are likely to be significant based on the sensitivity of the receptors and the magnitude of the impact.

7.3.13 The criteria set out in Table 7.5 have been used to assess the environmental sensitivity of receptors. The methodology and criteria for assessing the sensitivity of surface waters and groundwater receptors are detailed in Volume 2 – Chapter 14 – Water Resources and Flood Risk.

7.3.14 Sensitivity of surface water and groundwater are taken from Table 3.70 in road drainage and water environment LA113 and based on sensitivity given in Chapter 14 – Water Resources and Flood Risk.

Table 7.5: Criteria for determining the sensitivity of receptors for geology and soils

Sensitivity	Criteria
Very high	Human health: very high sensitivity land use such as residential or allotments.
High	Human health: high sensitivity land use such as public open space;
Medium	Human health: medium sensitivity land use such as commercial or industrial;
Low	Human health: low sensitivity land use such as highways and rail;
Negligible	Human health: undeveloped surplus land / no sensitive land use proposed;

7.3.15 Table 7.6 sets out the criteria used for assessing the magnitude of impacts on geology, soils and contaminated land receptors. The methodology and criteria for assessing the magnitude of impact on surface waters and groundwater receptors are set out in Volume 2 – Chapter 14.

Table 7.6: Assessment criteria for determining the magnitude of the impact for geology and soils

Magnitude of Change	Criteria
High	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.
Medium	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;
Low	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;
Negligible	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;
No change	Human health: reported contaminant concentrations below background levels;

7.3.16 The assessment of the significance of an effect combines the sensitivity of a receptor with the magnitude of impact to determine the overall effect of the development on a receptor. The assessment criteria that have been used are shown in Table 7.7.

Table 7.7: Factors in the assessment of significance of effect

Magnitude	Sensitivity				
	Very Low	Low	Medium	High	Very High
High	Minor	Moderate (Significant)	Moderate / Major (Significant)	Major (Significant)	Major/Very Substantial (Significant)
Medium	Negligible / Minor	Minor	Moderate (Significant)	Moderate / Major (Significant)	Major (Significant)
Low	Negligible	Negligible / Minor	Minor	Minor / Moderate	Moderate (Significant)
Negligible None	None/ Negligible Neutral	Negligible Neutral	Negligible Neutral	Negligible / Minor Neutral	Minor Neutral

7.3.17 For the purpose of this geology and soils assessment, effects of moderate significance or greater have been considered to be significant.

Matters Scoped Out of the Assessment

7.3.18 The matters that have been scoped out of this topic assessment, in accordance with the Scoping Opinion (Volume 4 – Appendix 1.1 and Appendix 1.2):

- soils – the Scheme is within an area classified as urban land; and
- geological designations - No designated geological sites identified within the study area.

7.3.19 These matters have been scoped out on the basis that the Scheme would not cause impacts.

Limitations and Assumptions

7.3.20 The potential impacts identified in this geology and soils chapter are based on the review of available desk study information including historical reports for the land and the ground investigation works undertaken to date. A Preliminary Risk Assessment Report is provided in Volume 4 – Appendix 7.2.

7.4 Baseline Conditions

Characterisation of the Environmental Baseline

7.4.1 Assessment of baseline conditions refers to existing environmental conditions in 2019.

7.4.2 Further information is provided in Volume 4 – Appendix 7.1 of this Environmental Statement', summaries are reported in the sections below.

7.4.3 Review of historical desk studies and ground investigation reports available for the site have been completed and reported in Volume 4 – Appendix 7.1. According to the reports reviewed, contamination has been found in the Down Carriage Sidings.

Scheme History

7.4.4 Historical land uses have been identified using a series of Historical Ordinance Survey Plans from Groundsure at scales of 1:500 and 1:1,250 dating from 1869 – 2012 and one aerial photograph. Google Earth was also used where appropriate. Details of the historical land use review is presented Section 4 of Appendix 7.1. A summary is given here.

7.4.5 The Oxford Station and sidings have been recorded since 1876, as well as Botley Road Bridge and the Sheepwash Bridge. Sidings and engine sheds are recorded at the location of the existing short stay car park. In 1876 a large engine shed is recorded in the Down Carriage Sidings. At that time the surrounding land use was agricultural to the west and residential to the southeast and southwest. A coal depot was located immediately east of the Scheme.

7.4.6 An area northeast of the site is recorded as industrial uses. Tallow Factory, Eagle Foundry (Iron and Brass) later renamed Eagle Iron works and Ink Works are recorded within this area from 1970s to 1989. This area corresponds later to the Eagle Iron Works historical landfill which has since been redeveloped to residential land use.

7.4.7 On the 1900 map, Roger Dudman Way is shown. New residential properties are recorded to the west of the station. Platforms 1, 2 and 3 are recorded. A goods shed is recorded at the current location of the short stay car park. In the surrounding areas a cemetery is recorded to the southwest of the site and the coal depot is now absent.

7.4.8 On the 1922 map, additional sidings are present to the west of the station. There are additional tracks in the Down Carriage Sidings and the footbridge adjacent to Sheepwash Bridge has now been built. No major changes are recorded for the surrounding areas adjacent to the Scheme except that there is an increase in road and residential housing construction.

7.4.9 On the 1975 map the only major change noted is that numerous sidings around the site have been removed.

7.4.10 On the 1993 map more sidings to the east of site area have been removed and replaced with car parking facilities.

7.4.11 On the 2002 map the site generally has its current layout and the sidings at the southern end of the site have been removed, with only the Up and Down Carriage Sidings remaining. In the surrounding areas, Rewley Road has been built on former sidings to the immediate northeast of the site.

7.4.12 The 2012 map shows that two railway tracks at the north of the site have been developed and a fourth platform has been built. In the surrounding areas allotment gardens previously recorded to the west of the site have been completely redeveloped for use as recreational grounds. The townscape surrounding the site has not materially altered.

Landfills

7.4.13 According to the Groundsure report, four historical landfills are recorded within 500m of the site:

- Rewley Road Historical Landfill located at Rewley Road. The waste type recorded as received was inert, industrial, household and liquid sludge;
- Walton Well Road Allotments Historical Landfill located at Walton Well Road. The waste type recorded as received was industrial, commercial and household;
- Eagle Iron Works Historical Landfill located in an area to the west of Rutherway. The waste type recorded as received was inert, industrial and liquid sludge. It operated between 1966 and 1989; and
- historical or planned scrap yard recorded as waste treatment, transfer or disposal sites, located to the south of Botley Road within Becket Street station car park and operational in 1989.

7.4.14 Consultation with Oxford City Council (OCC) and the Environment Agency (EA) has been conducted regarding the landfill sites. The consultation confirmed 3 of the 4 historical landfills identified. The historical or planned scrap yard was not reported in OCC or EA records. Information provided by OCC and the EA include current land use, waste type, remediation and monitoring undertaken at the sites. The consultation responses are available in Section 3.3 of Appendix 7.1. All historical landfills are shown in Figure 7.2 within Volume 3 of the Environmental Statement.

7.4.15 Rewley Road historical landfill has been redeveloped as residential land use and gas protections measures are in place for the residential properties.

7.4.16 Eagle Iron Works historical landfill has been redeveloped for residential use. Remediation works include: passive sub-floor venting to buildings; gas membrane; capping of gardens and soft landscaping areas; and removal of contamination source (oils and PAH).

7.4.17 The Walton Well Road Allotments historical landfill is currently used as allotments named Cripley Meadow. A 'Part 2a' site assessment was completed in 2010 with detailed quantitative risk assessment completed in 2011. These concluded that there was unlikely to be significant harm caused by this site, and therefore the land would not be considered contaminated. However, a diesel spill occurred during the development of Castle Mill Phase 2 student accommodation. Actions were completed to remove the diesel from groundwater. Monitoring of the groundwater was undertaken for 1 year and the levels of contamination were determined to be sufficiently low after a year of monitoring.

Unexploded Ordnance (UXO)

7.4.18 According to the online Zetica risk maps (ZeticaUXO, 2021) the area is classified as a low risk for UXO.

Geology, Hydrogeology and Hydrology

7.4.19 Made ground is recorded on British Geological Society maps around the station area (British Geological Society, 2021).

7.4.20 Superficial deposits within the site comprise alluvium described as clay, silt, sand and gravel overlaying sand and gravels (River Terrace Deposits). The alluvium is predominantly along the alignment of the River Thames.

7.4.21 Oxford Clay and West Walton Formation is present as the bedrock geology, underlying the superficial deposits.

7.4.22 The alluvium and River Terrace Deposits superficial deposits are designated as a 'Secondary A' aquifer. This indicates that they contain permeable layers which are capable of supporting water supplies at a local scale and acting as an important source of base flow to rivers. The Oxford Clay and West Walton Formation are designated as unproductive.

7.4.23 The River Thames is located approximately 150m to the west of Oxford Station. The Castle Mill Stream and Oxford Canal are located approximately 300m to the east of Oxford Station. Sheepwash Channel is located within red line boundary at Sheepwash Bridge. It flows from the River Thames under the railway line and Rewley Road Swing Bridge to join the Castle Mill Stream

7.4.24 More details of geology, hydrogeology and hydrology are provided in Section 3 of Appendix 7.1 and Section 14 – Water Resources and Flood Risk.

Geological Sites

There are no designated geological sites and Local Geological Sites identified within the Study Area as also discussed in the scoping report and consultation with Natural England and summarised in

7.4.25 Table 7.4.

Agricultural Soil

7.4.26 The Defra provisional agricultural land classification, published by Natural England in 2019, classifies the Scheme as urban land This topic was scoped out within the Scoping Report as agreed by Oxford City Council.

Site Walkover

7.4.27 A site walkover was completed by the geology and soils team on 14 January 2020. The areas visited included public places and Network Rail land (track excluded). A Network Rail representative accompanied Jacobs on the site visit within Network Rail land. Findings are reported in Volume 4 – Appendix 7.1.

Historical Ground Investigation Reports Summary

7.4.28 Historical ground investigation reports prepared by Halcrow – Tata Joint Venture have been reviewed. The full review can be found within Volume 4 – Appendix 7.1. A list of these reports is provided in Table 7.8.

Table 7.8: Historic reports reviewed

Year	Title
September 2014	Oxford Corridor Capacity Improvement Phase 1 and Phase 2 Ground investigation Report.
October 2014	Oxford Corridor Capacity Geo-Environmental Summary Memorandum
October 2014	Oxford Corridor Capacity Improvement - Contaminated Land Risk Assessment
June 2017	Oxford Corridor Roger Dudman Way Factual Ground Investigation Report
April 2018	Oxford Corridor Down Carriage Sidings Contaminated Land Study Report
November 2020	Oxford Corridor Phase 2 Design Environmental Management Plan

7.4.29 The historical ground investigations identified three areas where hydrocarbon contamination was present:

- Roger Dudman Way;
- Down Carriage Sidings; and
- Botley Road.

7.4.30 The contamination report on Roger Dudman Way identified one groundwater sample with elevated total petroleum hydrocarbon (TPH) levels. Groundwater flows southeast so any contamination from the station is likely to flow away from Roger Dudman Way. No gas data are available for this area.

7.4.31 The former tanks located at the Down Carriage Sidings, north of Sheepwash Bridge and west of the tracks are known to be a hydrocarbon contamination source. The Down Carriage Sidings report concludes that groundwater flows in a south easterly direction towards Sheepwash Bridge and has a potential 'smear zone' of 1-3m width within the soils.

7.4.32 The Botley Road has fewer investigation positions due to traffic management restrictions. The boreholes close to this area suggest made ground and some hydrocarbon contamination in borehole BH01 south east of the Botley Road Bridge.

7.4.33 The previous ground investigations and accompanying reports suggest that contamination is present across the area of Oxford Station.

Preliminary Risk Assessment Summary

7.4.34 A conceptual site model and risk assessment have been completed for the Scheme. A summary of the risk associated with the proposed works is reported here. The full risk assessment is available in Volume 4 – Appendix 7.2.

Sheepwash Bridge Replacement

7.4.35 Ground and groundwater contamination are recorded north of Sheepwash Bridge within the Down Carriage Sidings area and Castle Mill area. Historical fuel tanks within the Down Carriage Siding and a diesel spill during the Castle Mill development have led to hydrocarbon contamination within the soil and groundwater. According to the local groundwater flow direction, this contamination may have spread within the groundwater towards Sheepwash Channel.

7.4.36 There is the potential that during construction a new pathway could be created which may mobilise contamination from the Down Carriage Sidings area and Castle Mill to the Sheepwash Channel. Ground gas may also be present.

Roger Dudman Way, Western Entrance

7.4.37 Ground investigation showed considerable made ground including ballast and clinker.

7.4.38 There is the potential that during construction, excavation may create pathways which could increase the risk for potential contamination to infiltrate into groundwater and reach surface waters.

7.4.39 Further ground investigation is recommended before undertaking excavation works to assess presence and levels of contaminants in soil and groundwater. Also, to refine the geo-environmental risk assessment.

Platform 5 and Platform Buildings

7.4.40 Variable made ground including ash, bricks, ballast, and clinker is recorded within these areas. Some borehole logs mention a strong odour of hydrocarbons within the made ground. Peat is also noted on the borehole logs. Chemical analysis of environmental matrix and ground gas monitoring has not been undertaken in these areas.

7.4.41 There is the potential that during construction, new pathways could be created for contamination which could increase the risk to groundwater and surface waters.

7.4.42 Further ground investigation is recommended before undertaking excavation works to assess the presence and levels of contaminants in soil and groundwater and to refine the risk assessment.

Botley Road Realignment and Botley Road Bridge Replacement

7.4.43 Very few boreholes are located around the Botley Road due to traffic management. Variable composition and thickness of the made ground is present in this area with one borehole further south of Botley Road Bridge reporting visual evidence of hydrocarbons.

7.4.44 There is the potential that during the works new pathways could be created for contamination which could increase the risk to groundwater and surface waters.

7.4.45 Ground investigation is recommended before undertaking excavation works to establish presence and levels of contaminants in soil and groundwater and to refine the geo-environmental risk assessment.

Becket Street Station Car Park and Temporary Co-operative Childcare Relocation

7.4.46 It is known from ground investigations that the site of the temporary location proposed for Co-operative Childcare has hydrocarbon contamination (a single groundwater sample showed elevated concentrations of TPH). This was associated with low levels of carbon dioxide and methane. Ground gas may also be present. There is the potential that during construction a new pathway is created which may mobilise this contamination.

Future Baseline

7.4.47 The evaluation of future baseline condition is not applicable to geology and soils as no changes on the baseline conditions for human health and contaminated land are identified if the Scheme is not developed.

Identification of Sensitive Receptors

7.4.48 The following geology and soils sensitive receptors have been identified:

- human health (construction workers and nearby residents); and
- controlled waters (Secondary A aquifer and surface water).

7.5 Design and Best Practice Measures

Design

7.5.1 The Scheme has been designed, as far as possible, to avoid and reduce impacts and effects on geology and soils through the process of design-development considering good design principles. Embedded mitigation is defined within the Design Manual for Roads and Bridges (DMRB) as '*Design measures which are integrated into a project for the purpose of minimising environmental effects.'* The embedded mitigation is reported as part of the Scheme description in Chapter 2 – Description of Scheme.

7.5.2 The assessment of whether significant effects would be likely to occur has been based on the Scheme as described in Chapter 2 – Description of the Scheme and has taken account of measures embedded within the design as described in Chapter 4 – Approach to Environmental Impact Assessment.

7.5.3 The relevant measures embedded in the design of the Scheme for this geology and soils assessment are listed in Table 7.9.

Table 7.9: Design measures for this geology and soils assessment

Measure	Outcome / Benefit
Western retaining wall southern end piling platform removed.	Reduces the need for piling near to a largely residential area.
Vibro piling used throughout site.	Allows for quicker less intrusive pile installation. Less removal of soil, meaning less risk of disturbing contaminated soils and associated risk of emitting odours which could affect amenity at nearby sensitive locations.
Design avoids works in identified historical landfills or within the Down Carriage siding compound.	Reduces likelihood of excavating into contaminated land with associated dust, health, groundwater and waste issues, and risk of emitting odours which could affect amenity at nearby sensitive locations.

Measure	Outcome / Benefit
Botley Road Bridge has been designed to an efficient bridge deck depth.	Allows for shallower construction and therefore less intrusion into the water table. This limits potential impacts on the water environment and reduces the need for dewatering potentially contaminated groundwater. Otherwise could impact receptors such us surface water and humans.
Botley Road Bridge has been designed so that a grout curtain and sheet pile walls can be used. These act as a barrier to groundwater flow into the construction temporary works.	Reduces need for groundwater dewatering. This limits potential impacts on the water environment and the amounts of energy required for dewatering. This also limits the impact of dewatering potentially contaminated groundwater which could impact receptors such us surface water and humans.

7.5.4 The adoption of the embedded mitigation measures reported in Table 7.9 would reduce the potential environmental effects on geology and soils.

Construction Management Measures

7.5.5 The Scheme would be constructed in accordance with a Code of Construction Practice (CoCP) which is submitted as part of the Environmental Statement (Appendix 2.1). The CoCP would set out the principles for environmental mitigation, which would then be used as the basis for the Construction Environmental Management Plan (CEMP).

7.5.6 The CEMP would outline measures to be put in place to ensure that the quality of geology and soils does not deteriorate during the construction phase of the Scheme. In particular, the CEMP would detail pollution prevention and control measures, as well as contingency plans to deal with an accidental spillage or other potentially polluting incidents.

7.5.7 This geology and soils assessment has identified management measures which would be required to control contamination effects during the construction phase as shown in Table 7.10.

Table 7.10: Summary of construction management measures relevant to this geology and soils assessment

Measure	Outcome / Benefit
Environmental Incident Control and Emergency Preparedness Plan to be prepared. To include: • Control risk of pollution • Pollution prevention measures • Pro-active management practices for incidents • Criteria for implementing relevant measures	To limit the risk of environmental pollution incidents as a result of events such as diesel spillage, flooding, contaminated soils etc.
A robust pollution prevention strategy (covering air, surface and ground water, sedimentation etc) to be produced. Measures to be included in a Construction Environmental Management Plan (CEMP)	To limit the risk of environmental pollution incidents as a result of events such as diesel spillage, flooding, contaminated soils etc.
A contaminated land risk assessment to be produced based on the proposed work to be undertaken at Becket Street station car park to anticipate ground conditions. Temporary Co-operative Childcare would be housed in portacabins removing the need for foundations.	Portacabins reduce the need to excavate into Becket Street station car park. Risks of contamination from additional excavation would be reduced by measures identified during risk assessment.
Measures within the CEMP to include use of cut-off ditches/traps around excavation works, exposed ground and stockpiles	Reduces risk of uncontrolled release of sediments or contaminants from accidental spillages to soil or groundwater.
Construction management measures to be included within the CEMP to control pathways for ground gas release and mobilisation of contaminants into the ground and groundwater. Specifically, in the Down Carriage sidings compound and Becket Street station car park areas.	Reduces risk to human health, and groundwater.
Representative sampling of imported materials and materials for re-use within the Scheme. This would include chemical contamination testing where required for a range of soil and soil leachate. Analytical suites including an assessment against appropriate limit values for protection of controlled waters and human health.	Prevents the importation or reuse of contaminated or unsuitable fill materials to site.
The CEMP to include measures for suspected contaminated ground. If visual or olfactory evidence suggests contamination the following would be undertaken:	Controls the risk of contamination to the public and on-site workers.

Measure	Outcome / Benefit
• representative samples taken of the suspect material by a suitably qualified person and sent for laboratory analysis to assess the risk to potential receptors; or • if significant contamination were found where ground works could not be avoided, then the material would be removed for treatment or disposal and replaced with clean material prior to groundwork re-commencing where practicable.	
A piling risk assessment where piling could potentially impact aquifers. (National Groundwater and Contaminated Land Centre, 2001).	Reduces the risk of opening migration pathways for contaminants to deeper strata.
Targeted watching briefs, risk assessments and method statements to be produced. Control measures for working in or near to land affected by contamination to be implemented by the Main Contractor(s).	Reduces the risk to construction workers and population.
Stockpiling and testing of material suspected to be contaminated prior to reuse or disposal. Stockpiles to be segregated depending on the source of the material and nature of the contamination. Stockpiles to be placed on a low permeability liner or low permeability ground, suitably protected from damage by earthmoving plant. Testing of known or suspected contamination stockpile areas prior to and after use to assess for potential cross-contamination. Testing of site excavated material prior to reuse and assessment of test data against criteria for potential unacceptability in accordance with the MMP.	Reduces the risk of runoff of contaminants from stockpiles into surface water. Material should be tested for known contamination on site and waste suites provided by the waste contractor.
Measures to be put in place to ensure pre-mixing of concrete would be undertaken off-site or in controlled areas of site. Where this is not practicable the risks could be reduced by limiting the mixing and handling of wet concrete on site to designated areas where the release of runoff can be controlled and contained.	Reduces the risks of impacts from concrete preparation.
Buried services which may be impacted by the construction works to be protected from the ingress of mobile and aggressive contaminants within areas of known or suspected contamination. Example services include but are not limited to: highways drainage; utilities; and telecom ducts;	Protects buried services from mobile and aggressive contaminants and to prevent migration of contaminants.
The Main Contractor(s) to undertake a desk top review of unexploded ordanance (UXO), review the UXO assessment reports available prior to construction and undertake any necessary recommendations presented in the reports. The results to be set out in a Detailed Remediation Strategy. Where further UXO surveys are required these will be undertaken by the Main Contractor(s).	Reduces the risk of encountering UXO during construction.
Monitoring of groundwater and gases prior to, during and after construction. This would provide additional data to refine the on-site risk assessment and method statements. Targeted locations to be identified at next stage.	Key locations are: Down Carriage sidings to Sheepwash Bridge; Walton Well Road Allotments; south of Botley Road; and Botley Road Bridge. Reduces the risk to

Measure	Outcome / Benefit
	construction workers where ground gas is identified as a potential risk. Also, to reduce the risk to construction workers, groundwater aquifers and surface waters where contamination is identified as a potential risk.
Use of correct Personal Protective Equipment and watching brief for contaminated soil and groundwater during excavations.	Ensures the health and safety of workers.

7.6 Assessment of Geology and Soils Effects

7.6.1 The construction of the Scheme would have the potential to impact geology and soils through the migration or leaching of identified contaminants and ground gas build up. The following potential effects are considered possible.

Pollution of groundwater, surface water and damage to human health by the migration or leaching of identified contamination from the Down Carriage Siding.

7.6.2 The presence and extent of contaminated groundwater in the Sheepwash area is currently unknown. Therefore, there is a risk that contaminated material could be disturbed during the construction works and lead to pollution groundwater, surface water and damage to human health. This would have adverse impacts to surface water, groundwater and human health of low and medium magnitude on very high and high sensitivity receptor resulting in an adverse effect of minor/moderate to major significance.

Pollution of groundwater and surface water, and damage to human health, by the migration or leaching of potential contamination from other areas of the Scheme

7.6.3 Historical contamination is known to be present at the Scheme, however there are areas of proposed works where no environmental ground investigation has been undertaken. There is therefore a risk that contaminated material could be disturbed during the construction works and lead to pollution of groundwater, surface water and damage to human health. This would have adverse impacts to surface water, groundwater and human health of low and medium magnitude on very high and high sensitivity receptors resulting in an adverse effect of minor/moderate to major significance.

Damage to human health through a build-up of gas within enclosed spaces of the Scheme

7.6.4 Three historical landfills are present close to the Scheme as described in Volume 4 – Appendix 7.2. Therefore, there is a risk that landfill gases could migrate onto the site and build up within enclosed spaces.

7.6.5 Ground gas monitoring undertaken as part of historical ground investigations for the Scheme has shown elevated carbon dioxide and methane levels in some areas, and elevated carbon dioxide levels at other locations along the route. This could lead to a risk of explosion or asphyxiation. This would have adverse impacts to human health of medium magnitude on very high receptor resulting in an adverse effect of major significance.

Summary of potential geology and soils construction phase effects

7.6.6 With adoption of the design measures and the construction management measures described in Section 7.5, the only potential for likely significant effects on geology and soils during construction of the Scheme would arise from:

- pollution of groundwater, surface water and damage to human health by the migration or leaching of identified contamination; and
- damage to human health through a build-up of gas within enclosed spaces.

7.6.7 Table 7.11 summarises the potential construction effects of the Scheme in relation to contaminated land.

Table 7.11: Potential construction effects

Description of impact	Receptor	Sensitivity of receptor	Magnitude of impact	Predicted effects (without additional mitigation)
Pollution of groundwater, surface water and damage to human health by the migration or leaching of identified contamination from the Down Carriage Sidings.	Surface water (Castle Mill Stream and Sheepwash Channel)	High	Low adverse	Minor / moderate significant
	Controlled waters (Secondary A Aquifer)	High	Low adverse	Minor / moderate significant
	Human health - construction workers	Low	Medium adverse	Minor significant
	Human health – nearby residence	Very High	Medium adverse	Major significant
Pollution of groundwater and surface water, and damage to human health, by the migration or leaching of potential contamination from other areas of the Scheme.	Surface water (Castle Mill Stream and Sheepwash Channel)	High	Low adverse	Minor / moderate significant
	Controlled waters (Secondary A Aquifer)	High	Low adverse	Minor / moderate significant
	Human health - construction workers	Low	Medium adverse	Minor significant
	Human health – nearby residence	Very High	Medium adverse	Major significant
Damage to human health through a build-up of gas within enclosed spaces of the Scheme.	Human health - construction workers	Low	Medium adverse	Minor significant
	Human health – nearby residence	Very High	Medium adverse	Major significant

7.7 Additional Mitigation Measures

7.7.1 The following additional mitigation measures have been identified as a result of this assessment in addition to the measures included in Section 7.5:

- If elevated levels of landfill gas are detected which could impact human health and structures within the Scheme, gas protection measures, would be designed into the structures to protect them from the ingress of landfill gas. Such measures could include isolation of the structures from ground gas or venting of enclosed spaces.

- Ground investigation would be conducted on Botley Road Bridge before construction to assess the presence of contamination in made ground and groundwater. Ground investigation is also needed to assess ground gas concentrations which may affect the buildings planned for the western entrance to the station. Groundwater monitoring should be completed before and during construction to monitor contaminants movements to the surface water. This would allow risks to human health, surface water and groundwater to be assessed and appropriate mitigation measures to be incorporated as a result. Mitigation could include limiting public and worker access to excavations, groundwater control (e.g. dewatering), protecting excavations from surface water infiltration, removal of contaminated soils encountered during excavations, testing extracted water prior to discharge.

- Ground investigation should be conducted on Sheepwash Bridge before construction to assess the presence of contamination in made ground and groundwater. Groundwater and ground gas monitoring would be carried out at the Sheepwash Bridge before and during construction to monitor contaminants movements to the surface water, predict risk for construction workers and give an initial indication of potential ground gas impacting the Co-operative Childcare. Appropriate mitigation measures would be incorporated. Mitigation could include limiting access to excavations, groundwater control (e.g. dewatering), protecting excavations from surface water infiltration, removal of contaminated soils encountered during excavations, testing extracted water prior to discharge.

- Depending on the findings of the ground investigation additional construction management measures may be required to mitigate the potential impacts.

- If necessary, based on the ground investigation works undertaken, a remediation strategy would be developed to mitigate the risks identified.

7.8 Summary of Residual Geology and Soils Effects

7.8.1 The additional mitigation measures outlined would further reduce the potential effects reported in Section 7.6 and summarised in Table 7.11.

7.8.2 For potential contamination effects, the adoption of the additional mitigation measures would ensure that contamination sources or pathways would be identified and removed where necessary. As a result, effects from contamination sources on surface water, groundwater or human health would be reduced and would no longer be significant. Therefore, there would be no residual effects.

7.8.3 Table 7.12 summarises the residual likely effects of the Scheme for geology and soils.

Table 7.12: Residual effects for geology and soils

Description of effect	Effects predicted (without additional mitigation)	Proposed additional mitigation measure	Residual effects predicted (with additional mitigation)
Pollution of groundwater and surface water, and damage to human health by the migration or leaching of identified contamination from the Down Carriage Sidings.	Human Health - Major Significant (nearby residents)	Ground investigation would be undertaken at Sheepwash Bridge to assess soil and groundwater conditions. Groundwater monitoring would be completed before and during construction to monitor contaminants movements to Sheepwash Channel and predict risk for construction workers. This would allow risks to human health, surface water and groundwater to be assessed and appropriate mitigation measures to be incorporated. Mitigation could include limiting access to excavations, groundwater control (e.g. dewatering), protecting excavations from surface water infiltration, removal of contaminated soils encountered during excavations, testing extracted water prior to discharge. Depending on the findings of the investigations it may be necessary to undertake ground or groundwater remediation works. If this is required a Remediation Strategy would be developed and agreed with the regulators.	Human Health - Neutral
	Surface water - Minor / Moderate		Surface water - Neutral
	Groundwater - Minor / Moderate		Groundwater – Neutral
Pollution of groundwater and surface water, and damage to human health, by the migration or leaching of potential contamination from Botley Road area.	Human Health - Major Significant (nearby residents)	Ground investigation would be conducted in the area of Botley Road Bridge before and during construction to monitor contaminants movements to the surface water and predict risk for construction workers. This would allow risks to human health, surface water and groundwater to be assessed and appropriate mitigation measures to be incorporated. Mitigation could include limiting access to excavations, groundwater control (e.g. dewatering), protecting excavations from surface water infiltration, removal of contaminated soils encountered during excavations and testing extracted water prior to discharge. Depending on the findings of the investigations it may be necessary to undertake ground or groundwater remediation works. If this is required a Remediation Strategy would be developed and agreed with the regulators.	Human Health - Neutral
	Surface water - Minor / Moderate		Surface water - Neutral
	Groundwater - Minor / Moderate		Groundwater – Neutral
Damage to human health through a build-up of gas within enclosed spaces of the Scheme.	Human Health - Major Significant	Ground gas monitoring would be completed before and during the works. Gas protection measures would be designed into the structures to protect them from the ingress of ground gases. Such measures could include isolation of the structures from ground gas or venting of enclosed spaces.	Human Health - Neutral

7.9 Conclusions

7.9.1 This chapter reports the effects on geology and soils as a result of the Scheme.

7.9.2 Through the implementation of design and construction management measures, as described in Section 7.5, this has resulted in the reduction or avoidance of impacts on human health, surface water and groundwater receptors. These measures include siting the works outwith identified historical landfills and avoiding works within the Down Carriage Sidings compound where a well-known historical contamination is recorded.

7.9.3 Following the assessment of geology and soils effects by the Scheme, the additional mitigation measures described in Section 7.7 have also been incorporated into the Scheme to manage or reduce potential effects.

7.9.4 After the adoption of these measures, there would be no significant residual effects on human health, groundwater and surface water as a result of the Scheme.

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