

A47 Wansford to Sutton Dualling

Scheme Number: TR010039

Volume 6

6.1 Environmental Statement **Chapter 9 - Geology and Soils**

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ENVIRONMENTAL STATEMENT
Chapter 9 – Geology and Soils

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9. Geology and soils

9.1. Introduction

- 9.1.1. Highways England (the Applicant) has submitted an application for a development consent order (DCO) for the A47 Wansford to Sutton Scheme (hereafter referred to as 'the Proposed Scheme'). The Proposed Scheme comprises the dualling of a section of the A47 between Wansford to Sutton; improvements to the A47 Wansford junction; creation of the A47 Sutton Heath roundabout to replace the Nene Way roundabout; associated side road alterations; and walking, cycling and horse-riding connections.
- 9.1.2. This section of A47 road is currently unable to cope with the high traffic volume and there are limited opportunities to overtake slower moving vehicles on the single carriageway. The Proposed Scheme aims to reduce congestion related delay, improve journey time reliability and increase the overall capacity of the A47. Full details of the Proposed Scheme are provided in Environmental Statement Chapter 2 (The Proposed Scheme) (**TR010039/APP/6.1**).
- 9.1.3. The key elements of the Proposed Scheme include:
- approximately 2.6km of new dual carriageway constructed largely offline of the existing A47, including the construction of two new underpasses
 - a new free-flow link road connecting the existing A1 southbound carriageway to the new A47 eastbound carriageway
 - a new link road from the Wansford eastern roundabout to provide access to Sacrewell Farm, the petrol filling station and the Anglian Water pumping station
 - closure of the existing access to Sacrewell Farm with a new underpass connecting to the farm from the link road provided
 - a new slip road from the new A47 westbound carriageway also providing access to the petrol filling station
 - a link road from the new A47 Sutton Heath roundabout, linking into Sutton Heath Road and Langley Bush Road
 - new junction arrangements for access to Sutton Heath Road and Langley Bush Road
 - closure of the existing accesses to the A47 from Sutton Heath Road, Sutton Drift and Upton Road
 - new passing places and limited widening along Upton Drift (also referenced as Main Road)
 - new walking and cycling routes, including a new underpass at the disused railway
 - new safer access to the properties on the A1, north of Windgate Way
 - installation of boundary fencing, safety barriers and signage
 - new drainage systems including:
 - two new outfalls to the River Nene

- a new outfall to Wittering Brook
- extension of the A1 culvert at the Mill Stream
- realignment and extension of the A47 Wansford Sluice
- compensatory flood storage
- drainage ditch interceptors
- new attenuation basins, with pollution control devices, to control discharges to local watercourses
- River Nene compensatory flood storage area
- works to alter or divert utilities infrastructure such as electricity lines, water pipelines and telecommunications lines
- temporary compounds, material storage areas and vehicle parking required during construction
- environmental mitigation measures

9.1.4. Under the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, the Proposed Scheme is an Environmental Impact Assessment (EIA) development and as such requires submission of an Environmental Statement (ES) presenting the likely significant environmental effects of the Proposed Scheme.

9.1.5. As part of the Environmental Impact Assessment (EIA) process, this Environmental Statement (ES) chapter reports the potential significant effects for geology and soils as a result of the proposed A47 Wansford to Sutton scheme ('the Proposed Scheme').

9.1.6. The chapter text is supported by the following appendices:

- Appendix 9.1 - Hierarchy of Screening Criteria for Generic Quantitative Risk Assessment (**TR010039/APP/6.3**)
- Appendix 9.2 - Agricultural Land Classification report (**TR10039/APP/6.3**)
- Appendix 9.3 - Mott MacDonald Sweco JV. 2017 and 2018. A47 Improvements Programme – Wansford to Sutton Addendum Preliminary Sources Study Report (PSSR). HAGDMS: 29916. (**TR10039/APP/6.3**)
- Appendix 9.4 – Construction workers risk assessment (**TR10039/APP/6.3**)

9.2. Competent expert evidence

9.2.1. The competent expert is a contaminated land specialist (BSc, Chartered Environmentalist, Member of the Chartered Institution of Water and Environmental Management, Qualified Person under the DoW CoP) with 23 years of experience in environmental protection, contaminated land, risk assessment and Environmental Impact Assessments (EIA). They have experience of several large-scale Highways England Schemes including the A303.

- 9.2.2. The competent expert Technical Authority is a contaminated land and remediation specialist (MGeol, CGeol, FGS) with 20 years of experience in the brownfield industry in the UK and abroad. Key areas of expertise include design, implementation and management of site investigations and soil and groundwater remediation projects, contaminated land risk assessment, ground gas risk assessment, waste classification, sustainable material management, and environmental auditing. They have particular recent experience on several large-scale Highways England schemes, high profile urban regeneration schemes, National Grid and Defence Infrastructure Organisation Term Consultancy Frameworks, and residential and commercial developments
- 9.2.3. The agricultural land sections and appendix have been prepared by an Agricultural Land Classification (ALC) Consultant and an EIA Consultant. The Agricultural Land Classification Consultant is qualified as a Master of Science in Environmental Assessment and Management and has over five years' experience producing agricultural chapters for EIAs.
- 9.2.4. They have used their knowledge and professional judgement in identifying the likely significant impacts associated with the Proposed Scheme and providing technical guidance through the assessment process.

9.3. Legislation and policy framework

- 9.3.1. The main legislative framework for the geology and soils chapter (including contaminated land and soils as a natural resource) includes the following regulations, guidance, standards and best practice:

Table 9-1: Summary of legislation, regulations, standards and best practice

Legislation or regulation	Summary
Agricultural Land Classification for England and Wales: Revised Guidelines and Criteria for Grading the Quality of Agricultural Land (Ministry of Agriculture, Fisheries and Food (MAFF), 1988).	The revised guidelines provide the methodology and criteria for grading the quality of agricultural land, which has been used in the agricultural land classification (ALC) survey.
Agricultural Land Classification: protecting the best and most versatile agricultural land. (TIN049). Second edition (Natural England, 2012).	TIN049 provides Natural England's guidance on protecting best and most versatile (BMV) agricultural land. It includes an overview of the ALC system, the availability of ALC information and survey requirements and the consultation process for development proposals.
BSI. BS 3882:2015, 'Specification for Topsoil'.	British Standard for the specification for topsoil.
BSI. BS 8601:2013, 'Specification for subsoil and requirements for use'.	British Standard for the specification for subsoil and the requirements of use.

Legislation or regulation	Summary
Construction Code of Practice for the Sustainable Use of Soils on Construction Sites, (Department for Environment, Food and Rural Affairs (Defra), 2009).	The construction code provides guidance on how soils should be managed during construction works and forms the basis of mitigation to reduce impacts on soil quality during construction.
Environmental Protection Act 1990 (as amended by the Environment Act 1995)	Part IIA of this Act provides a framework for the definition, identification and remediation of contaminated land. Central to the assessment of potentially contaminated land is the concept of a Significant Pollutant Linkage, i.e. a significant connection between a source of contamination and a sensitive receptor via an appropriate environmental pathway. The Part IIA regime is underpinned by the core principles of the 'polluter pays' and that land must be suitable for use.
Environmental Protection (Duty of Care) Regulations 1991 (as amended 2003)	These regulations impose a duty of care on persons who produce, store, carry, treat or dispose of controlled waste or, as a broker, has control of such waste. The duty requires such persons to ensure that there is no unauthorised or harmful deposit, treatment or disposal of the waste, to prevent the escape of the waste from their control or that of any other person, and on the transfer of the waste to ensure that the transfer is only to an authorised person or to a person for authorised transport purposes and that a written description of the waste is also transferred.
Guide to assessing development proposals on agricultural land (Natural England, 2018).	This guide provides an overview of relevant policies for the protection of agricultural land and an overview of the ALC system. The guidance notes that where no suitable data on land quality exists, a detailed survey may be required to support a planning application.
Land contamination: risk management. Environment Agency, October 2020	The Land Contamination Risk Management guidance details how to assess and manage risks from land contamination. The guidance covers the use of a tiered approach to risk assessment: Stage 1: Risk assessment Stage 2: Options appraisal Stage 3: Remediation and verification The guidance applies to risks to human health, drinking water supplies, groundwater and surface water, soils ecosystems and property.
Contaminated Land Risk Assessment – A Guide to Good Practice C552 (CIRIA, 2001)	The C552 report examines risk assessment of contaminated land and the key elements of risk assessment practices and procedures. The guide describes the stages involved in identifying risks and assessing their significance.
The Contaminated Land (England) (Amendment) Regulations 2012	This regulation amends the contaminated land (England) regulations 2006 to provide stronger protection of controlled waters. This is an extension of the existing regulations which is designed to prevent land from being contaminated and to tackle existing contamination.
The Environmental Damage (Prevention and Remediation) (England) Regulations 2015	This regulation covers environmental liability with regard to the prevention and remedying of environmental damage. It specifies the types of damage

Legislation or regulation	Summary
	to a protected species or natural habitat, a site of special scientific interest, water or land which constitute environmental damage. The regulation also deals with prevention of environmental damage, remediation of damage, and recovery of costs.
The Environmental Permitting (England and Wales) Regulations 2016 as amended	The environmental permitting regime requires those carrying out activities that release emissions to land, air and water, or that involve certain waste types, to hold an environmental permit.
Code of Practice for the Sustainable Use of Soils on Construction Sites, (Department for Environment, Food and Rural Affairs (Defra), 2009)	Comprises a code of practice for the sustainable use of soils on construction sites, to assist anyone involved in the construction industry to protect the soil resources with which they work. Outlines current guidance and legislation concerning the use of soil in construction projects, offering stage by stage guidance on the use, management and movement of soil on-site.
Guide to assessing development proposals on agricultural land (Natural England, 2018)	This guide explains how local planning authorities can assess proposals to protect the best and most versatile (BMV) agricultural land from inappropriate and unsustainable development.
Agricultural Land Classification: protecting the best and most versatile agricultural land. (TIN049). Second edition (Natural England, 2012)	This note explains the Government Policy to protect agricultural land and the Agricultural Land Classification system and uses.
The Infrastructure Planning (EIA) Regulations 2017	These regulations implement the requirements of the Environmental Impact Assessment (EIA) Directive (85/337/EEC) for EIA procedures in the context of the nationally significant infrastructure regime.
National Policy Statement for National Networks (NPS NN)	The National Policy Statement for National Networks (NPS NN) provides guidance on the Government's policies for nationally significant infrastructure projects on the national road and rail networks in England. The NPS also highlights the economic importance of best and most versatile (BMV) agricultural land and requires that applicants seek to use areas of poorer quality land (and where possible previously developed sites) in preference to land of a higher quality. The NPS also requires that impacts on soil quality should be identified and minimised.
National Planning Policy Framework (NPPF)	The NPPF states that the purpose of the planning system is to contribute to the achievement of sustainable development. Achieving sustainable development means that the planning system has three overarching objectives: an economic objective, a social objective and an environmental objective. All three need to be explored in mutually supportive ways. The NPPF sets out the Government's planning policies for England and how these are expected to be applied. The Framework replaces the previous NPPF originally published in March 2012 and revised in July 2018. The overall strategic aims of the NPPF and the NPS NN are consistent, however the NPPF does not contain specific policies for NSIPs and will only be considered to the extent relevant to the project. Chapter 15 of the NPPF highlights the importance of policies that seek to conserve and enhance the natural environment and requires consideration of the "the economic and other benefits of the best and most versatile agricultural land". The NPPF goes on to state in footnote 53 that "Where significant development of agricultural land is demonstrated to be necessary, areas of poorer quality land should be preferred to those of a higher quality".

Legislation or regulation	Summary
Design Manual for Roads and Bridges (DMRB) LA 104 Environmental assessment and monitoring, Highways England 2019 (Revision 1)	DMRB LA 104 sets out the requirements for environmental assessment of projects, including reporting and monitoring of significant adverse environmental effects, applying a proportionate and consistent approach using best practice and ensuring compliance with relevant legislation. The approach to deriving impact significance from receptor value and magnitude of effects in DMRB LA 109 is undertaken in accordance with LA 104.
Design Manual for Roads and Bridges (DMRB) LA 109 Geology and Soils, (and associated supporting standards), Highways England (Revision 0)	DMRB LA 109 sets out the requirements for assessing and reporting the effects of highway projects on geology and soils, applying a proportionate and consistent approach using best practice and ensuring compliance with relevant legislation.
Design Manual for Roads and Bridges (DMRB) LA 113 Road Drainage and Water Environments, Highways England. (Revision 1)	DMRB LA 113 sets out the requirements for the assessment and management of the impacts that road projects can have on the water environment.

9.3.2. The Proposed Scheme will adhere to guidance detailed in the Planning Policy documents as summarised in Table 9-2.

Table 9-2: Summary of planning policy

Planning Document	Summary
National Policy Statement for National Networks (NPS NN) (Department for Transport, 2014)	NPS NN sets out the Government's vision and policy for the future development of the Nationally Significant Infrastructure Projects (NSIP) on the national road and rail networks in England and provides the basis for the examination by the Examining Authority and decisions by the Secretary of State.
National Planning Policy Framework (Ministry of Housing, Communities & Local Government, 2019)	The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied. It provides a framework within which locally-prepared plans for housing and other developments can be produced.
Peterborough Local Plan 2016 to 2026 (Peterborough City Council, 2019).	The Peterborough Local Plan contains the most appropriate planning policies for the growth and regeneration of Peterborough and surround areas. It sets out policies which will help the local authority promote sustainable development and help determine planning applications. Policy LP11: Development in the Countryside, Part F outlines how proposals should protect the best and most versatile agricultural land as to protect opportunities for food production and the continuance of the agricultural economy. Policy LP33: Development on Land Affected by Contamination includes the following guidance that all new development must take into account: • The potential environmental impacts on people, buildings, land, air and water arising from the development itself; • Any former use of the site, including, in particular, adverse effects arising from pollution

9.4. Assessment methodology

- 9.4.1. The following section describes the methodology used to determine the likely significant effects on geology and soils as a result of the Proposed Scheme.
- 9.4.2. The assessment has been undertaken in accordance with the methodology presented in DMRB LA 109 Geology and Soils, revision 0.
- 9.4.3. The standard provides requirements for assessing and managing the effects on geology and soils as a result of the Proposed Scheme. These include the consideration of the:
- effects on bedrock and superficial geology including geological designations and sensitive or valuable non-designated features
 - effects on soil resources
 - effects on agricultural land
 - effects from contamination on human health and surface water and groundwater.
- 9.4.4. The Scoping Report (**TR010039/APP/6.5**) has been reviewed and compared against the updated DMRB LA 109 Geology and Soils. The effects of the Proposed Scheme upon agricultural land have been moved to this Geology and Soils Chapter. The assessment criteria have been updated in line with DMRB LA 109 Geology and Soils. No other changes to the requirements have been identified to impact on the scope of this chapter.

Update to guidance and scope of assessment

- 9.4.5. This chapter follows the latest DMRB LA 109 standard issued in October 2019, which was published after the Scoping Report (**TR010039/APP/6.5**) for the Proposed Scheme. A summary of the proposed scope adhering to the latest DMRB LA 109 requirements is presented in Table 9-3.

Table 9-3: Summary of proposed scope

Scoping question	Comment	Scope in?
Is the project likely to affect designated geological sites (statutory or non-statutory)?	No statutory or non-statutory or nationally designated geological sites (includes SSSIs, UNESCO sites, rare, national or locally important geology) recorded within the Proposed Scheme boundary.	No
Is the project likely to affect the function or quality of soil as a resource?	The Proposed Scheme impacts agricultural land and is therefore likely to affect the function of soil as a resource for agriculture. Although soils within the study area also provide some other environmental services as there are also wooded areas within the study area, the majority of the land however is agricultural.	Yes
Is the project likely to affect agricultural land classified as	The Proposed Scheme impacts land which is being used for agriculture and may result in loss of best and most versatile (BMV)	Yes

Scoping question	Comment	Scope in?
best and most versatile (BMV) or prime land?	agricultural land. This includes agricultural land classified as Grade 2 and Grade 3a agricultural land under the Agricultural Land Classification (ALC) system.	
Is the project likely to disturb historical contamination?	Historical use associated with the disused railway line and construction of the current A47 carriageway are indicated to be possible sources of contaminants within the Proposed Scheme boundary. There is a potential for these sites to be disturbed during the construction of the Proposed Scheme. No significant sources of historical contamination have been identified, however, there is the possibility of unidentified contamination to be present.	Yes
Is the project likely to introduce significant sources of contamination?	No significant sources of contamination are likely to be introduced as part of the Proposed Scheme's construction.	No

- 9.4.6. Given the above, this assessment will concentrate on contamination and the effects on human health, surface water and groundwater from historical and ongoing potential sources of contamination including impacts to agricultural land as a soil resource and as best and most versatile (BMV) land or prime land.
- 9.4.7. The DMRB LA 109 provides specific requirements on assessing the effects of the Proposed Scheme on agricultural land. The sensitivity and magnitude criteria have therefore been updated since issue of the Scoping Report (**TR010039/APP/6.5**) in line with the DMRB LA 109 requirements.
- 9.4.8. The preliminary Unexploded Ordnance (UXO) Risk Assessment reported a low probability of encountering UXO on-site. In accordance with CIRIA C681 (CIRIA, 2009), no further action is required to address the UXO risk. It has therefore been scoped out of this assessment.

Consultation

- 9.4.9. Consultee comments were received in response to the Scoping Report (**TR010039/APP/6.5**). Following changes to DMRB requirements in 2019, the comments have been reassessed in light of this update. There are no significant changes to the scope outlined in the Scoping Report therefore no new consultation was undertaken. Responses to the Scoping Opinion (**TR010039/APP/6.6**) comments have been included within Appendix 4.1 (**TR0010039/APP/6.3**).
- 9.4.10. As stated in paragraph 9.4.4 the effects of the Proposed Scheme upon agricultural land have been moved to this Geology and Soils Chapter. As there

were no significant changes to the scope identified with the exception of its chapter change, no new consultation was undertaken.

- 9.4.11. The potential contaminated land risks are addressed through assessment of the ground investigation results against standards from published guidance and regulations. No specific consultation is therefore required for this aspect of the assessment.
- 9.4.12. The Environment Agency have been contacted with respect to controlled water risks with the details provided in Chapter 13 (Road Drainage and Water Environment) (**TR010039/APP/6.1**).

Assessment criteria

Sensitivity of receptors

- 9.4.13. Within DMRB LA 109, impacts on geology and soils are assessed by a qualitative comparison, evaluating the sensitivity of particular receptors impacted by the Proposed Scheme and assessment of the magnitude of that impact. The sensitivity of receptors, classes and the range of magnitude criteria are set out in the DMRB LA 109 standard.
- 9.4.14. The assessment of the effects of contamination on the identified receptors has been informed by the A47 Wansford to Sutton Dualling, Ground Investigation Report (GIR) (Sweco, 2020) (**TR010039/EXAM/9.2**). Effects on groundwater are also considered in the GIR which are assessed in Chapter 13 (Road Drainage and Water Environment) (**TR010039/APP/6.1**).
- 9.4.15. The criteria for assessing the sensitivity of receptor and magnitude of impact to these receptors is presented in Table 9-4 and Table 9-5 in accordance with LA 109 Geology and Soils and LA 113 Road Drainage and Water Environment. Table 9-4 is presented within table 3.11, Section 3.11 of LA109 Geology and Soils. Sensitivities pertaining to surface water and groundwater have been adapted from table 3.70, Section 3.9 of LA 113 Road Drainage and Water Environment.

Table 9-4: Sensitivity of receptor

Receptor value (sensitivity)	Description
Very high	Human health: Very high sensitivity land use such as residential or allotments Surface water: Watercourse having a Water Framework Directive (WFD) classification shown in a River Basin Management Plan (RBMP) and $Q_{95} \geq 1.0\text{m}^3/\text{s}$. Site protected/designated under EC or UK legislation (Special Area of Conservation (SAC), Special Protection Area (SPA), Sites of Special Scientific Interest (SSSI), Ramsar site, salmonid water)/Species protected by EC legislation

Receptor value (sensitivity)	Description
	Groundwater: Principal aquifer providing a regionally important resource and/or supporting a site protected under EC and UK legislation. Groundwater locally supports Groundwater dependent terrestrial ecosystems (GWDTE). Groundwater Source Protection Zone (SPZ) 1 Soils: ALC grade 1 & 2 or Land Classification for Agriculture (LCA) grade 1 & 2
High	Human health: High sensitivity land use such as public open space Surface water: Watercourse having a WFD classification shown in a RBMP and $Q_{95} < 1.0 \text{ m}^3/\text{s}$. Species protected under EC or UK legislation Groundwater: Principal aquifer providing locally important resource or supporting a river ecosystem. Groundwater supports a GWDTE. SPZ 2 Soils: ALC grade 3a, or LCA grade 3.1.
Medium	Human health: medium sensitivity land use such as commercial or industrial Surface water: Watercourses not having a WFD classification shown in a RBMP and $Q_{95} > 0.001 \text{ m}^3/\text{s}$. Groundwater: Aquifer providing water for agricultural or industrial use with limited connection to surface water. SPZ3 Soils: ALC grade 3b or LCA grade 3.2.
Low	Human health: Low sensitivity land use such as highways and rail Surface water: Watercourses not having a WFD classification shown in a RBMP and $Q_{95} \leq 0.001 \text{ m}^3/\text{s}$. Groundwater: Unproductive strata Soils: ALC grade 4 & 5 or LCA grade 4.1 to 7
Negligible	Human health: Undeveloped surplus land / no sensitive land use proposed Surface Water: not applicable for this sensitivity Groundwater: not applicable for this sensitivity Soils: previously developed land formerly in 'hard uses' with little potential to return to agriculture.

Magnitude of impact

- 9.4.16. The magnitude of impact is a predicted determination of the potential scale of effects and deviation from baseline conditions as a result of the Proposed Scheme. The qualitative impact is determined according to the criteria provided in Table 9-5, which has been taken from Table 3.12 and Table E/2.1 of LA 109.
- 9.4.17. Table 9-5 is presented within Table 3.12, Section 3.12 of LA109 Geology and Soils. The magnitude of impact pertaining to surface water and groundwater has been adapted from Table 3.71, Section 3.7 of LA 113 Road Drainage and the Water Environment.

Table 9-5: Magnitude of impact

Magnitude	Description
Major	Human health: Significant contamination identified. Contamination levels significantly exceed background levels and relevant screening criteria (e.g. category 4 screening levels) with potential for significant harm to human health. Contamination heavily restricts future use of land. Surface water: Loss or extensive change to a fishery. Loss of regionally important public water supply. Loss or extensive change to a designated nature conservation site. Reduction in water body WFD classification. Groundwater: Loss of regionally important water supply. Reduction in water body WFD classification. Loss of, or extensive change to GWDTEs. Soils: physical removal or permanent sealing of soil resource or >20 ha of agricultural land.
Moderate	Human health: Contaminant concentrations exceed background levels and are in line with limits of relevant screening criteria (e.g. category 4 screening levels). Significant contamination can be present. Control / remediation measures are required to reduce risks to human health / make land suitable for intended use. Surface water: Degradation of regionally important public water supply or loss of major commercial/industrial/agricultural supplies. Contribution to reduction in water body WFD classification. Partial loss in productivity of a fishery. Groundwater: Degradation of regionally important public water supply or loss of significant commercial/ industrial/ agricultural supplies. Partial loss of the integrity of GWDTEs Soils: physical removal or permanent sealing of 1 ha – 20 ha of agricultural land; or permanent loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
Minor	Human health: Contaminant concentrations are below relevant screening criteria (e.g. category 4 screening levels). Significant contamination is unlikely with a low risk to human health. Best practice measures can be required to minimise risks to human health. Surface water: Minor effects on water supplies. Groundwater: Minor effects on an aquifer, GWDTEs and abstractions. Soils: temporary loss / reduction of one or more soil function(s) and restriction to current or approved future use (e.g. through degradation, compaction, erosion of soil resource).
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. Surface water: No measurable impact upon a surface water features. Groundwater: No measurable impact upon an aquifer and/or groundwater receptor. Soils: no discernible loss / reduction of soil function(s) that restrict current or approved future use.
No Change	Human health: reported contaminant concentrations below background levels. Surface water: no measurable impact. Groundwater: no measurable impact. Soils: no loss/ reduction of soil function(s) that restrict current or approved future site use.

- 9.4.18. To assess whether contaminants in soils or groundwater have the potential to cause harm to health a contaminated land risk assessment is undertaken. This is a process by which the actual or potential risks posed by identified hazards to specific receptors are estimated. In the context of evaluation of contaminated land, hazards relate to sources, or potential sources of contamination capable of causing harm. The process of estimating risk from soil contamination is described in guidance documents set out in the Land Contamination: Risk Management (LCRM) and related guidance documents. For the Proposed Scheme, a quantitative risk assessment of the measured potential ground contaminants has been undertaken in the GIR (Sweco 2020) (**TR010039/EXAM/9.2**). The findings of the GIR are used to inform the risk assessment in this chapter.
- 9.4.19. Generic assessment criteria (GAC) have been sourced from current published guidance protective of human health and the environment. Appendix 9.1, Hierarchy of Screening Criteria for Generic Quantitative Risk Assessment (**TR010039/APP/6.3**) provides details on the source and application of these criteria.

Significance of effects

- 9.4.20. Determining the significance of an effect to receptors typically consists of assessing the environmental value (sensitivity) in combination with the magnitude of impact (degree of change).
- 9.4.21. Residual effects of moderate or above significance are considered significant.
- 9.4.22. The significance of effects will be determined in accordance with Table 3.7, Table 3.8.1 and Section 3.9 of DMRB LA 104 as stipulated by LA 109. Significant effects typically comprise residual effects that are within the moderate, large or very large categories.

9.5. Assessment assumptions and limitations

- 9.5.1. This assessment has been informed by information which has been obtained from a number of statutory and non-statutory bodies, previous reports and external subcontractors.
- 9.5.2. Previous reports used in this assessment includes the Preliminary Sources Study Report (PSSR) (Mott MacDonald Sweco JV 2018) and the Scoping Report (**TR010039/APP/6.5**).
- 9.5.3. Reported baseline conditions from the Ground Investigation Report (GIR) (Sweco 2020) have been used in this assessment.
- 9.5.4. The ground investigation information is limited to the locations investigated and there is the potential for unidentified contamination to be present outside of

investigated locations. Laboratory analysis has been completed to relevant standards.

- 9.5.5. A full ALC survey was undertaken under good weather conditions which provided sufficient information to grade the agricultural land in accordance with the MAFF guidelines and TIN049 guidance.
- 9.5.6. Following revision of the design for the scheme, two small areas of note totalling 3.9 ha lie outside the ALC survey area. Of this area approximately 2.7 ha is agricultural land. One area in the west covers 2.2 ha and the land is likely to be of Grade 3a quality based on published geological and soil information for the unsurveyed area being similar to that for closest surveyed observation point which was graded 3a. The other area is located in the north-east of the site and is primarily formed of non-agricultural land (i.e. road and road junctions), but with 0.5 ha of land that cuts across two agricultural fields. Based on published geological and soil information this 0.5 ha of land is likely to be Grade 3a or, if there is depth, stoniness and/or droughtiness limitation which could only be determined by field survey work, Grade 3b quality land. To take a conservative approach, this land is assumed to be Grade 3a.

9.6. Study Area

- 9.6.1. According to Section 3.5 of DMRB LA 109, the study area shall be identified on a project by project basis using professional judgement based on the following:
1. *The construction footprint / project boundary (including compounds and temporary land-take);*
 2. *The location of contamination outside the project boundary / footprint that have potential to migrate on site and effect receptors; and*
 3. *The location of sensitive off-site receptors (i.e. designated sites) that can be affected by the project, i.e. by re-mobilisation or introduction of contaminants.*
- 9.6.2. The study area for this assessment has therefore been defined as:
- all locations where physical works and ground disturbance would take place (Proposed Scheme boundary).
 - extending to 1km beyond the Proposed Scheme boundary in order to identify any past pollution incidents which may have affected geology and soils within the area and sensitive off-site receptors that could be affected by the Proposed Scheme.
- 9.6.3. In terms of agricultural land, the main focus of the assessment is the construction boudary as this covers the temporary and the permanent land-take area.

9.6.4. The extents of the study area are shown on Figure 9.2 (TR010039/APP/6.2).

9.7. Baseline conditions

9.7.1. The Proposed Scheme footprint lies within undeveloped agricultural land currently in use by a number of farms and utilises the existing A47 infrastructure.

9.7.2. Establishment of the baseline conditions have been sourced as part of the PSSR (Mott MacDonald Sweco JV 2018), GIR (Sweco 2020) and Scoping Report (TR010039/APP/6.5) and are summarised in Table 9-6 and on Figures 9.1 and 9.2 (TR010039/APP/6.2).

Table 9-6: Baseline Data

Aspect	Details
Geology	A basic summary of the geological sequence in the area of the Proposed Scheme is as follows, further details in 9.7.14. Figure 9.1 and Figure 9.2 (TR010039/APP/6.2) show the superficial and bedrock geology underlying the study area. Details on the geology have been obtained from the GIR (Sweco 2020) and Soils Limited (2018) ground investigation. Superficial Geology • Topsoil encountered extensively across the Proposed Scheme • Made ground - sands and gravels associated with the construction of existing A47 carriageway • Head Deposits – clays • Alluvium – gravels, sands and clays • River Terrace Deposits – gravels, sands, silts and clays Bedrock Geology • Rutland Formation – limestone, sands and clays • Lincolnshire Limestone Formation – Upper Lincolnshire Limestones and Lower Lincolnshire Limestones • Grantham Formation – mudstone, limestone and sandstone • Lias Group/ Whitby Mudstone Formation The Rutland Formation is underlain by the Upper and Lower Lincolnshire Limestone. The Grantham formation underlies the Limestone which is subsequently underlain by the Lias Group/Whitby Limestone as the most basal bedrock encountered.
Sites of Geological Interest	No Sites of Geological Interest within 1km of the Proposed Scheme boundary.
Hydrogeology	The Environment Agency Superficial and Bedrock Aquifer Designation maps indicate that the Proposed Scheme is underlain by: • The Upper and Lower Lincolnshire Limestone bedrock which is designated as a highly permeable Principal Aquifer. • The superficial Alluvium and River Terrace Deposits located along the Nene Valley to the south of the A47 are designated as Secondary A Aquifers. • The Rutland Formation bedrock is designated as a Secondary B aquifer.

Aspect	Details
	- The Grantham Formation bedrock and superficial Head Deposits are designated as Secondary Undifferentiated aquifers. - The Whitby Mudstone Group is classed as an Unproductive Strata. Groundwater vulnerability Groundwater vulnerability varies across the Proposed Scheme. The Alluvium and River Terrace Deposits are determined to be of intermediate vulnerability. The Upper and Lower Lincolnshire Limestones are classed as highly vulnerable. Borehole data presented within the GIR (Sweco, 2020) indicates that groundwater levels are generally the shallowest when adjacent to the River Nene to the south of the Proposed Scheme. The shallowest groundwater levels were recorded between 2.5m below ground level (bgl) and 6.8m bgl in the Lower Lincolnshire Limestone and Grantham Formation. Water Framework Directive The groundwater within northern, western and eastern extents of the study area is classified under the Wittering Brook groundwater body, while groundwater within the southern extent of the study area is classified under the Nene – Islip (tidal) groundwater body. Both groundwater bodies have Poor Chemical and Quantitative statuses (2019 cycle 2). The Nene – Islip (tidal) groundwater body is a Drinking Water Protected Area. Water abstraction and source protection zones The Environment Agency website indicates that the Proposed Scheme is not within or located near to any groundwater Source Protection Zones (SPZ). The two closest SPZ (outer protection zones) are located 1km to the east of the A1 and 1.2km north of the A47. There are two unlicensed groundwater abstractions within 1km of the Proposed Scheme. These are situated to the west of the A1 and likely abstract from the Lower Lincolnshire Limestone. No licensed groundwater abstractions exist within a 1km distance of the Proposed Scheme boundary. Refer to Chapter 13 (Road Drainage and the Water Environment) (TR010039/APP/6.1) for further information and hydrogeological assessment.
Hydrology	A total of six inland rivers traverse or adjoin the Proposed Scheme, with most generally trending from north to south. The largest of these being the River Nene which is located immediately to the south of the Proposed Scheme and flows from west to east. The PSSR identifies seventy four surface water features within 250m of the Proposed Scheme, including a series of large offline lakes and drainage ditches to the south of the River Nene and ten drainage channels situated within adjacent fields. Water Framework Directive The northern, western and eastern extents of the study area are classified under the Wittering Brook groundwater body which is not designated as artificial or heavily modified. The southern extent of the study area is classified under the Nene – Islip (tidal) groundwater body which is designated as heavily modified. The Wittering Brook has six linked protected areas (Nene Washes, River Nene, Upper Nene Valley, River Nene, SWSGZ1006), and the Nene – Islip (tidal). The Nene – Islip (tidal) groundwater body is a Drinking Water Protected Area which is linked to the River Nene protective areas. Surface water abstractions A total of nine surface water abstractions are located within the boundaries of the Proposed Scheme. Six of these are abstractions taken from a reach in the watercourse and three are abstractions taken from one point in the watercourse. Refer to Chapter 13 (Road Drainage and the Water Environment) (TR010039/APP/6.1) for further information and hydrological assessment.
Landfill Records	There are no Registered Landfill Sites within 1km of the Proposed Scheme boundary.

Aspect	Details
Current Land Use and Man-Made Features	The land surrounding the Proposed Scheme predominantly consists of agricultural fields and small wooded areas. Within the vicinity of the River Nene the current land use consists of lowland calcareous grasslands, coastal/floodplain grazing grasslands, deciduous woodland and lowland Fens to south of the river. The A1 trending north to south forms a junction at the far western extent of the Proposed Scheme. The village of Wansford is situated to the immediate west and the parish of Sutton is located within the south-eastern extent of the Proposed Scheme. A Site of Special Scientific Interest (SSSI), Sutton Heath and Bog is located approximately 50m to the north of the Proposed Scheme. Sutton Heath and Bog is of particular interest owing to the presence of rare calcareous and base-poor marshy neutral grasslands. A petrol filling station is located adjacent to the Proposed Scheme boundary within the western extents of the Proposed Scheme to the south of the current A47 carriageway. A Scheduled Monument is situated within the footprint of the Proposed Scheme to the north of the existing A47 carriageway and approximately 200m to the west of Sutton Heath Road. The Scheduled Monument is identified within the GIR to include Bronze age crop marks and pits.
Agricultural	The ALC survey undertaken identified that the agricultural land quality within the Proposed Schemes footprint is a mixture of Grade 2, Grade 3a (good quality) and 3b (moderate quality) agricultural land. The areas of Grade 2 and Grade 3a agricultural land are considered to be BMV agricultural land and make up approximately 49.5% of the study area. Further information on agricultural soils is provided below and in Appendix 9.2 (TR010039/APP/6.3).
Route History	Maps published circa 1885 detail the Proposed Scheme and surrounding land as mixed agriculture with the Stamford and Wansford Railway line shown to cross the midpoint of the Proposed Scheme. An associated railway station named Wansford Road Station is shown 50m to the north. The railway is noted as disused on maps published between 1952 to 1953. Historical land use continued as mixed agricultural with an old gravel pit shown on maps from 1900 to 1901 adjacent to the eastern extent of the Proposed Scheme. Further notable features recorded on maps dated from 1958 include Roman buildings to the south within the vicinity of the planned underpass. Transport network developments are noted on maps from 1952 to 1953 as the A1 was constructed to the west of the Proposed Scheme. Maps published between 1964-1965 indicate a new road and junction under construction within the current footprint of the A47. The petrol filling station and associated filling tank are noted on maps dated from 1970 to 1976 and a new access road to Sacrewell Farm to the north is shown. The Wansford sewage pumping station (refer to Figure 2.1 (TR010039/APP/6.2)) and associated mast are first indicated on published maps from 1980 to 1983, 25m to the south of the Proposed Scheme. A disused gravel working is shown 30m to the south of the Proposed Scheme in an aerial photograph published in 1999.
Potential Contamination Sources investigated in the GIR	The Envirocheck report contained within the PSSR notes a category 2 (water) pesticide and biocide pollution incident 3m to the east of the Proposed Scheme. The potential sources of contamination which may be present at or near the Proposed Scheme comprise of: • Agricultural land with the potential to contain agricultural pesticides, sewage sludge and possible farm plant fuel spillages. • Petrol filling station situated immediately to the south of the A47. • An electricity substation and mast are located 80m to the south and 80m to north respectively. • Made ground associated with Wansford sewage pumping station, which is located approximately 30m to the south of the Proposed Scheme route.

Aspect	Details
	- Made ground associated with the construction of the existing A47 carriageway and associated side roads. - Disused railway line crossing the Proposed Scheme. These potential sources present theoretical risks to and future site users, offsite receptors, surface water, groundwater, agricultural land and flora and fauna.

Conceptual Site Model

- 9.7.3. The GIR (Sweco 2020) (**TR010039/APP/6.3**) utilises information pertained from Soils Limited 2018 ground investigation, Appendix 9.3 PSSR (Mott MacDonald Sweco JV 2018) (**TR010039/APP/6.3**) and Scoping Report (**TR010039/APP/6.5**) to develop a Conceptual Site Model (CSM), which forms the basis to investigate potential contaminant linkages for the Proposed Scheme via a source-pathway-receptor model. For a source of contamination (or hazard) to present a risk to a receptor (such as soil or groundwater), there must be a viable exposure pathway.
- 9.7.4. The source-pathway-receptor model is considered best practice methodology to evaluate environmental risk arising from potential land contamination, according to the Department of Environment, Food and Rural Affairs (DEFRA) and Environment Agency guidance documentation (Environment Agency, 2020).
- 9.7.5. A risk evaluation has been undertaken by considering the source-pathway-receptor relationship in terms of both the probability (likelihood) that a source-pathway-receptor linkage will occur and the potential consequences of occurrence.

Potential Sources

- 9.7.6. In the context of this study, hazards relate to sources, or potential sources of contamination capable of causing harm. Table 9-7 lists the potential sources that have been identified in the GIR.

Table 9-7: Potential Sources

Potential Source	Description
Source 1: Agricultural land use	Land use surrounding and within the Proposed Scheme boundary of the Proposed Scheme predominantly consists of agricultural fields. There is a potential for agricultural pesticides, sewage sludge and fuel spillages from farm machinery to have been historically released into the ground.
Source 2: Petrol filling station	The petrol filling station located immediately to the south of the A47 adjacent to the Proposed Scheme boundary is a potential source of hydrocarbons.
Source 3: Electricity substation and mast	The electricity substation and associated mast located 80m to the north and 80m to the south of the Proposed Scheme respectively are a potential source of historic hydrocarbon leakages/spillages.

Potential Source	Description
Source 4: Made ground associated with the sewage pumping station	The made ground associated with the construction of Wansford Anglian Water pumping station (refer to Figure 2.1 TR010039/APP/6.2) located to the south of the A47 is a potential source of contamination.
Source 5: Made ground associated with the A47	Made ground associated with the existing A47 carriageway and associated sideroads is a potential source of contamination. Potential contaminants associated with use of the existing A47 carriageway and associated sideroads include vehicle fuels, brake and exhaust products.
Source 6: Disused railway line	The disused railway line crossing the central area of the Proposed Scheme is a potential source of contaminants including hydrocarbons.

Receptors

9.7.7. Receptors that could be adversely affected by a contaminant are listed in Table 9-8 with an assigned sensitivity in accordance with DMRB LA 109. Groundwater and surface water sensitivities have been adapted from Table 3.70, Section 3.9 of LA 113 Road Drainage and Water Environment.

Table 9-8: Potential Receptors

Potential Receptor	Description
Human Health	Future site users - A47 users (motorised), pedestrians and cyclists – low sensitivity Off-site receptors – users/occupiers of adjacent land areas; agricultural fields, petrol filling station, sewage pumping station, paths and off-site residents – very high sensitivity
Surface Waters	Six inland rivers traversing or adjoining the Proposed Scheme – high sensitivity as includes the Nene to Islip water body, a Water Framework Directive (WFD) surface water body. 74 surface water features are identified within 250m of the Proposed Scheme comprising inland rivers and lakes - high sensitivity as includes Wittering Brook a WFD surface water body. A series of large offline lakes and drainage ditches are located to the south of the River Nene and ten drainage channels are situated within adjacent fields to the north and south of the Proposed Scheme - high sensitivity as they make up the Nene to Islip water body a WFD surface water body.
Groundwaters	The Upper and Lower Lincolnshire Limestone is designated as a Principal Aquifer – very high sensitivity The Alluvium and River Terrace Deposits are designated as Secondary A Aquifers - very high sensitivity Rutland Formation is designated as a Secondary B Aquifer - very high sensitivity The Grantham Formation is designated as a Secondary Undifferentiated Aquifer - very high sensitivity The Lias Group / Whitby Formation is designated as Unproductive Strata - low sensitivity

Potential Receptor	Description
Agricultural Land	Agricultural land ALC grades 2 to 3b within and in proximity of the Proposed Scheme – medium sensitivity (grades 3b), high sensitivity (grades 3a) and very high sensitivity (grades 2).
Ecological	Flora and Fauna (including livestock) *

*DMRB LA 109 does not provide an ecological sensitivity rating.

Potential Pathways

9.7.8. For a hazard to present a risk to a receptor they must be linked by an exposure pathway. Possible plausible pathways identified include:

- Direct contact with or ingestion of contaminated soils and dusts by humans.
- Direct contact with or ingestion of contaminated shallow groundwater by humans.
- Inhalation of dusts (including asbestos fibres) by humans.
- Inhalation of ground gas/vapours by humans.
- Migration of ground gas/vapours into buildings.
- Leaching/dissolution and migration of contaminants through permeable strata in the unsaturated zone towards the saturated zone.
- Migration of contaminants in the saturated zone towards surface water.
- Surface run-off towards surface waters, including via local drainage systems.
- Lateral migration of contaminants via groundwater flow.
- Uptake by plant roots, ingestion/inhalation of contaminated soil/dust by animals.

9.7.9. The potential active contaminant linkages for the Proposed Scheme are summarised in Table 9-9. Linkages between off-site sources and off-site receptors are not considered.

Table 9-9: Potential active contaminant linkages

Source	Pathway	Receptor
Source 1: Agricultural land use	Direct contact with soils/dusts	Future site users
	Ingestion or inhalation of soils/dusts	Off-site human health receptors
	Inhalation of gas/vapours	Agriculture
	Uptake by plant roots	Ecological

Source	Pathway	Receptor
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water Surface run-off towards surface waters, including via local drainage systems	Surface water courses and drains (Six inland rivers interacting with the Proposed Scheme including the River Nene)
	Leaching/dissolution/migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)
Source 2: Petrol filling station	Direct contact with soils/dusts Ingestion or inhalation of soils/dusts Inhalation of gas/vapours Uptake by plant roots	Future site users Agriculture Ecological
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water Surface run-off towards surface waters, including via local drainage systems	Surface water courses (Six inland rivers interacting with the Proposed Scheme including the River Nene)
	Leaching/dissolution and migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)
Source 3: Electricity substation and mast	Direct contact with soils/dusts Ingestion or inhalation of soils/dusts Inhalation of gas/vapours Uptake by plant roots	Future site users Agriculture Ecological
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water	Surface water courses (Six inland rivers interacting with the Proposed Scheme including the River Nene)

Source	Pathway	Receptor
	Surface run-off towards surface waters, including via local drainage systems	
	Leaching/dissolution and migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)
Source 4: Made ground associated with the Anglian Water pumping station	Direct contact with soils/dusts Ingestion or inhalation of soils/dusts Inhalation of gas/vapours Uptake by plant roots	Future site users Agriculture Ecological
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water Surface run-off towards surface waters, including via local drainage systems	Surface water courses (Six inland rivers interacting with the Proposed Scheme including the River Nene)
	Leaching/dissolution and migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)
Source 5: Made ground associated with the A47	Direct contact with soils/dusts Ingestion or inhalation of soils/dusts Inhalation of gas/vapours Uptake by plant roots	Future site users Off-site human health receptors Agriculture Ecological
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water Surface run-off towards surface waters, including via local drainage systems	Surface water courses (Six inland rivers interacting with the Proposed Scheme including the River Nene)
	Leaching/dissolution and migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)

Source	Pathway	Receptor
Source 6: Disused railway line	Direct contact with soils/dusts Ingestion of or inhalation soils/dusts Inhalation of gas/vapours Uptake by plant roots	Future site users Off-site human health receptors Agriculture Ecological
	Leaching/dissolution of contaminants from made ground Migration of contaminants through permeable strata Migration of contaminants in saturated zone towards surface water Surface run-off towards surface waters, including via local drainage systems	Surface water courses (Six inland rivers interacting with the Proposed Scheme including the River Nene)
	Leaching/dissolution and migration of contaminants through permeable strata towards the saturated zone Lateral migration of contaminants by groundwater flow	Groundwater (Principal aquifer and Secondary aquifers)

Agricultural Soils

- 9.7.10. The ALC system provides a framework for classifying land according to the extent to which its physical or chemical characteristics impose long-term limitations on agricultural use. The principal physical factors influencing agricultural production are climate, site (including relief) and soil. By assessing these factors, it is possible to assign land into one of five land classification grades, Grade 1 land being the highest quality and Grade 5 the lowest quality agricultural land. Grade 3 is sub-divided into Subgrades 3a and 3b, to identify good quality agricultural land from moderate quality agricultural land (see Appendix 9.2 (**TR010039/APP/6.3**) for further information on the ALC system).
- 9.7.11. ALC Grades 1, 2 and 3a are classified as Best and Most Versatile land (BMV). BMV agricultural land is a finite national resource and is given special consideration in national policy and guidance. Based on the Provisional ALC map, Grade 1 agricultural land makes up approximately 63% of the agricultural land within Peterborough District, while Grade 2 agricultural land makes up approximately 48% of the agricultural land within the district. Approximately 47% of the agricultural land within the district is Grade 3 (the Provisional ALC map does not subdivide Grade 3 land into 3a and 3b). Grade 1 and Grade 2 land is predominately found in the east of the district, while Grade 3 land is found to the north and west of the district.

- 9.7.12. An ALC survey was carried out across the Proposed Scheme study area in July 2020 in accordance with the MAFF guidelines and the TIN049 guidance. The survey was based on observations at intersects of a 100m grid, giving a sampling density of at least one observation per hectare. During the survey, soils were examined via a combination of auger borings and a soil description pit to a maximum depth of 1.2m. The full results of the ALC survey are provided in Appendix 9.2 Agricultural Land Classification (**TR010039/APP/6.3**).
- 9.7.13. The detailed field work carried out for the assessment indicated that the agricultural land quality within the Proposed Scheme boundary of the Proposed Scheme is a mixture of Grade 2, Grade 3a (good quality) and 3b (moderate quality) agricultural land as shown below in Table 9-10. and Appendix 9.2 Agricultural Land Classification (**TR010039/APP/6.3**). The areas of Grade 2 and Grade 3a agricultural land are considered to be BMV agricultural land and make up approximately 49.5% of the study area.

Table 9-10: ALC grades within study area

ALC Grade	Total (ha)	Total (%)
Grade 1 (excellent quality)	-	-
Grade 2 (very good quality)	13.7	19.3
Grade 3a (good quality)	17.4	24.5
Grade 3b (moderate quality)	11.2	15.8
Grade 4 (poor quality)	-	-
Grade 5 (very poor quality)	-	-
Non-agricultural (existing A47 road, a residential property, some wooded areas and other amenity land)	26.1	36.6
Urban	-	-
Not surveyed	2.7	3.8
Total	71.1	100

Contamination baseline

- 9.7.14. The following assessment was undertaken and reported in the GIR (Sweco 2020).

Ground Conditions

- 9.7.15. The ground investigation encountered the following typical sequence of strata within the Proposed Scheme study area.
- 9.7.16. Topsoil was recorded extensively across the Proposed Scheme and had an average thickness of 0.4m and a maximum thickness of 1.2m. When encountered the topsoil comprised fine to coarse sand and gravelly silts and clays with frequent roots and rootlets.
- 9.7.17. Made ground was encountered across the Proposed Scheme but was more commonly observed adjacent to the existing A47 carriageway and therefore potentially associated with the construction of the existing A47 carriageways. Made ground deposits varied in nature however were generally described as sands and gravels. Inclusions within the made ground included asphalt, brick and concrete. An intact layer of asphalt was encountered between 1.7m bgl and 2.0m bgl along with a mild hydrocarbon odour, adjacent to the Wansford pumping station access road. The made ground encountered had an average thickness of 1.0m and a maximum thickness of 3.0m. Made ground was encountered to a maximum depth of 3.0m bgl.

Superficial Deposits

- 9.7.18. Head deposits comprising poorly sorted clays, silts, sands and gravels were observed orientated east to west on both sides of the A1 to the south of Wansford.
- 9.7.19. Granular and cohesive alluvial deposits comprising clays, sands and gravels were encountered on the northern bank of the River Nene. The deposits encountered were proven to a maximum thickness of 1.0m and to maximum depths of 2.3mbgl.
- 9.7.20. River Terrace Deposits were encountered during the ground investigation between the petrol filling station to the south of the existing A47 carriageway and the eastern limit of the Proposed Scheme. The deposits comprised interbedded granular and cohesive materials. The deposits were proven to a maximum thickness of 5.6m and an average thickness of 2.6m. The maximum depth of the deposits was proven to 5.9m bgl.

Solid Geology

- 9.7.21. The Rutland Formation comprised interbedded rock, granular and cohesive soils between the east of Sutton Heath Road and the eastern extent of the Proposed Scheme. The vertical extent of this stratum was not proven during the ground investigation. The Rutland Formation was observed at depths between 0.3m bgl and 8.1m bgl with the maximum unproven thickness recorded to be 3.6m. The

granular units of the Rutland Formation were identified typically as a very dense orange brown clayey, silty, gravelly fine to coarse sand. The cohesive Rutland Formation was encountered as a firm to very stiff, light grey and orange brown silty, sandy, gravelly clay. The Rutland Formation rock when encountered was predominantly a sandy limestone.

- 9.7.22. Lincolnshire Limestone Formation was encountered as a rock with interbedded cohesive and granular soil. The Lincolnshire Limestone Formation is comprised of Upper Lincolnshire and Lower Lincolnshire Limestone Members. The Upper Lincolnshire Member exists within the vicinity of the A1 and A47 intersection and the Lower Lincolnshire Member is present between the petrol filling station and the western extent of the Proposed Scheme. The Lower Lincolnshire Member is also found in the vicinity of the Sutton Heath Road and A47 intersection. The Lincolnshire Limestone bedrock ranged in thickness from 0.6m to 11.7m with an average thickness of 4.7m. The maximum depth this stratum was proven to was 12.3m bgl. When encountered as a rock the Lincolnshire Limestone Formation comprised a sandy limestone. The granular form exists as a brown clayey, gravelly, fine to coarse sand while the cohesive form was identified as a brown sandy gravelly locally silty clay.
- 9.7.23. Grantham Formation was encountered as interbedded granular and cohesive soils with the occasional thin rock strata. The Grantham Formation underlies the superficial deposits and made ground within the centre of the Proposed Scheme between the petrol filling station and Sutton Heath Road. The Grantham Formation was also encountered underlying the Lincolnshire Limestone Formation from the petrol fuelling station to the western extents of the Proposed Scheme. The Grantham Formation rock comprises sandy mudstone, fine grained limestone and a fine-grained ferruginous sandstone. The cohesive form was identified as a light to dark grey, fine to coarse sandy, locally gravelly, locally silty clay. The granular form was encountered as brown and grey silty, clayey, gravelly fine to coarse sand or fine to coarse sandy gravel. The Grantham Formation had an average thickness of 3.8m (range from 0.5m to 7.58m) with a maximum proven depth of 16.9m bgl.
- 9.7.24. The Lias Group / Whitby Mudstone Formation was encountered across the Proposed Scheme as the most basal unit underlying all other strata. When encountered the Lias Group deposits were identified as cohesive soils comprising grey, locally sandy silty, fossiliferous clays, with the occasional rock strata made up of fossiliferous mudstones. The thickness ranged from 1.35m to 14.59m and a maximum proven depth of 25.94m bgl was recorded.

Groundwater

- 9.7.25. Groundwater was encountered across the Proposed Scheme. Groundwater levels varied between 7.7mAOD (BH29 – Lower Lincolnshire Limestone) and 23.mAOD (BH06 – Lower Lincolnshire Limestone and Grantham Formation) and between 0.56mbgl (BH01A – Grantham Formation) and 8.6mbgl (BH16 – Lias Group). The groundwater monitoring results from the GIR, (Sweco 2020) indicate no discernible difference in groundwater levels between geological horizons. Full details of the hydrogeological regime are presented in Chapter 13 (Road Drainage and the Water Environment) (**TR010039/APP/6.1**).

Human health

- 9.7.26. Future site users and sensitive off-site receptors are considered to be potential receptors via dermal contact, inhalation, ingestion of soils, dust and ground gas/vapours.
- 9.7.27. Chemical analysis results have been compared in the GIR (Sweco, 2020) (**TR0010039/APP/6.3**) with generic assessment criteria (GAC) protective of a commercial/industrial end use. These are considered the most appropriate assessment criteria to assess risks to construction workers and future site occupiers.
- 9.7.28. Concentrations of benzo(a)pyrene, benzo(b)fluoranthene and dibenzo(a,h)anthracene slightly exceeding the screening criteria were identified at BH21A between 1.80 m bgl and 1.90 m bgl, located to the north of the Wansford pumping station where a mild hydrocarbon odour was recorded within made ground. The exceedances are likely due to the presence of asphaltic concrete. Given the depth to the exceedances and the presence of material above which does not exceed the criteria, recorded contaminant concentrations at this location are not considered to pose an unacceptable risk to human health.
- 9.7.29. No further samples from the remaining exploratory holes across the Proposed Scheme exceeded the screening criteria.
- 9.7.30. The results from chemical analysis assessment have identified the overall potential risks to human health to be low in regard to the current ground conditions within the study area.
- 9.7.31. Asbestos was not detected in any of the 110 soil samples that underwent lab analysis screening for asbestos and as a result the risk from asbestos is considered to be very low.

Ground gas

- 9.7.32. Ground gas monitoring was undertaken at nineteen locations within the study area over eight rounds between November 2018 and January 2019.
- 9.7.33. Results from the post ground investigation gas monitoring identified no ground gas hazards with respect to human health on the Proposed Scheme.

Visual and Olfactory

- 9.7.34. Visual or olfactory evidence of contamination was identified within made ground in five exploratory holes BH05, BH09, BH22, BH21A and TP24 situated within the western areas of the Proposed Scheme. Exploratory hole location plans are contained within Appendix A of the GIR (**TR010039/APP.6.3**).
- 9.7.35. Evidence of contamination identified included tarmacadam fragments, hydrocarbon odours, and bitumen and asphalt gravels which can be associated with the construction of the A47.

Controlled waters

- 9.7.36. Risks to groundwater from the Proposed Scheme have been assessed through comparing the chemical laboratory data against appropriate generic assessment criteria. The UK Drinking Water Standards (DWS) and World Health Organisation (WHO) guidelines for drinking water quality (2011) have been used for protection of the identified potentially sensitive aquifer receptors.
- 9.7.37. Risks to surface water from the Proposed Scheme have been assessed through comparing the chemical laboratory data against appropriate generic assessment criteria. The Water Framework Directive criteria has been used for protection of the identified potentially sensitive receptors including the River Nene.

Soil Leachability- Surface waters

- 9.7.38. Elevated leachable concentrations of copper, which were found to be above the screening criterion, were identified within made ground at four locations across the Proposed Scheme. Exploratory holes that contained elevated concentrations are shown within Appendix A of the GIR (**TR010039/APP/6.3**). to be located at the eastern extent (TP22) and western extent (TP25) of the Proposed Scheme as well as within boreholes situated to the south (BH30) and within the current footprint of A47 (BH25).
- 9.7.39. Marginal exceedances of the screening criteria for ammoniacal nitrogen as NH_4 , mercury and nickel were identified from within the topsoil, made ground, underlying River Terrace Deposits and Upper and Lower Lincolnshire Limestone Formation. The ammoniacal nitrogen as NH_4 is most likely derived from agricultural processes.

- 9.7.40. Further assessment of these marginal exceedances was not considered necessary.

Soil Leachability- Groundwater

- 9.7.41. An elevated leachable concentration of iron was recorded above the screening criteria in a topsoil sample taken from BH29. The location of this borehole is shown within Appendix A of the GIR (**TR010039/APP/6.3**) to be within the footprint of the current A47 at the centre of the Proposed Scheme.
- 9.7.42. Marginal exceedances of the screening criteria were identified within groundwater samples from made ground, River Terrace Deposits and the Upper and Lower Lincolnshire Limestone for ammoniacal nitrogen NH_4 , iron and mercury. Further assessment of these marginal exceedances was not considered necessary.

Groundwater Screening – Risk to surface waters

- 9.7.43. Marginal exceedances were identified for ammoniacal nitrogen as NH_4 and ammonium within three boreholes (BH24, BH26 and BH34), shown in Appendix A of the GIR (**TR010039/APP/6.3**) to be located in the central and western areas of the Proposed Scheme. A marginal exceedance of boron was identified within BH24 immediately to the south of petrol filling station. Further assessment of these marginal exceedances was not considered necessary.

Groundwater Screening – Risk to groundwater

- 9.7.44. Within BH24 and BH26 shown within Appendix A of the GIR (**TR010039/APP/6.3**) to be situated within the western extents of the Proposed Scheme marginal exceedances of ammoniacal nitrogen as NH_4 and ammonium were recorded. Within four boreholes (BH24, BH26, BH27 and BH34) situated within the west and central areas of the Proposed Scheme marginal exceedances of boron were identified. Further assessment of these marginal exceedances was not considered necessary.

Controlled Waters Summary

- 9.7.45. Considering the following site-specific factors, the potential for the identified exceedances to pose an unacceptable risk to controlled waters is considered Low:
- The recorded concentrations (above laboratory limit of detection) are generally slightly elevated above the relevant criteria and within one order of magnitude of the criteria.
 - No significant amounts of made ground with elevated concentrations of contaminants have been identified.

- The marginal exceedances identified within groundwater samples suggest that the elevated leachable concentrations of copper and iron are not impacting the groundwater.
- Assuming the works are undertaken in an appropriate manner, with risks to controlled waters mitigated as detailed in the Environmental Management Plan (EMP (**TR010039/APP/7.5**)).

Ecological

- 9.7.46. Flora and fauna are considered to be potential receptors via the uptake of plant roots and ingestion/inhalation of contaminated soils/dusts respectively.
- 9.7.47. In relation to flora and fauna there is not a set of quantitative generic screening criteria that can be used to identify possible unacceptable risks. The results of the generic quantitative risk assessment for human health did not identify any unacceptable risks, therefore the potential for impact on flora and fauna is considered to be very low.
- 9.7.48. The future baseline scenario outlines the likely evolution of the current state of the environment without the Proposed Scheme. This allows for the identification of effects and impacts of the Proposed Scheme against the baseline at both the commencement of construction and operation of the completed Scheme.

Construction year baseline (2023)

- 9.7.49. Potential changes to the identified baseline conditions for geology and soils, based on data in the Peterborough Local Plan 2016 to 2026 are limited to planned developments near the Proposed Scheme boundary. Planned development in the vicinity of the Proposed Scheme may result in changes to the soils or identification of contamination. Off-site developments would be required to adhere to current planning policy guidance and best practice such that any contamination identified would, if required, be subject to remediation or mitigation.
- 9.7.50. This assessment does not consider there to be any material or significant changes to the baseline ground conditions identified in this future construction year baseline assessment. This is because no developments have been identified that would affect the baseline conditions for geology and soils.

Operational year baseline (2025)

- 9.7.51. The Peterborough Local Plan 2016 to 2026 identifies potential development sites as part of Peterborough Councils urban expansion plans. This is not currently predicted to impact the Proposed Scheme in the future, however there is the potential for future development sites to be proposed and these should take into account the Proposed Scheme.

- 9.7.52. Given the locations of these potential development sites, this assessment does not consider there to be any material or significant changes to the baseline ground conditions identified in this future operational year baseline assessment.

9.8. Potential impacts

- 9.8.1. Potential impacts associated with the Proposed Scheme in the absence of mitigation have been identified during both construction and operation.

Construction

- 9.8.2. Potential negative construction impacts in terms of contamination include the following:
- potential to mobilise contaminants in soils and groundwater as a result of ground disturbance or dewatering activities
 - alteration of potential for contaminants to mobilise (leach) from soils during construction
 - generation of dust
 - increased potential for contaminants to enter surface water through drainage or surface run-off
 - increased potential for exposure to contaminants to human health receptors due to exposure of contaminated materials during construction
 - creation of preferential pathways such as piles penetrating through strata or via service corridors for migration of potential contaminants to groundwater
 - introduction of fuels, chemicals and fluids relating to construction activities
 - importation of unsuitable materials which have the potential to introduce new sources of contamination
- 9.8.3. With regards to geology and soil resources the following construction activities have the potential for negative impacts:
- creation of temporary access tracks and traffic diversions resulting in compaction or sealing of soils
 - land-take both temporary and permanent
 - impacts from proposed new or removed facilities e.g. severance of a path or a habitat
 - stripping and storage of soils, topsoil and materials leading to damage of these resources
 - storage of excavated made ground soils in stockpiles which could lead to the release of contamination to the ground through rainwater run-off and infiltration

- permanent land-take for potential flood storage

9.8.4. Table 9-11 shows the approximate permanent and temporary land-take associated with the Proposed Scheme, based on the preliminary design.

Table 9-11: Agricultural land-take

ALC grade	Approximate permanent land-take (ha)	Approximate temporary land-take (ha)	Approximate total construction land-take (ha)
Grade 2	11.0	2.7	13.7
Grade 3a	5.9	11.5	17.4
Not surveyed but assumed to be Grade 3a	2.2	0.5	2.7
Grade 3b	9.5	1.7	11.2

- 9.8.5. The temporary land-take would be restored and available for agricultural use following completion of the construction phase, subject to the provisions of a Soil Management Plan (SMP).
- 9.8.6. Although this land would be lost to agriculture, the soil resources would still be used to provide some ecosystem services. However, as none of this land would be retained for commercial agriculture, it is all considered as lost agricultural land for the purpose of this assessment.

Operational

- 9.8.7. The loss of the agricultural land occurs during the construction phase and no additional loss of agricultural land is expected during the operational phase.
- 9.8.8. It is predicted that the operation of the Proposed Scheme would have a limited interaction with geology and soils.
- 9.8.9. There are no screening criteria protective of flora or fauna however the results of the generic risk assessment did not identify any unacceptable risks to human health. The potential for impact from the Proposed Scheme on flora and fauna is considered very low.

9.9. Design, mitigation and enhancement measures

- 9.9.1. Design and mitigation shall be applied to avoid, reduce and remediate effects on geology and soils following the design and mitigation hierarchy outlined in DMRB LA 104.

- 9.9.2. Impacts on geology and soil resources during the construction phase shall be managed and minimised through the EMP (TR010039/APP/7.5).
- 9.9.3. The EMP will set out controls to ensure identified risks associated with contamination are appropriately managed and minimised. Mitigation measures within the EMP will include best practise environmental management procedures and appropriate waste management, such as, but not limited to:
- ensuring adequate space for storage of topsoil and subsoil which must be segregated during excavation
 - protection of watercourses from entry of polluting matter
 - stripping, storing and reinstating of soils using best practice measures to minimise the risk of degradation to soils
 - controls for identification of unexpected contamination
 - suppression of odour and dust and route selection
- 9.9.4. For the most applicable mitigation for reducing impacts on agricultural soils is through effective design and route selection.
- 9.9.5. The key principle considered to minimise effects on soils is to ensure that the footprint of the Proposed Scheme is reduced as much as practicable, without adversely affecting the design.

Construction

- 9.9.6. Made ground is present underlying the Proposed Scheme. Management of the associated potential risks would be undertaken in accordance with good practice including:
- monitoring of potential ground-gas and vapours in confined spaces during construction
 - design of in-ground structures to appropriate concrete design class
 - suitable personal protective equipment (PPE) and hygiene practices for construction and maintenance workers.
- 9.9.7. Stripping and storage of topsoil shall be managed with regard to BS 3882:2015 utilising best practice.
- 9.9.8. There are no additional measures that can mitigate the permanent land-take and therefore, there is a permanent loss of agricultural soils associated with the Proposed Scheme.
- 9.9.9. In order to mitigate impacts on temporary land-take areas, an SMP, incorporating guidance provided by the *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites* (Defra, 2009), will be produced to ensure the use

of best practice measures for soil handling. The SMP will ensure that soils in the areas subject to temporary land-take are properly handled, stored and reinstated.

- 9.9.10. The SMP will include a Soil Resource Plan and a Soil Handling Strategy, based on a soil resource survey. A Materials Management Plan (MMP) would be put in place to minimise over-excavation of soils and ensure that soils from permanent land-take areas would be reused as much as possible within the Proposed Scheme and that areas of temporary land-take are restored back to their former condition.
- 9.9.11. The SMP and MMP shall outline areas of soil to be protected from earthworks and construction activities; the areas and types of topsoil and subsoil to be stripped, haul routes, stockpile locations; the methods of stripping, stockpiling, re-spreading and ameliorating landscape soils and restoring temporary land-take areas, and a cut and fill balance to ensure as much material as possible is reused in the Proposed Scheme. All affected soil would be stripped, including topsoil and subsoil, and stored separately.
- 9.9.12. Construction compounds and working areas would include a clear demarcation (fence) of the construction area and prevent access onto adjacent areas of agricultural land that could result in compaction or damage of soils. Construction vehicles would be confined to designated haul routes to reduce the amount of compaction of soil.
- 9.9.13. Where there are excess soils generated, which cannot be reused in the Proposed Scheme, these would be saved and reused outside the Proposed Scheme where there are opportunities to do so.
- 9.9.14. Where necessary for protection from earthworks and construction activities, agricultural soils would be stripped, stored and replaced to their baseline condition, as far as possible.
- 9.9.15. Measures required for material reuse and disposal are detailed in Chapter 11 (Material Assets and Waste) (**TR010039/APP/6.1**).
- 9.9.16. Protection of controlled waters must be maintained throughout site works. Protection measures are further outlined within Chapter 13 (Road Drainage and Water Environment) (**TR010039/APP/6.1**).

Operation

- 9.9.17. No mitigation measures are proposed for operation of the Proposed Scheme.

9.10. Assessment of likely significant effects

9.10.1. Residual effects once mitigation measures are taken into consideration, have been identified based on ground investigation data (Sweco, 2020) and the preceding sections and are identified in Table 9-12. Mitigation measures are outlined in Section 9.9 Design, mitigation and enhancement measures. The methodology contained within DMRB LA 104 and DMRB LA 109 has been used to assign the sensitivity, magnitude and significance of the effects (summarised, in Section 9.4).

Table 9-12: Determinations of the sensitivity and magnitude of impacts to receptors

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
Construction				
Future users/occupiers of A47 <i>Direct contact with, inhalation or ingestion of contaminated soils, dusts and inhalation of ground gases/vapours.</i>	Low Negligible adverse	Users of the A47 will be present during construction and operation of the Proposed Scheme. No risks have been identified to Human Health from soils or ground gas on the Proposed Scheme.	Neutral	Use of best practice measures for earthworks including dust management strategies.
Offsite receptors <i>Direct contact with, inhalation or ingestion of contaminated soils and dusts, ground gases/vapours or contaminated groundwater.</i>	Very High Negligible adverse	Users/occupiers of adjacent land areas; agricultural fields, petrol filling station, sewage pumping station, paths and off-site residents. No risks have been identified to Human Health from soils or ground gas on the Proposed Scheme.	Slight adverse	Use of best practice measures for earthworks including dust management strategies.
Surface waters – River Nene <i>Migration of contaminants in the saturated zone towards surface water. Surface run-off towards surface waters, including via local drainage systems.</i>	High Negligible adverse	The River Nene is the most sensitive surface water receptor. No risks have been identified from soils to controlled waters.	Slight adverse	Inclusion of spill prevention and management procedures within the Environmental Management Plan (TR010039/APP/7.5). Inclusion of a Materials Management Plan which identifies any unforeseen potentially contaminated materials and appropriate management strategies to manage working with contaminated materials.
Groundwater – Principal and Secondary Aquifers	Very High Negligible adverse	The Upper and Lower Lincolnshire Limestone is designated as a Principal Aquifer. The	Slight adverse	Inclusion of spill prevention and management procedures within the

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
<i>Leaching/dissolution and migration of contaminants.</i>		Alluvium and River Terrace Deposits are designated as Secondary A Aquifers. The recorded concentrations (above laboratory limit of detection) are generally slightly elevated above the relevant criteria and within one order of magnitude of the criteria.		Environmental Management Plan (TR010039/APP/7.5). Inclusion of a Materials Management Plan which identifies any unforeseen potentially contaminated materials and appropriate management strategies to manage working with contaminated materials.
Agricultural soils- Grade 2 <i>Stripping of soil across the Proposed Scheme required for the permanent works (road, structures, drainage network, environmental bunds etc.).</i> <i>Permanent land-take of between 1 – 20 ha.</i>	Very high Moderate	Stripping of soil across the Proposed Scheme footprint required for the permanent works (road, structures, drainage network, flood storage etc.). Agricultural land would be removed/permanently sealed beneath new carriage ways which will be constructed as part of the Proposed Scheme. Permanent land-take of approximately 5.3 ha of ALC grade 2.	Very large adverse (due to the loss of over 10 ha of agricultural land)	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP). Minimising over-excavation of soils. Reuse of soils as much as possible on the Proposed Scheme Reduce the footprint of the Proposed Scheme as far as practicable. Use of best practice measures for soil handling Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities
Agricultural soils- Grade 2 <i>Stripping of soil across the Proposed Scheme required for the temporary works (construction compounds, haul roads etc.).</i>	Very high Minor	Stripping of soils across the Proposed Scheme footprint required for the temporary works (construction compounds, haul roads, etc.) Temporary land-take resulting in the potential for reduction of soil functions due to degradation, compaction and erosion of soil resource during the construction period.	Moderate adverse (due to temporary impacts)	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP), incorporating guidance provided by the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Minimising over-excavation of soils. Reuse of soils as much as possible on the Proposed Scheme Use of best practice measures for soil handling Protection of the agricultural soils within the temporary land-take Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
				Specifying areas of soils to be stripped, stored and replaced to their baseline condition
Agricultural soils-Grade 3a <i>Stripping of soil across the Proposed Scheme required for the permanent works (road, structures, drainage network, flood storage etc.).</i> <i>Permanent land-take of between 1 – 20 ha.</i>	High Moderate	Stripping of soil across the Proposed Scheme footprint required for the permanent works (road, structures, drainage network, flood storage etc.). Agricultural land would be removed/permanently sealed beneath new carriage ways which will be constructed as part of the Proposed Scheme. Permanent land-take of approximately 2.6 ha of ALC subgrade 3a.	Moderate adverse (due to the loss of less than 10 ha of agricultural land)	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP). Minimising over-excavation of soils. Reuse of soils as much as possible on the Proposed Scheme Reduce the footprint of the Proposed Scheme as far as practicable. Use of best practice measures for soil handling Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities
Agricultural soils-Grade 3a <i>Stripping of soil across the Proposed Scheme required for the temporary works (construction compounds, haul roads etc.).</i>	High Minor	Stripping of soils across the Proposed Scheme footprint required for the temporary works (construction compounds, haul roads, etc.) Temporary land-take resulting in the potential for reduction of soil functions due to degradation, compaction and erosion of soil resource during the construction period.	Slight adverse (due to temporary impacts)	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP) incorporating guidance provided by the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Minimising over-excavation of soils. Reuse of soils as much as possible on the Proposed Scheme Use of best practice measures for soil handling Protection of the agricultural soils within the temporary land-take Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities Specifying areas of soils to be stripped, stored and replaced to their baseline condition

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
Agricultural soils- Grade 3b <i>Stripping of soil across the Proposed Scheme required for the permanent works (road, structures, drainage network, flood storage etc.).</i> <i>Permanent land-take of between 1 – 20 ha.</i>	Medium Moderate	Stripping of soil across the Proposed Scheme footprint required for the permanent works (road, structures, drainage network, flood storage etc.). Agricultural land would be removed/permanently sealed beneath new carriage ways which will be constructed as part of the Proposed Scheme. Permanent land-take of approximately 2.2 ha of ALC subgrade 3b.	Moderate adverse	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP). Minimising over-excavation of soils. Reuse of soils as much as possible on the Proposed Scheme Reduce the footprint of the Proposed Scheme as far as practicable. Use of best practice measures for soil handling Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities
Agricultural soils- Grade 3b <i>Stripping of soil across the Proposed Scheme required for the temporary works (construction compounds, haul roads etc.).</i>	Medium Minor	Stripping of soils across the Proposed Scheme footprint required for the temporary works (construction compounds, haul roads, etc.) Temporary land-take resulting in the potential for reduction of soil functions due to degradation, compaction and erosion of soil resource during the construction period.	Minor adverse	Inclusion of a Materials Management Plan (MMP) and Soil Management Plan (SMP) incorporating guidance provided by the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Minimising over-excavation of soils Reuse of soils as much as possible on the Proposed Scheme Use of best practice measures for soil handling Protection of the agricultural soils within the temporary land-take Logistical planning of site layout and access Identifying soils subject to earthworks and construction activities Specifying areas of soils to be stripped, stored and replaced to their baseline condition
Operation				
Future users of Proposed Scheme <i>Direct contact with, inhalation or ingestion of contaminated soils</i>	Low No change	Users of the A47 will be present during construction and operation of the Proposed Scheme.	Neutral	No mitigation measures are proposed for the operation of the Proposed Scheme

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
<i>and dusts, ground gases/vapours or contaminated groundwater.</i>		No risks have been identified to Human Health from soils or ground gas on the Proposed Scheme.		
Offsite receptors <i>Direct contact with, inhalation or ingestion of contaminated soils and dusts, ground gases/vapours or contaminated groundwater.</i>	Very High No change	Users/occupiers of adjacent land areas; agricultural fields, petrol filling station, sewage pumping station, paths and off-site residents. No risks have been identified to Human Health from soils or ground gas on the Proposed Scheme.	Neutral	No mitigation measures are proposed for the operation of the Proposed Scheme
Surface waters – River Nene <i>Migration of contaminants in the saturated zone towards surface water. Surface run-off towards surface waters, including via local drainage systems.</i>	High Negligible	The River Nene is the most sensitive surface water receptor. No risks have been identified from soils to controlled waters.	Neutral	No mitigation measures are proposed for the operation of the Proposed Scheme
Groundwater – Principal and Secondary Aquifers Leaching/dissolution and migration of contaminants.	Very high No change	The Upper and Lower Lincolnshire Limestone is designated as a Principal Aquifer. The Alluvium and River Terrace Deposits are designated as Secondary A Aquifers. The recorded concentrations (above laboratory limit of detection) are generally slightly elevated above the relevant criteria and within one order of magnitude of the criteria.	Neutral	No mitigation measures are proposed for the operation of the Proposed Scheme
Agricultural soils <i>No additional loss of agricultural land is expected during the operational phase.</i>	Very high to low No change	Stripping of soil across the Proposed Scheme footprint required for the permanent works (road, structures, drainage network, flood storage etc.). Agricultural land would be removed/permanently sealed beneath new	Neutral	No mitigation measures are proposed for the operation of the Proposed Scheme

Receptor and description of impact	Sensitivity and Magnitude	Reasoning	Significance	Mitigation measures
		carriage ways which will be constructed as part of the Proposed Scheme.		

- 9.10.2. It is predicted that the Proposed Scheme is unlikely to give rise to any significant effects upon geology or soils during the operational phase.
- 9.10.3. Residual effects to human health and controlled waters from disturbance and mobilisation of contamination in geology and soils during construction have been identified as slight adverse.
- 9.10.4. The proposed mitigation for agricultural soils in Section 9.9 aims to maintain the quality of retained and excavated soils through best practice soil handling methods and techniques. The temporary land-take areas would be restored to agriculture following the completion of the construction phase. The temporary loss of agricultural land during the construction phase is considered to be of minor magnitude and moderate adverse significance for Grade 2 agricultural land, slight adverse significance for Grade 3a agricultural land and slight adverse significance for Grade 3b agricultural land.
- 9.10.5. Provided that the mitigation measures are effective and areas of temporary land-take are restored back to their former condition, the long-term residual effects on agricultural soils would be limited to the permanent loss of agricultural land:
- The permanent loss 11 ha of Grade 2 agricultural land is considered to be of moderate magnitude and very large adverse significance.
 - The permanent loss of 8.1 ha of Grade 3a agricultural land is considered to be of moderate magnitude and moderate adverse significance.
 - The permanent loss of 9.5 ha of Grade 3b agricultural land is considered to be of moderate magnitude and moderate adverse significance.
- 9.10.6. The Proposed Scheme is therefore considered to have significant effects due to the permanent loss of agricultural land.
- 9.10.7. The assessment indicates that the overall potential risk to the SSSI (Sutton Heath and Bog) located 50 m to the north of the Proposed Scheme is low.
- 9.10.8. Potential surface water impacts to the SSSI are assessed further in Chapter 13 (Road Drainage and Water Environment) (**TR010039/APP/6.1**).
- 9.10.9. Residual effects have been identified to be neutral for the operation of the Proposed Scheme.

9.11. Monitoring

- 9.11.1. No significant residual effects have been identified relating to contamination or geology and therefore physical monitoring through inground installations etc. is not considered necessary. No remediation due to contamination is required. Soils and other material assets would be handled according to the waste and materials asset requirements set out in the EMP (**TR010039/APP/7.5**). Monitoring of accordance with these requirements would be conducted via audit of the requirements.
- 9.11.2. Soil stripping, handling and storage would be monitored/audited to ensure that it follows the procedures outlined in the SMP. Following reinstatement of the temporary land-take, there would be a programme of monitoring of soil conditions to identify if there are soil problems which need to be remediated. This would include an assessment of the problem and design of a suitable remediation such as subsoiling or drainage followed by crop establishment.

9.12. Summary

- 9.12.1. Only minor evidence of contamination from historical activities were recorded during the site investigation and no special remedial activities are recommended for the Proposed Scheme.
- 9.12.2. Minor impact from ground contamination was identified in the ground investigation work and hence there is limited potential for construction activities to mobilise contaminants within the underlying soils or introduce contaminants which may potentially harm human health or environmental receptors such as the River Nene or Sutton Heath and Bog. Potentially harmful construction activities would be identified, controlled and mitigated by measures set out in the EMP.
- 9.12.3. The construction of the Proposed Scheme results in the permanent and temporary land-take of Grade 2 and Grade 3a land, which is considered to be BMV agricultural land, as well as Grade 3b land.
- 9.12.4. An SMP will be developed to help preserve land quality on the temporary land-take areas and to make effective reuse of the soils taken from the areas of permanent land-take. Long-term residual effects on agricultural soils will consist of the permanent loss of agricultural land. Provided that the mitigation and monitoring measures are effective and areas of temporary land-take are restored back to their former condition, the long-term residual effects on agricultural soils would be limited to the permanent loss of agricultural land. The permanent loss of 11 ha of Grade 2 agricultural land is considered to be of moderate magnitude and very large adverse significance, while the permanent land-take of 8.1 ha of Grade

3a and 9.5 ha of Grade 3b agricultural land is considered to be of moderate magnitude and moderate adverse significance of effect.

- 9.12.5. The operational phase of the Proposed Scheme results in a reduced potential for harm as the underlying soils are no longer exposed or disturbed effectively breaking potential pathways to receptors and presents no further impacts to agricultural soils.

9.13. References

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9.14. Glossary

Term	Definition
ALC	Agricultural Land Classification
BMV	Best and Most Versatile Land (land that can best deliver future crops for food and non-food uses)
CSM	Conceptual Site Model
DWS	Drinking water standards
EMP	Environmental Management Plan
EPH	Extractable petroleum hydrocarbons
GAC	Generic assessment criteria
GIR	Ground investigation report
GWDTE	Groundwater dependent terrestrial ecosystems
LCA	Land Classification for Agriculture
MAFF	Ministry of Agriculture, Fisheries and Food

MMP	Materials Management Plan
PAH	Polycyclic aromatic hydrocarbon
PEIR	Preliminary Environmental Information Report
PSSR	Preliminary Sources Study Report
Q ₉₅	The flow equalled or exceeded in a watercourse 95% of the time
RBMP	River Basin Management Plan
SMP	Soil Management Plan
SOM	Soil organic matter
SPZ	Source Protection Zone
SAC	Special Area of Conservation
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
WFD	Water Framework Directive
WHO	World Health Organisation