

## 12 Geology and soils

### Executive summary

This chapter reviews the scheme with regards to the impact on contamination (soil and groundwater) and geologically important sites. Road schemes can have an impact on both the soils and geology of an area, and the existing ground conditions can impose constraints on a proposed road scheme.

No significant geologically important sites are identified within 500m of the scheme.

The scheme is primarily located within greenfield land or land which is identified as having only limited contaminative potential. As such, the majority of the scheme is unlikely to be significantly impacted by contamination. Exceptions to this include existing contaminated sites, including:

- A former fuel storage depot (Buckden fuel depot) which the scheme passes through;
- A closed landfill site immediately adjacent to the scheme (Buckden South landfill); and
- Two permitted and restored landfills, including Buckden North which is adjacent to the scheme and Milton landfill which the scheme would encroach.

A number of mitigation measures are proposed at these locations to prevent significant adverse effects. Mitigation measures are likely to include design of earthworks to limit mobilisation of contamination and replacement of environmental monitoring locations if lost as part of the scheme. Throughout the scheme, any material identified as unacceptable based on site specific assessment criteria would be excavated and if feasible either treated or re-used in less sensitive areas of the scheme.

Impacts to human health and controlled waters are considered negligible for the majority of the scheme during construction and operation. However at the specific locations identified above there may be slight adverse impacts in the short term during construction.

Impacts to geologically important sites are considered negligible as no significant sites are identified within 500m of the scheme.

By adopting appropriate mitigation measures during the construction phase, major adverse effects relating to damage or destruction of high quality agricultural topsoil and subsoil across the scheme during construction would be reduced to slight adverse.

Any material used for the scheme, including the re-instatement of borrow pits would be proven 'suitable for use'. Material would be deposited under either Environmental Permitting regulations or the *Definition of Waste: Development Industry Code of Practice* (CL:AIRE, 2011).

This assessment has not identified any significant residual impacts on Geology and Soils from the scheme.

## 12.1 Introduction

- 12.1.1 Road schemes can have an impact on both the soils and geology of an area, and the existing ground conditions can impose constraints on a proposed road scheme. This chapter reviews the soils, geology and identified land contamination, and assesses the likely interaction between the scheme, contamination conditions and the subsequent potential for effects on the following receptors through disturbance of ground and groundwater quality conditions during construction and operation:
- human health;
  - controlled waters (surface waters and groundwater/aquifers); and
  - buildings and structures.
- 12.1.2 Further information with regards to contamination conditions is presented within *Appendix 12.1*.
- 12.1.3 Likely effects on geology and soils as important resources (e.g. geological Sites of Special Scientific Interest and Regionally Important Geological Sites) are covered in this chapter.
- 12.1.4 Contamination aspects of reusability of soils and aggregates derived from on-site and imported from off-site are also covered. Quantities and volumes of materials are discussed within *Chapter 13*.
- 12.1.5 This chapter addresses groundwater quality and vulnerability in the context of land contamination as described in *12.1.1*. It does not address groundwater supply, abstractions, hydrogeology or hydrology. These are addressed in *Chapter 17*.
- 12.1.6 Loss of agricultural soils is considered and reported within the Soil management strategy, presented as *Appendix 12.2*. A brief summary of the key conclusions is provided in this chapter for completeness. The impact of the scheme on agricultural land and farms is presented in *Chapter 16*.
- 12.1.7 Cumulative effects that may arise are covered in *Chapter 18*.
- 12.1.8 The assessment is based on guidance outlined in *Design Manual for Roads and Bridges Volume 11, Section 3, Part 11* (Highways Agency et al., 1999).
- 12.1.9 This assessment is divided into two sections:
- Likely impacts and effects that may arise during construction of the scheme; and
  - Likely impacts and effects that may arise during the operation of the scheme.

## Legislative and policy background

### *Primary and secondary legislation*

12.1.10 Legislation on land contamination (including groundwater) is included within the *Environmental Protection Act (EPA) 1990* and the *Environment Act 1995*. This legislation defines contaminated land and the procedures to identify and initiate remediation of such land. Contaminated land is defined in the EPA as land where, due to the presence of substances, it appears to the regulatory authority (the Local Authority and/or the Environment Agency) that:

*“Significant harm is being caused or there is a significant possibility of such harm being caused or significant pollution of controlled waters is being caused or there is a significant possibility of such pollution being caused.”*

12.1.11 Controlled waters include both surface water and groundwater. The legislation is supported by *Contaminated Land Statutory Guidance* (Defra, 2012), which provides advice on how the legislation should be implemented.

12.1.12 The *EU Council Directive (Directive 2000/60/EC)* established a framework for community action on water and is commonly known as the Water Framework Directive (WFD). The purpose of the WFD is to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater, which includes risks from contamination.

12.1.13 Land contamination issues have been a material consideration within planning legislation since 1974. The *Town and Country Planning Act 1990* sets out the legislative framework for the role of the planning authority and its scope to control the development of land affected by contamination through the use of planning conditions.

### *National Planning Policy*

12.1.14 The *National Planning Policy Framework (NPPF)* was introduced to simplify planning and was written to help achieve sustainable development. The *NPPF* indicates that *“To prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or proposed development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.”*

12.1.15 The *NPPF* indicates that after remediation (if required), land should not be capable of being determined as ‘contaminated land’ under Part 2A of the *EPA 1990*. Where a site is affected by contamination, the responsibility for securing a safe development rests with the developer and/or landowner.

- 12.1.16 The *NPPF* is supported by *Planning Practice Guidance* published online at <http://planningguidance.planningportal.gov.uk/>. This includes practice guidance on land affected by contamination.
- 12.1.17 Primary guidance for assessing and managing land contamination is presented in *Contaminated Land Report 11, Model Procedures for the Management of Land Contamination (CLR 11)* (Defra and Environment Agency, 2004). *CLR 11* provides a technical framework for identifying and remediating contamination through the application of a risk management process. The question of whether a risk is unacceptable involves scientific and technical assessments, as well as appropriate criteria to judge the risk and conclude exactly what risk would be unacceptable.
- 12.1.18 Land contamination is also referred to within the *Draft National Policy Statement (NPS) for National Networks* (Department for Transport, 2013):
- “For developments on previously developed land, applicants should ensure that they have considered the risk posed by land contamination and how this is proposed to be addressed.”*
- 12.1.19 The *Draft NPS for National Networks* refers to *CLR 11* for further details. This assessment considers *CLR 11* and accordingly is compliant with the *Draft NPS for National Networks*.
- 12.1.20 The *NPPF* and *Draft NPS for National Networks* also provide guidance with regards to geological conservation. The guidance indicates that the assessment should ensure that the effects on internationally, nationally and locally designated sites of geological conservation are considered. This includes taking advantage of opportunities to conserve geological interests. Guidance within the *Government Circular: Biodiversity and Geological Conservation – Statutory Obligations and their Impact within the Planning System* (ODPM 06/2005, Defra 01/2005) is referred to.

#### *Local planning policy*

- 12.1.21 A review of local planning policy identifies planning policy issues relevant to geology and soils, including:
- *Cambridge City Local Plan 2006*  
Policy 4/13 Pollution and Amenity; requires the developer to demonstrate that there would be no adverse impact from ground contamination.
  - *The Cambridge Local Plan 2014: Proposed Submission*  
Policy 33 Contaminated Land; extends the Local Plan 2006 to include explicit reference to controlled waters.

- *The South Cambridgeshire Local Plan 2011-2031: Proposed Submission*

Policy SC/12 Contaminated Land; requiring developers to include an assessment of the extent of contamination and any possible risks, where development is proposed on contaminated land or land suspected of being impacted by contaminants; proposals would only be permitted where land is, or can be made, suitable for the proposed use.

- *The South Cambridgeshire Development Control Policies 2007*

Policy NE7; this provides policy on dealing with sites of Biodiversity or Geological Importance.

The development control policies do not discuss potentially contaminated land.

- *The South Cambridgeshire Design Guide Supplementary Planning Document (2010)*

This document contains guidance on potentially contaminated land to help developers avoid or mitigate risks to human health and the environment to ensure that the proposed development would be suitable for use.

- *Huntingdonshire Council Core Strategy (2009)*

Policy CS1 Sustainable Development in Huntingdonshire; this promotes sustainable development including making best use of land, including the remediation of contaminated land.

- *Huntingdonshire Draft Local Plan to 2036*

Policy LP15 Ensuring a High Standard of Amenity; a proposal would be expected to demonstrate how it addresses the potential for adverse impacts from the contamination of land, groundwater or surface water.

## 12.2 Method of assessment

### Approach

#### *Spatial and temporal scope*

- 12.2.1 The assessment is based on guidance outlined in *Design Manual for Roads and Bridges Volume 11, Section 3, Part 11* (Highways Agency et al., 1999), adapted to take account of current legislation and guidance as outlined above.

- 12.2.2 The assessment area for the assessment of geology, soils and contamination includes:
- The scheme, including proposed borrow pits and flood compensation areas;
  - The adjacent and surrounding land; and
  - Groundwater receptors which may be impacted and/or affected by contamination through disturbance during construction and/or operation or off-site sources of contamination which might impact the scheme.
- 12.2.3 The assessment area generally includes a 250m buffer zone around the physical works boundary (i.e. the scheme boundary, but excluding the areas where no physical works would be undertaken such as the detrunking of the existing A14), extending to a greater distance should potential for contamination migration (either on or off-site) justify it. The assessment area is presented on *Figure 12.1*.
- 12.2.4 The inclusion of a 250m buffer is based on the *Guidance for the Safe Development of Housing on Land Affected by Contamination* (Environment Agency, 2008). This buffer is a conservative approach due to the lower sensitivity of roads relative to housing, but reasonable in the context of the scheme taking into account the distance over which contamination can migrate, and the relatively low density of development in the area of the scheme.
- 12.2.5 The baseline impact assessment is based on the ground conditions in 2014. Some of the data on which this assessment is based were collected during 2008 and 2009, however it is unlikely that ground conditions have changed significantly during this period, with the exception of some specific areas detailed later in the assessment. In general, ground conditions are not expected to change significantly between 2014 and 2016 (construction) or 2020 (operation).
- 12.2.6 At this preliminary design stage of the scheme, the assessment of likely construction impacts has been based upon the information provided within *Appendix 3.2*. For the purposes of this assessment, the likely worst case scenario assessed assumes that construction would be carried out concurrently across the scheme. This is a reasonable assumption for this assessment because the overall assessment of effects would not change if the works were undertaken within the specific envisaged periods for each section of works as described in *Appendix 3.2*. The baseline year of 2016 remains relevant across the construction programme, including section 6 which would not commence until the new route was operational, because the assessed conditions are not expected to change over the duration of the programme as presented in *Appendix 3.2*.
- Contamination risk assessment*
- 12.2.7 The process of contamination risk assessment, as defined in *CLR 11*, adopted for this assessment includes:

- Hazard identification, which involves establishing contaminant sources and hazard assessment, which involves establishing pathways (a route or means by which a receptor can be exposed to, or affected by, a contaminant) and receptors, and identifying potential pollutant linkages. Both hazard identification and assessment stages conclude in development of the conceptual site model.

- Risk estimation, which predicts the likelihood of harm or pollution occurring (probability assessment) and the degree of harm or pollution occurring (consequence assessment). Risk estimation is only undertaken when a potential pollutant linkage exists. Risk estimation has two components:
  - Probability assessment which relates to whether pollution/harm could occur in the short- and/or long-term; and
  - Consequence assessment which relates to the magnitude of harm that could occur because of the potential pollutant linkage, that is, the degree of harm or pollution considering the sensitivity of the receptor.
- Risk evaluation, which is the process of deciding whether a risk is acceptable or not, entails the application of evaluation criteria, which may be absolute standards or recommended limit values, for example, a health criterion for the intake of a substance.

12.2.8 This simple contamination risk assessment collates existing desk based and intrusive investigation information, reviewed and updated where required. In areas of the scheme where relevant intrusive investigation has not been completed previously (e.g. Huntingdon), a preliminary risk assessment has been completed in accordance with *CLR 11* to assess the risks and the potential impact of the scheme. This included a site walkover. This approach is sufficient to allow the reasonable worst case impacts from the scheme to be assessed.

#### Assessment criteria

12.2.9 Contaminated land risk assessment is typically undertaken by determining the risk to receptors from contamination within soils and/or groundwater. Receptors include humans, controlled waters, buildings and structures and the environment. Environmental impact assessment is typically undertaken by determining the risk to receptors from the scheme.

12.2.10 When assessing the effect of the scheme on contamination the assessment considers the likely significant effects from mobilisation of existing contamination and creation/amendment of pollution linkages as a result of the scheme. Equally, through effective mitigation measures, beneficial effects may be achieved, such as through breakage of existing pollutant linkages. The value of the resource, and the magnitude of the effect of the existing contamination and existing pollutant linkages, is determined as the baseline by interpreting the guidance outlined within *CLR 11*.

12.2.11 The value (sensitivity) of the identified receptors for the scheme is assessed using the general criteria outlined in *Table 12.1*. The approach, which is in accordance with the scoping report for this environmental assessment, is based on assessment by appropriately qualified and experienced professional specialists, as listed in *Appendix 6.1*.

**Table 12.1: Determining the value of the receptors**

Value /sensitivity of receptor / resource	Criteria
<b>High to very high</b>	<p>Areas containing geological features considered to be of a national interest e.g. Sites of Special Scientific Interest.</p> <p>Presence of source-pathway-receptor contamination linkage with a high risk of the possibility of causing significant harm to the scheme, environment, site workers and/or end users.</p>
<b>Medium</b>	<p>Areas containing geological features of designated regional importance considered worthy of protection for their educational, research, historic or aesthetic importance e.g. Regionally Important Geological Sites.</p> <p>Presence of source-pathway-receptor contamination linkage with moderate risk of causing significant harm to the scheme, environment, site workers and/or end users.</p>
<b>Low to negligible</b>	<p>Geological features not currently protected and not considered worthy of protection.</p> <p>Presence of source-pathway-receptor contamination linkage with a low risk of causing significant harm to the scheme, environment, site workers and/or end users.</p>

12.2.12 The magnitude of the impact (adverse or beneficial) on the identified receptors for the scheme would be assessed using the general criteria outlined in *Table 12.2*.

**Table 12.2: Determining the magnitude of the impact**

Magnitude of impact	Criteria (adverse)	Criteria (beneficial)
<b>Major</b>	<p>Partial (greater than 50%) or total loss of a geological site, or where there would be complete severance of a site such as to affect the value of the site.</p> <p>Contamination levels encountered in excess of human health, environment and/or property assessment criteria requiring significant remediation works.</p> <p>Significant volumes of excavated material being designated from a contamination perspective as unsuitable for re-use on-site and requiring off-site disposal.</p> <p>Requirement for significant re-engineering of landfill infrastructure and waste containment systems.</p>	<p>Partial (greater than 50%) or total creation of a geological site of high to very high value by (for example) exposing geology previously obscured from view.</p> <p>Significant bettering of ground or groundwater quality/contamination conditions through remediation and/or mitigation.</p> <p>Significant potential for re-use of site-won materials without any pre-treatment required.</p>

Magnitude of impact	Criteria (adverse)	Criteria (beneficial)
<b>Moderate</b>	<p>Loss of part (between approximately 15% and 50%) of a geological site, major severance, major effects to the setting, or disturbance such that the value of the site would be affected, but not to a major degree. Contamination levels marginally above human health environment and/or property assessment criteria requiring significant remediation works.</p> <p>Moderate volumes of excavated material being designated from a contamination perspective as unsuitable for re-use on-site and requiring off-site disposal.</p> <p>Requirement for slight re-engineering of landfill infrastructure and waste containment systems.</p>	<p>Partial (greater than 50%) or total creation of a geological site of medium value by; for example, exposing geology previously obscured from view or creation of part (between 15% to 50%) of a geological site of high to very high value.</p> <p>Moderate bettering of ground or groundwater quality/contamination conditions through remediation and/or mitigation.</p> <p>Significant potential for re-use of site-won materials with limited pre-treatment required.</p>
<b>Minor</b>	<p>Minimal effect on the geological site (up to 15%) or a medium effect on its setting, or where there would be a minor severance or disturbance such that the value of the site would not be affected.</p> <p>Contamination levels below human health or environment assessment criteria but minor remediation / mitigation works required as a result of impact to property.</p> <p>Small volumes of excavated material being designated from a contamination perspective as unsuitable for re-use on-site and requiring off-site disposal.</p> <p>Requirement for re-engineering of landfill infrastructure (not extending into the landfill waste containment system).</p>	<p>Partial (greater than 50%) or total creation of a geological site of medium value by (for example) exposing geology previously obscured from view.</p> <p>Slight bettering of ground or groundwater quality/contamination conditions through remediation and/or mitigation.</p> <p>Moderate potential for re-use of site-won materials with limited pre-treatment required.</p>

Magnitude of impact	Criteria (adverse)	Criteria (beneficial)
<b>Negligible</b>	<p>Very slight change from baseline condition. Change hardly noticeable approximating to a 'no change' condition.</p> <p>Contamination levels below human health, environment and property assessment criteria and no remediation required.</p> <p>Very minimal to no material excavated being designated from a contamination perspective as unsuitable for re-use on-site and requiring off-site disposal.</p> <p>Requirement for slight or negligible re-engineering of landfill infrastructure (not extending into the landfill waste containment system).</p>	<p>Partial (between approximately 15% to 50%) creation of a geological site of medium value by (for example) exposing geology previously obscured from view.</p> <p>Negligible bettering of ground or groundwater quality/contamination conditions through remediation and/or mitigation.</p> <p>Low potential for re-use of site-won materials with limited pre-treatment required.</p>

12.2.13 The significance of the effects (the consequences of the impacts) is assessed using the criteria outlined in *Table 6.1 of Chapter 6*.

### Consultation

- 12.2.14 The consultation process is described in *Chapter 5*. Consultation with regard to geology and soils largely took place through the scoping report which outlined the key issues proposed to be covered in the Environmental Statement (ES), to enable consultation with the Planning Inspectorate (PINS) and statutory consultees. The Environment Agency and local authority responses to the scoping report were mainly generic, but also raised specific points with regard to the landfills in proximity to the proposed route, in particular Milton landfill and Buckden South landfill,
- 12.2.15 The operators of Milton landfill were consulted with regard to the infrastructure and containment measures present in the vicinity of the proposed scheme. As a result of this consultation the engineering design of the scheme was altered to minimise the land take adjacent to the landfill. This included realignment of the A10 slip road with the addition of a retaining wall between the slip road and the main A14 carriageway, and repositioning of a gantry.
- 12.2.16 The operators of Buckden South landfill were also consulted with regard to landfill infrastructure in the vicinity of the scheme. The scheme is diverted to the south of Buckden landfill to avoid impacting the landfill.
- 12.2.17 Consultation was also undertaken in 2014 with the East of England Geodiversity Partnership (Geo-East) who confirmed that there are no RIGS present within the area.

## Limitations

- 12.2.18 Subsurface ground conditions are hidden from view and no assessment can be exhaustive to the extent that all soil and groundwater conditions are fully understood, especially in the case of Made Ground which is often highly variable. Made Ground is defined by the British Geological Survey as material which is known to have been placed by humans on the pre-existing natural or artificial land subsurface. On this basis actual ground conditions throughout the scheme have the potential to be at variance to those which have been reported here.
- 12.2.19 Assessment of the likely worst case impacts has been undertaken using a preliminary risk assessment process as outlined within *CLR 11*. Intrusive investigation is being undertaken to inform detailed design, including geotechnical design. It is being undertaken in the areas not previously investigated, as well as areas already investigated, to further inform the scheme design and ensure that unacceptable risks related to contamination are mitigated. The requirement for the intrusive investigation and subsequent interpretation is included within the Register of environmental actions and commitments (*Appendix 20.1*).
- 12.2.20 The intrusive investigation and subsequent interpretation would also be used to inform the contamination aspects of reusability of soils and aggregates derived from on-site. Derivation of soil acceptance criteria for determining reusability of soils and aggregates derived on-site (and imported from off-site) would be undertaken as part of the detailed design. The soil acceptance criteria would be derived to ensure that materials re-used or imported onto the site are determined 'suitable for use'. Deposition of material would be undertaken using either *Environmental Permitting (England and Wales) (Amendment) Regulations 2014* or the *Definition of Waste: Development Industry Code of Practice (CL:AIRE 2011)*.

## 12.3 Baseline conditions

### Sources of information

- 12.3.1 Previous reports relevant to this assessment include those listed below; information from these reports which is relevant to this assessment is summarised in *Appendix 12.1*:
- *A14 Improvement Ellington to Fen Ditton Preliminary Sources Study Report* (Atkins, 2004);
  - *A14 Improvement Ellington to Fen Ditton Land Contamination Technical Summary Report Section 1* (Atkins, 2009);
  - *A14 Improvement Ellington to Fen Ditton Land Contamination Technical Summary Report Section 2* (Atkins, 2009);
  - *A14 Improvement Ellington to Fen Ditton Land Contamination Technical Summary Report Section 3* (Atkins, 2009);
  - *A14 Ellington to Fen Ditton Phase 1a Preliminary Sources Study Report (Huntingdon Local Connections)* (Atkins, 2009);

- *A14 Ellington to Fen Ditton Phase 1a Ground Investigation Report Section 1* (Atkins, 2009);
- *A14 Ellington to Fen Ditton Phase 1a Ground Investigation Report Section 2* (Atkins, 2009);
- *A14 Ellington to Fen Ditton Phase 1a Ground Investigation Report Section 3* (Atkins, 2009);
- *A14 Improvement Ellington to Fen Ditton Environmental Statement* (Highways Agency, 2009). Available at: [http://iprojects.costain.com/a14\\_public\\_area/Public/DVD1.html](http://iprojects.costain.com/a14_public_area/Public/DVD1.html). Accessed 10 September 2014;
- *A14 Improvement Cambridge to Huntingdon Preliminary Sources Study Report Addendum* (Atkins, 2013);
- *Milton Landfill PPC Application Volumes 1 to 3* (East West Waste Limited, 2003);
- *Milton Landfill Leachate Management Plan* (FCC Environment, 2013);
- *Land Between Tin Lane and Station House, Brampton Road, Buckden - Phase 1 Contamination Report* (AF Howland Associates Limited, 2013);
- *A Report on Ground Investigation for a proposed Fuel Distribution Depot at Brampton Road, Buckden* (AF Howland Associates Limited, 2014);
- *Remediation Implementation and Verification Plan, Former Buckden Fuel Depot* (Arcadis, 2014);
- *Mill Common, Huntingdon, Cambridgeshire, Trench Evaluation and Community Archaeology Project* (Cambridgeshire County Council Archaeological Field Unit, 2006); and
- *A14 Improvement Scheme, Cambridgeshire, SiteSafe UXO Desk Study* (Zetica, 2014).

12.3.2 It should be noted that for earlier work on the scheme, undertaken by others and which previously extended to Fen Ditton (east of Cambridge), the previous scheme was divided into three sections:

- Section 1: Between Ellington and Fen Drayton;
- Section 2: Between Fen Drayton and Histon; and
- Section 3: Between Histon and Fen Ditton.

12.3.3 For the purposes of this assessment, the information is presented with reference to the current scheme which is geographically split into the following six sections, described in more detail in *Chapter 3*:

- Section 1: A1 Alconbury to Brampton Hut: Online widening.
- Section 2: A1/A14 Brampton Hut to East Coast Main Line (ECML): comprises a new bypass, incorporating connections between the A1 and the A14 and a road viaduct crossing the river Great Ouse.

- Section 3: ECML to Swavesey: A new section of three lane dual carriageway connecting to the existing alignment of the A14 at a junction south of Swavesey.
  - Section 4: A14 Swavesey to Girton (incl. Girton interchange): Online widening, including the construction of new access roads and reconfiguring of junctions.
  - Section 5: Cambridge Northern Bypass, Histon to Milton; online widening.
  - Section 6: Huntingdon Viaduct Demolition and A14 detrunking: Demolition of the Huntingdon A14 viaduct over the railway and Brampton Road, and construction of new link roads.
- 12.3.4 Many of the reports listed above refer to Sections 1 to 3 of the previous Ellington to Fen Ditton section which do not relate to the section numbering of the scheme being assessed.
- 12.3.5 Other sources used to complete the preliminary risk assessment as outlined in *CLR 11* include:
- Environment Agency What's In Your Backyard Online Mapping website: <http://apps.environment-agency.gov.uk/wiyby/default.aspx> (accessed November 2013 through June 2014);
  - Google Earth and Maps aerial photography and mapping: <http://maps.google.co.uk> (accessed between November 2013 and June 2014);
  - British Geological Survey (<http://www.bgs.ac.uk/GeoIndex> iGeology and Geoindex website (accessed between November 2013 and June 2014); and
  - Landmark Envirocheck Report covering Section 6 (Huntingdon improvements): Report reference: 52214422\_1\_1 (January 2014).

### Potentially contaminative land uses

#### *Current land uses*

- 12.3.6 A description of current land uses and the general topography for the scheme is provided within *Chapter 2*. The majority of the scheme passes through farmland. The following provides a summary of the sites with a potentially significant contaminative current land use. The sites are shown on *Figure 12.1*.
- 12.3.7 A site walkover of key areas of potentially contaminative land use was undertaken in May 2014. A site walkover of the Milton landfill site was undertaken in August 2014.

12.3.8 Sites with potentially contaminative land use and potential to significantly affect the scheme or be impacted by the scheme include:

- Former Buckden fuel depot, which is located to the east of Brampton Road, in vicinity to the proposed Brampton interchange and on the alignment of the scheme.
- Buckden South landfill, which is a closed landfill site within 10m of the alignment between Brampton Road and the East Coast Main Line railway.
- Buckden North landfill, which is a permitted, partially restored, partially operational landfill within approximately 10m of the re-aligned Buckden Road.
- Milton landfill, which comprises a permitted landfill (partially restored in the area of the scheme) to the north of the existing A14 at the far eastern end of the scheme.

12.3.9 These sites are discussed further below.

12.3.10 *Table 4.1* within *Appendix 12.1* provides details of all identified current potentially contaminative land uses, including those which are considered unlikely to have potential to be significant in the context of the scheme.

#### *Historical land uses*

12.3.11 A number of ordnance survey historical maps and environmental data reports procured from Landmark Information Group Limited (Landmark) were reviewed to inform historical development of the land surrounding the scheme and to inform the presence of historic (and current) potentially contaminative sites. The dates and references for the Landmark reports referred to are detailed in *Appendix 12.1*.

12.3.12 *Table 4.1* within *Appendix 12.1* provides details of historic potentially contaminative land uses. No further sites, over and above the former Buckden fuel depot, Buckden South landfill, Buckden North landfill and Milton landfill have been identified as being likely to be significant in the context of the scheme.

### **Geology**

#### *Published geology*

12.3.13 The published geology for the study area, based on the British Geological Survey 1:50,000 scale mapping is summarised in *Table 12.3*, in order of geological age. The published geology is also shown on *Figure 12.2* (Superficial deposits) and *Figure 12.3* (Bedrock geology) although it is noted that only 1:625,000 scale mapping is shown (and there are differences in geological nomenclature and grouping between the two scales of published mapping).

**Table 12.3: Published geology of the study area**

Geological unit		Geological period	
Superficial (Drift)	Alluvium (including Peat)	Recent and Pleistocene	
	River Terrace Deposits		Fourth Terrace
			Third Terrace
			Second Terrace
			First Terrace
	Glacial Deposits		Oadby Member Diamicton
Head Deposits			
Bedrock (Solid)	Gault Clay	Upper Cretaceous	
	Woburn Sands (Lower Greensand Group)	Lower Cretaceous	
	Kimmeridge Clay	Upper Jurassic	
	Amphill Clay		
	Oxford Clay		

- 12.3.14 Superficial deposits comprising Alluvium (including Peat), River Terrace Deposits and Glacial Deposits are present beneath the scheme between Ellington and Offord Cluny, to the south of Fen Drayton and throughout much of the scheme between Girton and Milton. Glacial Diamicton (gravels and till) are present beneath much of the western extent of the scheme between Brampton and the A1198. Glacial Head Deposits are shown to the immediate east of Girton.
- 12.3.15 Bedrock strata dip generally to the south-east and all solid geological units sub crop over some length of the scheme. The solid sequence starts with the Oxford Clay which lies close to the surface at the west end of the scheme and progresses through the various geologies with the Gault Clay present either at the surface or beneath superficial deposits at the eastern end of the scheme.
- 12.3.16 Huntingdon is underlain entirely by bedrock geology of the Oxford Clay which is in parts overlain by Alluvium, River Terrace Deposits and Glacial Deposits.
- 12.3.17 There are no designated Geological or Geomorphological Sites of Special Scientific Interest (SSSI) within the assessment area. Consultation with the East of England Geodiversity Partnership (Geo-East) in 2014 has confirmed there are no Regionally Important Geological Sites (RIGS) are known to exist within the assessment area.
- 12.3.18 A geological SSSI is present at Histon Road approximately 500m south of the scheme boundary in proximity to the Histon interchange. The deposit is important because it provides an almost complete record of the second half of the Ipswichian Interglacial, a period of time so far represented at only one other site outside East Anglia. The deposits at this site are currently unexposed, but its current use as allotments means that access to the deposits for future study is still possible.

*Geology encountered during ground investigations*

12.3.19 A number of ground investigations were undertaken in the 2000s directly associated with earlier schemes, including:

- Preliminary Ground Investigation, A14 Ellington to Fen Ditton, Geotechnical Engineering Limited for Costain/Skanska Joint Venture (Designer: Atkins) – the fieldwork was carried out in March and April 2008 and comprised 20 boreholes, 11 trial pits, 6 window samples, 6 dynamic probes and 132 Cone Penetration Tests (CPT).
- Main Ground Investigation, A14 Ellington to Fen Ditton - Section 1, Costain Geotechnical Services Limited for Costain/Skanska Joint Venture (Designer: Atkins) – the field work was carried between June and December 2008 and comprised 61 cable percussion boreholes (33 of which had rotary follow on drilling), 1 rotary borehole, 52 window sampler boreholes, 64 trial pits and 122 CPT.
- Main Ground Investigation, A14 Ellington to Fen Ditton - Section 2, Costain Geotechnical Services Limited for Costain/Skanska Joint Venture (Designer: Atkins) – the field work was carried out between June and December 2008 and comprised 42 cable percussion boreholes (28 of which had rotary follow on drilling), 36 window sampler boreholes, 42 trial pits and 163 CPT.
- Main Ground Investigation, A14 Ellington to Fen Ditton - Section 3, Costain Geotechnical Services Limited for Costain/Skanska Joint Venture (Designer: Atkins) – the field work was carried out between June and December 2008 and comprised 12 cable percussion boreholes (6 of which had rotary follow on drilling), 1 rotary borehole, 34 window sampler boreholes, 4 trial pits and 25 CPT.

12.3.20 The ground investigations broadly confirm the published geology with the addition of some localised specific features, for example additional areas of Glacial Till and Head Deposits. Detailed presentation of ground conditions encountered is not considered relevant for the purposes of this environmental statement. Given the emphasis of this chapter on contamination conditions encountered greater detail is provided on the Made Ground and indicators of contamination identified.

- 12.3.21 The geology of the western section between Alconbury and Swavesey interchange (Sections 1, 2 and 3 of the scheme) typically comprises topsoil with Made Ground in certain locations underlain by Drift comprising Alluvium, River Terrace Deposits and/or Glacial Deposits (Head Deposits and Glacial Till). Drift Deposits are underlain by solid strata comprising (west to east) Upper Jurassic age Oxford Clay, Ampthill Clay and Kimmeridge Clay. The Made Ground, which was up to 5.5m thick (at BH3096 to the east of Buckden South landfill) was found to be highly variable and a mixture of cohesive and granular material containing brick, concrete, ceramics and occasionally tarmac. A hydrocarbon odour was noted in WS3077 and WS3079 at the derelict former Buckden fuel depot and at TP3088 to the south of Buckden South landfill where "*Occasional pockets (up to 60mm) of black material with a very strong diesel/oil odour*" were recorded within River Terrace Deposits. There were no other indications of hydrocarbons recorded within Sections 1, 2 and 3 of the present scheme.
- 12.3.22 The geology of Section 4 (Swavesey to Girton) comprises typically topsoil and/or Made Ground (including embankment fill) in most locations underlain directly by solid strata comprising (west to east) Upper Jurassic age Kimmeridge Clay and the Cretaceous age Woburn Sands and Gault Clay. Made Ground was encountered in selected locations throughout the length of the scheme, and was principally found in locations where intrusive investigation was targeted on areas of potential concern for contamination. Made Ground was typically described as sandy, gravelly clay with gravel of flint and occasionally limestone, brick, ceramic, concrete, metal, charcoal and clinker.
- 12.3.23 Embankment fill was present in five areas within Section 4. Locations were generally offset from the scheme alignment and comprised earthworks forming junction slip roads or landscape bunds associated with the existing A14. A short stretch of embankment at Girton interchange had embankment fill up to 8.6m in height. Embankment fill was described typically as a gravelly sand or sandy gravelly clay, with predominantly flint gravel and occasionally chert, limestone, mudstone, ironstone, granite, concrete, clay pipe, tarmac, clinker and lignite.
- 12.3.24 A strong diesel odour was recorded at BH4288 at Girton interchange within Made Ground between 0.9m and 1.0m bgl. Also at Girton, a diesel odour was recorded at BH4210D within the Made Ground from ground level to 0.35m bgl,
- 12.3.25 At TP4117A (within Made Ground, 1.1m to 3.1m) in Bar Hill a strong hydrocarbon odour was recorded within the engineered fill. A hydrocarbon type odour was noted in BH4290 (east of Dry Drayton interchange) at a depth of 0.8 to 0.95m.

- 12.3.26 The geology of Section 5 (Girton to Milton) comprises typically topsoil and/or Made Ground (including embankment fill) in most locations underlain for the majority of the section by River Terrace Deposits. The Gault Clay is the solid strata underlying the entirety of the section. The embankment fill was found to be highly variable throughout Section 5, but typically comprises a clayey gravelly sand within the top 1.5m, overlying a sandy gravelly clay. The clay is typically described as firm or stiff. Made Ground was identified at several locations, specifically to the north of the Cambridge Regional College and at Impington bridge. The Made Ground was generally recorded as free from visual and olfactory indicators of contamination although ash, clinker, concrete, charcoal, coal and textiles were occasionally noted.
- 12.3.27 The historic ground investigations in Section 6 (Huntingdon improvements) were undertaken in 1965/1966. The investigation broadly confirmed published geology; Oxford Clay overlain by Alluvium, River Terrace Deposits and Glacial Deposits. Variable Made Ground was encountered within many boreholes, with deposits generally comprising sandy clay and stones with occasionally pottery, or brick and concrete fragments. At one location, near Huntingdon railway station, the Made Ground was described as *“stiff laminated grey silty clay and some industrial dust”*.
- 12.3.28 An archaeological investigation was undertaken in 2006 at Mill Common. The scheme passes through the south-eastern corner of Mill Common where there is evidence of infilled quarry. Only one hand pit was extended in this area to a depth of 1.1m below ground level (bgl). The Cambridgeshire County Council Archaeological Field Unit report notes *“This series of fills represents a small sample of the many layers of infilling within the larger quarry area consisting of a mix of silty sands, sandy clays and clay silts with varying quantities of domestic refuse intermixed. An area of quarrying such as this so close to the town would have become a general rubbish tip.”*

### Hydrogeology

#### *Published hydrogeology*

- 12.3.29 The aquifer classification status for each of the geological units and discussion of Source Protection Zones (SPZ) within the study area is presented within *Chapter 17* to which reference should be made. To aid the reader of this chapter, a summary of the aquifer classifications is presented below within *Table 12.4*.

**Table 12.4: Aquifer classifications in the study area**

Stratum	Aquifer classification
Alluvium	Secondary A
River Terrace Deposits	Secondary A
Glacial Head Deposits	Secondary Undifferentiated
Oadby Member Diamicton	Non Productive
Gault Clay Formation	Non Productive
Woburn Sands Formation	Principal Aquifer
Kimmeridge Clay Formation	Non Productive
Ampthill Clay Formation	Non Productive
Oxford Clay Formation	Non Productive

12.3.30 As can be seen on *Figure 12.3*, the scheme is only directly underlain by geological units with the most sensitive aquifer classification (the Woburn Sands Principal Aquifer) for less than 1.5km of the route (between Bar Hill and the Dry Drayton interchange), although the aquifer is present at depth beneath the Gault Clay for a further 8.5km of the scheme (from Dry Drayton to Milton). The lower sensitivity Secondary Aquifers in the superficial deposits are present over a greater proportion of the scheme (see *Figure 12.2*). Whilst these Secondary Aquifers are considered as receptors in their own right under the WFD they are primarily potential pathways of contamination to other receptors such as surface water bodies, Principal Aquifers or water-dependent ecological receptors. As discussed in *Chapter 17*, a number of water-dependent ecological receptors have been identified within the study area; in particular, extensive wetlands associated with the river Great Ouse/Buckden Gravel Pits complex and the Park Road Grasslands near Section 2 of the scheme.

#### *Discharges to groundwater*

12.3.31 With reference to the Landmark Information Group Ltd Envirocheck Reports procured for the study area, discharges to groundwater within 500m of the scheme have been identified. These are presented in *Table 2.1* within *Appendix 12.1*.

12.3.32 The discharges have all been identified as being related to agricultural practices. These are considered to have only limited potential to affect the scheme with regards contamination and are not considered further as sources of significant contamination in the context of the scheme. Existing ground investigation and contamination results do not suggest widespread or gross contamination should be anticipated from the agricultural activities within the study area.

#### *Abstractions from groundwater*

12.3.33 With reference to the Landmark Information Group Ltd Envirocheck Reports procured for the study area, abstractions from groundwater within 500m of the physical works scheme boundary have been identified. These are presented in *Table 2.2* within *Appendix 12.1*.

- 12.3.34 No active potable abstractions are reported within 500m of the scheme. A revoked potable abstraction, which is from the 'Greensand' i.e. the Woburn Sands Formation, is identified south of Huntingdon. However, the Woburn Sands are not present either at the surface or at depth at the reported location so it is considered an incorrect entry. It is likely that the abstraction is from underlying Jurassic limestone deposits, not the Cretaceous Woburn Sands. As the abstraction is revoked, significant impact from the scheme is unlikely.
- 12.3.35 The remainder of the abstractions identified are not considered to be significantly sensitive to water quality, such as abstractions for general farming purposes, with the possible exception of the 'industrial processing' abstraction from the Woburn Sands Formation (Bard Pharmaceuticals Ltd.). This abstraction is 230m to the south of the scheme and is reported as revoked. As such, significant impact from the scheme is unlikely.

*Groundwater conditions encountered during ground investigations and monitoring*

- 12.3.36 The 2008 and 2009 ground investigations and groundwater monitoring (including monitoring undertaken in 2011) encountered perched water in all areas of the Made Ground, together with groundwater in the Alluvium, River Terrace Deposits, Head Deposits, Glacial Till, Woburn Sands and Oxford Clay. Further details on groundwater levels are provided in *Chapter 17*.

**Hydrology**

- 12.3.37 There are a number of surface water courses present within the scheme of which the principal one is the river Great Ouse.

*Discharges to surface water*

- 12.3.38 With reference to the Landmark Information Group Ltd Envirocheck Reports (2013 and 2014) procured for the study area, discharges to surface water within 500m of the scheme were identified. These are presented in *Table 2.3* within *Appendix 12.1*.
- 12.3.39 None of the identified discharges are considered as significant contamination sources in the context of the scheme and as such are not considered further within this chapter.

*Abstractions from surface water*

- 12.3.40 With reference to the Landmark Information Group Ltd Envirocheck Reports (2013 and 2014) procured for the study area, abstractions from surface water within 500m of the scheme were identified. These are presented in *Table 2.4* within *Appendix 12.1*.
- 12.3.41 Of the recorded abstractions it is noted that the only surface water abstractions not reported as revoked are for spray irrigation - these are not considered to be liable to be significantly impacted by water quality (i.e. they are not potable or processing purposes).
- 12.3.42 Further details on hydrology and drainage are provided in *Chapter 17*.

## Baseline conceptual site model

### *Introduction*

- 12.3.43 The conceptual site model, generated as part of the preliminary risk assessment, draws upon information from a variety of sources including previous reports, environmental database searches (Envirocheck (2013 and 2014), Environment Agency website (2014)), site walkovers, intrusive investigation, chemical soil and groundwater sampling and gas monitoring.

### *Potential sources of contamination*

- 12.3.44 A number of areas of potentially contaminative land uses (current and historic) are identified in the previous sections and are presented in *Table 4.1* within *Appendix 12.1*. The potentially contaminative land uses are shown on *Figure 12.1*.
- 12.3.45 *Appendix 12.1* provides details of site observations, relevant soil, leachate or groundwater chemical sampling data and exceedances against assessment criteria and ground gas monitoring data available from the Costain 2008/2009 investigation.
- 12.3.46 Chemical sampling results and exceedances/ground gas monitoring data are discussed further within the *Baseline Contamination Risk Assessment* section later in this chapter.
- 12.3.47 Farms are present within proximity of the scheme. Farms have a limited capacity to have caused contamination in the context of the scheme. *Table 4.1* within *Appendix 12.1* lists only those farms for which the scheme encroaches into farm-yard areas. Farm-yard areas are considered to be the areas where contamination is most likely to be encountered. General agricultural land use, which covers the remainder of farms nearby is listed as a potential site wide contamination source, as well as Made Ground/embankment fill in existing areas of road and spillages/leakages from existing road usage.
- 12.3.48 The Buckden former fuel depot, Buckden South landfill, Buckden North landfill and Milton landfill are discussed in detail below.

### *Former Buckden fuel depot*

- 12.3.49 The scheme would traverse the former Buckden fuel depot. It is located to the west of Buckden South landfill and has an approximate area of 3700m<sup>2</sup>. The site is shown as being a petrol store on historical mapping dating from 1927. The site currently comprises vacant land in a poor state of repair. Investigation undertaken by Costain in 2008/2009 encountered strong hydrocarbon odours and black staining within the Made Ground.
- 12.3.50 It is understood that the current site owners are close to undertaking a scheme of voluntary remediation of a hydrocarbon plume at the site, and have already undertaken some remediation of a small area of the adjacent undeveloped land owned by a third party.

- 12.3.51 According to the *Remediation Implementation and Verification Plan, Former Buckden Fuel Depot* (Arcadis, 2014) the site was used as a fuel depot, with gas oil, diesel, kerosene and petrol reported to be stored at the site in underground and above ground storage tanks. Decommissioning works were undertaken on the site in 2005 and included removal of above ground storage tanks and underground storage tanks. When the underground tanks were removed, the supporting concrete cradles were left in place, and the excavation backfilled. Investigation in 2012 and 2013 indicated that there was Light Non Aqueous Phase Liquid (LNAPL) comprising degraded kerosene and degraded diesel on the shallow groundwater at the site and the extent of LNAPL contamination was delineated using laser induced fluorescence techniques. A risk assessment agreed with the Environment Agency concluded that the risks to human health and the environment from the contamination present at the site were not significant. The Environment Agency expressed a preference that LNAPL should be recovered from the site as far as practicable. The proposed voluntary remediation at the site would meet this request.
- 12.3.52 The proposed remedial works are programmed to be completed in 2014. The objective of the proposed works is the removal, recovery or treatment of LNAPL to minimise the potential for dissolution of petroleum hydrocarbons to groundwater. Soils would be excavated to a depth of up to 4.5m below ground level with a total estimated excavation volume of 1336m<sup>3</sup>. Excavated soils would be screened, segregated and treated as necessary in order to achieve the remediation criteria. Measures are proposed to ensure excavation stability and groundwater ingress, and may include the use of temporary sheet piling and battered slopes. The main soil treatment method proposed is the use of bio-piles, with suitable treated and screened soil re-used within the scheme for backfill. Backfilling is to be carried out in accordance with the highway specification '*Clause 612, Compaction of Fills of Volume 1 of the Specification for Highway Works: Series 600: Earthworks*' (Highways Agency, 2009).
- 12.3.53 Soils identified through the screening process to satisfy the remediation criteria would be segregated and stockpiled for re-use on site. The current site levels would be restored. On completion of the excavation works it is anticipated that any shoring used to support the excavation would be removed, subject to detailed design. The remediation plan for the adjacent land suggests that a low permeability barrier may be left in situ to protect the adjacent Goff Petroleum site from further migration of residual dissolved contamination.
- 12.3.54 For the purposes of this assessment, it is assumed that the remediation as outlined above will be undertaken by the landowner prior to commencement of construction of the scheme. In the event that the remedial works are not undertaken by the landowner prior to construction, it is assumed that equivalent remedial works would be undertaken as part of the scheme.

### Buckden South landfill

- 12.3.55 The scheme passes within approximately 10-15m of the southern boundary of Buckden South landfill at its closest point. Buckden South is a closed landfill site, previously operated by Refuse Disposal Ltd. It is understood however that FCC Environment Ltd., who operate the adjacent Buckden North landfill, undertake on-going environmental monitoring of the site.
- 12.3.56 The Buckden South landfill has been operational since the 1930s and covers an area of approximately 40 hectares. The last waste was accepted in 1994.
- 12.3.57 Prior to its use as landfill, the site was used for gravel extraction. The site was worked by Inns and Company in 1947 when planning permission was granted to continue the sand and gravel extraction. The sand and gravel was excavated to a depth of between 3m and 5.5m below existing ground level. Stiff Oxford Clay underlies the gravels to a depth of approximately 23m below ground level.
- 12.3.58 The landfill accepted a range of household, commercial/industrial and liquid/sludge waste. There is also evidence that asbestos waste, animal carcasses and clinical wastes were also accepted. Up to 20m thickness of waste is present in a domed landform with at least a 1m clay capping.
- 12.3.59 Landfill gas generated at both Buckden South and Buckden North landfills is collected and pumped to two gas turbines which generate electricity for use in the local grid.
- 12.3.60 The Buckden South landfill was constructed in cells using site won Oxford Clay. Leachate from the landfill is treated via dedicated plant to the east of the site though the available existing information indicates that leachate has previously possibly escaped from the southern boundary and the Costain 2008/2009 investigation encountered elevated ammoniacal nitrogen (and arsenic) within groundwater (refer to *Table 4.1* within *Appendix 12.1* for further details). Ammoniacal nitrogen is a common component of landfill leachate.
- 12.3.61 Environmental monitoring results for the period September 2009 to July 2014 were received from FCC Environmental Ltd. for nine combined gas and groundwater monitoring boreholes around the perimeter of Buckden South landfill. The results of the monitoring were reviewed and a summary of the pertinent gas and groundwater quality information is provided within *Table 5.1* within *Appendix 12.1*.
- 12.3.62 The scheme does not extend within the landfill boundary and accordingly containment infrastructure would not be impacted. Monitoring boreholes are also located within the boundary of the landfill and are not anticipated to be impacted.
- 12.3.63 The area surrounding Buckden South landfill would be further investigated as part of the intrusive investigation discussed above although the information available at the time of writing this environmental statement is suitable to allow a robust assessment of the reasonable worst case impact from the scheme upon the site and vice versa.

12.3.64 Review of the gas and groundwater monitoring data indicates that landfill gas is not present in the perimeter monitoring wells pertinent to the scheme at concentrations likely to be significant to the scheme. There is some evidence of low levels of leachate derived pollutants present in the groundwater, but the concentrations are not considered significant to the scheme.

*Buckden North landfill*

12.3.65 The current scheme includes re-alignment works on Buckden Road which is adjacent to the western boundary of Buckden North landfill. A borrow pit (Borrow Pit 2) would be located west of Buckden Road, approximately 150m away from the western boundary of Buckden North landfill at its closest location. The scheme does not extend within the boundary of the landfill.

12.3.66 Buckden North landfill, owned and operated by FCC Environment Ltd., is a permitted, operational landfill although some areas have been filled and restored. Cells 1 to 3 in the south-western-most portion of the landfill, which are in proximity to the scheme, were filled using inert waste only to minimise risks to nearby residential homes. Cells 4 to 6, which are also along the western boundary of the landfill, were also filled and restored although the waste deposited potentially included household, industrial, liquids, contaminated soils, construction waste and clinical waste. The landfill is understood to have been constructed on a full containment principle with a continuous basal and upper impermeable liner.

12.3.67 Environmental monitoring results for the period September 2009 to July 2014 were received from FCC Environmental Ltd. for monitoring boreholes around Buckden North landfill. 29 monitoring boreholes around the south-western perimeter of the landfill are considered relevant to the scheme.

12.3.68 The results of the relevant monitoring were reviewed and a summary of the pertinent gas and groundwater quality information is provided in *Table 6.1* within *Appendix 12.1*. The information shows the presence of methane and carbon dioxide in ground gas, and chloride and ammoniacal nitrogen in groundwater. These are key indicators of landfill gas and leachate migration.

12.3.69 Review of this gas and groundwater monitoring data indicates that landfill gas and leachate are not present in the perimeter monitoring wells pertinent to the scheme at concentrations likely to be significant to the scheme.

### Milton landfill

- 12.3.70 The scheme boundary and physical works extend into the boundary of Milton landfill, operated by FCC Environment Ltd. FCC Environment Ltd. were contacted for further information regarding the landfill and the company provided a copy of their *Pollution Prevention and Control (PPC) Permit Application* (December 2003), *Environmental Permit* (October 2007), the *Leachate Management Plan* (December 2013) and environmental data submissions covering the period February 2013 to October 2013. The information has been reviewed and a summary of the pertinent monitoring is provided below and within *Appendix 12.1*.
- 12.3.71 Milton landfill is situated approximately 1km west of the village of Milton and 3km north of the centre of Cambridge and is at the far eastern end of the scheme. The landfill comprises an L-shaped plot of land approximately 48.5 hectares in area which is divided up into three phases of development. Phases I and II are now largely restored along with Cells 12A – 14B of Phase III. Cells 15A and 15B are capped, Cells 16A and 16B are currently operational and Cells 17A – 19B remain undeveloped.
- 12.3.72 The landfill is regulated under Environmental Permit reference: BV4584IU, Variation Notice Number: WP3237LF. The current installation boundary and some monitoring wells are already located within the existing A14 Highway verge.
- 12.3.73 Reference should be made to *Figure 12.5* which presents the location of existing monitoring wells and waste cells in the vicinity of the scheme. The waste cell boundaries on this plan are understood to indicate the base of the waste cells, which have battered sides, with the waste believed to extend close to the site boundary. The cells potentially affected by the scheme include Phase One (along the boundary with the A10 where there is a proposed slip road widening) and Cell 1 and Cells 9-10 of Phase Two.
- 12.3.74 Developed within a number of disused clay pits excavated during the 1970's, the site has received waste since the 1980's. Phase Three however, was developed within arable land. The site is located on Gault Clay, which is overlain by River Terrace Deposits although these have been extracted over much of the landfill. The capping system emplaced/proposed across the site comprises 1m thick site derived clay overlain by subsoil.
- 12.3.75 Geological data suggests that locally, the thickness of the Gault Clay ranges from 10.2 – 18.7m and is underlain by the Cretaceous age Woburn Sand Formation (a Principal Aquifer).
- 12.3.76 Both hazardous and non-hazardous waste was accepted at Milton, up to 2004 and non-hazardous waste thereafter. Phase One received waste from 1980 to 1990, and Phase Two is recorded as having received waste from 1990-91. Since 1991 the cell construction has been subject to Construction Quality Assurance (CQA) procedures.
- 12.3.77 Phase One and Phase Two, Cells 1 – 5A were not constructed on the basis of engineered containment, but are reported to be hydraulically contained. The cells of these phases are purported to be naturally contained by a basal geological barrier comprised of in-situ Gault Clay.

- 12.3.78 In 1996, a clay sidewall liner was installed along the northern, eastern and southern perimeter of Phase One and was keyed into the perimeter clay bunds of Phase Two and Phase Three. The thickness of the clay sidewall is 1m where it is adjacent to the Gault Clay and is 3m where it lies against the River Terrace Gravel Deposits.
- 12.3.79 This remedial action was necessary due to the need to control leachate levels in Phase One. CQA information provided by FCC Environment Ltd. indicates that to the east of the engineered clay liner there is inert fill present overlying the Gault Clay.
- 12.3.80 Site walkovers of the southern and eastern boundaries of the landfill were undertaken in May and August 2014, with FCC Environment Ltd. and the Environment Agency in attendance.
- 12.3.81 The walkovers confirmed that a number of monitoring wells (BH5 to BH14 and BHW1) are present along the boundary of the landfill. The monitoring wells are likely to be destroyed or potentially impacted by the proposed scheme. The walkover did not confirm the extent of the waste although the observed surface topography appeared to suggest that the extent of waste as shown on *Figure 12.5* was likely.
- 12.3.82 The potential environmental impact of the scheme affecting the monitoring wells, as well as the likelihood of the scheme extending into deposited waste, or damaging the containment or gas/leachate management system is discussed further, together with mitigation measures, below.

*Potential receptors and pathways of contamination*

*On-site and off-site human receptors*

- 12.3.83 Current and proposed potential on-site receptors include people who access the predominantly agricultural land, road users including roadside vendors (low to medium value/sensitivity) and any construction or maintenance workers (medium to high value/sensitivity). These receptors would be located within the scheme boundary. The value/sensitivity of these receptors has been assessed in accordance with the criteria defined in *Table 12.1*. Human receptors accessing the agricultural land are assessed as low value based on the low potential significance of likely source-pathway-receptor contamination linkages as defined in *Table 12.1*, while roadside vendors are assessed as low to medium value/sensitivity and construction workers are assessed as medium to high value/sensitivity. On-site human receptor exposure pathways include:
- Contact with any contaminants in soil, soil-derived dust and surface water run-off from areas where soil is exposed at the surface and perched water in Made Ground and shallow groundwater in natural strata if excavation takes place below the perched water/groundwater table.
  - Ingestion of any contaminants in soil, soil-derived dust and surface water run-off from areas where soil is exposed at the surface and perched water in Made Ground and shallow groundwater in natural strata if excavation takes place below the perched water/groundwater table.

- Inhalation of any contaminants in soil-derived dust from areas where soil is exposed at the surface.
  - Inhalation of soil- and water-derived vapours and ground gas.
- 12.3.84 Potential current off-site receptors include people who live and work or access areas adjacent to the scheme but within the study area (i.e. within 0 – 250m from the scheme). People who live and work off-site are generally considered as low to medium value based on potential significance of source-pathway-receptor contamination linkages as defined in *Table 12.1*, while people who access the areas adjacent to the scheme are assessed as low to negligible value/sensitivity. Current off-site human receptor exposure pathways include:
- Contact with and ingestion of any contaminants in windblown soil-derived dust and migrating perched water and groundwater if excavation takes place below the perched water/groundwater table.
  - Inhalation of contaminants in windblown soil-derived dust. Inhalation of migrating soil and water-derived vapours and ground gas.

*Controlled waters receptors (e.g. aquifers and surface water bodies)*

- 12.3.85 The following potential controlled waters receptors are identified within the scheme and study area:
- Groundwater in the superficial deposits (Alluvium, RTD, Head Deposits and Glacial Gravels) by leaching of contaminants from the unsaturated zone to perched water in Made Ground and migration both laterally and vertically to the shallow groundwater and leaching of contaminants from the unsaturated zone to the shallow groundwater. These units are also a potential pathway for contaminants to underlying aquifers and surface water courses. This receptor is generally considered as low to medium value/sensitivity based on the potential source-pathway-receptor contamination linkages as defined in *Table 12.1*.
  - Groundwater within the Woburn Sands Formation Principal Aquifer by leaching of contaminants from the unsaturated zone and vertical migration downwards of contaminants in groundwater from shallower horizons. This receptor is generally considered as medium to high value/sensitivity based on the potential source-pathway-receptor contamination linkages.
  - Surface watercourses across the site by discharge of contaminants entrained in surface water run-off from areas where soil is exposed at the surface and by discharge of contaminants in migrating groundwater. This receptor is generally considered as medium value/sensitivity based on the potential source-pathway-receptor contamination linkages.

### Built environment receptors

- 12.3.86 Existing and proposed structures of the scheme are at risk from elevated explosive ground gases accumulating within voids and confined spaces and causing explosion, such as drainage and service corridors. As defined in *Table 12.1*, built environment receptors are generally considered as low value/sensitivity based on potential source-pathway-receptor contamination linkages.

### **Baseline contamination risk assessment**

#### *Introduction*

- 12.3.87 Ground investigations have previously been undertaken in proximity of the scheme. Most investigations were for geo-technical purposes only and are of limited value for determining contamination conditions for the scheme. The 2008 and 2009 Costain investigation (see above) included investigation for contamination purposes, covering Sections 2 to 5 of the scheme.
- 12.3.88 Elements of the 2008/2009 Costain ground investigation relating to land contamination comprised:
- 6 rounds of groundwater and gas monitoring;
  - 322 soil samples sent for laboratory analysis;
  - 36 soil leachate samples sent for laboratory analysis; and
  - 33 groundwater samples sent for laboratory analysis.
- 12.3.89 Chemical testing undertaken was for a range of determinands including:
- metals;
  - inorganics (including cyanides, sulphur and ammonium);
  - organics, including phenols, BTEX (benzene, toluene, ethylbenzene and xylene), Polycyclic Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbon (TPH), Volatile Organic Compounds (VOC) and Semi Volatile Organic Compounds (SVOC); and
  - Miscellaneous others, including asbestos, moisture content, pH and total organic carbon.
- 12.3.90 Not all samples were analysed for the full suite of determinands.
- 12.3.91 The results of the soil sample analysis were compared against assessment criteria derived (by Atkins using the Environment Agency's CLEA software) to be protective of human health whilst soil leachate and groundwater analysis results were compared against Environmental Quality Standards (EQS) for freshwater and UK Drinking Water Standards (UK DWS). Soil results were then compared against acceptability criteria derived (by Atkins using ConSim model) to be protective of controlled waters.
- 12.3.92 This approach is considered suitable for the purposes of informing the likely worst-case impacts reported within this chapter. The approach fits in with the standard tiered approach for the assessment of land contamination as described in *CLR 11*.

*Human health risk assessment*

- 12.3.93 Following consideration of all possible human receptors, the critical human health receptors, those who were considered most at risk, were determined as the roadside caterers and flower/paper sellers, who would be frequently returning to the same roadside location. This is considered to be a very conservative approach.
- 12.3.94 In some cases, two sets of site-specific assessment criteria were derived. The lower, more conservative, value was based on soil saturation limits for individual hydrocarbon contaminants which assumed that free phase hydrocarbons were present in the soil. The higher, less conservative, value represents the actual assessment criteria but assumes that free phase hydrocarbons are not present in the soil. This second value was derived for hydrocarbon contaminants that exceeded the first and lower value and the sample analysed was examined to ensure that application of the second, higher value was appropriate.
- 12.3.95 The logs from the ground investigation were reviewed and no free phase hydrocarbon was noted to be present. Accordingly, application of the actual assessment criteria was considered appropriate. None of the soil results were found to exceed the assessment criteria indicating none of the samples analysed represented an unacceptable risk to human health receptors. However a number of the samples were found to exceed the lower saturation limit based guideline value:
- 4 samples from Section 2 to Section 3 (Brampton to Swavesey);
  - 15 samples from Section 4 (Swavesey to Girton); and
  - 10 samples from Section 5 (Girton to Milton).
- 12.3.96 Of these samples, visual or olfactory (smell or odour) indicators of contamination were noted at the following locations only:
- WS3077 and WS3079 (at Buckden fuel depot) where black hydrocarbon staining and fuel/oil/hydrocarbon odours were noted (although it is understood that voluntary remediation of significantly impacted soils at this site is likely to be undertaken prior to construction of the scheme); and
  - WS3178 (at Linton's Farm, close to an observed fuel tank) where an organics odour was recorded.
- 12.3.97 Visual or olfactory evidence of hydrocarbons was also noted at several other locations in the ground investigation, but no testing was undertaken:
- BH4228 (at Girton interchange) where a strong diesel odour was recorded; and
  - BH4210D (at Girton interchange) where a diesel odour was recorded.
- 12.3.98 It is recommended that material with visual or olfactory evidence of hydrocarbons is not re-used within the top 0.3m of the finished surface level to further limit the exposure of the human health receptors to contamination.

- 12.3.99 Exposure to contaminants in surface water and perched water/groundwater via direct contact pathways is mitigated by the carriageway and measures used to prevent exposure to soils. Therefore, the only exposure pathway for road users, including roadside vendors is considered to be inhalation of water-derived vapours. Chemical testing results from water samples taken from groundwater monitoring and from 'grab' samples were screened against *UK Drinking Water Standards (DWS; Water Supply (Water Quality) Regulations 2000)* and in the absence of *UK DWS, Guidelines for drinking-water quality, fourth edition* (World Health Organization (WHO), 2011).
- 12.3.100 The values are very conservative for the conceptual site model as the *UK DWS* and WHO guidelines assume consumption of two litres of water per day. Whilst a number of exceedances of these criteria were recorded, given the only identified pathway is inhalation of vapours the actual exposure is likely to be considerably less and accordingly these exceedances are not considered significant.

*Controlled waters risk assessment*

- 12.3.101 As an initial assessment, a generic quantitative risk assessment (GQRA) was undertaken as part of the 2009 data assessment to inform the quality of the in-situ soils and groundwater and identify contaminants of concern (CoC) which potentially pose a risk to controlled waters receptors. The GQRA comprised screening results of analysis of soil leachate and groundwater samples against freshwater EQS and *UK DWS*. Freshwater EQS are considered protective of surface water receptors whilst *UK DWS* are protective of identified groundwater aquifer receptors. It is noted however that this is a conservative assessment as *UK DWS* are limits set at the consumer's tap and EQS are limits set for water entering surface water bodies.
- 12.3.102 A number of exceedances were identified. Further details are presented in *Table 4.1* within *Appendix 12.1*.
- 12.3.103 Detailed quantitative risk assessment (DQRA) was then undertaken to derive soil and soil leachate acceptance criteria for re-use of site won materials as imported fill that were considered protective of controlled waters. A summary of the methodology adopted in deriving the 2009 acceptance criteria and their applicability to the different areas of the scheme is provided below in *Table 12.5*.

**Table 12.5: Summary of soil and soil leachate acceptance criteria modelling methodology**

Acceptance criteria	Relevant WQS	Locations where relevant
U1 B1	UK DWS	Where Woburn Sands Group outcrops to east of Bar Hill interchange and west of Dry Drayton interchange
U1 B2	UK DWS	Around Dry Drayton interchange where Woburn Sands is overlain by at least 5m of unsaturated deposits
U1 B3	Fresh-water EQS	All areas within 50m of a surface water receptor
U1 B4	Fresh-water EQS	Areas greater than 50m from a surface water receptor and underlain by unproductive strata
U1 B5	Fresh-water EQS	Areas greater than 50m from a surface water receptor and underlain by Secondary A aquifers over unproductive strata – specifically Brampton interchange to west of the river Great Ouse, east of river Great Ouse to Offord Road bridge, a small stretch east of New Barns bridge and from the east of Cawcutts Reservoir to end of Section 3

12.3.104 The soil results were compared against the derived acceptance criteria to inform material re-usability for the scheme. The results indicated, based on the available soil chemical data, all site won material would be suitable for re-use in areas where U1 B5 acceptance criteria (*Table 12.5*) apply. Results from Swavesey to Girton were not assessed against the least conservative U1 B5 acceptance criteria given this was not relevant to the section. Meanwhile, only some locations would provide suitable material for re-use in areas where the most stringent U1 B1 acceptance criteria apply.

#### *Ground gas risk assessment*

12.3.105 Six rounds of ground gas monitoring were undertaken between 8 October 2008 and 15 January 2009 at a selection of up to 98no. exploratory locations. The locations were chosen based on the results of preliminary ground gas monitoring. For the latter rounds those locations which recorded ground gas concentrations above instrument detection limits were targeted.

12.3.106 Monitoring was generally phased to intercept periods of low or falling atmospheric pressure, when ground gases preferentially diffuse into atmosphere although it is noted that actual pressures recorded indicated generally high and stable conditions.

12.3.107 A summary of the ground gas monitoring records is provided in *Table 3.1* within *Appendix 12.1*.

- 12.3.108 A ground gas risk assessment was completed as part of the 2008/2009 works using guidance within *BS8485:2007 Code of practice for the characterization and remediation from ground gas in affected developments* (BSI, 2007), *CIRIA C665 Assessing Risks Posed by Hazardous Ground Gases to Buildings* (Construction Industry Research and Information Association, 2007) and *The Local Authority Guide to Ground Gas* (Chartered Institute of Environmental Health (CIEH), 2008).
- 12.3.109 These documents recommend a risk-based approach and place emphasis on the use of data from dedicated ground gas monitoring boreholes to include gas flux as well as concentration. The data is then used to derive appropriate Gas Screening Values (GSV) or hazardous gas flow rates. The GSV or hazardous gas flow rate is subsequently used to assess the risk posed by gassing sites, by comparison to *CIRIA C665 Characteristic Situations (CS)*, measured on a scale of 1 (very low risk) to 6 (high risk). These assist in the determination of potential risks associated with a site and provide a general scope of protection measures.
- 12.3.110 For the available borehole ground gas data collected, the GSV has been calculated in accordance with the guidance, by multiplying the worst case (maximum) recorded ground gas flows with the worst case (maximum) recorded ground gas concentrations, as per the following formula:
- $$\text{GSV (l/hr of gas)} = \text{maximum borehole flow rate (l/hr)} \times \text{maximum gas concentration (\%)}$$
- 12.3.111 The CH<sub>4</sub> and CO<sub>2</sub> GSV were calculated for each exploratory hole monitored. The vast majority of the locations were recorded as CS1 (very low risk). The threshold for increasing from CS1 to CS2 (low risk) based on GSV is 0.07l/hr and greater. Three locations recorded GSV above the threshold for CS2: BH4069 adjacent to the Buckingham Business Park, BH4136 adjacent to Bar Hill Golf Course and BH5076 adjacent to Milton landfill.

### Unexploded ordnance

- 12.3.112 Historic military land is located within the scheme. As such, a desk based study investigating the risk of encountering unexploded ordnance (UXO) within the physical works scheme boundary (including a 250m buffer) was undertaken in 2014. Most of the scheme is low risk as there is no positive evidence that UXO is present, but its occurrence cannot be totally discounted and two moderate risk areas have been identified.
- 12.3.113 A WWII bombing decoy, partly within the scheme, near Conington is considered to provide a moderate UXO hazard level to the scheme due to the potential presence of unexploded bombs.

- 12.3.114 To the west of Brampton overspill from a WWII bombing range, centred approximately 0.8km to the south of the existing A14, is considered to present a moderate UXO hazard level to the scheme which comprises installation of roadside gantries in this area. The 'designated danger area' of the bombing range extends approximately 0.6km from the centre, although given the inaccuracy of training pilots bombs frequently fell outside the danger area on wartime ranges. Practice bombs were typically used on inland bombing ranges, containing a small explosive charge although many ranges also used live bombs, particularly during wartime.
- 12.3.115 The UXO hazard levels for the scheme are presented on *Figure 12.4*.

## 12.4 Potential effects

### Construction stage

- 12.4.1 At this preliminary design stage of the scheme, the assessment of likely construction impacts has been based upon the information provided within *Appendix 3.2*. For the purposes of this assessment, a likely worst case scenario has been taken as assuming construction would be carried out concurrently across the scheme. This is a reasonable assumption for this assessment because it does not change the overall assessment of effects. The baseline year of 2016 remains relevant across the construction programme, including section 6 which would not commence until the new route was operational, because the assessed conditions are not expected to change over the duration of the programme as presented in *Appendix 3.2*.
- 12.4.2 Construction of the scheme would include the following potential activities which could influence the land contamination present either positively or negatively:
- Above and below ground decommissioning, demolition and removal of buildings, bridges, structures, hardstanding, embankments, tanks, bunds, pipework, which could cause the accidental release of solids, liquids and dusts such as asbestos containing material. Contaminants could be introduced into the air, ground, groundwater and surface watercourses.
  - Excavation works including for borrow pits and/or flood compensation areas on or close to the potentially contaminative activities identified, such as the landfills, Buckden fuel depot, service stations, wastewater treatment works, which could increase/modify the leachate, contaminated groundwater and ground gas regime in these areas.
  - Vegetation clearance, excavation and removal of the ground, which would potentially remove contaminants but could also release and mobilise existing contaminants during the clearance/excavation process.
  - Redistribution of the ground and contaminants, which could increase the potential for leaching of contaminants from the ground to the controlled waters receptors or introduce contaminants into new areas of the site and thus to additional receptors.

- Piling, specifically for bridges and related structures, which could introduce migration pathways for contaminants to deeper strata.
- Stockpiling of excavated material prior to either reuse or removal, which could release existing contaminants in the stockpile by entrainment in surface water run-off and increased leaching.
- Use of plant and equipment on the site, which could accidentally leak fuels and oils and introduce contaminants into the ground.
- Storage of fuel and oils on the site, which could again leak/spill and introduce contaminants into the ground.
- Importation and placement of fill.
- Placement of clean fill, foundations and hardstandings, which would potentially act as pathway barriers to human receptors and reduce the potential for infiltration of rainfall and reduce leaching to the controlled waters receptors.
- Temporary dewatering of the excavations, which could potentially alter the groundwater flow direction for a short time and draw groundwater and contaminants into the excavation.
- Installation of service trenches, which can act as preferential pathways for migration of ground gas, soil and water-derived vapours and contaminants in groundwater.

#### *Human receptors*

- 12.4.3 Construction workers would be considered as new human receptors on-site during the construction stage. Construction workers could be exposed to contaminants in soil, soil-derived dust and surface water run-off, through dermal contact, ingestion or inhalation. Construction workers could also be exposed to contaminants in perched water/shallow groundwater, if excavation takes place below the perched water/groundwater table and dewatering is carried out. The baseline condition indicates that these receptors could be exposed, via the exposure pathways listed, to contaminants already detected in the ground, together with any other contaminants which may be present and have not yet been identified or are introduced accidentally by the construction stage works. In addition, ground gas and soil/water-derived vapours may be released from the ground during excavation/dewatering. The effects on construction workers for the majority of the scheme would be minor adverse rising to moderate adverse around Buckden South landfill and Buckden North landfill and major adverse around Buckden Depot and Milton landfill.
- 12.4.4 Whilst off-site human receptors and exposure pathways would be the same as the baseline, the potential for contaminant migration may increase. Contaminants already detected in the ground, together with any other contaminants which may be present and have not yet been identified, and ground gas and soil/water-derived vapours may be released during construction stage works. Contaminants may also be introduced by the construction stage works. Given the results of the human health risk

assessment, effects on off-site human receptors are considered negligible in the context of the scheme.

#### *Controlled waters receptors*

- 12.4.5 Whilst groundwater receptors and pathways would remain the same as the baseline, the potential for contaminant migration may increase. Contaminants may be introduced into the ground, perched water and groundwater by construction stage activities. Greater areas of ground may be exposed to rainfall and water may be introduced into the ground from construction activities, resulting in increased leaching of contaminants from the unsaturated ground to the shallow groundwater. Dewatering may draw groundwater and contaminants to the site, increasing off-site contaminant sources. Unsealed/uncovered soil stockpiles may present areas where surface water run-off can entrain contaminants and then soak into the ground and can also increase the area available for leaching. The requirement for monitoring of groundwater quality during the works is included in the Register of environmental actions and commitments (*Appendix 20.1*).
- 12.4.6 In addition, surface watercourses may become a receptor through discharge of contaminants carried in surface water run-off from soil stockpiles located on the site and close to the river and/or direct leaks and spills from storage areas/containers, plant and equipment.
- 12.4.7 For the majority of the scheme, effects on the quality and vulnerability of controlled waters receptors related to contamination are considered negligible in the context of the scheme. The effects related to controlled waters as a resource are considered in *Chapter 17*.
- 12.4.8 Notwithstanding this, in four areas outlined separately below, effects are considered separately where there is an increased risk of encountering or interfering with existing contamination.
- 12.4.9 The scheme crosses directly over the former Buckden fuel depot, which is approximately 40m wide at this location. Hydrocarbon contamination has been encountered in the ground at this location, and effects from construction of the scheme are considered moderate to large adverse, where remediation would likely be required, if the site remained in its current condition. It is noted that at this area the site owners are understood to be planning to undertake voluntary remediation in 2014 to remove Light Non Aqueous Phase Liquid (LNAPL). As detailed in *12.3.54*, in the event that the remedial works are not undertaken by the landowner prior to construction, it is assumed that equivalent remedial works would be undertaken as part of the scheme. Based on the remediation plans for the works submitted to the Environment Agency, the proposed remedial works would likely reduce effects to slight adverse for this area.
- 12.4.10 At Buckden South landfill, where the scheme passes in close proximity, effects from construction of an approximately 300m stretch of road are considered to be slight adverse where there is potential to interfere with ground and/or groundwater potentially impacted by leachate which has historically migrated from the landfill.

- 12.4.11 At Buckden North landfill, effects from excavation of borrow pit two, including likely de-watering and potential re-direction of groundwater flow direction, are considered to be slight adverse to negligible. There is potential to interfere with ground and/or groundwater potentially impacted by leachate which has historically migrated from the landfill.
- 12.4.12 At Milton landfill, where approximately 500m of the scheme encroaches upon the landfill boundary, impacts upon existing perimeter monitoring boreholes and potentially extends into landfill waste, the potential effects are considered to be moderate, rising to major if re-engineering of landfill containment or gas/leachate extraction system is required.

#### *Built environment receptors*

- 12.4.13 Whilst elevated ground gases have been recorded at a small number of individual locations within the scheme, recorded levels are low and actual receptors in the scheme are limited. As such, construction stage effects are considered negligible in the context of the scheme.

#### *Geological sites of importance*

- 12.4.14 Whilst the scheme would involve a major earthworks operation with potential to disturb important geological features, no geological Sites of Special Scientific Interest or Regionally Important Geological Sites are present within the study area. As such, effects are considered negligible in the context of the scheme.

#### *Agricultural topsoil and subsoil*

- 12.4.15 As outlined within *Chapter 16* and *Appendix 12.2* the majority of the scheme is underlain by best and most valuable agricultural land in which the soils are considered a high value resource.
- 12.4.16 The scheme would have a potential major adverse effect on the soil resources of the area due to the large scale construction works. The construction works and associated effects are typical of a highway development of this scale. The main activities posing a potential impact to soil resources include:
- soil excavation and borrow pits;
  - storage of soil;
  - compaction under working areas; and
  - restoration and landscaping scheme.

### **Operational stage**

#### *Human receptors*

- 12.4.17 Operational stage on-site human receptors would include road maintenance workers and the 'site users' identified and assessed by the risk assessment (e.g. drivers and roadside vendors). In addition, sources of contamination and exposure pathways would have been changed. Only material considered suitable would have been allowed to be reused/remain on the site. In this case, either it is unlikely that source contaminants would be present and thus no potential pollutant linkages would be present or contaminants remaining would not pose a risk to the on-site receptors.

- 12.4.18 In addition, most site surfaces would be covered with hardstanding forming the road and associated structures and 'clean' material associated with embankments and landscape works. These would present exposure pathway barriers (dermal contact, ingestion and inhalation) to any contamination still present in adjacent or underlying ground. In this case, no exposure pathway would be present and thus no potential pollutant linkages would be present.
- 12.4.19 It is unlikely that soil-derived vapours would be present after all the construction stage activities, which would remove contamination or cause volatilisation. In this case, either it is unlikely that source contaminants would be present and thus no potential pollutant linkages would be present or contaminants remaining would not pose a risk to the on-site receptors.
- 12.4.20 Potential risks posed to human receptors, specifically road maintenance workers accessing enclosed spaces, by any ground gas migrating to the site would be negligible for the majority of the scheme although in proximity to Buckden Depot, Buckden South landfill and Buckden North landfill effects would rise to slight adverse. At Milton landfill effects would be moderate adverse.
- 12.4.21 Any source of contamination for off-site receptors would have been removed during the construction works and/or exposure pathway barriers would be in place and thus no potential pollutant linkages would be present.
- 12.4.22 Accordingly effects to human receptors from contamination are considered negligible in the context of the scheme.

#### *Controlled waters receptors*

- 12.4.23 The controlled waters receptors would remain the same as the baseline. However, sources and pathways would have changed. Only material proven 'suitable for use' would be allowed to be re-used/remain on the site. In this case, either it is unlikely that source contaminants would be present and thus no potential pollutant linkages would be present or contaminants remaining would not pose a risk to the controlled waters receptors.
- 12.4.24 In addition, most site surfaces would be covered with hardstanding forming the road and associated structures or with 'clean' material associated with embankments and landscape works. These would present pathway barriers to the infiltration of rainfall and reduce the likelihood of leaching of contaminants from the unsaturated ground to the groundwater. On this basis, the potential risk from the baseline contamination detected to both groundwater and surface water receptors would be reduced.
- 12.4.25 The scheme effects on controlled waters receptors are considered negligible in the context of the scheme.
- 12.4.26 It is anticipated that some of the borrow pits would be re-instated for agricultural purposes following the scheme and this would involve re-use of soil materials stripped from the site. Fill would be proven 'suitable for use' prior to deposition with regards to risks to human health and the environment. Acceptability criteria would be derived during the detailed design stage. As such, effects are considered negligible.

### *Built environment receptors*

- 12.4.27 Levels of elevated ground gases are generally low and actual receptors in the scheme are limited, as there are no proposed buildings, only roadway and bridges. As such operational stage effects on built environment receptors are considered negligible in the context of the scheme.

### *Geological sites of importance*

- 12.4.28 No geological Sites of Special Scientific Interest and Regionally Important Geological Sites are present within 500m of the scheme. As such operational effects are considered negligible in the context of the scheme.

### *Agricultural topsoil and subsoil*

- 12.4.29 The scheme is not expected to have any significant impacts on soil during operation

## **12.5 Mitigation**

- 12.5.1 Mitigation will be secured by way of requirements in the DCO and via contractual responsibilities placed by the Highways Agency on detailed design and construction contractors.
- 12.5.2 The minor adverse impacts on the health of construction workers during construction would be addressed by contractor risk assessment and appropriate use of personal protective equipment which is a standard requirement of any construction project in previously developed land, reducing the effect to negligible. The requirement for contractor risk assessment of health and safety is included in the Register of environmental actions and commitments (*Appendix 20.1*).
- 12.5.3 The majority of effects of the construction stage activities on geology and soils can be contained and/or controlled by appropriate mitigation measures which are included in the Code of construction practice (*Appendix 20.2*) and secured in the Register of environmental actions and commitments (*Appendix 20.1*).
- 12.5.4 As there are no designated sites of geological interest within the area of the scheme, there are no impacts on geoconservation. However during construction there is likely to be temporary exposure of sections of superficial and bedrock strata not usually seen. There is an opportunity for enhanced geoconservation as recommended by the National Networks National Strategy Policy if temporary access is granted to local geological interest groups to observe and record the temporary exposures, however this is not required for mitigation.
- 12.5.5 Effects on soil can be contained and/or controlled by appropriate mitigation measures which are included in the Soil Management Strategy (*Appendix 12.2*). This would have the effect of reducing effects on agricultural soil to minor adverse.
- 12.5.6 As detailed below, greater consideration would be required to mitigation measures in areas where there is an increased impact from the scheme, including:

- Former Buckden fuel depot if remediation is not completed by others;
  - Buckden South landfill where there is possibility of encountering leachate contaminated ground and/or groundwater; and
  - Milton landfill where existing environmental monitoring boreholes would be destroyed and landfill waste, containment and/or gas/leachate collection systems may be impacted by the scheme.
- 12.5.7 At these locations, the detailed mitigation measures would be designed taking account of the findings of the intrusive investigation being undertaken to inform the detailed design of the scheme. The detailed mitigation measures would reduce likely effects to receptors to slight adverse as a likely worst case.
- 12.5.8 Derivation of soil acceptance criteria for determining reusability of soils and aggregates derived on-site (and imported from off-site) would be undertaken as part of the detailed design. The soil acceptance criteria would be derived to ensure that materials re-used or imported onto the site are determined 'suitable for use'. Deposition of material would be undertaken using either *Environmental Permitting (England and Wales) (Amendment) Regulations 2014* or the *Definition of Waste: Development Industry Code of Practice* (CL:AIRE 2011). The derivation of 'suitable for use' criteria and appropriate, managed deposition is included within the Register of environmental actions and commitments (*Appendix 20.1*).
- 12.5.9 Consultation with the Environment Agency and FCC Environment Ltd. regarding the Milton Landfill has resulted in agreement in principle from the Environment Agency to the positioning of boreholes to replace existing monitoring boreholes, to be destroyed by the scheme. These boreholes would be excavated under an agreed CQA process with a view to creation of new perimeter monitoring boreholes outside the waste mass. The proposed borehole locations are presented on *Figure 12.5*. The predicted impact from this process would be negligible.

## 12.6 Significance of effects

- 12.6.1 *Table 12.6* summarises the significance of the effects for the scheme.

**Table 12.6: Summary of significance of effects**

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
<b>Human health receptors</b>									
Construction workers	General unspecified areas of the scheme	Low, since linkage has only a low risk of causing significant harm.	Minor adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination. Contractor risk assessment and correct use of appropriate PPE by construction workers.	Negligible	Neutral
Construction workers	Buckden Depot, Milton Landfill	High, since linkage has a high risk of causing significant harm.	Major adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination. Contractor risk assessment and correct use of appropriate PPE by construction workers.	Minor	Slight adverse

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
	Buckden South Landfill, Buckden North Landfill	Medium, since linkage has a moderate risk of causing significant harm.	Moderate adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination. Contractor risk assessment and correct use of appropriate PPE by construction workers.	Negligible	Neutral
Maintenance workers	General unspecified areas of the scheme	Low, since linkage has only a low risk of causing significant harm.	Minor adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Operation	Temporary	Appropriate site practices including contractor risk assessment and correct use of appropriate PPE by maintenance workers.	Negligible	Neutral

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
	Milton Landfill	Medium, since linkage has a moderate risk of causing significant harm.	Moderate adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Operation	Temporary	Appropriate site practices including contractor risk assessment and correct use of appropriate PPE by maintenance workers.	Negligible	Neutral
	Buckden Depot, Buckden South Landfill, Buckden North Landfill	Low, since linkage has a low risk of causing significant harm.	Minor adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Construction	Temporary	Appropriate site practices including contractor risk assessment and correct use of appropriate PPE by maintenance workers.	Negligible	Neutral

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
Other human receptors, including people accessing the on-site and adjacent land, and road users	General unspecified areas of the scheme	Negligible to low, since linkage has a very low risk of causing significant harm.	Negligible adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Neutral	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination.	Negligible	Neutral
	Buckden Depot, Milton Landfill, Buckden South Landfill, Buckden North Landfill	Low, since linkage has only a low risk of causing significant harm.	Minor adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination.	Negligible	Neutral

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
Other human receptors, including people accessing the on-site and adjacent land, and road users	Entire scheme	Negligible, since linkage has a very low risk of causing significant harm.	Negligible adverse impact. Risks to human health as a result of interaction with contamination (including gases and vapours) within soils and groundwater.	Neutral	Operation	Long term	None	Negligible	Neutral
<b>Controlled water receptors</b>									
Controlled Waters, including groundwater aquifers and surface water bodies	General unspecified areas of the scheme	Low to negligible, since linkage has only a low to very low risk of causing significant harm.	Minor adverse impact. Risks to groundwater aquifers and surface water bodies from mobilising contamination and creation of preferential pollution pathways.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of contamination.	Negligible	Neutral

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
	Buckden Depot, Buckden South Landfill, Buckden North Landfill	Medium, since linkage has a moderate risk of causing significant harm.	Moderate adverse impact. Risks to groundwater in River Terrace Deposits and surface water bodies from mobilising contamination and creation of preferential pollution pathways.	Adverse	Construction	Temporary	Appropriate construction practices to reduce mobilisation of any significant contamination identified at detailed design stage. Off-site removal or treatment of locally impacted soil if encountered.	Minor	Slight adverse
	Milton Landfill	High, since linkage has a high risk of causing significant harm if realised.	Major adverse impact. Risks to groundwater in Woburn Sands Formation aquifer from breaching landfill leachate containment.	Adverse	Construction	Temporary	Appropriate detailed design to maintain landfill containment and monitoring and gas extraction infrastructure if need is identified at detailed design stage.	Minor	Slight adverse

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
Controlled Waters, including groundwater aquifers and surface water bodies	Entire scheme	Low to negligible, since linkage has only a low to very low risk of causing significant harm.	Minor impact. Risks to groundwater aquifers and surface water bodies from mobilising contamination and creation of preferential pollution pathways.	Beneficial	Operation	Long term	Appropriately designed earthworks resulting soils/fill being proven 'suitable for use', which would have the overall effect of removing existing soil not meeting these criteria from the route. Increased hardstanding reducing infiltration and leachate generation.	Negligible	Slight beneficial

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
<b>Built environment receptors</b>									
Structures within the scheme	General unspecified areas of the scheme	Negligible to low, since linkage has a very low risk of causing significant harm.	Negligible impact. Risks to structures within the scheme as a result of accumulation of explosive ground gases within voids and confined spaces resulting in explosion.	Neutral	Construction	Temporary	None	Negligible	Neutral
	Milton Landfill, Buckden Depot, Buckden South Landfill, Buckden North Landfill	Medium, since linkage has a moderate risk of causing significant harm.	Moderate adverse impact. Risks to structures within the scheme as a result of accumulation of explosive ground gases within voids and confined spaces resulting in explosion.	Adverse	Construction	Temporary	Appropriate construction practice and design to minimise voids and confined spaces; Contractor risk assessment and monitoring of voids if required.	Minor	Slight adverse

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
Structures within the scheme	General unspecified areas of the scheme	Negligible to low, since linkage has a very low risk of causing significant harm.	Negligible impact. Risks to structures within the scheme as a result of accumulation of explosive ground gases within voids and confined spaces resulting in explosion.	Neutral	Operation	Long term	None	Negligible	Neutral
	Milton Landfill, Buckden Depot, Buckden South Landfill, Buckden North Landfill	Medium, since linkage has a moderate risk of causing significant harm.	Moderate impact Risks to structures within the scheme as a result of accumulation of explosive ground gases within voids and confined spaces resulting in explosion.	Adverse	Operation	Long term	Appropriate design to minimise voids and confined spaces.	Minor	Slight adverse

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
<b>Geologically important sites</b>									
Destruction of geologically important sites	Entire scheme	Negligible, since no sites of regional geological importance identified within scheme.	Neutral	Neutral	Construction	Temporary	None	Negligible	Neutral
	Entire scheme	Negligible, since no sites of regional geological importance identified within scheme.	Neutral	Neutral	Operation	Long term	None	Negligible	Neutral

Receptor / resource description	Location	Value/ Sensitivity	Description and magnitude of unmitigated impact	Adverse / beneficial	Construction/ operation	Temporary / long term	Mitigation	Residual magnitude of impact	Residual significance of effect
<b>Soil</b>									
Destruction or damage of high quality agricultural soil (topsoil and subsoil)	Entire scheme	High, since scheme is predominantly within an area of best and most versatile agricultural land	Major adverse impact. Risk of destruction or damage to soil resulting from practices involved with excavation / stripping, storage and compaction of the soil.	Adverse	Construction	Long term	Adoption of appropriate mitigation measures and construction practices as set out within the Soil management strategy ( <i>Appendix 12.2</i> ).	Minor	Slight adverse

## 12.7 Summary and conclusion

- 12.7.1 This chapter has reviewed the scheme with regards to impact on contamination (soil and groundwater) and geologically important sites.
- 12.7.2 The scheme is primarily within either greenfield land or land which has been identified as having only limited contaminative potential and accordingly the majority of the scheme is unlikely to be significantly impacted by contamination. There are notable exceptions to this - mainly at a former fuel storage depot (Buckden fuel depot), a closed landfill site immediately adjacent to the scheme (Buckden South landfill) and two permitted, partially restored landfills: Buckden North which is adjacent to the scheme and Milton landfill within which the scheme would encroach.
- 12.7.3 At Buckden fuel depot, Buckden South landfill and Buckden North landfill, in a likely worst case scenario, careful consideration of mitigation measures would be required to prevent slight to moderate adverse impacts. The detailed mitigation would be designed after further ground investigation and subsequent interpretation has been completed (and more data obtained from the landowners) although likely mitigation measures include excavation of unacceptable material followed by treatment/re-use in less sensitive areas of the scheme and design of earthworks to limit mobilisation of contamination. These mitigation measures are commonplace within industry best practice, and would be secured through the *Register of environmental actions and commitments Appendix 20.1*. Residual effects at these locations would be neutral.
- 12.7.4 At Milton landfill, where the scheme encroaches into the landfill boundary, destroying environmental monitoring boreholes and possibly interfering with landfill containment and/or waste, more detailed mitigation would be required to prevent major impact to the scheme. However, mitigation measures, which are to be confirmed at detailed design but are likely to include replacement of monitoring wells and reinstatement of any containment features, would reduce impacts to slight adverse as a likely worst case.
- 12.7.5 Impacts to geologically important sites are considered negligible for the scheme given that no significant sites have been identified within 500m of the scheme.
- 12.7.6 Any material used for the scheme or reinstating borrow pits would be proven 'suitable for use' by adoption of acceptance criteria.

## 12.8 Bibliography

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