West Winch Housing Access Road

Environmental Statement Chapter 12: Geology and Soils: Appendix 12.1: Preliminary Risk Assessment

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Document Reference: NCC/3.12.01

Version Number: 001

Date: October 2023

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Foreword

The Proposed Scheme is located to the southeast of Kings Lynn between the A47 (northern extent) and the A10 (southern extent), crossing a number of agricultural land parcels and will provide a link between the A47, to the north, and A10, to the south. The Proposed Scheme would allow for access and egress to the proposed housing developments within land immediately to the east of West Winch village. This land has been designated under the Borough Council of Kings Lynn and West Norfolk (BCKLWN) Local Plan for up to 4,000 dwellings.

A Preliminary Risk Assessment (PRA) has been undertaken to develop a preliminary conceptual site model (pCSM) identifying potential ground contamination risks and evaluate the likely significant risks, and to provide a preliminary assessment of geotechnical risks associated with the scheme.

It should be noted that this executive summary does not form a standalone document and should be read in conjunction with the WSP Preliminary Risk Assessment (Ref: 70100518-PRA).

Environmental Setting

The ground profile along the Proposed Scheme is likely to be variable, comprising superficial deposits of Head, Lowestoft Formation, Raised Beach Deposits, Alluvium and the Tottenhill Gravel Member and bedrock geology of Leziate Member, Mintlyn Member, Roxham and Runcton Members (clayey sands from the Sandringham Sands formation) and the Kimmeridge Clay Formation.

The Head and Lowestoft Formation are designated as Secondary (Undifferentiated) Aquifers and the Raised Beach Deposits, Alluvium and the Tottenhill Gravel Member are designated as Secondary (A) Aquifers.

The bedrock geology of Leziate Member, Mintlyn Member and Roxham and Runcton Members (Sandringham Sands) are designated as Principal Aquifers. The Kimmeridge Clay Formation is designated as an Unproductive Stratum.

Based on previous ground investigation in 2020, BGS borehole logs and EA Aquifer designations, shallow groundwater would be expected within predominately granular

strata, such as the Tottenhill Sands and Gravels, Mintyln Member and the Roxham and Runcton Beds as well as within the Lowestoft Formation. Groundwater levels encountered during the 2020 investigation ranged between 0.10m bgl to 3.41m bgl

The Pierpoint Drain is located approximately 300m north-east of Hardwick Interchange and flows east to west towards the River Nar. There are numerous unnamed ditches, field drains and bodies of waters (ponds or pooling surface water) observed on OS mapping on the scheme route or within 500m of the scheme route in all directions. The River Nar is the nearest named river that is classified as a Main River and is located approximately 2.2km west of the scheme and approximately 1.15km south of the southernmost point (Southern Branch) of the scheme. The River Great Ouse Relief Channel and the River Great Ouse are located over 3km west of the Proposed Scheme.

Potential for Ground Contamination

WSP considers that on-scheme sources of potential contamination comprise current and historical use as agricultural fields including a sheep wash (Hardwick Interchange), current and historical roads, historical railway (Hardwick Interchange) and an inactive clay pit.

Potential off-scheme sources of contamination generally included current and historical agricultural land use, historical mineral extraction sites, current and historical landfills, including unknown filled ground, and surrounding current and historical industrial land uses.

Plausible contaminant linkages have been identified with respect to human health including dermal contact with contaminated soils, inhalation of soils, dust, gas and vapours or ingestion of contaminated soils, dust or water.

Plausible contaminant linkages identified to controlled waters include the possibility of leaching of contaminants from the unsaturated zone, lateral migration of contaminants in surface water on to, and off of the scheme, dissolution of non-aqueous phase liquid (NAPL) into recharge of groundwater and lateral migration of contaminated groundwater from up gradient off-scheme sources on to the scheme.

Plausible contaminant linkages to building structures include direct contact with contaminated soils, groundwater or immiscible contaminants.

Potential receptors were identified as:

- Current and future users;
- Construction and maintenance workers;
- Sandringham Sands Formation (Principal Aquifer), Raised Beach Deposits, Alluvium and Tottenhill Gravel Member (Secondary (A) Aquifers) and Head Deposits and Lowestoft Formation (Secondary Undifferentiated Aquifers);
- Surroundings ponds, field drains, ditches and the Pierpoint Drain;
- Structures, particularly any utilities; and
- Potable water supply pipes.

Although plausible pollutant linkages are present, the PRA concludes that there is generally a low risk to human health and a low to moderate risk to controlled waters.

Recommendations

WSP recommends the following actions are undertaken:

- An additional targeted intrusive ground investigation would be required for the development of the scheme, and would comprise the following;
    - Baseline ground conditions along the scheme including geology, contaminant concentrations, ground gas and groundwater monitoring;
    - Production of a Ground Investigation Report (GIR);
    - Using the parameters detailed in WSP Ground investigation Appraisal report and those from further ground investigation, a detailed design of the proposed foundation solutions and earthworks solutions should be carried out; and

- Geotechnical Design Report (GDR) and Earthworks Specification for the foundation solutions and required earthworks.

1 Introduction and Objectives

1.1 Authorisation and Purpose of Assessment

1.1.1 WSP was instructed by Norfolk County Council (NCC) ("the client") who are working in partnership with the Borough Council of Kings Lynn and West Norfolk (BCKLWN) to undertake a Preliminary Risk Assessment (PRA) for along the route of the proposed West Winch Housing Access Road (WWHAR) scheme (referred to within this report as 'The Proposed Scheme') as shown on Figure 1.1 in Appendix 12.1.A.

1.1.2 This report is for the purpose of establishing a technical baseline regarding ground contamination and other potential ground risks and constraints. The report can be used to support subsequent planning applications for the Site.

1.1.3 It should be noted the A10 has been included as part of the proposed scheme red line boundary. It is understood that there will be no development works completed on part of the A10, this area of the red line boundary has therefore not been included as part assessment.

1.2 Proposed Scheme

1.2.1 The Proposed Scheme is located to the southeast of Kings Lynn between the A47 (northern extent) and the A10 (southern extent), crossing a number of agricultural land parcels and will provide a link between the A47, to the north, and A10, to the south. The Proposed Scheme would allow for access and egress to the proposed housing developments within land immediately to the east of West Winch village. This land has been designated under the BCKLWN Local Plan for up to 4,000 dwellings.

1.2.2 For this assessment, and to enable easier reference of features, the WWHAR scheme has been split into three sections; Northern Section (north of Mill Lane), Central Section (between Mill Lane and Chequers Lane, including

Rectory Lane) and Southern Section (Northern and Southern Branch) (south of Chequers Lane) as shown on Figure 1.1 in Appendix 12.1.A.

1.2.3 The Proposed Scheme comprises the following key elements:

- 3.5km of new single lane Housing Access Road designed for a 40 miles per hour (40 mph) speed limit;
- A new roundabout junction between the WWHAR and the A47 trunk road providing access to the planned Hardwick Green development;
- A new roundabout junction between the WWHAR and the A10 at the southern end of the WWHAR;
- Intermediate access junctions on the WWHAR to provide access to the residential allocation area;
- Treatment of local roads which will be severed by the WWHAR, including a new road over bridge with shared footway and cycleway on Rectory Lane to cross over the proposed WWHAR and the permanent stopping up of Chequers Lane for vehicular traffic. A new foot/cycle bridge is to be constructed over Chequers Lane to maintain access to pedestrians over WWHAR;
- Modification of the Hardwick Interchange plus a re-orientation of trips through the junction;
- Dualling of the A47 to the north of the existing highway alignment) between the WWHAR and the A10/A47 Hardwick Interchange junction;
- Temporary working areas for road construction including haul routes. The largest of the compounds will be located to the north at the new roundabout on the A47 with a further compound located to the south west of the new overbridge off Rectory Lane; and
- Two sets of National Grid gas main diversion works including construction compounds and temporary access and working areas The scheme requires the diversion of the National Grid Feeders 2 and 4

high pressure gas pipelines, the indicative location of which and diversion works extent are show in Figure 1.1 (Appendix 12.1.A). Ground moving activities required as part of the works will include the excavation of a gas pipe trench and the establishment of temporary compound areas and access roads.

1.3 Objectives

1.3.1 The key objectives of this assessment are to:

- Develop a preliminary conceptual site model (pCSM) to identify potential ground contamination risks associated with the scheme;
- Evaluate the likely significance of risks associated with potential ground contamination through a contaminant linkage assessment for the proposed scheme; and
- Provide a preliminary assessment of geotechnical risks associated with the proposed scheme.

1.4 Scope of Works

1.4.1 The scope of works undertaken in this assessment comprises:

- A walkover of publicly accessible areas to document the current land use and setting, along the scheme route. Where areas are not accessible the proposed route will we reviewed by driving the route and observing the proposed alignment from field boundaries and roadways, etc;
- A review of relevant previous reports pertaining to the Proposed Scheme (where available);
- A review of publicly available historical maps and plans to identify former land uses and potential contaminative activities on and surrounding the proposed scheme;

- A review of relevant regulatory authorities including the Environment Agency (EA), Local Council planning website, the Contaminated Land Officer (CLO) and Building Control Officer (BCO);
- A review of relevant publicly available information relating to hydrological features, hydrogeology, neighbouring land use, ecologically sensitive uses and geology in order to establish the environmental setting of the proposed scheme and the sensitivity of the location;
- Development of a pCSM via the source-pathway-receptor contaminant linkage approach;
- An outline of environmental risks with respect to ground, groundwater and ground gas conditions, which may potentially arise as liabilities or constraints; and

1.4.2 This report has been prepared in general accordance with:

- Part 2A, Environmental Protection Act 1990;
- Environment Agency Land Contamination Risk Management (LCRM) 2020; and
- The National Planning Policy Framework.

1.4.3 The report contains British Geological Survey (BGS) and EA information.

1.5 Limitations

1.5.1 This report is addressed to and may be relied upon by the client (Norfolk County Council). It may not be relied upon or transferred to any other parties without the express agreement of WSP in writing. The report should be read and used in full. No responsibility will be accepted where this report is used, ether in its entirety or in part, by any other party. WSP cannot be held liable for third party information.

1.5.2 The limitations of this assessment are attached in Appendix 12.1.B.

2 Reports Review

2.1 WSP, Ground Conditions Appraisal, February 2021

2.1.1 A ground investigation was completed along the Proposed Scheme by Norse Group in 2020. Following this WSP produced a ground conditions appraisal report in February 2021 which detailed the ground conditions encountered along the route and information on groundwater levels as well as including a Generic Quantitative Risk Assessment (GQRA).

2.1.2 The purpose of the investigation was to identify existing ground conditions along the alignment of the scheme, consider geotechnical behaviour of the strata influencing settlement, foundation and earthworks design and to provide preliminary geotechnical parameters to inform outline geotechnical design.

2.1.3 The ground investigation comprised the advancement of nine trial pits and six window samples. An exploratory hole plan is presented as Figure 1.2, included in Appendix 12.1.A. The exploratory hole logs are presented in Appendix 12.1.E.

Geology Encountered

2.1.4 The geology encountered across the length of the Proposed Scheme was variable.

2.1.5 Topsoil was encountered within all exploratory holes ranging in thickness from 0.30m to 0.65m, and generally comprised dark brown to brownish grey, slightly gravelly, sandy silty, slightly clayey topsoil with some rootlets and straw and an organic odour.

2.1.6 Alluvium was encountered underlying the topsoil in one location in the north of the scheme (TP217) and comprised dark grey, sandy silty clay with occasional roots and a slight organic odour. This deposit measured 1m in thickness and reached up to 1.60m bgl.

2.1.7 The Head Deposits were encountered underlying the topsoil at one location in the south of the scheme (WS106). The deposits comprised mottled orange brown and grey silty, slightly gravelly clayey fine to medium sand with gravel of sub-angular to subrounded flint. The deposits measured1.50m thick.

2.1.8 Tottenhill Sands and Gravels was encountered within the central and southern sections of the scheme and generally comprised dark brown to brownish grey, slightly clayey, silty very gravelly fine to medium sand with fine to coarse angular to sub-rounded flint, quart, ironstone and carstone gravels. The deposit ranged in thickness between 0.40m and 1.85m.

2.1.9 The Lowestoft Formation was encountered within the central and southern sections of the scheme and generally comprised firm to very stiff orange brown to dark grey, slightly silty, sandy, gravelly clay, with fine to coarse angular to sub-rounded flint, chalk and mudstone gravels. The deposit ranged in thickness between 0.40m to 4.80m.

2.1.10 The Mintyln Beds Formation was encountered throughout the length of the scheme and generally comprised light brown to dark grey slightly clayey, slightly gravelly silty fine to medium sand with laminations and thin beds of weak to moderately weak sandstone, ironstone and siltstone. Cohesive deposits were encountered and comprised stiff mottled reddish-brown gravelly very sandy clay with fine to coarse angular to sub-rounded flint, ironstone, chert and phosphatic nodules gravels. The deposit ranged in thickness between 0.50 to 4.60m. The base of the unit was not proven within the central area of the Proposed Scheme.

2.1.11 Roxham and Runcton Beds were encountered throughout the length of the Proposed Scheme and generally comprised firm to very stiff silty sandy clay and dark grey to brown slightly gravelly, very silty, fine to medium sand, with gravels of fine to medium subrounded flint, sandstone, pyrite nodules and phosphate nodules. The deposit ranged in thickness between 0.20 to 2.60m.

2.1.12 The Kimmeridge Clay Formation was encountered predominantly in the northern and southern sections of the Proposed Scheme. The Formation

generally comprised firm to stiff dark grey to bluish grey laminated clay with lenses of light grey silty fine sand and occasional shell fragments. The maximum depth encountered was 5.45m below ground level (bgl) due to exploratory holes terminating within this stratum.

Ground Encountered

2.1.13 During the ground investigation groundwater was encountered within the predominately granular strata, such as the Tottenhill Sands and Gravels, Mintyln Member and the Roxham and Runcton Beds as well as within the Lowestoft Formation.

2.1.14 A total of 11no. groundwater monitoring visits were completed at the site, within the window sample exploratory holes between August and December 2020. Groundwater samples were collected from the window sample locations on two occasions (August and November 2020). Groundwater levels ranged from 0.10m bgl to 3.41m bg and were encountered resting across varying strata.

Contamination Results

Human Health Risk Assessment

2.1.15 A total of 19no. soil samples were submitted for laboratory analysis of pH, metals, cyanide, sulphate (water soluble), hexavalent chromium, phenols, pesticides, herbicides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), semi-volatile organic compounds (SVOCs), volatile organic compounds (VOCs), Total Petroleum Hydrocarbon Criteria Working Group (TPH-CWG), asbestos and soil organic matter (SOM).

2.1.16 The soils analysis results were screened against WSP's Generic Assessment Criteria (GAC) / Category 4 Screening Levels (C4SLs) for public open space. No exceedances were noted within the soil samples from across the scheme. It should be noted that the results were also below the threshold for the most conservative end use (residential with plant uptake).

Controlled Waters

2.1.17 Five groundwater samples were collected in August and six samples in November 2020. The samples were submitted for laboratory analysis of pH, ammoniacal nitrogen, nitrite, nitrate, sulphate, cyanide, phenols, metals, PAHs, PCBs, SVOCs, VOCs, TPH-CWG and BTEX. Three of the groundwater samples were analysed for the above suite plus pesticides, insecticides and herbicides.

2.1.18 There were a number of minor exceedances above the surface water quality standards for copper, nickel, zinc, fluoranthene, benzo (a) pyrene, and Total PAH summed. There was one minor exceedance for benzo(a)pyrene within WS101 above the drinking water quality standards.

2023 Summary

2.1.19 The risk to human health receptors and below ground services was recorded as Low.

2.1.20 The risk to controlled waters was recorded as Low to Moderate as only minor exceedances were noted during the works however localised exceedances are noted in two locations. Due to the limited nature of the ground investigation it is not possible to confirm that these exceedances are due to onsite sources however likely to be representative of regional background concentrations. To date groundwater exceedances do not correspond with the analysed soil samples

2.1.21 Contamination identified in the shallow groundwater has the potential to migrate laterally across the site and offsite. It should be noted that the site does not lie within a source protection zone and no groundwater abstraction points are located on or in the vicinity of the site.

Recommendations

2.1.22 The report recommended that the following works is undertaken to progress the geotechnical design within the project:

- Further targeted ground investigation to inform on the design of the Proposed Scheme structures;
- A Ground Investigation Report (GIR) shall be prepared for the Proposed Scheme;
- Using the parameters detailed above and those from further ground investigation, a detailed design of the proposed foundation solutions and earthworks solutions should be carried out; and
- Geotechnical Design Report (GDR) and Earthworks Specification for the foundation solutions and required earthworks.

3 Site Reconnaissance

3.1 Site Description

3.1.1 The Proposed Scheme location is provided as Figure 1.1 and a layout plan as Figure 1.3 (Appendix 12.1.A). A site visit was carried out by WSP in May 2019. Photographic records are included as Appendix 12.1.C. Figure 1.3 shows the location of each photo taken during the Site visit and should be used in conjunction with Appendix 12.1.C.

3.1.2 Table 3-1 provides information relating to the Proposed Scheme obtained from a review of Ordnance Survey (OS) mapping, online aerial photography, the walkover and relevant regulatory information contained within the Envirocheck Report (Appendix 12.1.D).

Table 3.1 – Site description

Details	Description
Name and address	WWHAR, West Winch, Kings Lynn
Description and current use	The Proposed Scheme was located on predominantly greenfield agricultural land (Grade 2 and 3) **(Photo 1, 2, 3)** with the exception of an area of scrubland where the scheme joins the A47 (Northern Section) **(Photo 4)**. The agricultural fields were bound by hedgerows; however, many boundaries were marked by rough grass and/or drainage ditches lined with reeds and rushes. Small areas of woodland and individual trees were noted along the scheme. Infrastructure noted along the scheme included the A47 road **(Photo 5 and 6)**, A10 **(Photo 7)**, Rectory Lane **(Photo 8),** Chequers Lane **(Photo 9)** and the Hardwick Interchange roundabout **(Photo 10)**. A National Grid Gas Vale Compound **(Photo 11)** was noted approximately 290m west of Chequers Lane.
Ground cover	The Proposed Scheme is covered with undeveloped grassland in areas of agricultural land and scrubland, and hardstanding across roadways.
Trees and invasive species	Agricultural fields were bound by hedgerows. Mature trees were present in small areas long the Proposed Scheme.
Bulk material storage	No bulk material storage was noted. There may be the potential for a barn adjacent of the A47 in the north of the Proposed Scheme to be present within the red line boundary, there may therefore be the potential for bulk material storage.
Polychlorinated biphenyls (PCBs)	Electricity pylons and overhead cables were noted towards the south of the scheme.
Waste storage	No waste storage was noted. There may be the potential for a barn located adjacent of the A47 in the north of the scheme to be present within the red line boundary, there may therefore be the potential for waste storage in this area.

Details	Description
Asbestos containing materials (ACMs)	No ACMs were noted, however there may be potential for the presence of ACMs within the fabric of the barn located adjacent of the A47 in the north of the Proposed Scheme (should it be shown to lie within the red line boundary).

4 Historical Potentially Contaminative Land Uses

4.1 History

4.1.1 The history of the Proposed Scheme and local environs has been reviewed and determined with reference to Ordnance Survey maps contained within the Envirocheck Report (Ref: 201802352_1_1). A study has been undertaken to identify potentially contaminative former land uses. The following section provides a summary of this information, and the Envirocheck Report is attached as Appendix 12.1.D.

Located within the Proposed Scheme

Table 4.1 – Historical map review within the proposed scheme

Date of Mapping	Scale	Northern Section Comments
1884	1;10,560	The Proposed Scheme route comprised agricultural fields, separated by trees along the field boundaries. A road and a footpath going north-west to south-east labelled as Constitution Hill was noted traversing the area towards the north of the section.
1885	1:2,500	An inactive clay pit, potentially a pond, was noted slightly impeding onto the scheme towards the south-west of the section.
1887	1:2,500	**Hardwick Interchange** The majority of the area comprises agricultural land separated with trees along the field boundaries. Constitution Hill Road was noted along the east of the area. A road was noted bisecting the area running north to south towards the west of the area connecting to Constitution Hill Road adjacent to the north of the area. Buildings and footpaths are noted towards the centre of the area. A sheepfold was noted towards the centre of the area, adjacent north of the buildings.
1905	1:2,500	**Hardwick Interchange** Footpaths were noted traversing the aforementioned roads. A sheepwash was noted towards the east of the area. The sheepfold identified in the 1887 mapping was no longer noted. A road cutting was noted towards the far south-east of the area. A railway was noted bisecting the area towards the south running in a north-west to south-east direction.
1906	1:10,560	No apparent change apart from the railway was noted as Midland and Great Northern Joint Railway.
1928	1:2,500	No apparent change.
1929 (Only Hardwick Interchange area)	1:2500 1:10,560 (whole of Northern section)	No apparent change.
1930	1;10,560	No apparent change.
1938	1:10,560	No apparent change.
1952	1:10,560	Railway no longer labelled as a railway, however infrastructure still noted.
1959	1:10,000	No apparent change.
1967	1:2,500 1:10,000	**Hardwick Interchange** A roundabout was noted towards the north of the area. The buildings, footpaths and sheepwash were not noted. Three ponds were noted towards the centre of the area, a drain was noted in the same area running east to west. A track was noted towards the west of the area. A number of drains were noted running along the main road. An electricity overhead cable was noted traversing the area north-east to south-west towards the south of the area. The rest of the area comprised undeveloped open land.

Date of Mapping	Scale	Northern Section Comments
1968	1:2,500	**Hardwick Interchange** The road was labelled as Constitution Hill A47 and included a layby. The second road was labelled as A10. A road was noted connecting to the A10 towards the south-west of the area.
1969	1:2,500	The aforementioned clay pit was noted labelled as a pond.
1971	1:10,00	The railway was noted as disused.
1977 – 1983	1:2,500	Cuttings were noted across the centre of the area. Likely associated with creating the landscaping areas in-between the roundabout and the roads.
1979	1:10,00	The disused railway was no longer noted.
1984 (Only Hardwick Interchange area)	1:2,500	No apparent change.
1989	1:2,500	A cutting / embankment running east to west was noted south of the section.
1991	1:10,000	No apparent change.
1994	1:2,500	No apparent change apart from an electricity sub-station encroaches onto the scheme located towards the north-east of the section. The footpath is no longer labelled.
1999	Aerial Photo	No apparent change.
2000	1:10,000	No apparent change.
2006	1:10,000	A roundabout and roads were present towards the south of the area.
2019	1:10,000	No apparent change.
Date of Mapping	**Scale**	**Central Section Comments**
1884	1:10,560	The Proposed Scheme route comprised, agricultural fields, separated by trees along the field boundaries. A track / road was noted towards the south of the section running east to west. Cock Lane (track) bisects the scheme route east to west.
1885	1:2,500	A potential pond was noted slightly impeding onto the east towards the north of this section.
1905	1:2,500	No apparent change apart from a footpath running east-west was shown towards the north of the section and north of Cock Lane. A potential pond and a footpath were shown towards the south-west of the section. A footpath running east to west was shown traversing Cock Lane.
1907	1:10,560	No apparent change.
1928	1:2,500	No apparent change, apart from the track / road towards the north of the section running west to east was labelled as Chequers Lane.
1929	1:1,10,560	No apparent change.
1938	1:10,560	No apparent change.

Date of Mapping	Scale	Northern Section Comments
1952	1:10,560	No apparent change.
1956	1:10,000	No apparent change.
1959	1:10,000	No apparent change.
1967	1:10,000	No apparent change.
1968	1:2,500	No apparent change to the agricultural fields. Cock Lane was shown in the same location but labelled as Rectory Lane. The aforementioned footpath north of Cock Lane was no longer noted however a drain (along the field boundaries) was noted running east to west in the same location. The aforementioned potential pond and footpath were no longer noted, trees were noted in this location. A drain (along the field boundaries) was noted running north to south adjacent to the trees. A drain (along the field boundaries) was noted running east to west south of the trees connecting to the drain mentioned above.
1971	1:10,000	No apparent change.
1981 - 1988	1:2,500	No apparent change.
1989	1:2,500	No apparent change apart from the aforementioned trees was no longer noted and the drain running north-south was no longer labelled.
1991	1:10,000	No apparent change.
1994	1:2,500	No apparent change.
1996	1:2,500	No apparent change.
1999	Aerial Photo	No apparent change.
2000 - 2019	1:10,000	No apparent change.
Date of Mapping	**Scale**	**Southern Section Comments**
1883	1:2,500	The majority of the Proposed Scheme comprised agricultural fields separated by trees along the field boundaries. The Northern and Southern Branches of the Proposed Scheme were part of a track / road. A footpath was noted running across the Southern Branch in a north-south direction. Trees were noted along the east of the track / road.
1884	1:10,560	No apparent change.
1885	1:2,500	A track / road was noted towards the north of the section running west to east. The rest of the section comprised agricultural fields. A footpath is noted running east to west towards south of the section.
1905	1:2,500	The aforementioned trees were no longer noted. No apparent change to the rest of the Proposed Scheme.
1907	1:10,560	No apparent change.
1928	1;2,500	No apparent change apart from the track / road towards the north of the section running west to east was labelled as Chequers Lane.

Date of Mapping	Scale	Northern Section Comments
1929	1:10,560	No apparent change.
1938	1;10,560	No apparent change.
1952	1:10,560	No apparent change.
1958 – 1959	1:10,000	No apparent change apart from the aforementioned track / road was labelled as A10 Main Road. The footpath was no longer noted.
1966 - 1967	1:10,000	No apparent change.
1968 -1974	1:2,500	No apparent change.
1971 - 1978	1:10,000	No apparent change.
1975	1:2,500	No apparent change.
1979	1:10,000	No apparent change.
1980 - 1988	1:2,500	No apparent change.
1989 - 1990	1:2,500	No apparent change.
1994	1:2,500	No apparent change.
1996	1:2,500	No apparent change.
1999	Aerial Photo	No apparent change.
2000 - 2019	1:10,000	No apparent change.

Located within 250m of the proposed scheme

Table 4.2 – Potentially contaminative historical features within 250m of the scheme

Name	Direction	Approx. Distance	Years feature observed
Agricultural land Residential properties with gardens and roads also electricity substations	N, S, E, W	Adjacent to 250m from Southern section	1884 to 1964 1964 to present
Agricultural land and heath land	N, S, E, W	Adjacent to 250m from Central and Northern section	1884 to present
Agricultural land Midland and Great Northern Joint Railway Disused railway Dismantled railway	SE, NW	Adjacent to 250m from Hardwick Interchange	1884 to 1906 1906 to 1971 1971 to 1979 1979 to present
A47 Constitution Hill Road	SE, NW	Adjacent to 250m from the Northern section	1884 to present
Agricultural fields Factories, depots, warehouses, roads, car parks, superstores, trading estates, industrial estates.	NW, SW	Adjacent to 250m	1884 to 1979 1979 to present
Hardwick road siding	S	20m from Hardwick Interchange	1905 to present
Pond	E	20m from Central section	1884 to present
Agricultural land Works Works expanded south	W	60m from Southern Branch of the Southern section	1884 to 1974 1974 to 1994 1994 to present
Trees Building / undeveloped area Cold Storage depot	NE	100m from Hardwick Interchange	1884 to 1905 1905 to 1929 1967 to present
Agricultural fields Brook Farm and associated tanks	W	105m from Central section	1884 to 1968 1968 to present
Old clay pit Pond Heathland	W	115m from Northern Section	1885 to 1969 1969 to 2006 2006 to present
Sheepfold and buildings Buildings Undeveloped land and buildings	NE	120m	1884 to 1885 1905 to 1967 1967 to present
A10 Main Road	W	140 to 250m from the Southern section	1884 to present

Name	Direction	Approx. Distance	Years feature observed
Agricultural land Allotment gardens Undeveloped land Residential properties with gardens	NW	155m from Northern Branch of the Southern section	1885 to 1905 1905 to 1968 1968 to 1996 1996 to present
Electricity overhead cable	S	160m from Southern Branch of the Southern section	1975 to present
Pond Pond / tank Pond	E	190m from Central section	1884 to 1968 1968 to 1989 1989 to present
Agricultural land Depot	W	210m from Hardwick Interchange	1884 to 1977 1977 to present
Agricultural land Garage	NW	215m from Hardwick Interchange	1884 to 1967 1967 to present
Brick yard and kiln Buildings / undeveloped land Undeveloped land Residential properties with gardens	W	220m from Northern Branch of the Southern section	1884 to 1905 1905 to 1974 1974 to 1980 1980 to present
Pond	W	225m from Northern section	1989 to present
Manor Farm	E	230m from Southern Section	1885 to present

5 Environmental Setting

5.1 Geology and Hydrogeology

5.1.1 The BGS Map Sheet 145 with part of 129 Solid and Drift – King's Lynn and the Wash (1:50,000, 1978); and Sheet 159 Solid and Drift – Wisbech (1:50,000, 1995) have been reviewed along with WSP Ground Appraisal Report (see Section 2 for more details) . The underlying geology is presented in Table 5.1 together with EA aquifer designations for the relevant geological units. It is anticipated that the superficial deposits along the length of the route will be variable.

Table 5.1 – Ground conditions summary

Geological unit	Thickness (m)*	Location	Description*	Aquifer designation
Topsoil	0.30 – 0.65	Across the scheme*	Dark brown to brownish grey, slightly gravelly, sandy silty, slightly clayey topsoil with some rootlets and straw and an organic odour.	N/A
Alluvium	1.00	Encountered in one location (TP217) in the north. Not noted on BGS mapping for the scheme.	Dark grey, very sandy silty clay with occasional roots and a slight organic odour.	Secondary (A)
Raised Beach Deposits	N/A	Not encountered during the GI BGS mapping indicates this is located in the north of the scheme.	Shingle, sand, silt and clay (from BGS maps as not encountered in GI)	Secondary (A)
Tottenhill Gravel Member	0.40 – 1.85	Central and southern section's* BGS mapping indicates this is within the southern area of the scheme.	Dark brown to brownish grey, slightly clayey, silty very gravelly fine to medium sand with fine to coarse angular to sub-rounded flint, quart, ironstone and carstone gravels.	Secondary (A) Aquifer
Head	1.50	Encountered in one location (WS106) located in the south-west of the scheme. BGS mapping indicates this is potentially located west area of the Hardwick Interchange.	Mottled orange brown and grey, slightly silty to very silty, slightly gravelly clayey fine to medium sand.	Secondary Undifferentiated

Geological unit	Thickness (m)*	Location	Description*	Aquifer designation
Lowestoft Formation	0.40 – 4.80	Central and Southern section's*. BGS mapping indicates this is also potentially located in the northern area of the scheme.	Firm to very stiff orange brown to dark grey, slightly silty sandy, gravelly clay, with fine to coarse angular to sub-rounded flint, chalk and mudstone gravels.	Secondary Undifferentiated
Sandringham Sand Formation (Leziate Member)	N/A	Not encountered during the GI. BGS mapping indicates this is located in the northern and central sections of the scheme.	Pale grey fine to medium-grained, cross-bedded quartz sands with bands of silt or clay and pyrite nodules. Glauconite is locally abundant. (from BGS maps as not encountered in GI)	Principal Aquifer
Sandringham Sand Formation (Mintlyn Member)	0.50 – 4.60 (Not Proven in the central section)	Northern, Central and southern sections	Light brown to dark grey slightly clayey slightly gravelly silty fine to medium sand with laminations and thin beds of weak to moderately weak sandstone, ironstone and siltstone. Cohesive encountered comprised stiff mottled reddish-brown gravelly very sandy clay with fine to coarse angular to sub-rounded flint, ironstone, chert and phosphatic nodules gravels	Principal Aquifer

Geological unit	Thickness (m)*	Location	Description*	Aquifer designation
Sandringham Sand Formation (Roxham and Runcton Member)	0.20 – 2.60	Northern, central and southern sections	Firm to stiff silty sandy clay and dark grey to brown slightly gravelly very silty, fine to medium sand, with fine to medium subrounded flint, sandstone, pyrite nodules and phosphate nodules gravels	Principal Aquifer
Kimmeridge Clay Formation	0.40 – 3.55 (not proven)	Northern, and Southern sections. Potential to be encountered in the central sections.	Firm to stiff, dark grey to bluish grey laminated clay with lenses of light grey silty fine sand and occasional shell fragments.	Unproductive Stratum

** Information taken from WSP Ground Investigation Appraisal Report, February 2021*

Historical Borehole Records

5.1.2 Relevant publicly available BGS boreholes within or adjacent to the Proposed Scheme have been summarised within Table 5-2. The BGS borehole locations are shown on Figure 1.1 and the logs are presented in Appendix 12.1.E.

Table 5.2 – BGS borehole summary

Strata	Description	Depth to base (m bgl)	Water strikes (m bgl)	Encountered In
Topsoil	Not Provided TF61NW257- Stony Cryoturbation bed, orange-brown sandy stony clay and clayey sand (TF61SW120)	0.20- 0.79 1.80	None recorded	TF61NW305 TF61NW304 TF61NW293 TF61NW302 TF61SW120 TF61NW295
Made Ground	Loose grey - brown clayey silty sand, with some gravel, brick, rubble, wood fragments and occasional roots. TF61NW355, TF61NW356– Concrete TF61NW259 – sandy flint gravel	0.80 - 1.90	0.70 (TF61NW355) 1.70 (TF61NW356) 0.80 (TF61NW257)	TF61NW355 TF61NW356 TF61NW109 TF61NW262 TF61NW259 TF61NW257

Strata	Description	Depth to base (m bgl)	Water strikes (m bgl)	Encountered In
Tottenhill Gravel Member	Fine and medium-grained sand, gravel of flint, chalk and peat clay fragments	5.60	None Recorded	TF61SW120
Lowestoft Formation (Glacial Deposits)	Soft brown very sandy clay Stiff light brown, light grey / dark grey clay with chalk sand and fine and medium coarse chalk, flint and ironstone gravel	0.58 8.23 8.87(TF61NW237)	8.23	TF61NW302 TF61NW237

Strata	Description	Depth to base (m bgl)	Water strikes (m bgl)	Encountered In
Sandringham Sand Formation (Leizgate Member)	Soft grey silty clay and fine grey/ brown/ ref-brown silty, clayey sand Soft blue-grey clay with seams of fine red-brown silty sand. (TF61NE305) Sandstone (TF61NW302)	2.13 – 3.84 Not proven (TF61NW305) 8.84	2.62 (rose to after 10mins) (TF61NE305) 3.05 (TF61NW304) 8.23, rising to 7.32 in 10 mins (TF61NW302)	TF61NW305 TF61NW304 TF61NW302
Sandringham Sand Formation (Weathered Mintyln Member)	Fine and medium brown clayey sand with some medium coarse gravel (TF61NW293)	0.90 - 2.13	None Recorded	TF61NW293 TF61NW295

Strata	Description	Depth to base (m bgl)	Water strikes (m bgl)	Encountered In
Sandringham Sand Formation (Mintyln Member)	Dark grey-green sandy clay Soft dark grey silty clay with partings of fine silty sand (TF61NW293)	Not Proven	3.05 (TF61NW293)	TF61NW304 TF61NW293 TF61NW203 TF61NW109 TF61NW295
Kimmeridge Clay Formation	Firm becoming stiff dark grey / grey-brown friable silty clay with some compressed shells. Fissured with depth and very stiff with depth	102 (TF61NW237) Not Proven	3.60 (TF61NW262) 1.50 (TF61NW257) 12.35 (TF61NW257)	TF61NW355 TF61NW356 TF61NW237 TF61NW109 TF61NW262 TF61NW259 TF61NW257
Ampthill Clay	Note Provided	Not Proven	None Recorded	TF61NW237

5.1.3 It should be noted that in TF61NW237 Sandringham Sands were recorded to a depth of 9.25m bgl and TF61NW109 to a depth of 3.05m bgl; however, this formation was not divided into the separate members. Based on the geology maps it is likely to be the Mintlyn Member and/or the Roxham and Runcton Members that were encountered. It should be noted that borehole TF61SW120 recorded Nar Valley beds (Tidal Flat Deposits) underlying the Tottenhill Gravel Member, which are not expected to be encountered along the scheme.

5.2 Hydrology

5.2.1 The River Nar is the nearest named river that is classified as a Main River and is located approximately 2.2km west of the Proposed Scheme and approximately 1.15km south of the southernmost point (Southern Branch) of the scheme. The River Great Ouse Relief Channel and the River Great Ouse are located over 3km west of the Proposed Scheme.

5.2.2 The Pierpoint Drain (Middleton Stop Drain) is located approximately 300m north-east of the northernmost point of the Proposed Scheme (Hardwick Interchange) at its closest point. It flows from east to west on the north of the scheme towards the River Nar.

5.2.3 The Puny Drain located approximately 1.3km west of the scheme and approximately 1.12km south of the southernmost point of the scheme (Southern Branch). It flows east to west on the south side of the scheme, crossed by the existing A10 and then flows north-west and then north to the west of West Winch. This drain receives discharges from numerous field drains along its course.

5.2.4 There are numerous unnamed ditches, field drains and bodies of waters (ponds or pooling surface water) observed on OS mapping on the Proposed Scheme route or within 500m of the Proposed Scheme route in all directions. During the WSP Ecology Team Survey carried out in 2018, two ponds were within the vicinity of Proposed Scheme, however these were noted as being dry.

5.2.5 The Proposed Scheme is designated as Flood Zone 1 (land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding (<0. 1%)). The area adjacent north, east and west of the Hardwick Interchange is located within Flood Zone 2 and 3 but does benefit from flood defences.

5.2.6 One surface water abstraction is recorded within 500m of the Proposed Scheme. The abstraction is located approximately 300m north-east (Sheet Map E / ID 48) from the Pierpoint Drain. The abstraction relates to Hardwick Farm Partnership for spray irrigation. The permit start date is recorded as April 2018 with no supplied end date.

5.2.7 The entire Proposed Scheme area is located within a Nitrate Vulnerable Zone.

5.3 Preliminary Hydrogeological Model

5.3.1 The Head and Lowestoft Formation are designated by the EA as Secondary (Undifferentiated) Aquifers and the Raised Beach Deposits, Alluvium and the Tottenhill Gravel Member are designated as Secondary (A) Aquifers.

5.3.2 The bedrock geology of Leziate Member, Mintlyn Member and Roxham and Runcton Members (Sandringham Sands) are designated as Principal Aquifers. The Kimmeridge Clay Formation is designated as an Unproductive Stratum.

5.3.3 Groundwater is likely to flow westerly towards the River Nar, however this is likely to be variable. Based on the BGS borehole logs groundwater levels are likely to be shallow at approximately 1 m bgl – 12 m bgl, depending on the location along the Proposed Scheme.

5.3.4 During the ground investigation in 2020 shallow groundwater was encountered within predominately granular strata, such as the Tottenhill Sands and Gravels, Mintyln Member and the Roxham and Runcton Beds as well as within the Lowestoft Formation. Groundwater levels encountered ranged between 0.10m bgl to 3.41m bgl.

5.3.5 The Proposed Scheme is not located within an EA groundwater Source Protection Zone.

5.3.6 No groundwater abstractions are located within 500m of the scheme.

5.4 Radon

5.4.1 The BGS indicates that the scheme varies from an intermediate probability radon area (1 to 3% of homes are estimated to be at or above the action level) and a lower probability radon (less than 1% of homes are estimated to be at or above the action level). No radon protection measures are necessary in the construction of new dwellings or extensions.

5.5 Unexploded Ordnance Risk (UXO)

5.5.1 Publicly available bomb risk mapping supplied by Zetica and presented in Appendix 12.1.F states that the Proposed Scheme has a low risk of UXO.

5.6 Mineral Extraction

5.6.1 The BGS have recorded a number of former mineral sites within 500m of the Proposed Scheme. These are summarised in Table 5-3. An initial desktop review of the Norfolk Minerals and Waste Core Strategy indicates that the sand geology (Sandringham Sand Formation) beneath the Proposed Scheme is a safeguard mineral resource. Policies are in place to ensure that mineral resources (silica sand beneath the scheme are safeguarded to ensure future resources are not built upon and to avoid detrimental impact of the mineral resource through development. Silica sand resources in Norfolk are considered to be of national strategic importance.

Table 5.3 – Summary of BGS recorded mineral sites

Name	Type and Status	Commodity	Map Sheet / ID Reference	Approximate Position in Relation to Scheme
Northern Section North Runcton Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map C / ID 282	Adjacent west
Northern Section North Runcton Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map C / ID 283	135m west
Northern Section North Runcton Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map C / ID 288	250m east
Central Section North Runcton Pit	Opencast Ceased	Common Clay and shale (Lowestoft Formation)	Map C / ID 285	150m west
Central Section West Winch Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map C / ID 284	160m west

Name	Type and Status	Commodity	Map Sheet / ID Reference	Approximate Position in Relation to Scheme
Central Section North Runcton Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map C / ID 286	200m east
Central Section Manor Farm Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map Sheet C / ID 287	230m west
Central Section West Winch Pit	Opencast Ceased	Common clay and shale (Lowestoft Formation)	Map Sheet C / ID 289	350m west
Southern Section Gravelhill Lane Brick Yard	Opencast Ceased	Common clay and shale	Map Sheet A / ID 247	250m west (Northern branch)
Southern Section Setchey Gravel Pit	Opencast Ceased	Sand and gravel (Tottenhill Gravel Member)	Map Sheet A / ID 248	380m south-west (Southern Branch)

5.7 Landfilling

5.7.1 Two historical landfills have been identified within 500m of the Proposed Scheme, these have been summarised in Table 5.4.

Table 5.4 – Summary of historical landfills

Landfill Name	EA Reference	Dates	Waste	Map Sheet / ID Reference	Approximate Position in Relation to Scheme
Southern Section Setchey	EAHLD00715	not supplied	not supplied	Map Sheet A / ID 235	250m south (Southern Branch)
Southern Section Setch Tip	EAHLD31112	First Input – 31/07/1959 Last Input – 31/07/1972	Commercial waste	Map Sheet A / ID 236	290m south (Southern Branch)

5.7.2 One BGS recorded landfill site (Map Sheet A / ID 234), Setch Tip, was noted approximately 290m south and one local authority landfill site (Map Sheet A / ID 237) located 410m south of the Southern Section. It is assumed these relate to Setch Tip detailed in **Table 5-4** above.

5.7.3 One registered landfill (ref: 35/4/2221) operated by S George was noted approximately 365m south of the Southern Section Southern Branch (Map Sheet A / ID 246); the license was lapsed / cancelled / surrendered on the 1 July 1977. No information provided on the waste source or the maximum input rate. Four areas of unknown filled ground (pit, quarry, etc.) have been recorded within 500m of the scheme. Sheet Map A identifies 206m west of southern section, 312m south of southern section and 412m south of southern section and Sheet Map E identifies 443m north-west of Hardwick Interchange (Northern Section).

5.7.4 One area of unknown filled ground (pond marsh, river, stream, dock, etc.) has been recorded 413mm south-west of the Central Section (Sheet Map A / ID 244)

5.7.5 A total of 12no. areas of unknown filled ground (pond marsh, river, stream, dock, etc.) have been recorded within 500m (206m to 442m NW) of Hardwick Interchange (Northern Section Sheet Map C and E).

5.7.6 No waste transfer registered waste treatment or disposal sites are recorded within 500m of the Proposed Scheme.

5.8 Ecology

5.8.1 The Proposed Scheme is not located within any statutory or non-statutory designated sites. There are no statutory or non-statutory designated areas within 500m of the Proposed Scheme.

6 Regulatory Consultation

6.1 Regulatory Information

6.1.1 Information relating to various regulatory controls has been taken from the Envirocheck Report, which is presented in Appendix 12.1.D. The potential for hazardous materials to impact upon the ground conditions, surface or groundwater on route are summarised below within Table 6-1. It should be noted that since completing the Envirocheck the red line boundary of the Proposed Scheme has been updated. The distances presented within the Envirocheck report may therefore vary to Table 6-1 below.

Table 6.1 – Regulatory information within 500m

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Contaminated land register entries and notices	Sheet ID	No data	No entries on the contaminated land register were recorded within 500m of the scheme.	No
Discharge Consents	Sheet C / ID 1	On-route south-west within the Hardwick Interchange (Northern Section) Ref: Aecnf1858 Revoked May 1992	Anglian Water Services Limited discharge of storm / emergency overflow. Receiving water not recorded.	No
Discharge Consents	Sheet C / ID 2	180m west of the Central section Ref:Aecnf1856 Revoked May 1992	Anglian Water Services Limited discharge of storm / emergency overflow. Receiving water not recorded.	No
Discharge Consents	Sheet E / ID 2	200m north of Hardwick Interchange (Northern Section) Ref:Aecnf1864 Revoked May 1992 Ref:Aecnf2578 Revoked May 1992	Anglian Water Services Limited discharge of storm emergency overflow. Receiving water for Aecnf2578 – Tributary of River Nar.	No
Discharge Consents	Sheet C / ID 4	240m east of the Central section Ref: Pr1lfu162 Revoked June 1997	Mr H E Chapman, unknown discharge onto land.	No
Discharge Consents	Sheet C / ID 3	310m south-west of the Hardwick Interchange Ref:Prclf03085 Revoked October 1996	Mr and Mrs H Grey, unknown discharge onto land.	No
Discharge Consents	Sheet E / ID 1	340m north-west of the Hardwick Interchange (Northern Section) Ref:Prcnf05445 Issued March 1995	National Westminster Bank Plc discharging treated effluent. Receiving water recorded as tributary Pierpoint Drain.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Discharge Consents	Sheet E / ID 3	350m north of the Hardwick Interchange (Northern Section) Issued March 1994 Ref: Aecnf11047# Revoked: March 1994 Ref: Aecnf11047	Anglian Water Services Limited discharging of other matter. Receiving water recorded as Pierpoint Drain.	No
Discharge Consents	Sheet A / ID 2	390m north-east of the northern area of the Southern section Revoked April 1991 (Ref: Aecnf1878) Revoked April 1992 (Aecnf2505)	Anglian Water Services Limited discharging storm / emergency overflow. Receiving water not recorded. Receiving water recorded for Aecnf2505 as a ditch.	No
Discharge Consents	Sheet A / ID 1	400m west of the Southern section Revoked April 1991 (Ref: Aecnf1879) Revoked April 1992 (Ref: Aecnf2330)	Anglian Water Services Limited discharge of storm / emergency overflow. Receiving water not recorded. Receiving water noted for Aecnf230 as tributary of the River Nar.	No
Discharge Consents	Sheet C / ID 5	480m south-west of Hardwick Interchange (Northern Section) Ref: Aw1nf894 Effective June 1970 Ref: Aecnf1854 Revoked May 1992 Ref: Aecnf2356 Revoked May 1992	Anglian Water Services Limited, discharge of storm / emergency overflow water. Receiving water not recorded for Aecnf1854) Receiving water recorded for Aecnf2356 as a tributary of the River Nar.	No
Local Authority Pollution Prevention and Controls	Sheet A / ID 9	Adjacent to the northern part of the Southern Section	National Grid Gas Plc PG1/15 odourising natural gas and liquid petroleum gas, permitted March 1998.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Local Authority Pollution Prevention and Controls	Sheet A / ID 8	220m east of the Southern section	Countryside Recycling Solutions, PG13/16 mobile screening and crushing processes, permitted, date not supplied.	Yes
Local Authority Pollution Prevention and Controls	Sheet E / ID 22	240m north-west of the Hardwick Interchange	Tesco Garage, PG1/14 petrol filling station, permitted January 1999. Sainsburys petrol filling station, PG1/14 petrol filling station, permitted, date not supplied.	No
Local Authority Pollution Prevention and Controls	Sheet C / ID 23	270m north of the Hardwick Interchange	Dersingham Autos, PG1/1 waste oil burners less than 90.4MV net rated thermal input, revoked June 1992.	No
Local Authority Pollution Prevention and Controls	Sheet E / ID 13	260m south-west	Mann Egerton, PG6/34 Respraying of road vehicles. Authorisation revoked, December 1993	No
Local Authority Pollution Prevention and Controls	Sheet C / ID 24	260m west of the Hardwick Interchange	Rmc Readymix Eastern, PG3/1 blending, packing, loading and use of bulk cement, authorised February 2004.	No
Local Authority Pollution Prevention and Controls	Sheet C / ID 25	355m west of the Northern section	West Winch Service Station PG14 petrol filling station, permitted January 1999.	No
Integrated Pollution Prevention and Controls	Sheet C / ID 18 Sheet E / ID 9	200m north-west of the Hardwick Interchange (Northern Section) 320m north-east of the Hardwick Interchange (Northern Section)	Greenyard Frozen UK Limited, activity description; animal vegetable and food treating, vegetable raw material for food greater than 300T/day also disposal of >50 T/day non-hazardous waste involving physio-chemical treatment. 240m north-west: Effective date March 2017. Status – superseded by variation. 320m north-east: Effective June 2018.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Integrated Pollution Prevention and Controls	Sheet C / ID 19	130m north of the Hardwick Interchange (Northern Section)	Pinguin Food UK Limited, activity description; animal vegetable and food treating, vegetable raw material for food greater than 300T/day also disposal of >50 T/day non-hazardous waste involving physio-chemical treatment. Effective date November 2005 and June 2015. Status superseded by variation.	No
Integrated Pollution Prevention and Controls	Sheet C / ID 20	345m south-west of the Hardwick Interchange (Northern Section)	Tulip Limited, activity description; animal vegetable and food, treating animal raw materials (not milk) for food >75T/day. Effective date November 2004 and July 2007. Status superseded by variation.	No
Pollution Incidents to Controlled Waters	Sheet C / ID 28	60m west of the Hardwick Interchange	1993, Category 2 – Significant Incident for vegetable washings. Receiving water tributary of the Nar Valley Drain.	No
Pollution Incidents to Controlled Waters	Sheet A / ID 16	140m west of the Southern Section	1993 and 1994, Category 3 – Minor Incident for an unknown pollutant. Receiving water, Nar Valley Drain.	No
Pollution Incidents to Controlled Waters	Sheet C / ID 29	90m north-west of the Hardwick Interchange (Northern Section)	1994, Category 3 – Minor Incident for other organics wastes due to a blocked sewer. Receiving water Pierpoint Drain	No
Pollution Incidents to Controlled Waters	Sheet E / ID 20	165m north of the Hardwick Interchange (Northern Section)	1999, Category 3 – Minor Incident for organic wastes due to accidental spillage. Receiving water Pierpoint Drain. Two in 1997, Category 2 – Significant Incident for organic wastes due to poor practice. Receiving water Pierpoint Drain.	No data
Pollution Incidents to Controlled Waters	Sheet C / ID 30	180m north-west of the Hardwick Interchange (Northern Section)	1996, Category 3 – Minor Incident for diesel oil due to accidental spillage / leakage. Receiving water tributary of the Nar Valley Drain.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Pollution Incidents to Controlled Waters	Sheet C / ID 31	240m south-west of the Hardwick Interchange (Northern Section)	1992, Category 3 – Minor Incident for an unknown pollutant. Receiving water Pierpoint Drain. 1994m Category 3 – Minor Incident for a miscellaneous pollutant. Receiving water tributary of Middleton Stop.	No
Pollution Incidents to Controlled Waters	Sheet A / ID 17	250m east of the Southern section	1999, Category 2 – Significant Incident for diesel oil including agricultural. Receiving water, Nar Valley Drain. Cause of incident noted as vandalism.	No
Pollution Incidents to Controlled Waters	Sheet E / ID 21	260m north-east of the Hardwick Interchange (Northern Section)	1993, Category 3 – Minor Incident for unkown pollutant. Receiving water, Pierpoint Drain.	No
Pollution Incidents to Controlled Waters	Sheet E / ID 22	335m north of the Hardwick Interchange (Northern Section)	1994, Category 3 – Minor Incident for unknown pollutant. Receiving water, Pierpoint Drain. 1995, Category 3 – Minor Incident for chemical solvents. Receiving water, Pierpoint Drain. 1992, Category 2 – Significant Incident for unknown pollutant. Receiving water, Pierpoint Drain.	No
Pollution Incidents to Controlled Waters	Sheet C / ID 32	340m west of the Hardwick Interchange (Northern Section).	1995, Category 2 – Significant Incident for other organic wastes due to accidental spillage / leakage. Receiving water tributary of the Nar Valley Drain.	No
Pollution Incidents to Controlled Waters	Sheet E / ID 23	355m north of the Hardwick Interchange (Northern Section).	5no. dated from 1993 to 1997. Noted as Category 2 – Significant Incident and Category 3 – Minor Incident. Pollutant unknown and organic wastes. Receiving water – Pierpoint Drain.	No
Pollution Incidents to Controlled Waters	Sheet A / ID 18	405m west of the Central section	1994, Category 3 – Minor incident for a natural pollutant into a watercourse within the Nar Valley Drain Catchment.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Pollution Incidents to Controlled Waters	Sheet C / ID 33	480m south-west of the Hardwick Interchange (Northern Section)	1992, Category 3 – Minor incident for n unknown pollutant into a drain of Nar Valley.	No
Substantiated Pollution Incident Register	Sheet C / ID 38	100m north of the Hardwick Interchange	2014, water: Category 2 – Significant incident, Land: Category 3 – Minor Incident for general biodegradable material.	No
Substantiated Pollution Incident Register	Sheet A / ID 23	250m east of the Southern section	2017, air: Category 2 – Significant incident, land: Category 3 – Minor Incident for smoke and firefighting run-off.	Yes
Substantiated Pollution Incident Register	Sheet E / ID 45	240m north and 350m north of the Hardwick Interchange (Northern Section)	2009 and 2016, water: Category 2 – Significant Incident for general biodegradable materials and waste & unknown pollutant	No
Substantiated Pollution Incident Register	Sheet E / ID 44	250m north of the Hardwick Interchange (Northern Section)	2003, water: Category 2- Significant Incident for general biodegradable materials and wastes.	No
Substantiated Pollution Incident Register	Sheet A / ID 24	340m south of the Southern section	2002, air: Category 2 – Significant incident, land: Category 3 – Minor Incident for household waste.	No
Substantiated Pollution Incident Register	Sheet E / ID 46	345m north of Hardwick Interchange (Northern Section)	2005, water: Category 2 – Significant Incident for general biodegradable.	No
Substantiated Pollution Incident Register	Sheet C / ID 39	430m south-west of the Hardwick Interchange (Northern Section)	2007, water: Category 2 – Significant Incident, Incident for biodegradable materials and wastes.	No
Prosecutions relating to controlled waters	Sheet C / ID 17	150m north-east of the Hardwick Interchange.	1 case: Prosecution Text: allowing waste water to escape into a drain, affecting a nearby watercourse. Verdict guilty, cost £1580.	No
Prosecutions relating to controlled waters	Sheet E / ID 8	390m north of the Hardwick Interchange	1 case: Prosecution Text: Pollution Pierpoint Drain on three occasions with oil from overflowing tank. Verdict guilty, cost £980	No
Trade Directory Entries	No data	On-route Active	No entries	No
Trade Directory Entries	No data	On-route Inactive	No entries	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Trade Directory Entries	No data	0-100m Active	No entries	No
Trade Directory Entries	No data	0-100m Inactive	Commercial cleaning services and road haulage services.	Yes
Trade Directory Entries	No data	100-250m Active	Pet foods and animal feeds, car customisation and conversion specialist and engineers.	Yes
Trade Directory Entries	No data	100-250m Inactive	Road haulage services, garage services, furniture manufactures, car body repairs, car breakdown and recovery services and car dealers.	Yes
Trade Directory Entries	No data	250-500m Active	Commercial cleaning services, engineers, tyre dealers, commercial vehicle servicing repairs, powder coatings, car paint and lacquer manufactures and suppliers, MOT testing centres, petrol filling stations, used car dealers, frozen food processors and distributors, conveyors and conveyor belts, printers- glass, metal and plastic,	Yes
Trade Directory Entries	No data	250-500m Inactive	Pet foods and animal feeds, car body repairs, fencing manufacturers, commercial vehicle serving, repairs, scrap metal merchants, petrol filling station, PVC-U products, manufactures and suppliers, caravan dealers and manufacturers, road haulage services, medical and dental laboratories, car paint and lacquer manufactures and suppliers, electrical appliance repairs, wallpapers and wall coverings, and bus and coach operators and stations.	Yes
Control of major accident hazards sites (COMAH)	Sheet C / ID 278	430m south-west of the Hardwick Interchange (Northern Section)	Calor Gas Ltd, Type – lower tier Status ceased.	No

Environmental Data	Sheet Map Ref	Distance from scheme (within 500m)	Details	Potential risk
Registered radioactive substances	No data	No data	No entries within 500m of the scheme.	No
Notification of installations handling hazardous substances	Sheet C / ID 280	430m south-west of the Hardwick Interchange (Northern Section)	P P and H Limited, status not active.	No
Planning Hazardous Substance Consents	No data	No data	No entries within 500m of the scheme.	No
Fuel station entries	Sheet C / ID 334	120m north-west of the Hardwick Interchange	Hypermarket, Tesco - Open	Yes
Fuel station entries	Sheet C / ID 335	220m north-west of the Hardwick Interchange	Swan Street Motors Limited - Obsolete	No
Fuel station entries	Sheet E / ID 178	250m north of the Hardwick Interchange (Northern Section)	Sainsburys Kings Lynn - Open	Yes
Fuel station entries	Sheet C / ID 336	300m south of the Hardwick Interchange (Northern Section)	Esso, Mrh West Winch - Open	Yes
Gas Pipeline	Sheet A / ID 290	Adjacent south of Chequers Lane west to east. On the route of the scheme.	Brisley to Wisbech Nene West, owned by National Grid. Diameter, 900mm. Status, active.	Yes
Gas Pipeline	Sheet C / ID 363	Running across the scheme running east to west in the Northern Section.	Kins Lynn Comp to Wisbech Nene West, owned by National Grid. Diameter, 900mm. Status, active.	Yes

6.2 Correspondence

Environmental Agency (EA)

6.2.1 The EA was contacted on 03 May 2019. A response was received on 14 June 2019 and a summary of the information provided is included below;

- There are two historic landfill Sites, Setch Tip and Sethcley within 500m of the Proposed Scheme;
- There have been 32no. pollution incidents to controlled waters within 1km of the Proposed Scheme, details are provided in Appendix 12.1.G;
- There are no records of contaminated land as defined under Part 2A of the Environmental Protection Act 1990 within 500m of the Proposed Scheme; and
- There are no groundwater monitoring boreholes within 1km of the Proposed Scheme.

6.2.2 A copy of this response is included within Appendix 12.1.G.

6.2.3 The EA were also contacted on 15 May 2019 and on 12 May 2023 for any additional information that may be available. Response provided on 14 June 2019, detailing information on any potential sources of contamination to include landfills and pollution incidents. Confirmation was provided that there are no records of contaminated land as defined under Part 2A of the Environmental Protection Act 1990 within 500m of the scheme. An additional update was received on 13 June 2023, detailing that there is one abstraction license within 500m. Any pertinent information will be included or added as an addendum to this report.

Contaminated Land Officer (CLO)

6.2.4 The CLO was contacted on 03 May 2019 and on 12 May 2023. Response provided 18 May 2023, detailing:

- Setch tip and Setchy landfill, approximately 350m to the south of the site.There are no records of PWS within 500m.

- Two part B processes within 500m (Sainsburys Petrol station and West Winch service station).
- The site has not been prioritised for inspection under Part 2A, is not known to be contaminated or undergone remediation.
- A site approximately 200m to the east has been inspection under Part 2A following a major fire. (Manor Farm).

6.2.5 If pertinent information is found this report will be updated or the information will be sent as an addendum to this report.

Building Control Officer (BCO)

6.2.6 The BCO was contacted on 12 May 2023. No response has yet been received. If pertinent information is found this report will be updated or the information will be sent as an addendum to this report.

7 Conceptual Site Model (CSM)

7.1 Introduction

7.1.1 The preliminary CSM is based upon the environmental conditions of the Proposed Scheme as described in the previous sections.

7.1.2 The methods used within this assessment follow a risk-based approach with the potential environmental risk assessed qualitatively using the 'source-pathway-receptor' contaminant linkage concept introduced in the guidance documents (principally the EA's CLR11) on the practical implementation of the Environmental Protection Act 1990.

7.1.3 Environmental risk can be defined as the combination of the consequence of a harmful effect and the probability of its occurrence. The existence of a contaminant linkage is primarily dependant on scheme usage and environmental conditions.

7.1.4 The environmental risk assessment has been carried out by identifying and evaluating the significance of the following:

- Potential Sources of Contamination: these include any actual or potentially contaminating materials and activities, located either on or in the vicinity of the Proposed Scheme;
- Potential Pathways for Contamination Migration: these are the routes or mechanisms by which contaminants may migrate from the source to the receptor; and
- Potential Receptors of Contamination: these include present or future land users, activities or persons at the Proposed Scheme.

7.1.5 The preliminary CSM was developed based on a proposed industrial/commercial end use at the site. A summary of the applicable legislative and planning framework for the assessment is presented in Appendix 12.1.H.

7.1.6 Table 7-1 provides a key to the potential pathways and receptors identified along the Proposed Scheme. The on-scheme preliminary CSM is presented in Table 7-2, and the off-scheme CSM in Table 7-3.

Table 7.1 – Potential pathways

Receptor Type	Receptors	Potential pathways On-scheme contaminant source	Potential pathways On-scheme ID	Potential pathways Off-scheme contaminant source	Potential pathways Off-scheme ID
Human Health	Users (current and future)	– Dermal contact with contaminated soils and waters – Inhalation of contaminated soils, waters and vapours/gas – Ingestion of contaminated soils and waters	**1**	– Inhalation/ingestion of contaminated soils in airborne dust	**6**
Human Health	Neighbouring users	– Inhalation/ ingestion of contaminated soils in airborne dust	**2**	– Not relevant	**No data**
Groundwater	Sandringham Sands Formation (Principal Aquifer), Raised Beach Deposits, Alluvium and Tottenhill Gravel Member (Secondary A Aquifer), Head and Lowestoft Formation (Secondary Undifferentiated Aquifer).	– Leaching of contaminants from soils – Migration of contamination in groundwater – Migration of immiscible contaminants – Infiltration of contaminated surface water – Dissolution of non-aqueous phase liquid (NAPL) into recharge of groundwater – Lateral migration of contaminated groundwater	**3**	– Migration of contaminated groundwater, surface water or immiscible contaminants	**7**
Surface Water	Surrounding ponds, field drains and ditches. Pierpoint Drain 300m NE (Hardwick Interchange)	– Runoff of contaminated surface water – Migration of immiscible contaminants	**4**	– Migration of contaminated groundwater, surface water or immiscible contaminants	**8**
Building Structures	Buried concrete and potable water supply pipes	– Direct contact with contaminated soils, groundwater or immiscible contaminants	**5**	– Migration of contaminated groundwater, surface water or immiscible contaminants	**9**

Table 7.2 – Conceptual site model – within the proposed scheme

Location	Source	Potential Contaminants	Pathway ID (Table 7-1)	Comment on Hazard Realisation	Risk Rating
Entire scheme	Current and historical roads including A10, A147, Rectory Lane and Chequers Lane.	Metals, hydrocarbons, polycyclic aromatic hydrocarbons (PAH).	▪ 1-5	▪ A10, A47, Rectory Lane and Chequers lane run through the proposed scheme route. ▪ Possibility of migration of contaminants via fugitive dust or surface flow from any road spills. ▪ No Made Ground or asbestos was encountered during the investigation in 2020. ▪ No exceedances were identified within the soils to the Public open space GAC or most conservative land use (residential with plant uptake) in the 2020 investigation. ▪ Minor Exceedances in metal (copper, nickel and zinc) concentrations were noted within groundwater sampled from six locations across the site. Minor Exceedances in PAHs were also noted in groundwater from one location, Due to the limited nature of the ground investigation it is not possible to confirm that these exceedances are due to onsite sources however likely to be representative of regional background concentrations. To date groundwater exceedances do not correspond with the analysed soil samples ▪ Contamination identified in the shallow groundwater has the potential to migrate laterally across the site and offsite. ▪ Surface water features were noted to be dry during the site walkover in 2018. ▪ It should be noted that the site does not lie within a source protection zone and no groundwater abstraction points are located on or in the vicinity of the site.	Low to Moderate
Entire scheme	Current and historical agricultural use including a sheepwash (Hardwick Interchange)	Pesticides, pathogens	1-5	▪ It is unknown what chemicals the farmers use or have used. Inorganic pesticides (e.g. containing arsenic) could have been used. ▪ Sheepwash was recorded on the 1905 mapping in the centre of the Hardwick Interchange area. ▪ No exceedances were identified within the soils to the Public open space GAC or most conservative land use (residential with plant uptake) in the 2020 investigation.	Low

Location	Source	Potential Contaminants	Pathway ID (Table 7-1)	Comment on Hazard Realisation	Risk Rating
South area of Hardwick Interchange	Historical railway	A wide range of potential contaminants, depending on the source of material, but may include asbestos, metals, cyanide, hydrocarbons, PAH, phenols, volatile organic compounds (VOCs), and semi volatile organic compounds (SVOCs).	1-5	▪ It is unknown if any Made Ground is buried under the scheme. ▪ The area was regenerated to form the Hardwick Interchange post 1970s. ▪ No Made Ground or asbestos was encountered during the investigation in 2020. ▪ No exceedances were identified within the soils to the Public open space GAC or most conservative land use (residential with plant uptake) in the 2020 investigation. ▪ Minor Exceedances in metal (copper, nickel and zinc) concentrations were noted within groundwater sampled from six locations across the site. Minor Exceedances in PAHs were also noted in groundwater from one location, Due to the limited nature of the ground investigation it is not possible to confirm that these exceedances are due to onsite sources however likely to be representative of regional background concentrations. To date groundwater exceedances do not correspond with the analysed soil samples ▪ Contamination identified in the shallow groundwater has the potential to migrate laterally across the site and offsite. ▪ Surface water features were noted to be dry during the site walkover in 2018. ▪ It should be noted that the site does not lie within a source protection zone and no groundwater abstraction points are located on or in the vicinity of the site.	Low

Location	Source	Potential Contaminants	Pathway ID (Table 7-1)	Comment on Hazard Realisation	Risk Rating
Northern section	Inactive clay pit	A wide range of potential contaminants, depending on the source of material, but may include asbestos, metals, cyanide, hydrocarbons, PAH, phenols, VOCs, SVOCs and ground gases.	1-5	▪ The specific nature and source of fill materials is unknown. ▪ Feature recorded as a pond from 1969. ▪ No Made Ground or asbestos was encountered during the investigation in 2020. ▪ No exceedances were identified within the soils to the Public open space GAC or most conservative land use (residential with plant uptake) in the 2020 investigation. ▪ Minor Exceedances in metal (copper, nickel and zinc) concentrations were noted within groundwater sampled from six locations across the site. Minor Exceedances in PAHs were also noted in groundwater from one location, Due to the limited nature of the ground investigation it is not possible to confirm that these exceedances are due to onsite sources however likely to be representative of regional background concentrations. To date groundwater exceedances do not correspond with the analysed soil samples ▪ Contamination identified in the shallow groundwater has the potential to migrate laterally across the site and offsite. ▪ Surface water features were noted to be dry during the site walkover in 2018. ▪ It should be noted that the site does not lie within a source protection zone and no groundwater abstraction points are located on or in the vicinity of the site.	Low

Table 7.3 – Off-site conceptual site model

Location	Source	Potential Contaminants	Pathway ID (Table 7-1)	Comment on Hazard Realisation	Risk Rating
Adjacent to 380m west, south-east and east	Mineral extraction sites	A wide range of potential contaminants, depending on the source of material, but may include asbestos, metals, cyanide, hydrocarbons, phenols, VOCs, SVOCs, polychlorinated biphenyl's (PCBs), PAH and ground gases.	6-9	▪ The specific nature and source of fill materials is unknown. ▪ Migration of contamination into underlying Principal, Secondary A and Secondary Undifferentiated Aquifers is possible. ▪ No exceedances were identified within the soils during the ground investigation in 2020. ▪ Minor metal exceedances were identified within the groundwater sampled These minor exceedances do not correspond with the analysed soil samples. ▪ Shallow groundwater encountered within granular deposits across the site indicates contamination has the potential migrate laterally on or offsite. ▪ A low risk is considered to the surrounding ponds, field drains and ditches as these are predominantly located to the east and west, with limited potential for surface water flow.	Low
250m and 290m south of the Southern section 206m to 412 west and south of southern section 413m south-west of central section 206m to 443m north-west of Hardwick Interchange	Current and historical landfills and unknown filled ground.	A wide range of potential contaminants, depending on the source of material, but may include asbestos, metals, cyanide, hydrocarbons, PAH, phenols, VOCs, SVOCs and ground gases.	6-9	▪ The specific nature and source of fill materials is unknown. ▪ The potential for leaching and ground gas generation exists, however the distance from the scheme would mitigate any migrating contamination. ▪ No exceedances were identified within the soils during the ground investigation in 2020. ▪ Minor metal exceedances were identified within the groundwater sampled These minor exceedances do not correspond with the analysed soil samples. ▪ Shallow groundwater encountered within granular deposits across the site indicates contamination has the potential migrate laterally on or offsite. ▪ A low risk is considered to the surrounding ponds, field drains and ditches as these are predominantly located to the east and west, with limited potential for surface water flow.	Low
0 – 500m surrounding the scheme	Current and historical agricultural land uses	Pesticides	6-9	▪ It is unknown what chemicals the farmers use or have used. Inorganic pesticides (e.g. containing arsenic) could have been used.	Low

Location	Source	Potential Contaminants	Pathway ID (Table 7-1)	Comment on Hazard Realisation	Risk Rating
0 – 500m surrounding the scheme	Surrounding current and historical industrial land uses as outlined in Table 4-2 and Table 6-1.	A wide range of potential contaminants, depending on the source of material, but may include asbestos, metals, cyanide, hydrocarbons, PAH, phenols, VOCs, SVOCs and ground gases	6-9	▪ Unknown if the electrical substations have been maintained. ▪ Unknown if good environmental practices were undertaken. ▪ Leaks and spillages may have occurred at the petrol stations and garages north-west and south-west of Hardwick Interchange. ▪ A Category 2 – Significant Incident to controlled waters occurred 305m east of the southern section in 2004 for oil. ▪ Category 2 – Significant incident to Land for firefighting run-off occurred in 2017 255m eat of the southern section. ▪ Category 2 – Significant incident to land for household waste occurred in 2002, 385m south of the Southern section. ▪ Due to the distance from the scheme, for the pollution incidents, it is unlikely that the scheme would have been impacted. ▪ No exceedances were identified within the soils during the ground investigation in 2020. ▪ Minor metal exceedances were identified within the groundwater sampled These minor exceedances do not correspond with the analysed soil samples. ▪ Shallow groundwater encountered within granular deposits across the site indicates contamination has the potential migrate laterally on or offsite. ▪ A low risk is considered to the surrounding ponds, field drains and ditches as these are predominantly located to the east and west, with limited potential for surface water flow.	Low

8 Conclusions and Recommendations

8.1.1 Based on the findings of this preliminary assessment, WSP makes the following conclusions in the context of the Proposed Scheme.

8.2 Environmental Setting

8.2.1 The ground profile along the Proposed Scheme is likely to be variable, comprising superficial deposits of Topsoil, Head, Alluvium, Lowestoft Formation, Raised Beach Deposits and the Tottenhill Gravel Member and bedrock geology of Leziate Member, Mintlyn Member, Roxham and Runcton Members (clayey sands from the Sandringham Sands formation) and the Kimmeridge Clay Formation.

8.2.2 The Head and Lowestoft Formation are designated as Secondary (Undifferentiated) Aquifers and the Raised Beach Deposits, Alluvium and the Tottenhill Gravel Member are designated as Secondary (A) Aquifers.

8.2.3 The bedrock geology of Leziate Member, Mintlyn Member and Roxham and Runcton Members (Sandringham Sands) are designated as Principal Aquifers. The Kimmeridge Clay Formation is designated as an Unproductive Stratum.

8.2.4 Based on previous ground investigation in 2020, BGS borehole logs and EA Aquifer designations, shallow groundwater would be expected within predominately granular strata, such as the Tottenhill Sands and Gravels, Mintyln Member and the Roxham and Runcton Beds as well as within the Lowestoft Formation. Groundwater levels encountered during the 2020 investigation ranged between 0.10m bgl to 3.41m bgl

8.2.5 The River Nar is the nearest named river that is classified as a Main River and is located approximately 2.2km west of the scheme and approximately 1.15km south of the southernmost point (Southern Branch) of the scheme. The River Great Ouse Relief Channel and the River Great Ouse are located over 3km west of the scheme. The Pierpoint Drain is located approximately

300m north-east of Hardwick Interchange and flows east to west towards the River Nar. There are numerous unnamed ditches, field drains and bodies of waters (ponds or pooling surface water) observed on OS mapping on the scheme route or within 500m of the scheme route in all directions.

8.3 Potential for Ground Contamination

8.3.1 WSP considers that on-scheme sources of potential contamination comprise current and historical use as agricultural fields including a sheepwash (Hardwick Interchange), current and historical roads, historical railway (Hardwick Interchange) and an inactive clay pit.

8.3.2 Potential off-scheme sources of contamination generally included current and historical agricultural land use, historical mineral extraction sites, current and historical landfills including unknown filled ground and surrounding current and historical industrial land uses.

8.3.3 Plausible contaminant linkages have been identified with respect to human health including dermal contact with, inhalation of soils, dust, gas and vapours or ingestion of contaminated soils, dust or water.

8.3.4 Plausible contaminant linkages identified to controlled waters include the possibility of leaching of contaminants from the unsaturated zone, lateral migration of contaminants in surface water on to, and off of the scheme, dissolution of NAPL into recharge of groundwater and lateral migration of contaminated groundwater from up gradient off-scheme sources on to the scheme.

8.3.5 Plausible contaminant linkages to building structures include direct contact with contaminated soils, groundwater or immiscible contaminants.

8.3.6 Potential receptors were identified as:

- Current and future users;
- Construction and maintenance workers;

- Sandringham Sands Formation (Principal Aquifer), Raised Beach Deposits, Alluvium and Tottenhill Gravel Member (Secondary (A) Aquifers) and Head Deposits and Lowestoft Formation (Secondary Undifferentiated Aquifers);
- Surroundings ponds, field drains, ditches and the Pierpoint Drain;
- Structures, particularly any utilities; and
- Potable water supply pipes.

8.3.7 Although a number of plausible pollutant linkages have been identified, the preliminary risk assessment indicates generally a **low** risk to human health generally **low to moderate** risk to controlled waters.

8.4 Recommendations

8.4.1 WSP recommends the following actions are undertaken:

- An additional targeted intrusive ground investigation would be required for the development of the Proposed Scheme, and would comprise the following;
  - Baseline ground conditions along the scheme including geology, contaminant concentrations, ground gas and groundwater monitoring;
  - Production of a Ground Investigation Report (GIR);
  - Using the parameters detailed in WSP Ground investigation Appraisal report and those from further ground investigation, a detailed design of the proposed foundation solutions and earthworks solutions should be carried out; and
  - Geotechnical Design Report (GDR) and Earthworks Specification for the foundation solutions and required earthworks.