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Highways England

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Project Manager:	Paul Manamike
Author:	Oliver Wotton
	Katherine Hunt
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Jacobs U.K. Limited

1180 Eskdale Road
Winnersh, Wokingham
Reading RG41 5TU
United Kingdom
Data Protection Act

www.jacobs.com

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1. Introduction

1.1 Proposed M11 Junction 7A Scheme

1.2 Scope and Objective of this Report

This Remediation Strategy has been prepared for the Proposed M11 J7A Scheme.

This report includes a desk-based review of available land quality information (e.g. existing reports, historical maps, aerial photographs and environmental data searches), a preliminary Conceptual Site Modal (CSM) and risk assessment. This report also presents the findings of the 2015-2016 Ground Investigation (GI), which was completed to address data gaps in the contamination information identified from the preliminary assessment.

The findings of the 2015-2016 GI have been assessed and an updated CSM and risk assessment has been undertaken, to identify potential pollutant linkages which might impact or be impacted by the Proposed Scheme. The assessment has been carried out in general accordance with Model Procedures for the Management of Land Contamination: Contaminated Land Report 11 (CLR11) (Environment Agency and Department for Environment, Food and Rural Affairs (Defra), 2004) [(15)].

This report provides a remediation strategy for the mitigation of potential pollutant linkages during the works.

2. Desk Study

2.1 Location

Harlow is situated in the west of the County of Essex. It is flanked by the M11 to the east which provides its main connectivity (via Junction 7) to the M25, London, Stansted Airport, Cambridge and the north east of England. It is also served by the West Anglia Main Line which provides a direct rail link into London Liverpool Street, London. Another major link within the county and into Hertfordshire is provided by the A414.

The proposed M11 Junction 7A scheme is located within Epping Forest District and within Green Belt land in open, gently undulating countryside. The land is used predominantly for arable cultivation with some housing. The Pincey Brook bounds this area to the north with The Mores Wood to the south. The B183 Gilden Way follows a green corridor into Harlow with mature hedgerows and trees along its length. Open countryside is replaced by houses and business premises towards Harlow town centre.

At the proposed location of Junction 7A, an overbridge and roundabouts will be constructed above the M11 motorway. The proposed works will also include widening and construction of earthworks along the M11 and the construction of new earthworks (mostly embankments) along the series of link roads and roundabouts to the B183 Gilden Way / Sheering Road.

The Proposed Scheme area is shown on Figure 1.

2.2 Study Area

The study area for this desk study is defined as the route of the Proposed Scheme and the area in the vicinity of the route that could be impacted by ground conditions along it or which could impact the route itself. For the purpose of this assessment this is generally considered to be approximately 250m on either side of the route, however this may be increased or decreased depending on the potential magnitude of impact. The study area buffer is shown on Figure 2.

2.3 Sources of Information

The following documents were reviewed and data within was used to complete the desk study for this remediation strategy:

- Jacobs, 2015, M11 Junction 7A Preliminary Sources Study Report, Document Number: B3553F05/0600.06a/0002 [(22)];
- Jacobs, 2015, M11 Junction 7A, Gilden Way Preliminary Sources Study Report, Document Number: B3553F05/0600.06a/0005 [(23)];
- Jacobs, 2017, M11 Junction 7A Environmental Statement, Document Number: B3553F05-3000-REP-0036 [(25)]; and
- Jacobs, 2013, M11, Junction 7A, Harlow, Preliminary Geo-environmental Assessment [(26)].

2.4 Sensitive Land Designations

2.4.1 Geological Sites

Based on a review of the Essex geology (GeoEssex) website [(20)] there are no geological SSSIs or Local Geological Sites (LoGS), formerly called Regionally Important Geological Sites or RIGS, within the study area.

2.4.2 Mineral Sites

Based on a review of the local mineral planning policy for Essex [(18)], no mineral safeguarded sites have been identified in the study area.

2.4.3 Other Sensitive Sites

The Envirocheck mapping [27] and use of the Environment Agency's (EA) 'What's in Your Back Yard' [16] tool indicates that the eastern section of the Proposed Scheme is in an area of adopted green belt. In addition the entire study area falls within a designated surface water Nitrate Vulnerable Zone (NVZ) and drinking water safeguard zone (SgZ)

2.5 Soil quality and Agricultural Land Classification

2.5.1 Soil type

The soils underlying the western section of the Proposed Scheme including Gilden Way and Sheering Road are classed as "freely draining slightly acid but base rich soils". In terms of groundwater vulnerability for the majority of this section, soils are classed as "Soils of Intermediate Leaching Potential (I1)"; these soils can possibly transmit a range of pollutants. In a small area close to Old Harlow the soils are classed as "Soils of High Leaching Potential (U)".

The soils underlying the eastern section of the Proposed Scheme including the existing M11 are classed as "lime rich loamy and clayey soils with impeded drainage". The impeded drainage could potentially cause overland flow where soils are compacted. The soils in this area are not classed in terms of groundwater vulnerability as this area is underlain by unproductive strata. In one small area around The Campions, the soils are classed as "Soils of Intermediate Leaching Potential (I1)" [11].

2.5.2 Agricultural land classification

The Agricultural Land Classification (ALC) system set out within Agricultural Land Classification of England and Wales: Revised Guidelines and Criteria for Grading the Quality of Agricultural Land [2] defines six grades of soils: Grade 1 (excellent quality), Grade 2 (very good quality), Subgrade 3a (good quality), Subgrade 3b (moderate quality), Grade 4 (poor quality) and Grade 5 (very poor quality). Grades 1 to Subgrade 3a are determined as BMV agricultural land. This is the most flexible land in terms of the range of crops that can be grown, the level and consistency of yield and the cost of obtaining it, and offers the best prospect for both food and non-food crop production. Land in sub-grade 3b is of moderate quality with lower yields, and/or a more restricted cropping range.

For the Proposed Scheme area, only provisional ALC data were available, obtained from the post 1988 survey published by NE. Based on these data, the majority of the eastern scheme area would be classified as ALC Grades 2 and 3, with urban land to the west (see Figure 9-5). Following the above guidance, ALC Grade 2 land is classified as BMV, which is considered a high sensitivity receptor. Agricultural land Classification Grade 3 land is classified as moderate/good quality and could potentially be BMV. Without a more detailed assessment it has been assumed that the Grade 3 land is Grade 3a. This would therefore also be considered a high sensitivity receptor. Based on the current Proposed Scheme design, approximately 26.3ha (53%of Proposed Scheme area) is classified as Grade 2, approximately 16.5ha (33% of Proposed Scheme area) as Grade 3 and approximately 6.8ha (14% of Proposed Scheme area) as urban land. These areas include temporary land use during construction as soil in these areas could potentially be impacted by the Proposed Scheme. Chapter 12 – People and Communities, discusses the potential permanent land take impacts to agricultural land.

The agricultural land classifications are shown on Figure 3.

2.6 Published Geological Information

The geology of the study area is shown on the Geological Survey of Great Britain (England and Wales), Sheet E240, Epping, Solid and Drift Edition, 1:50,000 series, 1981 map [19]. The associated geological memoir for the study area is the BGS, The geology of the country around Epping, Sheet E240, D Millward et al. 1987 [3]. The BGS online resources were also used [, 5, 6, 6]. Figure 1 shows geology within the proposed schemed area.

2.6.1 Artificial

The British Geological Survey (BGS) artificial ground map on the BGS onshore GeoIndex [6] shows an area of made ground directly south east of the Churchgate Roundabout. This area is now marked as a recreation

ground. There is another area marked immediately north of the Pincey Brook extending to the west and slightly across Sheering Road. In addition, the general area is known to have been extracted for sand, gravel and clay and as a consequence, there are a number of potentially infilled pits within the scheme area. It should be noted that the precise locations of all of these areas cannot be confirmed.

The Envirocheck [27] historical land use information indicates the location of some potentially infilled areas noted as resulting from brick and clay manufacture. These are located to the west and east of Marsh Lane, and to the west and east of Sheering Road. A number of these areas match areas of known pits. Additionally, made ground is expected in areas of existing roads, with some areas of reworked ground, infilled pits and demolished buildings also expected.

2.6.2 Superficial

The majority of the Proposed Scheme is underlain by superficial deposits of the Lowestoft Formation (Diamicton), with head deposits in a narrow band running parallel west to east across the study area towards the existing M11 and extending south through the central section of the Gilden Way. A band of alluvium to the north of the head deposits extends in a parallel band across the area, following the approximate path of the Pincey Brook. In addition, there is a band of glaciofluvial deposits in the western section of Gilden Way.

2.6.3 Bedrock

The area in the vicinity of the M11, to the east of Gilden Way, is underlain by the London Clay Formation, which thins towards the west. In the centre of the proposed Gilden Way, London Clay is absent (where it has been eroded away). Where the London Clay is absent the underlying older Thanet Sand Formation and Lambeth Group (undifferentiated clay silt and sands) are revealed and then the older still Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated), which are shown to subcrop beneath the superficial deposits.

2.7 Published hydrological and hydrogeological Information

2.7.1 Aquifer Classifications

The EA classifies the superficial deposits of head as Secondary Undifferentiated Aquifers with the glaciofluvial deposits and alluvium deposits classified as Secondary A Aquifers. The Lowestoft Formation is classified as unproductive strata and has negligible significance for water supply or river base flow.

The EA's bedrock aquifer map and groundwater vulnerability map [16] shows the majority of the study area to be within a non-aquifer zone (London Clay), classified as unproductive strata. The eastern and western area of Gilden Way is classified as a Secondary A Aquifer of intermediate vulnerability (Thanet Sand Formation and Lambeth Group) with the centre (extending north and south) classified as a Principal Aquifer of high vulnerability (Lewes Nodular Chalk Formation and Seaford Chalk Formation).

2.7.2 Published Hydrology

There are two brooks within the study area: Pincey Brook, which crosses under the existing M11 and the proposed route and Harlowbury Brook which crosses the centre of the Gilden Way section of the scheme. The Harlowbury Brook also has smaller associated water courses branching off from it within the study area. Both Pincey Brook and Harlowbury Brook are tributaries of the River Stort which is approximately 1.5km to the north of the study area.

In addition, there are several ditches and ponds located in the vicinity of the Proposed Scheme. A ditch crosses the proposed route running north of two ponds near to Morgan Farm. A number of ponds are also indicated on the mapping in the area of The Campions.

The Pincey Brook has a river quality General Quality Assessment (GQA) Grade of B (Good). This river quality grade was awarded in 2000. GQA assesses the river water chemistry, biology and nutrients.

The Harlowbury Brook is not listed on the Environment Agency surface water quality maps [17] and therefore a classification is unavailable.

2.8 Current Land Uses

The proposed motorway junction is located within Green Belt land in open, gently undulating countryside. Land use for the Proposed Scheme area is predominantly arable or residential. The hamlet of The Campions lies to the west of the proposed re-alignment of Gilden Way. Mayfield Farm lies opposite The Campions which has a bakery business, shop and café.

2.9 Historic Land Uses

A number of ordnance survey historical maps and environmental data reports procured from Landmark [27] were reviewed to inform historical development of the land surrounding the scheme and to inform the presence of historic (and current) potentially contaminative sites.

2.9.1 On-site land use

The Proposed Scheme area has comprised primarily agricultural/undeveloped land since at least 1881 (first available historic mapping). Between 1898 and 1923, Mayfield Farm was developed to the south east of Sheering Road. For the Gilden Way, there has been no significant change until it was built (present on maps from 1965). The location of the proposed site compound to the south of the Gilden Way is shown as a plant nursery from the 2006 map. In the vicinity of the M11 no significant changes are recorded until 1982 when the M11 is shown.

2.9.2 Off-site land use

The land surrounding the Proposed Scheme has been predominantly agricultural/undeveloped land since at least 1881 (first available historic mapping). Between 1881 and 1887 gravel and clay pits and a brickfield are shown to the north and south of the eastern section of Gilden Way - the closest being approximately 40m south of Gilden Way. These are no longer shown by 1982 and appear to have been infilled. Between 1887 and 1889, there is increased residential development, a number of gravel pits present on the maps and a fire station house to the north of the Gilden Way. On the 1923 map there is some additional development, with Mayfield Farm and some allotments (parallel to the Gilden Way, near to Harlow) present. Between 1947 and 1982 housing developments appear to have expanded and redeveloped to the north and south of the M11 Westbound Link. In the area of the proposed Gilden Way scheme there is no significant change depicted until 1960, when there is some increased development in Harlow, with an electrical substation shown (1965-1986 map). In 1982, Harlow (now labelled as 'Old Harlow') and the Churchgate area to the north of the Gilden Way appeared to have further developed, with the fire station house now labelled as F House and ambulance station and the gravel pits no longer present (the latter potentially infilled). From 1982 the land within the study area appeared to remain largely unchanged with the exception of the addition of Morgan Farm (to the south of the M11 Westbound Link) and another farm in 2013 (next to Sheering Hall).

2.10 Regulatory and Archive Information

2.10.1 Discharge Consents

With reference to data within the Envirocheck [27] report, there are a number of discharge consents within the study area, the majority of which are for sewage discharges, with one listed for other matter and one of unknown type. The discharge consents are located in the housing area close to Moor Hall Road (~95m and ~195m from scheme), just south of Matchings Road (~145m and ~210m from scheme), at Mayfield Farm (~30m from scheme) and at Sheering Hall Farm (~300m from scheme).

2.10.2 Groundwater Abstraction Consents

Based on review of Envirocheck [27] data and information provided by the EA, there are two groundwater abstraction consents within the study area. The abstractions are both shown as being less than 10m from the

scheme (located near the proposed Sheering Road Roundabout). The abstractions are recorded as spray irrigation related to agricultural practices. One of the groundwater abstraction consents (No.21 on Figure 2) is listed as “revoked” and no evidence of this abstraction was observed within the scheme area. It is therefore considered likely that only one groundwater abstraction is present within the scheme area.

2.10.3 Surface water Abstraction Consents

The Envirocheck [27] data shows one surface water abstraction consent less than 10m from the scheme, to the north of the proposed Sheering Road Roundabout. No additional surface water abstraction information was provided by the EA.

2.10.4 Pollution Incidents to Controlled Waters

The Envirocheck [27] mapping shows no recorded Pollution Incidents to Controlled Waters and Substantiated Pollution Incidents within 250m of the Proposed Scheme.

2.10.5 Waste and Landfills

The nearest recorded historical landfill is the Moor Hall Road landfill, located at the southern edge of the study area (approximately 240m from the Proposed Scheme). This is recorded as having accepted inert waste between 1974 and 1976. As the Moor Hall Road landfill site is at the edge of the study area and would not be impacted by the Proposed Scheme, it has been discounted from further assessment. The location of the landfill is shown on Figure 2.

Another former landfill site was identified by information provided by Epping Forest District Council, located at OSGR: 548903, 212547. The waste type accepted is unknown. This former landfill is located approximately 85m from the Proposed Scheme and is not mentioned in EA information or on the EA website. However, due to the distance from the Proposed Scheme, and the fact that no elevated gas levels or groundwater contamination has been detected in the area, this landfill has been discounted from further assessment.

In addition, there is one licensed waste management facility within the study area (middle section of Gilden Way, south of Mulberry Gardens. This facility is for the management of composting waste (only accepting organic materials suitable for composting). The licence status for this site is currently dormant.

There are a number of abandoned mineral extractions sites. These are all located close to the eastern end of Gilden Way and were all for the extraction of sand and gravel. The closest was approximately 20m north of the Gilden Way north. The extraction would have been open cast so the resulting pits at these locations would likely have been infilled since the extraction ceased. One of the sites close to the Proposed Scheme is identified in correspondence from Harlow Council who state that the pit may have been infilled “presumably with domestic refuse”.

Within the study area there are a number of small-scale, sand, gravel and clay pits as well as several brickfields marked on historical maps. It should be noted that not all of the extraction locations are marked on historical plans and that the precise location of these areas cannot be confirmed.

2.10.6 Potentially Contaminative Land Uses

The data reports procured from Landmark [27] Information Group Limited (Landmark) were reviewed to provide information on potentially contaminative uses within the study area. The following were identified:

- The reports indicate one polythene and plastic sheeting supplier (active), a sausage manufacturer (active), a furniture manufacturer (inactive), meat wholesaler (inactive) and cheese supplier (inactive) at the eastern end of Gilden Way;
- On Oxleys Road which connects to the middle section of Gilden Way there is an active road haulage services listed;
- On Mulberry Green which connects to the middle section of Gilden Way there is an inactive slate products company listed;

- Farmland covering the majority of the scheme; and
- There are no fuel station entries listed within the study area.

2.10.7 Radon

The Indicative Atlas of Radon [21] shows the site to be located in an area where 0-1% of homes are at or above the action level for Radon.

In terms of development no protective measures are required in this area according to BR211: (Radon-Guidance on Protective Measures for new buildings) [7].

2.10.8 Unexploded Ordnance Risk (UXO)

The risk of Unexploded Ordnance (UXO) in the study area was initially assessed by Dynasafe Bactec Ltd. in May 2015 as 'Low' to 'Medium'. Details of the assessment and recommended risk mitigation measures are provided in the Dynasafe Bactec Ltd., Explosive Ordnance Threat Assessment Desk Study, Document No. 6025TA, Rev 0, May 2015 (superseded by Rev 1) [1 1st Line Defence Ltd., Report on UXO, Non-Intrusive Magnetometer Survey, Report Reference].

Anecdotal evidence of World War II UXOs between the M11 motorway and Gilden Way/Mayfield Farm area was subsequently provided by the landowner before the recent GI commenced. The anecdotal evidence includes details of the following findings:

- 1970 - three or four German 1kg incendiary bombs were discovered within a farmer's field following agricultural ploughing to depths of approximately 200-350mm; and
- 1991 to 1993 - similar to the previous incident, three or four German 1kg incendiary bombs found during ploughing and were subsequently destroyed.

In light of the new information above, the risk of UXOs was amended by Dynasafe Bactec Ltd. to Medium. Further details are provided in the updated Dynasafe Bactec Ltd., Explosive Ordnance Threat Assessment Desk Study, Document No. 6025TA, Rev 1, October 2015[14].

Dynasafe Bactec Ltd.'s recommendation for a non-intrusive magnetometer survey and targeted investigation was adopted during the ground investigation undertaken at the scheme. First Line Defence Ltd. carried out the non-intrusive magnetometer survey during which 4,213 magnetic anomalies were identified. First Line Defence Ltd. has also recommended that a targeted investigation is carried out prior to construction works commencing. Further details are provided in the 1st Line Defence Ltd., Report on UXO, Non-Intrusive Magnetometer Survey, Report Reference OPN2825NIS, 27 November 2015 (see Soils Ltd., Factual Ground Investigation Report, Reference 15096/GIR, April 2016 for full report).

2.11 Preliminary Conceptual Site Model and Preliminary Risk Assessment

2.11.1 Assessment of Risk

A preliminary conceptual site model and risk assessment has been undertaken for the Proposed Scheme to identify the main potential land contamination constraints to the development based upon review of the site history, ground conditions and environmental setting. The method for risk evaluation has been based on guidance by CIRIA (2001) 'C552: Contaminated Land Risk Assessment - A Guide to Good Practice' [8], which is a qualitative method of interpreting the risks based on the magnitudes of both the potential consequence (severity) and the probability (likelihood) of the risk occurring.

The risk tables (are used to classify the consequence and likelihood of a risk. The risk matrix (Table 2-C) has been used to estimate a risk for each potential constraint to development (hazard) for potential land contamination issues identified. Table 2-D is used to describe the level of risk identified.

Classification	Definition
Severe	Acute risk to human health likely to result in “significant harm” as defined by EPA 1990 Part 2A. Short term risk to sensitive water resource. Catastrophic damage to buildings/property. A short term risk to a particular ecosystem or organism forming part of that system.
Medium	Chronic damage to Human Health. Pollution of sensitive water resource. Significant change to an ecosystem or organism forming part of ecosystem.
Mild	Pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services. Damage to sensitive buildings/structures/ services or the environment.
Minor	Harm, which may not be significant and may result in financial loss, or expenditure to resolve. No permanent health effects to human health (preventable by PPE). Easily repairable effects of damage to buildings, structures and services.

Table 2-A Classification of Consequence (CIRIA, 2001)

Classification	Definition
High Likelihood	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low Likelihood	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place, and is even less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 2-B Estimation of Likelihood

Risk Matrix		Consequence (Severity)			
		Severe	Medium	Mild	Minor
Probability (likelihood)	High Likelihood	Very High	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low Likelihood	Moderate	Moderate/Low	Low	Very Low
	Unlikely	Moderate/Low	Low	Very Low	Very Low

Table 2-C Estimation of Severity of Risk

Risk	Risk Description
Very High	There is a high likelihood of the event occurring and having severe consequences. If the risk is realised it is likely to result in a substantial liability.
High	It is likely that an event with medium or even severe consequences could arise. If the risk is realised it may result in a substantial liability.
Moderate	It is possible that an event could occur and it is either unlikely and consequences may be severe or if it were to occur it is likely that consequences would be relatively mild. Investigation would normally be required to clarify the risk and determine the potential liability.
Low Risk	It is possible that an event could occur but it is likely that the consequences would be at worst mild.
Very Low	It is unlikely that an event could occur, and if it happened the consequences are likely to be at worst mild.

Table 2-D Risk Description

The estimation of risk is based on qualitative assessment using desktop data reviewed and relates primarily to long term risks to site users, buildings and the surrounding environment.

2.11.2 Legislative background

The Legislative Framework for dealing with historical land contamination is set out within Part 2A of the Environmental Protection Act (EPA) 1990 [(12)]. The legislation embraces the “suitable for use” approach, which comprises three principal elements:

- Ensuring that land is suitable for its current use, such that contamination is not causing unacceptable risks to human health and the environment;
- Ensuring that land is made suitable for the new use intended, as planning permission is given for that new use; and
- Limiting requirements for remediation to the work necessary to prevent unacceptable risks to human health or the environment in relation to the current use or future use of the land for which planning permission is being sought.

Under the planning and development control regime, as set out in Department for Communities and Local Government (2012) National Planning Policy Framework [(10)], the aim is to ensure that there are no unacceptable risks to either receptors relevant to Part 2A, or to others that may be covered by other regimes, taking into account the proposed new land use.

The assessment below is based on the Contaminated Land Report (CLR) 11: Model Procedures for the Management of Land Contamination [15]. CLR 11 has been developed to provide the technical framework for applying a risk management process when dealing with land affected by contamination. An important thread throughout the overall process of risk assessment is the need to formulate and develop a Conceptual Site Model (CSM) for the Proposed Scheme, which supports the identification and assessment of pollutant linkages. Development of the CSM forms the main part of preliminary risk assessment, and the model is subsequently refined or revised as more information and understanding is obtained through the risk assessment process.

2.11.3 Potential Sources of Contamination

The following potential sources of contamination were identified based on the desk study information:

- Farms and agricultural land use, involving potential oils, solvents, pesticides and fertiliser use;
- Made ground underlying the study area from roads and previous constructions, including abandoned and backfilled sand, gravel and clay pits; and
- Commercial/industrial areas in and around Harlow including the proposed site compound off Gilden Way.

2.11.4 Potential Pathways

The following potential pathways were identified based on the desk study information:

- Dermal contact, ingestion and inhalation;
- Leaching and migration;
- Direct entry (via local watercourses, drainage channels, base flow), surface water run – off and infiltration;
- Migration and accumulation of ground gas: and
- Direct contact with buried infrastructure and buried ground.

2.11.5 Potential Receptors

The following potential receptors were identified based on the desk study information:

- Current site users;
- Construction and/or maintenance workers;
- Future site users;
- Groundwater;
- Surface waters;
- Offsite users; and
- Current and future highways and associate infrastructure.

2.11.6 Conceptual Site Model (CSM) and Preliminary Risk Assessment

The CSM and preliminary risk assessment of potential pollutant linkages associated with the potential sources of contamination are summarised in Table 2-E below.

Source	Pathway	Receptor	Plausible Pollutant Linkage	Risk Level
Farms and agricultural land uses – oils, solvents, pesticides, fertilisers	Dermal contact, inhalation and ingestion. Leaching and migration. Direct entry, surface water run – off and infiltration.	Current and future site users	The nature and extent of potential contamination is unknown. It is considered **unlikely** that current and future users may be exposed to potential contamination due to these receptors being unlikely to disturb the ground. The consequences of exposure may be **medium**.	**Low Risk**
		Construction and / or maintenance workers	The nature and extent of potential contamination is unknown. It is considered **likely** that construction and / or maintenance workers may be exposed to potential contamination due to the expectation of significant ground excavation during this development. The consequences of exposure may be **medium**.	**Moderate Risk**
		Ground and surface water	The nature and extent of potential contamination is unknown. It is considered **likely** that ground and surface water may be exposed to potential contamination due to the expectation of significant ground excavation during the development which could mobilise contaminants. The consequences of exposure may be **medium** due to the presence of secondary aquifers underlying the majority of the farmland. The principle aquifer underlying Gilden Way is located west of the majority of farmland therefore it is considered exposure may be a **low likelihood** however the consequences of exposure may be **severe** due to the importance and vulnerability of this aquifer.	**Moderate Risk**
		Offsite users	The nature and extent of potential contamination is unknown. It is considered a **low likelihood** that offsite users may be exposed to potential contamination. The consequences of exposure may be **medium**.	**Moderate/Low Risk**
Made Ground including infilled pits - metals, oils, asbestos, organic and inorganic	Dermal contact, inhalation and ingestion. Leaching, and migration.	Current and future site users	The nature and extent of potential contamination is unknown. It is considered a **low likelihood** that current and future site users may be exposed due to the receptors being unlikely to disturb the ground. The consequences of exposure may be **medium**.	**Moderate/Low Risk**

Source	Pathway	Receptor	Plausible Pollutant Linkage	Risk Level
contaminants, gas	Direct entry, surface water run – off and infiltration	Construction and / or maintenance workers	The nature, extent and thickness of made ground within the study area is unknown, and therefore potential contamination is unknown. It is considered **likely** that construction and / or maintenance workers may be exposed due to the expectation of significant ground excavation during the development. If appropriate risk mitigations such as PPE and dust suppression are applied then the risk to human health could be **medium**.	**Moderate Risk**
		Ground and surface water	The nature, extent and thickness of made ground within the study area is unknown, and therefore potential contamination is unknown. It is considered **likely** that ground and surface water may be exposed to potential contamination due to the expectation of significant ground excavation during this development which could mobilise contaminants. The consequences of exposure may be **medium** due to the presence of secondary aquifers.	**Moderate risk**
			It is considered **likely** the principle aquifer underlying Gilden Way may be exposed to potential contamination due to the overlying made ground of Gilden Way. The consequence of exposure may be **severe** due to the importance and vulnerability of this aquifer.	**High Risk**
		Offsite users	The nature, extent and thickness of made ground within the study area is unknown, and therefore potential contamination is unknown. It is considered a **low likelihood** that offsite users may be exposed to potential contamination. The consequence of exposure may be **medium**.	**Moderate/Low Risk**
	Migration and accumulation of ground gases	Construction and / or maintenance workers	The potentially infilled historical mineral extraction pits may have the potential to generate ground gases from the material they have been filled with. The infill material type is unknown with the exception of one pit which may be infilled with 'domestic refuse'. The low permeability Lowestoft Formation and underlying London Clay Formation may impede migration of ground gases. However, the development may disturb these pits promoting migration as well as providing preferential	**Moderate Risk**

Source	Pathway	Receptor	Plausible Pollutant Linkage	Risk Level
			pathways from ground excavation. It is considered **likely** that construction and / or maintenance workers may be exposed to ground gases if they are present. The consequence of exposure may be **medium**.	
		Current and future highways and associated infrastructure	The potentially infilled historical mineral extraction pits have the potential to generate ground gases from the material they have been filled with. The infilling material type is unknown at present with the exception of one pit which may be infilled with 'domestic refuse'. The low permeability Lowestoft Formation and underlying London Clay Formation may impede migration of ground gases. However, the development may disturb these pits promoting migration as well as providing preferential pathways from ground excavation. It is considered a **low likelihood** that current and future highways and associated infrastructure may be exposed to ground gases. The consequence of exposure may be **medium**.	**Moderate/Low Risk**
		Nearby site users	The potentially infilled historical mineral extraction pits have the potential to generate ground gases from the material they have been filled with. The infilling material type is unknown at present with the exception of one pit which may be infilled with 'domestic refuse'. The low permeability Lowestoft Formation and underlying London Clay Formation may impede migration of ground gases. However, the development may disturb these pits during ground excavations promoting ground gas migration. It is considered a **low likelihood** that nearby site users may be exposed to ground gases. The consequences of exposure may be **medium**.	**Moderate/Low Risk**
	Direct Contact with buried infrastructure and aggressive ground	Current and future highways and associated infrastructure	The nature, extent and thickness of made ground within the study area is unknown. The made/infilled ground may contain materials which could affect the aggressivity of the ground locally. It is considered **unlikely** that current and future highways infrastructure may be exposed to aggressive made ground contaminants, buried infrastructure would be at most risk. The consequence of exposure may be **medium.**	**Low Risk**
Industrial areas in	Dermal contact,	Current and future site users	The nature and extent of potential contamination is unknown. It is	**Moderate/Low**

Source	Pathway	Receptor	Plausible Pollutant Linkage	Risk Level
and around Harlow (including: fire station, ambulance station, road haulage, allotments and proposed site compound off Gilden Way previously used as a plant nursery).	ingestion and inhalation. Leaching and migration. Direct entry, surface water run-off and infiltration.		considered a **low likelihood** that current and future site users may be exposed to potential contamination. The consequences of exposure may be **medium**.	**Risk**
		Construction and/or maintenance workers	The nature and extent of potential contamination is unknown. It is considered **likely** that construction and / or maintenance workers may be exposed to potential contamination. The consequences of exposure may be **medium**.	**Moderate Risk**
		Nearby site users	The nature and extent of potential contamination is unknown. It is considered a **low likelihood** that nearby site users may be exposed to potential contamination. The consequences of exposure may be **medium**.	**Moderate/Low Risk**
		Ground and surface water	The nature and extent of potential contamination in the study area is unknown. It is considered a **likely** that ground and surface water may be exposed to potential contamination from industrial areas. The consequence of exposure may be **severe** due to the presence of a principal aquifer underlying Gilden Way. .	**High Risk**
	Direct Contact with buried infrastructure and aggressive ground	Current and future highways and associated infrastructure	The nature and extent of potential contamination is unknown. It is considered **unlikely** that current and future highways and associated infrastructure will be exposed to potential aggressive contamination from industrial activities. The consequences of such exposure would be **medium**.	**Low Risk**

Table 2-E Preliminary risk assessment

2.11.7 Recommendations for Refinement of Preliminary CSM

The above preliminary CSM and risk assessment identified various potential risks to receptors throughout the Proposed Scheme. However, a number of uncertainties were also identified within the CSM which would need further assessment and investigation in order to refine the risk assessment. The key uncertainties can be summarised as:

- The presence, extent, thickness, nature, variability and contaminative status of areas of made ground within the study area;
- The presence and nature of contamination associated with areas of industrial or agricultural use;
- The presence / absence of ground gas / vapours or aggressive ground beneath the study area; and
- Location and infill materials of former pits close to the road scheme (particularly the pit recorded by Harlow Council, which is presumed to be infilled with domestic refuse).

Based on the findings of the desk study, a ground investigation was undertaken to refine these uncertainties with the following objectives relating to land contamination;

- Gain a better understanding of the geological strata in the study area;
- Provide information on the location and water quality status of the shallow aquifers in the study area;
- Provide information on the land contamination status of the shallow soil in the study area;
- Provide information on the extent, nature and thickness of made ground / infilled pits in the study area; and
- Provide information on potential ground gas concentrations in the area.

The findings of the ground investigation are presented in Section 3.

3. Ground Investigations

3.1 Introduction

A number of previous ground investigations have been undertaken on the study area that are relevant to understanding land contamination. However, based on the review of these previous ground investigations, it was identified that available data was insufficient to assess potential land contamination risks for the scheme.

A combined geotechnical and land contamination ground investigation was therefore undertaken for the scheme by Jacobs between October 2015 and February 2016 to investigate the risks identified in the preliminary risk assessment in Section 2.10. The results of this ground investigation, including the ground model developed from this investigation, are summarised below. Further details of the ground investigations undertaken are given in Jacobs report B3553F05/REP/36 [24].

The Jacobs 2015-2016 borehole locations are shown on Figure 1.

3.2 Ground Conditions

The following sections are interpretations of the ground conditions encountered during the 2015-2016 Jacobs ground investigation along with the previous ground investigations and the BGS 1:50,000 series geological map, Sheet E240 (Epping) [19] and accompanying memoir [3].

The ground conditions encountered in the 2015 – 2016 ground investigation broadly confirmed the published geology in the study area.

3.2.1 Topsoil

Topsoil was encountered in the majority of the exploratory holes carried out during the recent and previous ground investigations. The topsoil typically consists of clay with varying proportions of sands and gravels. The gravel within the topsoil is typically described as subrounded to angular, fine to coarse flint. The majority of the topsoil encountered ranges from 0.2m to 0.4m in thickness. It has also been encountered up to a maximum thickness of 1.0m in previous ground investigations located offline of the B183 Gilden Way

3.2.2 Made ground

The majority of the ground encountered during the investigation was assessed as natural. Made ground was only identified in a total of 8 out of the sixty two exploratory holes. This was at BH1 and BH2 (on the M11 embankment), and WS1, WS2, WS10, WS11, WS12 and BH33 (along Gilden Way). The cohesive Made Ground typically comprised dark brown slightly gravelly slightly sandy to sandy silty clay, also encountered as soft brown slightly gravelly clayey silt with frequent roots. Sand was fine. Gravel was fine to medium flint, concrete and brick. The minor amounts of anthropogenic materials were observed in the made ground which largely comprised brick and concrete fragments with lesser amounts of metal, glass and tarmac.

BH1 and BH2 Made Ground are identified as Embankment Fill typically consists of stiff clay with varying proportions of silts and gravels. The gravel within the Embankment Fill is typically described as fine to coarse chalk nodules and sub-rounded to sub-angular flint. Embankment Fill typically ranges from 1.2m to 4.5m in thickness.

No significant visual or olfactory indications of contamination were encountered during the investigations.

3.2.3 Superficial

3.2.3.1 Alluvium

Alluvium was encountered in BH29 and TPB3 carried out during the recent ground investigation and in TL41SE33 and TL41SE92 carried out during the previous ground investigations. These exploratory holes are located to the north of the scheme in the general area of Pincey Brook.

The Alluvium encountered typically consists of very soft to soft clay with varying proportions of silts, sands and gravels. The rare presence of organic material was noted during the ground investigations. Alluvium encountered ranges from 1.3m to 3.1m in thickness.

3.2.3.2 Head Deposits

Head Deposits were encountered in several exploratory holes during the recent and previous ground investigations. The material typically consists of soft to firm slightly gravelly, sandy and silty clay. Head Deposits encountered range from 0.3m to 5.2m in thickness.

3.2.3.3 Lowestoft Formation

Lowestoft Formation was encountered in the majority of the exploratory holes carried out during the recent and previous ground investigations.

The Lowestoft Formation typically consists of firm to stiff sandy, silty, gravelly clay. The gravel within the Lowestoft Formation is typically described as fine to medium chalk and subrounded to angular flint. Glacial sands and gravels ranging from 0.3m to 4.8m in thickness were occasionally found interbedded with the Lowestoft Formation. These deposits have been interpreted as Glaciofluvial Deposits. Lowestoft Formation encountered ranges from 0.1m to 42.7m in thickness.

3.2.3.4 Glaciofluvial Deposits

Glaciofluvial Deposits were encountered within and directly beneath the Lowestoft Formation in several exploratory holes during the recent and previous ground investigations. The deposits typically consist of loose fine to medium dense sand and loose to medium dense gravel. The gravel is also described as subrounded to angular flint. The Glaciofluvial Deposits underlying the Lowestoft Formation range from 0.3m to 10.7m in thickness.

3.2.4 Bedrock

3.2.4.1 London Clay Formation

The London Clay Formation was encountered in several exploratory holes across the study area during the recent and previous ground investigations.

The London Clay Formation typically consists of weathered and unweathered material with occasional selenite crystals. The weathered London Clay Formation is typically described as firm to stiff fissured greyish brown and brown silty clay. The unweathered London Clay Formation is typically described as stiff fissured grey and/or blue silty clay.

The London Clay Formation encountered during the ground investigations ranges from 0.8m to 17.6m in thickness. The full thickness of the material was not proven in any of the exploratory holes.

3.2.4.2 Undifferentiated Lambeth Group and Thanet Formation

The undifferentiated Lambeth Group and Thanet Formation was encountered in the recent ground investigation in BH24. It is described as either medium dense greyish brown silty fine to medium sand, moderately weak greyish brown sandstone. Recovered as gravelly fine to medium sand, Very stiff friable greyish brown and dark

brown possibly interlaminated clayey SILT. The full thickness of the undifferentiated Lambeth Group and Thanet was not proven in the exploratory hole.

3.2.4.3 Chalk

Chalk was only encountered during the previous ground investigations in TL41SE80 located south of the B183 Gilden Way. The full thickness of the Chalk was not proven in the exploratory hole.

3.2.5 Contamination Assessment

As part of the ground investigation, selected soil samples (91 in total) were scheduled for chemical analysis in order to obtain general information regarding the soil quality likely to be encountered during the works, along with the potential risks that contamination might pose to workers and the environment.

Chemical analyses scheduled included: metal suite (arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel and zinc), Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), Benzene, Toluene, Ethylbenzene and Xylene (BTEX) and MBTE, asbestos screen, pH, semi volatile organic compounds (SVOCs) and pesticides and herbicides.

The chemical concentrations of soil samples were compared against Category 4 Screening Levels (C4SL) [13] and / or Suitable 4 Use Levels (S4ULs) [28] guideline values for commercial/industrial, allotment and residential with plant uptake land use.

The results indicate no exceedances of the guideline values for a commercial / industrial or residential land use with the exception of a topsoil soil sample (WS7) which exceeded the allotment land use criteria for lead. This land use criteria value is considered conservative for the Proposed Scheme and the measured concentration was well below the guideline values for residential and commercial land use.

No asbestos was detected in any samples.

Soil waste assessment using software HazWaste Online in accordance with Environment Agency Technical Guidance “WM3: Waste Classification - Guidance on the classification and assessment of waste” [17] was also undertaken indicates that all samples can be classed as ‘non-hazardous’ with respect to waste disposal.

Waste Acceptance Criteria (WAC) analysis indicates that 29 of those samples that were tested would be suitable for disposal in inert landfill. An additional 17 samples had Hazardous WAC suite testing undertaken, however were classified as non-hazardous under WM3. It is considered these samples represent soil which would be suitable for disposal in inert landfill although this cannot be verified due to the lack of testing against full/inert WAC suite. The sample from BH2 indicated suitability for disposal in non-hazardous landfill.

3.3 Groundwater Conditions

3.3.1 Made Ground/Perched Water

Groundwater was not encountered within the made ground during the 2015 – 2016 ground investigation boreholes.

3.3.2 Superficial Geology

The majority of groundwater strikes from the 2015 – 2016 Jacobs ground investigation were recorded within the superficial geology, at depths between 1.1m.bgl and 22.5m.bgl.

17 strikes were recorded within the Glaciofluvial deposits, and 11 were recorded within the Lowestoft Formation, No strikes were recorded within the alluvium.

3.3.3 Bedrock Geology

One groundwater strike from the 2015- 2016 Jacobs ground investigation was recorded within the London Clay bedrock at a depth of 24m.bgl.

3.3.4 Groundwater Monitoring

Groundwater standpipes were installed in selected exploratory holes during the Jacobs 2015-2016 ground investigation. 13 rounds of groundwater monitoring were undertaken between December 2015 and February 2016.

The monitoring results show that groundwater beneath the study area ranges from 0.5m and 16.5m in depth. The results also show seasonal fluctuations in groundwater level with an overall maximum rise of 5.7m in BH14 between 1st December 2015 and 17th February 2016.

As part of the ground investigation, one round of groundwater monitoring of 20 boreholes was undertaken to assess groundwater conditions. Twenty two samples were collected and tested from all 20 boreholes in January 2016.

Chemical analyses scheduled included: metal suite (arsenic, boron, cadmium, chromium, copper, lead, mercury, nickel and zinc), TPH, PAH, pH, pesticides and herbicides, total cyanide, ammoniacal nitrogen, sulphate, chloride and phenol.

A total of 13 samples exceeded the Environmental Quality Standard (EQS) for chromium, copper, nickel, zinc and ammoniacal nitrogen. For chromium five samples exceeded the EQS: BH27, BH28, BH33, BH34 and BH23. For copper, one sample exceeded the EQS, BH19. For zinc, six samples exceeded the EQS: BH3, BH8, BH9A, BH9B, BH17 and BH11B. Nickle was below the method detection limit (MDL) in all samples with the exception of BH19 which exceeded the EQS of 4µg/l. However, as the MDL for nickel is 5µg/l which is higher than the EQS (4µg/l), it cannot be determined if there are further exceedances. Ammoniacal nitrogen exceeded the EQS at BH19.

All other samples were either below the Method Detection Limit (MDL) or below the guideline values.

3.3.5 Ground Gas Conditions

Seven rounds of ground gas monitoring were undertaken during the Jacobs 2015-2016 ground investigation. The first round was undertaken on 1st December 2015 with subsequent rounds completed at weekly intervals between 13th January 2016 and 17th February 2016. Measurements of flow, differential pressure, methane equivalent, carbon dioxide, oxygen, hydrogen sulphide, carbon monoxide, VOCs and groundwater levels were taken during each round.

Using guidance presented within CIRIA C665 [(9)], a 'Characteristic Situation' has been calculated per borehole, derived from Gas Screening Values *(GSV (l/h) = borehole flow rate (l/h) x gas concentration (v/v %)),* to provide some indication of potential ground gas risk based on the available data.

BH20 was identified as 'Characteristic Situation 3', and BH30 as 'Characteristic Situation 2'. All remaining boreholes were identified as being of 'Characteristic Situation 1'.

BH20 recorded a maximum flow of >30 l/hr during the gas monitoring. On two occasions the gas tap was left open and then monitored again at the end of the day to assess whether the flow rate was due to pressure build up. However the flows were still at a high level. CH4 was not recorded at this location, and CO2 was recorded at a maximum of 3.2%, with depleted O2. No gas sources have been identified at or close to this location. The response zone for this borehole is between 12m and 19m across the Lowestoft and Glaciofluvial deposits, with monitored groundwater levels between 14.9m and 15.6m, which does not indicate that the response zone is flooded.

BH30 was classed as characteristic situation 2. CO2 was recorded at a maximum concentration of 1.6% and flow at a maximum rate of 10l/h. No CH4 was detected at this location. No gas sources have been identified at this location.

It is unclear as to why flow was detected in BH20 and BH30. It is possible that pressure changes are occurring in the boreholes due to groundwater fluctuations or gradients between ground and air temperatures.

No gas monitoring was possible along the Gilden Way section of the scheme. Site access constraints along the verge of the existing road meant that only window sample boreholes were possible along this part of the route and these were backfilled on completion due to safety concerns. This means that it was not possible to fully assess whether any ground gas may be impacting on the scheme in this area from the infilling of the old gravel pit to the north of Gilden Way. The closest borehole to the former pit, BH34 (approximately 100 to 140m from the estimated boundary of the pit) did not detect elevated gas levels.

4. Updated Conceptual Site Model and Risk Assessment

4.1 Conceptual site model

Following completion of the ground investigations, it is possible to update the CSM based on the findings of the investigations. In addition, since completion of the ground investigations, other developments have allowed further refinement of the CSM. The main developments include:

- The addition of the new M11 off slip extension (southbound); and
- Receipt of information on Agricultural Land Classification (ALC) for the Proposed Scheme.

The CSM has now been up-dated accordingly. The up-dated CSM below outlines the revised potential pollutant linkages following assessment of the information received since the preliminary CSM. An up-dated qualitative risk assessment has been undertaken to re-assess these potential linkages in accordance with guidance outlined in Model Procedures for the Management of Land Contamination, Contaminated Land Report 11 (EA, 2004) [(15)].

The updated CSM and risk assessment is presented in Table 4-A. A summary of the potential sources and receptors of contamination is provided below.

Potential contamination sources

Potential contamination sources at the Proposed Scheme are identified below. Some of the potential sources of contamination have been refined from the preliminary CSM due to design developments or the findings of the ground investigation:

- Potential contamination from farms and agricultural land use;
- Potential contamination from former clay and gravel pits;
- Made ground identified during the GI – Identified in the banking adjacent to the M11 and at a number of locations along Gilden Way;
- Potential contamination at the proposed site compound to the south of the Gilden Way - site previously used as a plant nursery; and
- Soils along new M11 off slip extension.

Potential contamination receptors

Potential receptors to contamination sources at the scheme are identified below. Some of the potential sources of contamination have been refined from the preliminary CSM due to design developments, further desk-based assessment or the findings of the ground investigation:

Humans, flora, fauna

- Construction workers during the works;
- Future maintenance workers;
- Public/pedestrians during construction works; and
- Flora, fauna.

Controlled waters

- Surface water (Pincey Brook and Harlowbury Brook); and
- Groundwater (Superficial geology (Head - Secondary Undifferentiated Aquifers and Glaciofluvial and Alluvium - Secondary A Aquifers); Bedrock (Thanet Sand Formation and Lambeth Group - Secondary A Aquifers and Lewes Nodular Chalk Formation and Seaford Chalk Formation - Principal Aquifer).

Soils

- Agricultural land Classification Grade 2 and 3 land (BMV) – potential contamination could impact soil re-use.

Potential contamination pathways

Potential human health and flora and fauna exposure pathways from existing contamination sources are:

- Exposure of construction workers and future maintenance workers via pathways such as direct dermal contact, ingestion and inhalation of dust;
- Exposure of the public on or close to the site during the development works to wind-blown dust via inhalation;
- Exposure of flora and fauna to contamination via pathways such as direct dermal contact, ingestion and inhalation of dust; and
- Ground gas migration.

Potential controlled waters pathways from existing contamination sources are:

- Leaching of contaminants from the made ground into groundwater within the superficial and bedrock geology; and
- Base flow from groundwater within the superficial geology to the Pincey Brook; and
- Surface runoff of soil into Pincey Brook.

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
Ground investigation summary: Soil chemical data demonstrate that there were no exceedances of the commercial/industrial screening criteria. Total petroleum hydrocarbon (TPH) and SVOC concentrations were below or marginally over the limits of detection, and pesticide and herbicide concentrations were below the limits of detection. TPH, PAHs, SVOC, herbicides and pesticides were all below the limits of detection in the groundwater samples collected. A total of 13 samples exceeded the Environmental Quality Standard (EQS) for chromium, copper, nickel, zinc and ammoniacal nitrogen. Exceedances of the EQS are considered to be a function of the conservative thresholds rather than indicative of significant anthropogenic contamination. Ground gas risk assessment indicates predominantly low risks. Higher risk categories have been assigned to two boreholes due to elevated flow rates not elevated gas concentrations. Note: some areas of the scheme (new off slip extension of M11 and proposed site compound south of Gilden Way) were not investigated during the GI and therefore these areas have been assessed individually compared to the preliminary CSM.				
Farms and agricultural land uses – oils, solvents, pesticides, fertilisers	Dermal contact Inhalation Ingestion Surface water run off Infiltration, gas migration	Construction and/or future maintenance workers	It is unlikely that contamination may impact on construction and/or maintenance workers given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Future site users	It is unlikely that existing contamination may impact on future site users, given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
		Groundwater	It is unlikely that existing contamination may impact on groundwater given that no widespread contamination in the soil was identified during the GI. Groundwater chemical data was largely below detection limits. Low permeability Lowestoft Formation and Head Deposits directly underlie the majority of the study area and would therefore limit vertical migration. The consequences of exposure may be medium.	Low Risk
		Surface water	It is unlikely that existing contamination may impact on surface water given that no widespread contamination in the soil was identified during the GI. Made ground was limited to the M11 banking and to some locations along Gilden way, which are not in proximity to water courses. Groundwater chemical data was largely below detection limits. Low permeability Lowestoft Formation and Head Deposits directly underlie the majority of the study area and would therefore limit vertical migration and subsequent base flow. The consequences of exposure may be medium.	Low Risk
		Flora, fauna	It is unlikely that contamination may impact on flora and fauna given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination, given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Soil quality	The GI results indicate that there is a low likelihood that contamination would have impacted high grade soils or have rendered the material unsuitable for re-use during the Proposed Scheme (with necessary environmental permitting or similar regulations adopted, i.e. CL:AIRE Definition of Waste: Development Industry Code of Practice). The consequences of soils being impacted or unsuitable for re-use due	Moderate

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
			to contamination are considered severe given that the soils on site are classed as BMV a high value resource; however, the impact is likely to be localised.	
Gravel and clay pits - metals, oils, asbestos, organic and inorganic contaminants, gas	Dermal contact Inhalation Ingestion Surface water run off Infiltration, gas migration	Current site users	It is unlikely that existing contamination would impact on current site users given that no widespread contamination was identified. The consequences of exposure may be medium.	Low Risk
		Construction and/or maintenance workers	It is unlikely that existing contamination would impact on construction and/or maintenance workers given that the Proposed Scheme does not encroach on the gravel pit location and that no widespread contamination was identified. The consequences of exposure may be medium.	Low Risk
		Future site users (without mitigation)	It is unlikely that existing contamination would impact on future site users given that no widespread contamination was identified. The consequences of exposure may be medium.	Low Risk
		Ground water	It is unlikely that existing contamination would impact on groundwater given that no widespread contamination in the soil was identified during the GI. Groundwater chemical data were largely below detection limits. Low permeability Lowestoft Formation and Head Deposits directly underlie the majority of the study area and would therefore limit vertical migration. The consequences of exposure may be medium.	Low Risk
		Surface water	It is unlikely that existing contamination would impact on surface water given that no widespread contamination in the soil was identified during the GI. Groundwater chemical data were largely below detection limits. Low permeability Lowestoft Formation and Head Deposits directly underlie the majority of the study area and would therefore limit vertical migration and subsequent base flow. The consequences of exposure may be medium.	Low Risk

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
		Flora, fauna	It is unlikely that contamination would impact on flora and fauna given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination given that no widespread contamination was identified. The consequences of exposure may be medium.	Low Risk
		Soils	The GI results indicate that there is a low likelihood that contamination would have impacted high grade soils or have rendered the material unsuitable for re-use during the scheme (with necessary environmental permitting or similar regulations adopted, i.e. CL:AIRE Definition of Waste: Development Industry Code of Practice). The consequences of soils being impacted or unsuitable for re-use due to contamination are considered severe given that the soils on site are classed as BMV a high value resource; however, the impact is likely to be localised.	Moderate
Made Ground - metals, oils, asbestos, organic and inorganic contaminants, gas	Dermal contact Inhalation Ingestion Surface water run off Infiltration	Current site users	It is unlikely that existing contamination would impact on current site users, as made ground is limited to farms and roads and no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Construction and/or maintenance workers	It is unlikely that existing contamination would impact on construction and/or maintenance workers given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Future site users (without mitigation)	It is unlikely that existing contamination would impact on future site users given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
		Ground and surface waters	It is unlikely that existing contamination would impact on ground and surface waters, given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Flora, fauna	It is unlikely that contamination would impact on flora and fauna given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low Risk
		Soils	The GI results indicate that there is a low likelihood that contamination would have impacted high grade soils or have rendered the material unsuitable for re-use during the scheme (with necessary environmental permitting or similar regulations adopted, i.e. CL:AIRE Definition of Waste: Development Industry Code of Practice). The consequences of soils being impacted or unsuitable for re-use due to contamination are considered severe given that the soils on site are classed as BMV a high value resource; however, the impact is likely to be localised.	Moderate
Industrial areas in and around Harlow (including: fire station, ambulance station, road haulage, allotments (excluding proposed site compound off Gilden Way)	Dermal contact Inhalation Ingestion Surface water run off Infiltration	Current site users	It is unlikely that existing contamination would impact on current site users as no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
		Construction and/or maintenance workers	It is unlikely that existing contamination would impact on construction and/or maintenance workers given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
		Future site users (without mitigation)	It is unlikely that existing contamination would impact on future site users given that no widespread contamination was	Low

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
			identified during the GI. The consequences of exposure may be medium.	
		Ground and surface waters	It is unlikely that existing contamination would impact on ground and surface waters, given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
		Flora, fauna	It is unlikely that contamination would impact on flora and fauna given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination given that no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
		Soils	It is unlikely that existing contamination would impact on current site users, as no widespread contamination was identified during the GI. The consequences of exposure may be medium.	Low
Proposed site compound off Gilden Way (previously used as a plant nursery – potential made ground, demolished buildings, oil storage)	Dermal contact Inhalation Ingestion Surface water run off Infiltration	Current site users	It is unlikely that contamination (if present) would impact on current site users, as contamination is likely to be localised and pathways would be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium	Low Risk
		Construction and/or maintenance workers	It is likely that existing contamination (if present) may impact on construction and/or maintenance workers during shallow ground works; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Moderate Risk
		Future site users (without mitigation)	It is unlikely that contamination (if present) would impact on future site users as contamination is likely to be localised and pathways will be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
		Ground and surface waters	It is unlikely that contamination (if present) would impact on ground and surface waters; however, no GI data is available to confirm ground conditions. The consequences of exposure may be severe given the sensitivity of the underlying aquifers.	Moderate Risk
		Flora, fauna	It is unlikely that contamination (if present) would impact on flora and fauna as contamination is likely to be localised; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination (if present) as contamination is likely to be localised and pathways will be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk
		Soils	There are no GI data for this location; however, the classification of this land is urban, therefore it is considered unlikely that high grade soil would be impacted. The consequences would be considered minor.	Very Low
Soils along new M11 off slip extension	Dermal contact Inhalation Ingestion Surface water run off Infiltration	Current site users	It is unlikely that existing contamination (if present) would impact on current site users as contamination is likely to be localised and pathways will be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk
		Construction and/or maintenance workers	It is likely that existing contamination (if present) may impact on construction and/or maintenance workers during shallow ground works; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Moderate Risk
		Future site users (without mitigation)	It is unlikely that existing contamination (if present) would impact on future site users as contamination is likely to be localised and pathways will be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of	Low Risk

Source	Pathway	Receptor	Plausible pollutant linkage	Risk level
			exposure may be medium.	
		Ground and surface waters	It is unlikely that existing contamination (if present) would impact on ground and surface waters; however, no GI data are available to confirm ground conditions. The consequences of exposure may be severe given the sensitivity of the underlying aquifers.	Moderate Risk
		Flora, fauna	It is unlikely that contamination (if present) would impact on flora and fauna as contamination is likely to be localised, however no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk
		Offsite users	It is unlikely that offsite users would be impacted by existing contamination (if present) as contamination is likely to be localised and pathways will be limited by areas of hardstanding; however, no GI data are available to confirm ground conditions. The consequences of exposure may be medium.	Low Risk
		Soils	There is no GI data for this location; however, the nearest GI boreholes indicate that there is a low likelihood that contamination would render the material unsuitable for re-use during the scheme. The consequences of the soils being adversely impacted by contamination and being unsuitable for re-use are considered severe given that the soils on site are classed as BMV a high value resource, however the impact is likely to be localised.	Moderate

Table 4-A Updated CSM and risk assessment

5. Potential Impacts

The updated CSM and risk assessment has not identified substantial source – pathway – receptor linkages requiring actual ground or groundwater remediation. However, a number of potential linkages could be realised as a result of activities associated with the Proposed Scheme unless some remedial measures are implemented.

The updated CSM and risk assessment above along with knowledge of the Proposed Scheme design and the local area can be used to identify which specific activities associated with the Proposed Scheme could have impacts on receptors. This allows identification of where remedial measures may be required. The identified activities and possible impacts are listed below.

Possible Construction Activities and Impacts:

1) Vegetation clearance and excavation works - could increase/modify contaminated groundwater and ground gas regime in the scheme area

2) Piling – potential to introduce migration pathways for contaminants to deeper strata

3) Installation of service trenches – these could act as preferential pathways for migration of ground gas, soil and water-derived vapours and contaminants in groundwater

4) Dewatering – if water arising from de-watering were contaminated and discharged locally it could have a detrimental impact on water courses

5) Damage to abstraction borehole resulting in potential contamination impacts to groundwater

6) Accidental spills and leaks – could impact surface or groundwater

7) Use concrete and cement products – could impact on water quality, flora and fauna

8) Construction workers disturbing ground – potential exposure to contamination

9) Activities resulting in migration of contaminants through existing boreholes

10) Impacts due to lack of land quality information for Gilden Way site compound

11) Potential importation of contaminative fill material

12) Dust or mud from soils containing elevated concentrations of contaminants impacting on general public

13) Loss of or damage to soils – there is potential to damage soils during the works, resulting in a loss of high grade agricultural land within the scheme footprint

14) Existing contamination impacting highways infrastructure

15) Creation of voids leading to gas accumulation

16) Ground disturbance resulting in risk of encountering Unexploded Ordnance (UXO)

6. Remediation Options Appraisal

No specific requirements for ground or groundwater remediation have been identified.

However, as potential source – pathway – receptor linkages could result from activities associated with construction and operation of the Proposed Scheme, remedial measures are recommended to reduce the risk (likelihood or severity) of these impacts. A variety of remedial measures are possible depending upon the nature of the activity, the potential pathway and the potential receptor. The aim of remediation is to reduce the likelihood of a source – pathway – receptor linkage.

An options appraisal has been undertaken of possible remedial measures to address each of the potential impacts identified in the previous section. This is presented in Table 6-A below.

Option	Description	Benefits	Disadvantages	Selected Option
Vegetation clearance and excavation works - could increase/modify contaminated groundwater and ground gas regime in the scheme area				
1	Do nothing	No up-front cost	Contaminated groundwater and ground gas regimes in the scheme area could be increased or modified if vegetation clearance or excavation disturbs undetected contamination	Option 2: The likely additional costs are considered minimal compared to the benefits. Although the risks are not fully eliminated by this alone, the findings of the ground investigation have determined that there is little likelihood of substantial contamination or ground gas. Together with implementing the additional gas investigations mentioned below, it is considered that this is a practicable option
2	Prepare and implement Construction Environmental Management Plan (CEMP) to identify measures to control risks of disturbing undetected contamination (e.g. watching brief for suspect contamination, sampling and segregation of suspect materials, gas monitoring in excavations close to abandoned mineral extraction sites on Gilden Way)	The risk of increased or modified contaminated water or ground gas regimes in the scheme area would be reduced	This would have costs and take time to prepare and may not fully eliminate the risk by itself	
Piling – potential to introduce migration pathways for contaminants to deeper strata				
1	Do nothing	No up-front cost	Contaminants could impact deeper strata if present	Option 2: The likely additional costs are considered minimal compared to the benefits. Although the risks are not fully eliminated, the findings of the ground investigation have determined that there is little
2	Undertake piling risk assessment for any areas where piling would potentially impact aquifers.	Mitigation measures could be implemented in areas that are deemed at risk in the risk assessment, which would	This would take time to prepare and may not fully eliminate the risk	

Option	Description	Benefits	Disadvantages	Selected Option
		significantly limit the risk of contaminants impacting deeper strata		likelihood of substantial contamination
3	Do not use piling	No risk of pathways for contaminants to be introduced to deeper strata	Would require a new design or route to avoid piling which may not be feasible	
Installation of service trenches – these could act as preferential pathways for migration of ground gas, soil and water-derived vapours and contaminants in groundwater				
1	Do nothing	No up-front cost	Gas, vapours and contaminants in the groundwater could migrate and impact receptors	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Prepare and implement CEMP to identify measures to control contamination risk (e.g. watching brief for suspect contamination, sampling and segregation of suspect materials, gas monitoring in excavations close to abandoned mineral extraction sites on Gilden Way).	Reduced risk of impact to receptors	Additional time and cost would be required	
Dewatering – if water arising from dewatering was contaminated and discharged locally it could have a detrimental impact				
1	Do nothing	No up-front cost	Receptors could be impacted by contaminants	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Prepare and implement CEMP to identify measures to identify and control contamination discharges (such as testing water prior to discharge, installing silt traps)	Reduced risk of impact to receptors	Additional time and cost would be required	

Option	Description	Benefits	Disadvantages	Selected Option
Damage to abstraction borehole and potential contamination impacts				
1	Do nothing	No up-front costs	Abstraction borehole could be damaged and there may be contamination impacts if it acts as a pathway for contaminants into aquifer	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Protect abstraction borehole with physical barriers and avoid damage to any associated pipework and/or services	Reduced risk of impact to abstraction borehole	Additional time and cost would be required	
Accidental spills and leaks – could impact surface or groundwater				
1	Do nothing	No up-front costs	Surface water and groundwater could be impacted by contaminants	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Prepare and implement CEMP to identify measures to control accidental spills and leaks (such as bunding, spill emergency plans, spill kits etc)	Risk to surface water and groundwater would be reduced.	Additional time and cost would be required	
Concrete and cement products – uses could impact on water quality, flora and fauna				
1	Do nothing	No up-front costs	Potentially high impacts to water quality, flora and fauna could occur	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Prepare and implement CEMP to identify measures to control and contain the preparation and	If followed correctly this would limit the impacts to water, flora and fauna from releases of	This would take time and incur cost to prepare and implement on	

Option	Description	Benefits	Disadvantages	Selected Option
	handling of concrete	concrete and cement products	site correctly	
3	Do not use concrete or cement products during construction	There would be no impact to water quality, flora or fauna	There is no suitable alternative to using these products during construction	
Construction workers – potential exposure to contamination				
1	Do nothing	No up-front cost	Construction workers may be impacted by potential contaminants	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Control measure implemented such as undertaking appropriate health and safety risk assessments and adopting control measures and PPE if necessary	The risk to construction workers would be reduced	Additional time and cost would be required	
Potential migration of contaminants through existing boreholes				
1	Do nothing	No up-front costs	There would be a risk that migration of contaminants could occur	Options 2 and 3 depending upon whether the boreholes are to be used during the construction or operation of the Proposed Scheme: The likely additional costs are considered minimal compared to the benefits.
2	Decommission boreholes within the scheme area	No pathway would exist if done correctly	Additional time and cost would be required	
3	Protect boreholes within the scheme area	The pathway for migration of contaminants would be limited	Additional time and cost would be required	
Lack of land quality information for Gilden Way site compound				

Option	Description	Benefits	Disadvantages	Selected Option
1	Do nothing	No up-front cost	If elevated levels of contaminants are present they may be mobilised if nothing is done to mitigate the risk	Option 2: The likely additional costs are considered minimal compared to the benefits. Undertaking a desk study would help to identify if a site investigation is required, and enable a targeted site investigation to be undertaken if required.
2	Undertake desk study for proposed site compound location to assess the risk of contamination and additional site investigation if necessary	A desk study would identify if there are potential sources of contamination at the site which could then be assessed further by means of site investigation. This would allow mitigation of the risks (if necessary)	Additional time and cost will be needed to complete a desk study and site investigation if required	
3	Undertake non-targeted site investigation	This would save time compared to undertaking a desk study first	This would be costly and may not be required, especially on a large scale A non-targeted investigation may not be undertaken in the areas of most risk	
Potential importation of contaminative material				
1	Do nothing	No up-front cost	Sensitive receptors may be impacted if material containing elevated concentrations of contaminants is imported and used in the scheme construction	Option 2: The likely additional costs are considered minimal compared to the benefits.
2	Prepare and implement CEMP to include acceptance criteria for imported materials on site to include chemical and geotechnical properties	Risk of contaminated imported materials would be reduced.	Additional time and costs would be needed to prepare and implement adequately	

Option	Description	Benefits	Disadvantages	Selected Option
3	Do not import materials	No risk from imported materials	This may delay the start of construction as the design would need to be changed. It may also not be feasible due to the topography and existing levels of road network.	
Dust or mud from soils containing elevated concentrations of contaminants impacting on general public				
1	Do nothing	No up-front cost	General public may be impacted if they come into contact with soils containing elevated concentrations of contaminants	Option 2: The likely additional costs are considered minimal compared to the benefits of not doing this
2	Prepare and implement CEMP to control contamination risk to public by implementing dust control measures and preventing tracking of mud onto public roads	Risk to general public would be reduced	Additional time and costs would be needed to prepare and implement adequately	
Loss of soils – There is potential for damaged soils and there will be a loss of high grade agricultural land within the scheme footprint				
1	Do nothing	No up-front cost	There could be unnecessary loss of or damage to high grade soils	Option 2: It would not be practicable to significantly change the scheme route, however doing nothing would result in unnecessary loss of high grade soils. Option two would limit the loss of high grade soils where possible in a cost effective way and therefore is considered the most appropriate option.
2	Undertake Soil Resources Survey and prepare Soil Management Plan (SMP) to manage and reduce loss of or damage to soil	This would aim to limit the loss of high grade soils where possible	There would still be some loss of high grade soils	
3	Change Proposed Scheme route so that no excavation or construction is required in areas	There would be no loss of high grade agricultural soils	The scheme route would have to be significantly changed in order to avoid these areas	

Option	Description	Benefits	Disadvantages	Selected Option
	containing high grade agricultural land			
Undiscovered contamination impacting highways infrastructure				
1	Do nothing	No up-front cost	Potential long term damage to highways infrastructure	Option 3: It is considered that the site setting and existing site investigation data indicates that substantial contamination is not likely and therefore a watching brief during construction works would be sufficient mitigation
2	Undertake further site investigation to better inform design	Increased likelihood of identifying contamination if present to allow for mitigation in design	Likely to be costly as it would require extensive investigation to provide greater confidence that risk can be ignored	
3	Prepare and implement CEMP to manage any suspect contamination found during construction not identified in the GI. This should include a watching brief during groundworks and procedures to follow if potential contamination identified	Risk to highways infrastructure would be reduced Would not incur significant cost to investigate Would not cause delay to start of construction	Could delay works if testing of soils required Design could prove inadequate in places if contamination not allowed for and subsequently detected	
Gas accumulation in voids				
1	Do nothing	No up-front cost	Potential risk of gas accumulation and subsequent explosive and asphyxiation risks in highways infrastructure	Option 2. The likely additional costs are considered minimal compared to the benefits achieved from obtaining gas data
2	Complete additional monitoring and gas sample collection at BH20 and BH30 to refine gas risk assessment and design	Should allow refinement of risks and better confidence to either design mitigation or not	Additional cost of investigations	

Option	Description	Benefits	Disadvantages	Selected Option
	mitigation measures as part of the Proposed Scheme if required Installation of gas monitoring well along Gilden Way to assess for possible gas migration from the nearby infilled gravel pit. It would be prudent to also sample groundwater from this well if groundwater is detected. Further risk assessment could be carried out based on the results	implement mitigation measures		
Risk of encountering Unexploded Ordnance (UXO)				
1	Do nothing	No up-front cost	Risk of unexpectedly encountering UXO during the works.	Option 2: The likely additional costs are considered minimal compared to the benefits achieved from obtaining UXO information
2	Undertake a targeted investigation prior to any construction works commencing. This investigation would help to identify and further refine the risks on site	Better knowledge of possible presence of UXO prior to construction Reduced risk of encountering unexpected UXO Would allow mitigation measures and staff training in the event that UXO presence likely	Additional cost of investigations	

Table 6-A Updated CSM and risk assessment

7. Remediation Strategy

7.1 Introduction

The options appraisal undertaken in Section 6 has assessed remedial measures which could be implemented to reduce potential source – pathway – receptor linkages during construction and operation of the Proposed Scheme. The preferred options have been incorporated into a remediation strategy for the Proposed Scheme below.

7.2 Remediation Actions

The following remediation/mitigation should be implemented during the construction and operation of the Proposed Scheme in order to reduce the potential source – pathway – receptor linkages identified from the desk studies and ground investigations undertaken, the subsequent CSM and risk assessments and the remedial options appraisal:

1) Prepare a Construction and Environmental Management Plan to include:

    - Watching brief during groundworks and procedures to follow if potential contamination is identified.
    - Control measures for contamination risk to public
    - Control measures implemented for risk to construction workers such as adopting PPE with appropriate health and safety risk assessments
    - Acceptance criteria for imported materials on site to include chemical and geotechnical properties
    - Control measures for the preparation and handling of concrete
    - Control measures for contamination discharges

2) Undertake a targeted UXO investigation prior to any construction works commencing

3) Install gas monitoring borehole along Gilden Way and complete additional gas monitoring, with groundwater sampling if groundwater is detected. Gas sample collection at BH20 and BH30 to refine gas risk assessment.

4) Undertake Soil Resources Survey and prepare Soil Management Plan (SMP) to manage and reduce loss or damage of soil

5) Undertake desk study for proposed site compound location to assess the risk of contamination and additional site investigation if identified

6) Decommission or protect boreholes within the scheme area

7) Protect the abstraction borehole with physical barriers and avoid damage to any associated pipework and/or services

8) Undertake piling risk assessment for any areas where piling would potentially impact aquifers.

The remedial measures are shown on Figure 4.

8. Verification Plan

The Contractor responsible for undertaking the construction works for the Proposed Scheme should produce a Verification Report detailing that the remedial works identified in this Remediation Strategy have been completed.

The Verification Report should clearly state the objectives of the work, its limitations, a summary of the works undertaken on-site, and any variations that occurred to the original strategy and why these occurred.

The Verification Report should be submitted to the regulators to provide evidence that the remediation works have been successfully completed on-site.

As no requirement for specific ground or groundwater remediation has been identified for the Proposed Scheme, the remediation verification plan below comprises a register of required remediation and suggested, associated verification documentation.

Remediation Activity	Verification Evidence (Report reference, drawing numbers, ananlytical certificate details etc.)
1) Prepare a Construction Environmental Management Plan to include: • Watching brief during groundworks and procedures to follow if potential contamination is identified. • Control measures for contamination risk to public • Control measures implemented for risk to construction workers such as adopting PPE with appropriate health and safety risk assessments • Expectance criteria for imported materials on site to include chemical and geotechnical properties • Control measures for the preparation and handling of concrete • Control measures for contamination discharges	Reference to Construction Environmental management Plan and confirmation that the have been completed in accordance with the requirements of the plan. Details of any potential contaminated identified during the works and copies of analytical test results of any samples collected. Summary of any remedial measures undertaken as a result of the findings. List of agreed imported material acceptance criteria. Copies of analytical test results for imported materials with assessment against acceptance criteria. Details of control measures implemented to reduce the risk of contamination due to concrete preparation and handling. Details of any breaches of control measures and summary of action undertaken to rectify the breach. Details of control measures implemented to limit contamination discharges. Details of any breaches of control measures and summary of actions undertaken to rectify the breach.
2) Undertake a targeted UXO investigation prior to any construction works commencing	Reference to UXO investigation report and details of any subsequent control measures implemented and any remedial measures undertaken.
3) Install gas monitoring borehole along Gilden Way and complete additional gas monitoring and gas sample collection at BH20 and BH30. Collect water sample from Gilden way borehole	Reference to borehole log and installation details of borehole installed along Gilden way. Reference to report with results of gas and groundwater monitoring undertaken. Details of any remedial works undertaken as a result of the findings.

Remediation Activity	Verification Evidence (Report reference, drawing numbers, ananlytical certificate details etc.)
4) Undertake Soil Resources Survey and prepare Soil Management Plan (SMP) to manage and reduce loss or damage of soil	Reference to Soil Resources Survey report. Reference to Soil Management Plan. Reference to report and/or as-built drawings indicating soil management works undertaken.
5) Undertake desk study for proposed site compound location to assess the risk of contamination and additional site investigation if possible contamination is identified	Reference to desk study report Reference to reports on any subsequent site investigation works carried out. Details of any remedial works undertaken as a result of the findings.
6) Decommission or protect boreholes within the scheme area	Details of boreholes decommissioned and methodology employed.
7) Protect the abstraction borehole	Details of measures taken to protect existing abstraction borehole.
8) Undertake piling risk assessment for any areas where piling would potentially impact aquifers.	Reference piling risk assessments undertaken and details of any mitigation measures implemented to protect groundwater.

Table 8-A Remedial verification plan

9. References

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21 J C H Miles, J D Appleton, D M Rees, B M R Green, K A M Adlam and A H Myers, 2007, Indicative Atlas of Radon in England and Wales, Health Protection Agency, Didcot.

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24 Jacobs, 2016, M11 Junction 7A Ground Investigation Report, Document Number: B3553F05/REP/36

25 Jacobs, 2017, M11 Junction 7A Environmental Statement, Document Number: B3553F05-3000-REP-0036

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28 Nathanail, C.P., McCaffrey, C., Gillett, A.G., Ogden, R.C. and Nathanail, J.F. 2015. The LQM/CIEH S4ULs for Human Health Risk Assessment. Land Quality Press, Nottingham. Copyright Land Quality Management Limited reproduced with permission; Publication Number 54UL3226. All rights reserved.

Appendix A. Figures

DESCRIPTION

BH - Borehole

TPB - Trial Pit Boring

WS - Windows Sample

Sheering Lower Road

Pincey Brook

Sheering Road

Gilden Way

Moor Hall Road

Proposed Junction 7a

M11 Motorway

TP 5 TPB 3 BH 1 BH 2 TPB 4 TPB 1 TPB 2 BH 3 TPB 5 BH 24 BH 29 BH 26 BH 25 TPB 8 BH 23 TP 7 TP 2 TP 6 BH 21 TPB 7 BH 5 BH 4 BH 27 BH 22 TP 8 BH 28 TP 1 TPB 6 BH 30 TP 3 BH 20 BH 19 BH 7 BH 6 BH 31 BH 18 BH 8 BH 9 TP 4 BH 10 BH 11 BH 32 BH 12 BH 33 BH 13 WS 1 BH 14 WS 2 BH 34 BH 15 WS 3 WS 4 BH 16 WS 6 WS 5 BH 17 WS 7 WS 8 WS 9 WS 11 WS 10 WS 12

150 75 0 150 300 450 Metres

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Notes

1. Do not scale

Key

- Design iteration 1 PCF stage 3
- 250m scheme buffer
- Attenuation pond
- Jacobs 2015/16 borehole location
- Existing boreholes (possible groundwater monitoring wells)

Superficial Geology

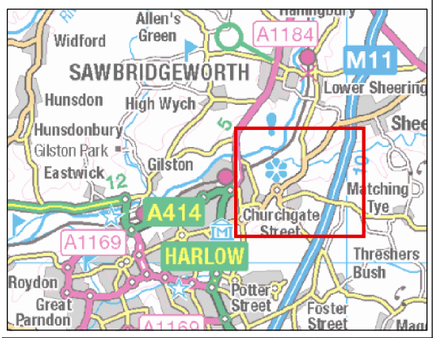
- Alluvium - clay, silt, sand and gravel
- Head - clay, silt, sand and gravel
- Head - gravel, sand, silt and clay
- Lowestoft formation – diamicton
- Glaciofluvial deposits, mid pleistocene - sand and gravel
- River terrace deposits, 1 - sand and gravel
- River terrace deposits, 2 - sand and gravel

Bedrock Geology

- London clay
- Lewes nodular chalk formation and Seaford chalk

Artificial Ground and Landslip

- Infilled ground
- Made ground (undivided)



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	05/17	ISSUED FOR PLANNING APPLICATION	KK	ML	MAW	PM

Drawing Status

PRELIMINARY DESIGN

RINGWAY JACOBS integrated expertise | Essex County Council

Mark Rowe, Service Director, Highways
Seax House, Victoria Road South, Chelmsford, CM1 1QH
Tel: 0845 6037631

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Scheme Title

M11 JUNCTION 7A

Drawing Title

FIGURE 1
BOREHOLE LOCATION PLAN

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
EW	KK	ML	MAW	PM
DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017

DRAWING UNITS U.N.O.

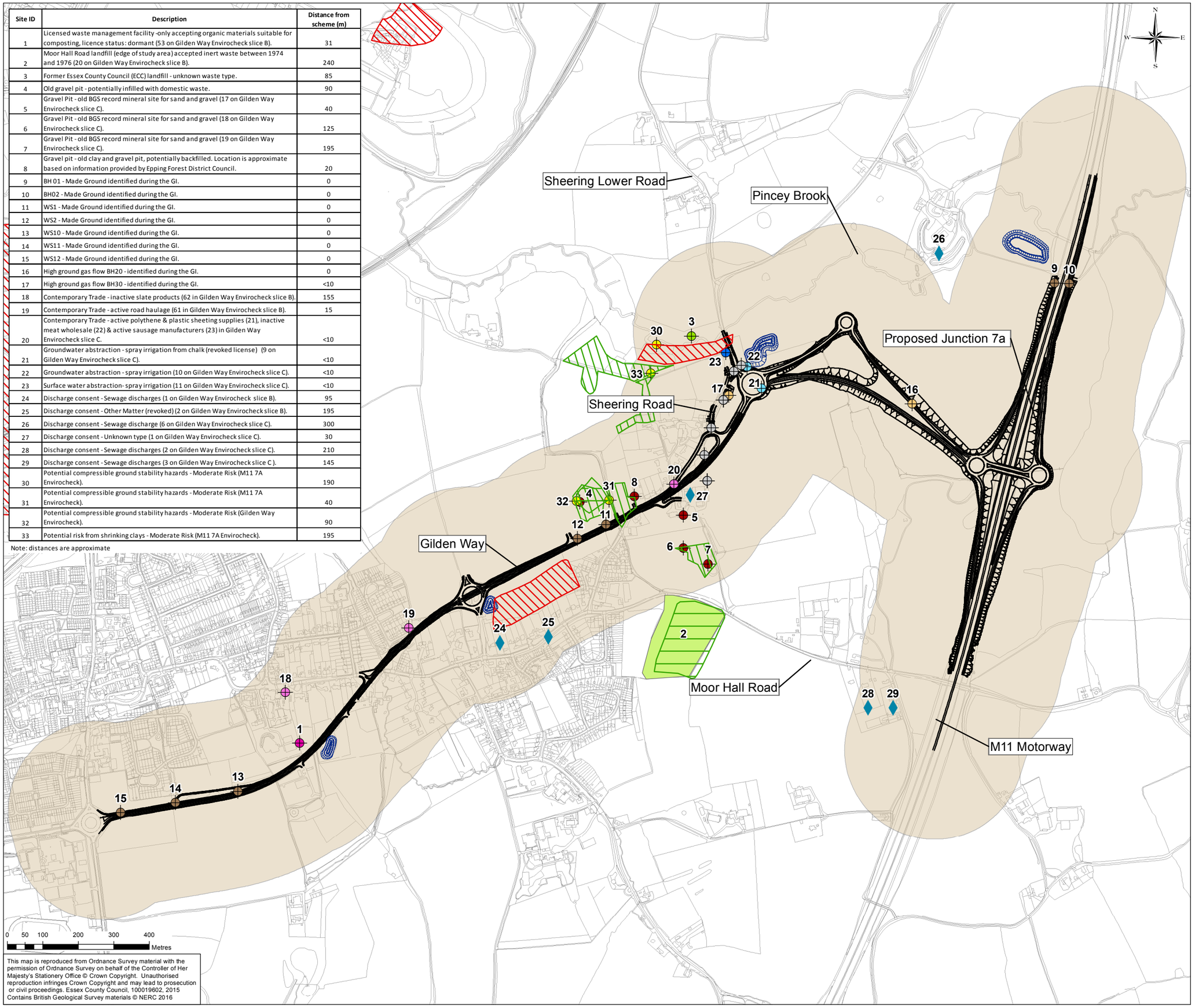
SCALE AT A3 (420 x 297 mm) 1:10,000

DRAWING NO. B3553F05-0000-DR-1018

REV. P0

Site ID	Description	Distance from scheme (m)
1	Licensed waste management facility -only accepting organic materials suitable for composting, licence status: dormant (53 on Gilden Way Envirocheck slice B).	31
2	Moor Hall Road landfill (edge of study area) accepted inert waste between 1974 and 1976 (20 on Gilden Way Envirocheck slice B).	240
3	Former Essex County Council (ECC) landfill - unknown waste type.	85
4	Old gravel pit - potentially infilled with domestic waste.	90
5	Gravel Pit - old BGS record mineral site for sand and gravel (17 on Gilden Way Envirocheck slice C).	40
6	Gravel Pit - old BGS record mineral site for sand and gravel (18 on Gilden Way Envirocheck slice C).	125
7	Gravel Pit - old BGS record mineral site for sand and gravel (19 on Gilden Way Envirocheck slice C).	195
8	Gravel pit - old clay and gravel pit, potentially backfilled. Location is approximate based on information provided by Epping Forest District Council.	20
9	BH 01 - Made Ground identified during the GI.	0
10	BH02 - Made Ground identified during the GI.	0
11	WS1 - Made Ground identified during the GI.	0
12	WS2 - Made Ground identified during the GI.	0
13	WS10 - Made Ground identified during the GI.	0
14	WS11 - Made Ground identified during the GI.	0
15	WS12 - Made Ground identified during the GI.	0
16	High ground gas flow BH20 - identified during the GI.	0
17	High ground gas flow BH30 - identified during the GI.	<10
18	Contemporary Trade - inactive slate products (62 in Gilden Way Envirocheck slice B).	155
19	Contemporary Trade - active road haulage (61 in Gilden Way Envirocheck slice B).	15
20	Contemporary Trade - active polythene & plastic sheeting supplies (21), inactive meat wholesale (22) & active sausage manufacturers (23) in Gilden Way Envirocheck slice C.	<10
21	Groundwater abstraction - spray irrigation from chalk (revoked license) (9 on Gilden Way Envirocheck slice C).	<10
22	Groundwater abstraction - spray irrigation (10 on Gilden Way Envirocheck slice C).	<10
23	Surface water abstraction- spray irrigation (11 on Gilden Way Envirocheck slice C).	<10
24	Discharge consent - Sewage discharges (1 on Gilden Way Envirocheck slice B).	95
25	Discharge consent - Other Matter (revoked) (2 on Gilden Way Envirocheck slice B).	195
26	Discharge consent - Sewage discharge (6 on Gilden Way Envirocheck slice C).	300
27	Discharge consent - Unknown type (1 on Gilden Way Envirocheck slice C).	30
28	Discharge consent - Sewage discharges (2 on Gilden Way Envirocheck slice C).	210
29	Discharge consent - Sewage discharges (3 on Gilden Way Envirocheck slice C).	145
30	Potential compressible ground stability hazards - Moderate Risk (M11 7A Envirocheck).	190
31	Potential compressible ground stability hazards - Moderate Risk (M11 7A Envirocheck).	40
32	Potential compressible ground stability hazards - Moderate Risk (Gilden Way Envirocheck).	90
33	Potential risk from shrinking clays - Moderate Risk (M11 7A Envirocheck).	195

Note: distances are approximate



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Notes

1. Do not scale

Key

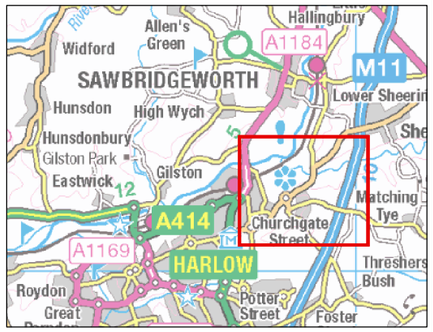
- Design iteration 1 PCF stage 3
- 250m scheme buffer
- Attenuation pond

Artificial Ground and Landslip

- Infilled ground
- Made ground (undivided)
- Potentially infilled land from historical land use
- Moor Hall Road historic landfill
- Existing dual borehole (possible groundwater monitoring wells)

Land Quality Features

- Area of Made Ground (Confirmed by GI)
- Area of potential Made Ground
- Discharge consent
- Gravel pit
- Groundwater abstraction
- Industrial - contemporary trade
- Landfill
- Licensed waste management facility
- Potential gas risk
- Potential ground instability (moderate risk area)
- Surface water abstraction



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	05/17	ISSUED FOR PLANNING APPLICATION	EW	ML	MAW	PM

Drawing Status

PRELIMINARY DESIGN

RINGWAY JACOBS integrated expertise

Essex County Council

Mark Rowe, Service Director, Highways
Seax House, Victoria Road South, Chelmsford, CM1 1QH
Tel: 0845 6037631

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Scheme Title

M11 JUNCTION 7A

Drawing Title

FIGURE 2
LAND QUALITY FEATURES PLAN

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
EW	EW	ML	MAW	PM
DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017

DRAWING UNITS U.N.O.

SCALE AT A3 (420 x 297 mm) 1:10,000

DRAWING NO. B3553F05-0000-DR-1017

REV. P0

Sheering Lower Road

Pincey Brook

Proposed Junction 7a

Sheering Road

Gilden Way

Moor Hall Road

M11 Motorway

150 75 0 150 300 450 Metres

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Notes

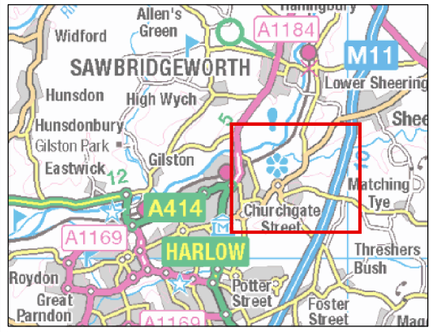
1. Do not scale

Key

- Design iteration 1 PCF stage 3
- 250m scheme buffer
- Attenuation pond

Agricultural land classification

- Grade 2
- Grade 3
- Grade 4
- Urban



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	05/17	ISSUED FOR PLANNING APPLICATION	EW	ML	MAW	PM

Drawing Status

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RINGWAY JACOBS integrated expertise

Essex County Council

Mark Rowe, Service Director, Highways
Seax House, Victoria Road South, Chelmsford, CM1 1QH
Tel: 0845 6037631

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Scheme Title

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Drawing Title

FIGURE 3
AGRICULTURAL CLASSIFICATION PLAN

DESIGNED	DRAWN	CHECKED	REVIEWED	APPROVED
EW	EW	ML	MAW	PM
DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017

DRAWING UNITS U.N.O.

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REV. P0

DESCRIPTION

BH - Borehole

TPB - Trial Pit Boring

WS - Windows Sample

Sheering Lower Road

Pincey Brook

Groundwater abstraction borehole - physical protection of housing, casing and pipework.

All existing boreholes to be decomissioned or protected

Sheering Road

Gas monitoring borehole to be installed

Gas samples to be taken (BH20 & BH30)

Gilden Way

Moor Hall Road

Proposed Junction 7a

M11 Motorway

Proposed site compound - undertake desk study, including contaminated land risk assessment with subsequent ground investigation if required.

TP 5 TPB 3 BH 1 BH 2 TPB 4 BH 3 TPB 5 BH 5 BH 4 TPB 6 BH 19 BH 7 BH 6 BH 18 BH 8 BH 9 BH 10 BH 11 BH 12 BH 13 BH 14 BH 15 BH 16 BH 17 TPB 1 TPB 2 BH 24 TPB 8 BH 23 BH 29 BH 26 BH 25 TP 7 TP 2 TP 6 BH 21 TPB 7 BH 27 BH 22 TP 8 BH 28 BH 30 TP 3 TP 1 BH 20 BH 31 TP 4 BH 32 BH 33 BH 34 WS 1 WS 2 WS 3 WS 4 WS 5 WS 6 WS 7 WS 8 WS 9 WS 10 WS 11 WS 12

170 85 0 170 340 510 Metres

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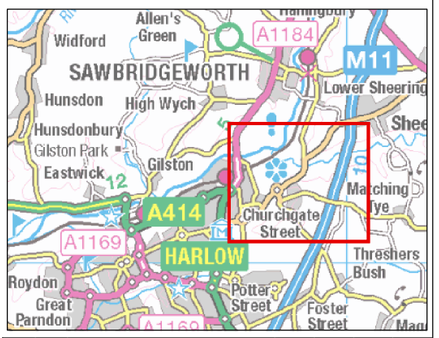
Notes

1. Do not scale

Key

- Design iteration 1 PCF stage 3
- 250m scheme buffer
- Gas monitoring borehole
- Groundwater abstraction borehole
- Gas samples to be taken from BH20 & BH30
- Jacobs 2015/16 borehole location - to be decomissioned or protected
- Existing boreholes (possible groundwater monitoring wells) - to be decomissioned or protected
- Attenuation pond
- Proposed site compound



Rev.	Date	Description of revision	Drawn	Checked	Review'd	Approv'd
0	05/17	ISSUED FOR PLANNING APPLICATION	OW	ML	MAW	PM

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Seax House, Victoria Road South, Chelmsford, CM1 1QH
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FIGURE 4
REMEDIAL MEASURES PLAN

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OW	OW	ML	MAW	PM
DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017	DATE 31/05/2017

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