RAIL CENTRAL DEVELOPMENT

MILTON MALSOR, NORTHAMPTONSHIRE

SOIL RESOURCE SURVEY

Prepared on behalf of:

ASHFIELD LAND MANAGEMENT LTD

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Prepared by: Tim O'Hare Associates LLP
Howbery Park, Wallingford
Oxfordshire, OX10 8BA
Tel: 01491 822653
Email: info@toha.co.uk
Web: www.toha.co.uk

TIM O'HARE ASSOCIATES

SOIL & LANDSCAPE CONSULTANCY

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1.0 INTRODUCTION

Tim O'Hare Associates (TOHA) LLP was commissioned by Ashfield Land Management Ltd to carry out a Soil Resource Survey for the Rail Central development site at Milton Malsor, Northamptonshire.

Our authority to carry out the work is contained in email correspondence between Barry Chinn Associates Ltd and TOHA, dated 20th March 2017.

1.1 Purpose

The proposed development comprises construction of a new rail freight interchange, with a number of building units and associated soft landscape scheme. The site is 'Greenfield' (mostly arable farmland) and covers approximately 650 acres (263 Ha). The landscape scheme is currently at Masterplan stage and the design is to be guided by the existing soil conditions.

There is currently no information on the suitability of the soil resources available across the site for soft landscape purposes. Therefore, a Soil Resource Survey (SRS) was required to assess the existing soil conditions, and advise on their re-use potential.

It is anticipated that a significant surplus of topsoil will be generated from the development. Therefore, of particular interest was the maximum depth to which the topsoil can be placed in new landscape areas, including suggested options / techniques to increase depths where possible.

1.2 Actions

Tim O'Hare Associates LLP has evaluated the quality and suitability of the soils for landscape purposes by a combination of desk study review, on-site investigation and laboratory analysis.

This report issues the findings of the soil investigation, including our site observations and soil descriptions, results and interpretation of all analyses, discussion on soil quality and suitability for future landscape construction.

2.0 DESK STUDY REVIEW

The following desk study review summarises information gathered from the following websites / documents:

- British Geological Survey Website (Geology of Britain);
- Soil Map of England and Wales – Sheet 3: Midland and Western England (1:250,000);
- LandIS Soilscapes Viewer – www.landis.org.uk/soilscapes
- Reading Agricultural Consultants – *Agricultural Land Classification – Auger Boring Record* – issued to TOHA via email on 13/06/2017
- ADAS – *Public Transport Interchange, Blisworth, Northamptonshire – Agricultural Land Classification* – Report Ref. 105/96 – January 1997 (obtained from Natural England publications portal – http://publications.naturalengland.org.uk/)
- Barry Chinn Associates, Drawing No. 1627-16-04 – *Illustrative Landscape Masterplan* – Rev. F, dated 01/07/2016
- Email correspondence: Barry Chinn Associates / TOHA re. project proposals – dated 02/02/2017

A summary of the information contained within these sources is given below.

2.1 British Geological Survey – Site Geology

The *British Geological Survey* website (*Geology of Britain 1:50,000*) describes the site geology (Bedrock and Superficial Deposits) as follows:

Table 1: Bedrock Geology

Zone of Site	Formation	Rock Type	Age (million years)	Deposition Environment
Majority of site	*Whitby Mudstone*	Sedimentary	176 – 183 Ma *Jurassic*	Shallow seas
Central Strip	*Marlstone Rock Formation – Limestone, Ferruginous*		176 – 190 Ma *Jurassic*	
	Dyrham Formation – Siltstone and Mudstone, Interbedded		183 – 190 Ma *Jurassic*	
South-east corner	*Northampton Sand Formation – Ironstone, Ooidal*		172 – 176 Ma *Jurassic*	
	Stamford Member – Sandstone and Siltstone, Interbedded		165 – 172 Ma *Jurassic*	Swamps, estuaries, deltas
	Wellingborough Limestone Member		165 – 168 Ma *Jurassic*	Shallow carbonate seas

Superficial deposits are not recorded for the majority of the site, with some occurring within the northern and eastern parts. Alluvium is present in a zone towards the centre of the development area.

Table 2: Superficial Deposits

Zone of Site	Formation	Age (million years)	Deposition Environment
Northern	*Glaciofluvial Deposits, Mid-Pleistocene – Sand and Gravels*	Up to 2 Ma *Quaternary*	Ice age
Eastern	*Oadby Member – Diamicton*		
Central	*Alluvium – Clay Silt, Sand & Gravel*		Rivers

Borehole Data

British Geological Survey Borehole information indicates the presence of Upper Lias and Glacially Affected Upper Lias (Whitby Mudstone Formation), Milton Sand, together with Made Ground alongside the A43 in the west.

2.2 Soil Map of England and Wales and LandIS Soilscapes – Soil Classification

The Soil Map of England and Wales (1:250,000 scale) classifies the soils of this site as follows:

The soils within the majority of the site fall into the following classification:

Table 3: Soil Classification – Majority of Site

Major Group	*Surface-Water Gley Soils* – seasonally waterlogged slowly permeable soils that are prominently mottled above 40cm depth.
Group	*Stagnogley Soils* – soils with a distinct topsoil, occurring on tills and soft argillaceous (clay containing) rocks.
Subgroup	*Pelo Stagnogley Soils* – clayey stagnogley soils.
Series	*DENCHWORTH (712b)* – Slowly permeable, seasonally waterlogged clayey soils with similar fine loamy over clayey soils. Some fine loamy over clayey soils with only slight seasonal waterlogging and some slowly permeable calcareous clayey soils.

The LandIS Soilscapes information indicates that such soils are typically moderately fertile and have impeded drainage. Surplus winter rainwater mainly moves away laterally at shallow depth. As such, drainage assistance and treatments such as subsoiling are often necessary.

The soils within the northern part of the site are classified as follows:

Table 4: Soil Classification – Northern Part of Site

Major Group	*Brown Soils* – Soils in which soil forming processes have produced predominantly brownish or reddish subsurface horizons with no prominent mottling or greyish colours (gleying) above 40cm depth
Group	*Brown Earths* – Non-alluvial loamy soils with a non-calcareous subsoil without significant clay enrichment.
Subgroup	*Typical Brown Earths* – unmottled subsoil.
Series	*WICK 1 (541r)* – Deep well-drained coarse loamy and sandy soils, locally over gravel. Some similar soils affected by groundwater.

The LandIS Soilscapes information indicates that such soils typically have a low fertility status and are freely draining.

The following soil classifications fall just within the confines of the site on the southern and eastern edges:

Table 5: Soil Classification – Southern and Eastern Edges

Zone of Site	Major Group	Group		Classification	LANDIS Soilscapes Information
Southern Edge	*Brown Soils*	*Brown Earths*	*Ferritic brown earths* Ferruginous subsoil	*BANBURY 544 – Well drained brashy fine and coarse loamy ferruginous soils over ironstone. Some deep fine loamy over clayey soils with slowly permeable subsoil and slight seasonal waterlogging*	Typically high fertility Free draining
Eastern Edge	*Pelosols* – Slowly permeable soils with no prominently mottling at or above 40cm depth.	*Calcareous pelosols* Calcareous subsurface horizon and no clay-enriched subsoil	*Typical Calcareous pelosols*	*HANSLOPE (411d) – Slowly permeable calcareous clayey soils. Some slowly permeable seasonally waterlogged non-calcareous clayey soils.*	Typically high fertility Slightly impeded drainage

2.3 Agricultural Land Classification Surveys

Agricultural Land Classification (ALC) information is available for the majority of the site. The findings of these surveys are summarised below.

ADAS Report – ALM Land

The ADAS report covers the western part of the site (Ashfield Land Management (ALM) owned land). The information indicates the majority of the area to comprise ALC Grade 3a ('good' quality) and Grade 3b ('moderate' quality). An area of Grade 2 ('very good' quality) land is indicated in a small area in the northeast part of the survey zone (alongside Gayton Road). The report describes the soils within each of the 'Grade' zones as follows:

Table 6: ADAS Report – Soil Descriptions

Grade	Description
Grade 3a	*Very slightly stony, non-calcareous medium clay loam (occasionally heavy clay loam) topsoil, over very slightly stony, non-calcareous heavy clay loam upper subsoil. Lower subsoil comprises stoneless non-calcareous clay with gleying occurring at 40/45cm. These soils are typically assessed as Wetness Class III, but occasionally slightly better drained profiles occur (Wetness Class II).*
Grade 3b	*Stoneless, non-calcareous heavy clay loam (occasionally medium clay loam) topsoil over slowly permeable stoneless clay subsoil. Gleying occurs at 30/35cm and the soils are assessed as Wetness Class IV, or less typically Wetness Class III.*
Grade 2	*Very slightly stony, slightly calcareous medium clay loam or sandy clay loam topsoil. Overlies slightly stony non-calcareous sandy clay loam or heavy clay loam upper subsoil. Lower subsoil comprises moderately stony, calcareous sandy clay loam (occasionally sandy clay). The soils are free-draining and are assessed as Wetness Class I.*

Reading Agricultural Consultants Auger Boring Record

The supplied auger boring record produced by Reading Agricultural Consultants covers the central and western part of the site. This indicates the majority of the land covered to be classed as either Grade 3b, followed by Grade 3a. Occasional Grade 1 or 2 profiles were also recorded at discrete locations.

The record indicates the profile to comprise:

Table 7: RAC Report – Soil Description Summary

Depth Range (bgl)	Description
Topsoil Depth range: 200/450mm (average topsoil depth 310mm)	*Predominantly heavy clay loam or clay, with pockets of sandy clay loam, medium sandy loam, silty clay loam, medium clay loam and sandy silt loam also recorded.* *Usually non-calcareous, with slight to moderately calcareous soils recorded in far eastern part of site.*
Subsoil	*Predominantly clay, with sandy clay loam, sandy clay, medium sand or loamy medium sand occasionally recorded.* *Ochreous mottling recorded in most horizons, varying in abundance.*

Laboratory analysis results supplied for topsoil samples taken from trial hole location No's. 6 and 11 indicate the samples to comprise slightly alkaline, clay with adequate reserves of organic matter and mineral plant nutrients (phosphorus, potassium and magnesium) in relation to landscape use.

Based on our review of the supplied ALC data from both sources, it would appear that the majority of the soils are heavy in texture, with slightly more medium to light textured soils recorded within a discrete zone in the north-western part of the site (Fossett and Halestrap land, together with the northernmost ALM land). With reference to the Geology and Soil Map information, these lighter soils could correspond with the superficial *Glaciofluvial Deposits, Mid-Pleistocene – Sand and Gravels* and 'WICK 1' soil series, as discussed above in sections 2.1 and 2.2.

2.4 Illustrative Landscape Masterplan

The detailed landscape scheme design has not yet been produced, however, the *Illustrative Landscape Masterplan* indicates the initial proposals to include blocks of native tree and shrub planting, together with grass and wildflower areas. Existing vegetation is to be retained in some zones, with certain trees subject to tree protection order (TPO). A number of screening bunds are proposed, together with potential wildlife sites and new waterbodies. It is assumed that these elements will also have associated soft landscape requirements.

The following section gives consideration to a range landscape types that could potentially be established as part of this scheme.

Rootballed Trees

Trees that are supplied either with a rootball or in an "air-pot" are usually the most demanding planting type. Good aeration and drainage around the rootball, as well as moderate to high fertility status, are critical at planting and during the establishment period. Without these properties, trees can very quickly suffer and possibly die during their first few growing seasons after planting.

Given their demanding nature, all rootballed trees should be planted with well-aerated and free-draining soils to the full rooting depth (normally considered to be 1.0m).

Tree planting in hard landscape will require a load-bearing system to support the surfacing and sub-base, whilst maintaining an uncompacted rooting zone for the trees. The nature of the system will depend on the specific load requirements, i.e. vehicular, cyclist and / or pedestrian traffic.

Shrub Planting

Container grown shrubs normally require shallower depths of soil than trees and the plants themselves can be variable in their specific soil requirements. Container grown shrubs in particular are not usually tolerant of adverse soils conditions and would normally require soils which are fertile, well drained and aerated.

Bare-Root Stock

Bare root plants, including small trees, native whips or transplants are considered to be less demanding than containerised stock. As such, a broader range of soil types may be re-used for these, provided the species selected do not require any specific growing conditions. The soils must possess a satisfactory structure to support plant growth. The topsoil and subsoil should have suitable pH and drainage characteristics for the selected species.

Amenity Grass

Grass is generally a robust planting type that does not require a specialist soil, unless higher levels of foot traffic are expected. The topsoil and subsoil should possess adequate soil structure and no excessive compaction to allow sufficient drainage and aeration to sustain healthy grass growth.

Species-rich Wildflower Grassland

Species-rich wildflower grasslands typically require low-nutrient soils, and in particular low phosphorus levels, so that aggressive weeds and grasses such as dandelion, nettle and rye-grass cannot dominate the sward. Moderate to high organic matter and total nitrogen content is desirable to support healthy seed growth. Appropriate management practices (e.g. periodic mowing and collection of cuttings to prevent seed head development) are often necessary to maximise diversity in the sward.

Marginal/Aquatic Planting

Low nutrient substrate is important for aquatic environments to reduce risk of eutrophication caused by rapid algal growth. Planting baskets or mats may also be used in such environments. Ecological design requirements may also dictate the nature of the planting substrate in these environments, e.g. to support invertebrates for example.

2.5 Earthworks Proposals

With reference to email correspondence from Barry Chinn Associates it is understood that there will be a large-scale topsoil stripping operation to enable construction of large buildings and hardstanding areas. It is also anticipated that subsoil material may also be generated as a result of foundation and infrastructure excavations.

3.0 SITE INVESTIGATION

3.1 Site Visit

The site was visited on 15th, 16th and 21st June 2017 during a period of warm, dry weather.

3.2 The Site

The development site as a whole is centred on National Grid Reference SP 73355 54655 and is situated to the south of Milton Malsor, near Northampton.

The land within the current application area is predominantly Greenfield and is divided between numerous landowners. For the purpose of this soil assessment, the areas surveyed have been referenced according to landowner, together with a subdivision of field number. These references are summarised below in Table 8 and each field number is shown on the site plan in **Appendix 1.**

Table 8: Survey Area References

Survey Area Ref.	Field No. References
Ashfield Land Management (ALM)	ALM 1, ALM 2, ALM 3, ALM 4, ALM 5, ALM 6, ALM 7, ALM 8, ALM 9, ALM 10
Treharne	TRE 1, TRE 2, TRE 3, TRE 4, TRE 5, TRE 6, TRE 7, TRE 8, TRE 9, TRE 10, TRE 11, TRE 12
Browne	BRW 1, BRW 2 (*not surveyed*)
Halestrap	HAL 1, HAL 2
Fossett	FOS 1, FOS 2, FOS 3, FOS 4, FOS 5
Milosevic	MIL 1
Wakelin	WLN 1, WLN 2, WLN 3, WLN 4, WLN 5
HC PCC	HCP 1
Byrne	BYN 1 (*not surveyed*)
Wake	WKE 1, WKE 2, WKE 3, WKE 4 (*not surveyed*)

Note at the time of the survey, access had not been granted to Browne, Byrne or Wake owned land.

Land use within each of these zones was variable, being either arable or grassland. The vegetation type / cropping details for each field at the time of the survey are given in **Appendix 2**. Horsetail (*Equisetum arvense*) (commonly known as 'Marestail') was present within the trackway alongside the eastern edges of field refs. ALM 4 and ALM5.

At the time of the survey, field reference TRE 2 and parts of ALM 7 were inaccessible due to livestock (cattle with calves / bulls). Access to the majority of HAL 1 was prevented by inaccessible boundaries to the south, west and east (ditches / barbed wire) and restricted across this field from the north by established oil seed rape crop.

In other fields where established oil seed rape was present (see details in Appendix 2), access was restricted to the edges of these fields.

Large pieces of rubble were observed on the surface on the northern edge of ALM1.

The topography of the survey areas was gently undulating, with generally higher ground in the north and far eastern parts of the site. Overall gradual slopes were towards the southern railway line and Grand Union Canal to the southwest.

The photographs below illustrate the typical land-uses at the time of the survey.

Plate 1: Oil Seed Rape – WLN 4

Plate 2: Beans – ALM land

Plate 3: Cereals – TRE12

Plate 4: Livestock – ALM10

Plate 5: Improved grassland – HCP1

Plate 6: Semi-improved grassland – MIL1

Plate 7: Sugar beet – TRE1

Plate 8: Horsetail (*Equisetum arvense*) established in trackway along south-eastern boundary of ALM4

3.3 Soil Conditions

The soils were examined by constructing a total of 53 No. hand-dug trial holes (TH) at representative locations within each survey area, to a maximum depth of 1000mm where possible. The trial hole locations (approximate) are indicated on the site plan in **Appendix 3**.

At each trial hole, the soils were examined with reference to the Soil Survey Field Handbook. Important physical soil characteristics were recorded, including texture, structure, compaction, waterlogging, anaerobism, topsoil depths and the presence of deleterious materials. Representative soil samples were taken from each trial hole for laboratory analysis.

Our soil examinations identified 2 No. typical soil profiles, based on soil texture. For the purpose of this survey, these profiles are referred to as *Main Soil Profile* and *Light Soil Profile*. A Topsoil Types Plan indicating the approximate extent of the topsoil from each of these soil profiles is presented in **Appendix 4**.

Main Soil Profile

The soils over the majority of the site were reasonably similar in appearance and texture and as such, can be grouped into one main soil profile, referenced *Main Soil Profile.* This soil profile appears to correspond with the '*DENCHWORTH*' soil classification. The soils were found to be predominantly heavy, and occasionally medium, in texture and were predominantly non-calcareous.

In the far eastern part of the site, the subsoils were typically found to be moderate or very calcareous and appeared to correspond with the distribution of the '*HANSLOPE*' soil classification and *Oadby Member Diamicton* superficial deposit, which is known to contain limestone and chalk clasts.

The soil profile was described as:

Topsoil	GL – 240/400mm	Brown to dark brown, occasionally dark greyish brown (Munsell Colours 10YR 4/3, 5/3, 3/3 and 4/2), dry to slightly moist, friable to slightly plastic or firm, non-calcareous to occasionally very slight to moderately calcareous, HEAVY CLAY LOAM, MEDIUM CLAY LOAM and SILTY CLAY. Typically with moderately developed structures. Predominantly stone-free or virtually stone-free. At TH11, the topsoil contained common large limestone clasts and occasional part bricks and clay tile. Ochreous root-hair mottles recorded in uncultivated (grassland) topsoil at TH33 and TH34. Topsoil often deeply cracked at surface. Clear to gradual boundary to subsoil.
Subsoil	240/400 – 550/850mm	Variable Colour: Yellowish brown, strong brown, dark grey, dark yellowish brown or olive yellow (Munsell Colours 10YR 5/4, 5/6, 5/8, 4/1, 4/4, 7.5YR 5/8 and 2.5Y 5/6), Slightly moist, slightly plastic to plastic or firm, CLAY, HEAVY CLAY LOAM, SILTY CLAY LOAM, or SILTY CLAY. Pocket of SANDY CLAY LOAM recorded between 520mm and 900mm bgl at TH5. Predominantly stone-free or very slightly stony. At TH4, pockets of calcareous 'grit' were recorded and small limestone fragments were also seen at TH2, TH3, TH5 and TH40. Ochreous mottling commonly recorded (ranging from faint to distinct). At TH2, TH3, TH5 and TH40, the subsoil was moderate to very calcareous. Common, fine, faint to distinct mottles recorded, with occasional gleying.
Parent Material	550/850 – 1000mm	At depths ranging 550mm to 850mm bgl, the subsoil became less weathered in appearance, comprising predominantly dark grey (Munsell Colour 4/1) CLAY or SILTY CLAY.

Plate 9: Topsoil at TH1

Plate 10: Topsoil at TH33

Plate 11: Topsoil at TH38

Plate 12: Ochreous root hair mottles in topsoil at TH33

Plate 13: Clay tile and limestone fragments seen on topsoil surface in vicinity of TH11

Plate 14: Large limestone fragment on topsoil surface in vicinity of TH11

Plate 15: Subsoil at TH7

Plate 16: Subsoil at TH9

Plate 17: Subsoil at TH26

Plate 18: Mottled Subsoil

Plate 19: Transition from subsoil (left) to less weathered clay (parent material) (right) at TH6

Plate 20: Subsoil at TH4, showing calcareous 'grit' in soil matrix at bottom of core sample (right)

Light Soil Profile

The soils within the *Light Soil Profile* were significantly lighter in texture than elsewhere on site, with no signs of drainage restriction (e.g. mottling). The soils were non-calcareous. This profile was identified at TH8, TH21, TH35, TH37, TH52 and TH53 and appears to correspond with the distribution of the '*WICK 1*' soil classification and *Glaciofluvial – Sand and Gravels* superficial deposit. This profile also corresponds with the areas of Grade 2 or Grade 1 soil profiles identified in the ALC data.

This soil profile was described as:

Topsoil	GL – 200/370mm	Brown (Munsell Colour 7.5YR 4/3 to 4/2), slightly moist, friable, non-calcareous, fine to medium SANDY LOAM, LOAMY SAND or SANDY CLAY LOAM with weakly developed structures (occasionally moderate). Stone-free. Clear to gradual boundary to subsoil.
Subsoil	200/370 – 690/700mm	Strong brown (Munsell Colour 7.5YR 5/6) to yellowish red (Munsell Colour 5YR 4/6), slightly moist, friable, non-calcareous LOAMY SAND to SANDY LOAM. Virtually stone-free. At TH21 and TH52, CLAY LOAM encountered at 550mm and 300mm bgl respectively, with clay content increasing with depth. At TH52 and TH53, no further progress at 300mm on account of compact/dry nature of the subsoil.
Parent material	690/700 – 1000mm	Brownish yellow (Munsell Colour 10YR 6/8), non-calcareous LOAMY SAND to SAND (where recorded). At TH37, CLAY was encountered at 1000mm bgl.

Plate 21: Topsoil at TH8

Plate 22: Subsoil at TH8

Plate 23: Topsoil at TH37

Plate 24: Subsoil at TH35

3.4 Topsoil Depths

The following topsoil depths were recorded at each trial hole:

Table 9: Recorded Topsoil Depths

Trial Hole No.	Topsoil Depth (mm)	Trial Hole No.	Topsoil Depth (mm)
TH1	240	**TH28**	300
TH2	300	**TH29**	280
TH3	300	**TH30**	250
TH4	310	**TH31**	270
TH5	280	**TH32**	260
TH6	300	**TH33**	220
TH7	280	**TH34**	300
TH8	290	**TH35**	260
TH9	250	**TH36**	300
TH10	290	**TH37**	370
TH11	350	**TH38**	340
TH12	310	**TH39**	320
TH13	280	**TH40**	320
TH14	380	**TH41**	380
TH15	260	**TH42**	300
TH16	300	**TH43**	320
TH17	270	**TH44**	310
TH18	300	**TH45**	350
TH19	260	**TH46**	250
TH20	250	**TH47**	250
TH21	260	**TH48**	350
TH22	250	**TH49**	280
TH23	270	**TH50**	290
TH24	400	**TH51**	300
TH25	240	**TH52**	360
TH26	300	**TH53**	310
TH27	340		
Average topsoil depth = 300mm			

4.0 LABORATORY ANALYSIS

4.1 Analytical Schedule

Representative samples of topsoil and subsoil were submitted to the laboratory for analysis.

The samples were analysed in accordance with all or part of the following schedule:

- particle size analysis;
- stone content;
- pH value;
- calcium carbonate;
- electrical conductivity values;
- major plant nutrients – N, P, K, Mg
- organic matter content;
- C:N ratio.

The results are presented on the Certificates of Analyses in **Appendix 6** and our interpretation of the results is given below.

4.2 Results of Analysis – Topsoils

Particle Size Analysis

Main Topsoil

The *Main Topsoil* samples fell into the *heavy clay loam*, *silty clay* and *medium clay loam* texture classes.

The topsoil samples were predominantly heavy in texture, with medium textured topsoil in places. Once excavated and amalgamated, the resource is likely to be dominated by the more widespread heavier textured topsoil.

Such soils usually have good water and nutrient retention capacities, but they do have physical limitations for use in landscaping. These soils would be, at best, only slowly permeable, and are likely to be subject to poor drainage and waterlogging, especially in prolonged wet weather. In addition, clay or silt dominated soils are prone to structural degradation when handled (e.g. stripping, stockpiling, respreading), especially when wet and plastic, and they do not respond favourably to cultivation until dry and friable in consistency. Silty soils can be particularly problematic.

Provided the structural condition of the soil is restored following the earthworks phase, the texture of the *Main Topsoil* would be suitable for a number of robust planting types, provided species tolerant of heavy textured, moisture retentive slow-draining soils are selected.

Light Topsoil

The *Light Topsoil* samples fell into the *sandy loam* and *sandy clay loam* texture classes. The sand fraction of the sample from TH8/TH37 comprised predominantly *fine* (0.15-0.25mm) to *medium* (0.25-0.50mm) sized particles. These particle size distributions would be considered suitable for most general landscape purposes, provided the soil's physical condition is maintained.

Stone Content

The topsoil samples were stoneless to virtually stone-free and as such, stones should not restrict the use of the topsoils for landscape purposes.

At TH11 (field ref. TRE11), the topsoil contained common large limestone clasts and occasional tile fragments, which may need to be raked out, particularly if this topsoil is used in any grass areas.

pH and Electrical Conductivity

The topsoil samples were predominantly slightly acid to slightly alkaline in reaction (pH 6.0 to 7.5), with a pH range that would be considered ideal for landscape purposes.

Topsoil samples ref. *ALM1 TH53*, *ALM4*, *ALM8 TH40* and *TRE11* were alkaline to strongly alkaline in reaction (pH 7.6 to 8.0). The higher pH at these locations is likely to be due to the presence of calcareous material (e.g. limestone fragments).

The *Light Topsoil* sample from TH8/TH37 was acid in reaction (pH 5.5).

Unless the topsoil within these areas where the pH differs from the dominant range is stripped separately, species selected should have a wide pH tolerance.

The electrical conductivity (salinity) values of the topsoil samples tested were low to moderate and, as such, soluble salts should not be present at levels that would be harmful to plants.

Organic Matter and Nutrient Status

The table presented in Appendix 7 summarises the organic matter contents and fertility status for each topsoil sample.

On the whole, the topsoil samples contained sufficient reserves of organic matter and nitrogen, with slight deficiencies within the *Light Topsoil* samples. The levels of mineral nutrients were variable. High levels of organic matter were recorded in samples from *ALM 7 (TH47)* and *ALM 8 (TH45+46)*.

The topsoil samples from field refs. *MIL1*, *TRE 4/6*, *TRE 7/8*, *ALM8* and *ALM9* contained noticeably lower levels of extractable phosphorus. This deficiency will need to be addressed for most landscape applications but it is seen as advantageous for species-rich wildflower grassland and marginal habitat creation where lower phosphorus levels are preferred. These habitats prefer infertile soils to prevent domination of the sward by grasses and aggressive weeds such broad-leaved dock (*Rumex obtusifolius)* and stinging nettle (*Urtica dioica*), and to reduce the input of phosphate to water courses.

4.3 Results of Analysis – Subsoils

Particle Size Analysis

Main Subsoils

The *Main Subsoil* samples were predominantly heavy to very heavy in texture and fell into the *clay, heavy clay loam*, *silty clay loam* and *silty clay* texture classes.

Heavy subsoils, such as these, are typically slow draining and tend to suffer from seasonal waterlogging following periods of prolonged or heavy rainfall. As such, they are restricted in terms of their potential landscape re-use. Very heavy textured soils can be particularly resistant to cultivation, becoming plastic at relatively low moisture content and forming strong structures when dry that are difficult to break down.

The texture of the *Main Subsoils* would be suitable for less-demanding planting types, provided the structural condition of the soil is repaired following the earthworks phases and species tolerant of heavy moisture retentive soils are selected. These subsoils are unsuitable for plant species or landscape environments that require light or free-draining soils, such as tree pits.

Light Subsoil

The *TH8+TH37* (*Light Subsoil)* sample fell into the *loamy sand* texture class. Subsoil with this particle size distribution should function satisfactorily for a range of landscape types, provided its physical condition is restored following the earthworks and it is not overly-compacted.

Stone Content

The subsoil samples were stone free to very slightly stony. As such stones should not restrict the use of these subsoils for landscape purposes.

pH and Electrical Conductivity

The majority of the subsoil samples were slightly acid to alkaline in reaction (pH 6.2 to 7.7), which is ideal for landscaping.

Subsoil samples ref. *ALM4* and *TRE 7-8* were strongly alkaline in reaction (pH 8.0 to 8.2), which is indicative of the calcareous materials present in these subsoils (e.g. limestone).

The electrical conductivity (salinity) values of the samples were all low, indicating that soluble salts were not present at levels that would be harmful to plants.

Organic Matter Content

The majority of the subsoil samples had low to moderate organic matter content results, with levels that are generally typical of subsoil.

The organic matter content of the subsoil samples ref. *ALM7* and *ALM8 TH45+46* were a little higher than the levels usually seen in subsoil. The topsoil in these locations had noticeably higher organic matter contents and as such, these higher levels in the subsoil could be indicative of a more organic soil profile.

Where tested, the subsoil samples contained low to moderate levels of mineral nutrients, typically with particularly low extractable phosphorus contents.

5.0 DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a new rail freight interchange on this site, with a number of building units and associated soft landscape scheme.

At this stage it is proposed to use site-won topsoil and subsoil for the soft landscaping scheme, where possible. The purpose of the survey was therefore to assess the existing soil conditions and advise on their potential for re-use for landscape purposes.

5.1 Summary of Findings

From our visual examination and laboratory analysis, two distinct soil profiles were identified across the site based on soil texture. Variations in soil fertility and pH were also identified, however, further investigation is needed to confirm the extent and significant of these in terms of profile differentiation (see Section 6.0 below).

The soil conditions encountered are summarised in Table 10 below.

Table 10: Summary of Soil Conditions

Main Soil Profile	
Soil Layer	**Characteristics**
Main Topsoil	• Predominantly heavy (*heavy clay loam*, *silty clay, medium clay loam)* • Stone-free to virtually stone-free • Slightly acid to slightly alkaline soil reaction, occasionally alkaline or strongly alkaline • Non-calcareous to slightly calcareous • Non-saline • Sufficient reserves of organic matter and nitrogen, occasionally high • Variable levels of mineral nutrients
Main Subsoil	• Heavy to very heavy soil texture (*clay, heavy clay loam*, *silty clay loam* and *silty clay)* • Stoneless to very slightly stony • Predominantly slightly acid to slightly alkaline soil reaction occasionally alkaline or strongly alkaline • Non-calcareous, occasionally calcareous • Non-saline • Low to moderate organic matter content • Low to moderate reserves of mineral nutrients

Light Soil Profile	
Soil Layer	**Characteristics**
Light Topsoil	• Light to medium soil texture (*sandy loam* and *sandy clay loam)* • Stone-free • Acid to slightly alkaline soil reaction • Non-calcareous • Non-saline • Moderate to low reserves of organic matter and nitrogen • Low to moderate levels of mineral nutrients
Light Subsoil	• Light to medium soil texture (*loamy sand to sandy loam or sandy clay loam)*, in places underlain at depth by medium or heavy textured lower subsoil/parent material • Virtually stone-free • Slightly acid soil reaction • Non-calcareous • Non-saline • Low organic matter content • Low to moderate levels of mineral nutrients

The soil considerations for soft landscape construction are discussed in Section 5.2 below.

5.2 Soil Quality in Relation to Landscape Use

Topsoil

Main Topsoils

The *Main Topsoil* was predominantly heavy in texture. Topsoil such as this can be re-used successfully for a range of landscape environments provided it has an adequate structure. However, it will be prone to compaction caused by soil handling, particularly if handled when wet and plastic and is likely to be prone to waterlogging for prolonged periods of the year. Furthermore, topsoil that is dominated by clay sized particles is likely to form strong structures when dry that are difficult to break down.

The physical condition of the site topsoils is currently satisfactory or good and this will need to be maintained by careful management and appropriate programming of earthworks.

The *Main Topsoil* would be considered suitable for a range of landscape types, provided species tolerant of heavy, moisture retentive soils, ideally with a wide pH tolerance, are selected for planting. Nutrient deficiencies should be remedied by appropriate fertiliser applications where necessary.

In relation to species-rich wildflower grassland establishment, the majority of the topsoil would be considered to have an intermediate or high fertility status. As such, high levels of floristic diversity may not be achievable with these soils. However, the soils within field refs. *MIL1*, *TRE 4/6*, *TRE 7/8*, *ALM8* and *ALM9* contained noticeably lower levels of extractable phosphorus and could therefore be prioritised for this re-use in zones where higher levels of biodiversity are desirable.

The potential diversity of wildflower swards may be increased during the establishment phase by an appropriate mowing regime followed by future management of the sward, including spot treatment of any invasive weeds and emergent arable species (e.g. oil seed rape).

Light Soil Profile Topsoil

The sandy texture of the *Light Topsoil* means that it is better suited to a wider range of landscape types, given its favourable handling properties and potentially better drainage performance post-handling. It will be sensible to recover this topsoil separately from the *Main Topsoil* so that it can be re-used for more demanding planting types (e.g. tree pits / shrub beds). This topsoil type should still be handled with care during the earthworks phase, especially as sandy soils have a low structural strength.

The lower organic matter and pH of this topsoil indicates that it could benefit from an application of green compost and/or fertiliser for most landscape types where higher fertility is required.

Considerations for Topsoil in Landscape Bunds

There can be a greater risk of anaerobism (oxygen depletion) when placing topsoil to depths exceeding 400mm.

The organic matter content of the site topsoils is not excessively high and as such, it should be suitable for use for bund construction (provided no vegetation is incorporated during the stripping process). We would recommend the use of subsoil within the planting profile on the outer part of the bunds, together appropriate cultivation works (see Section 5.4 below).

Subsoil

Main Soil Profile Subsoil

The majority of the site subsoils were heavy to very heavy in texture. Such soils are typically very slow draining and tend to suffer from seasonal waterlogging following periods of prolonged or heavy rainfall. It is also likely that these soils will suffer from significant structural degradation during the earthworks phase which will further reduce their permeability.

It will be important to ensure that the subsoil's physical condition is satisfactory prior to topsoiling or any planting, turfing or seeding. This will involve deep ripping all subsoil prior to topsoil spreading. In addition, the plant species selected should be tolerant of heavy, moisture retentive soils that will be subject to periodic waterlogging.

In its current condition, the subsoil has potential for re-use in a number of robust planting environments, including, native planting (bare root stock), amenity grass areas (low-foot-traffic only), and species-rich grassland establishment, provided the physical condition is adequate.

The subsoil may also be considered suitable for tree pits for smaller trees (bare root and rootballed up to heavy standard), containerised shrub planting and areas of amenity grass in high foot traffic zones, provided consideration is given to improving its drainage potential.

The subsoil will be prone to self-compaction if placed below the weight of a tree root ball or large containerised shrubs and so is not considered suitable for use as backfill in planting pits/beds for such specimens (extra heavy standard to semi-mature trees, large shrubs). We recommend that an appropriate free-draining sand or sandy subsoil is used to backfill the lower portion of these planting pits/beds, such as the *Light Subsoil* found on site.

Given their low phosphorus content, the *Main Subsoil* could be considered as an alternative 'topsoil' for species-rich grassland, provided species tolerant of heavy moisture retentive soils are selected. For example, a shallow layer (e.g. 150mm) of subsoil could be placed in these areas (potentially over topsoil if the profile is appropriately prepared). The absence of, or reduced, weed seed bank within the subsoil horizon would also be desirable to discourage out-competition in the sward. However, the particularly heavy texture of the subsoil should be taken into account with regards to successful cultivation to form a suitable seed bed, certainly in the short-term.

Light Soil Profile Subsoil

The lighter textured subsoil should be suitable for a wide range of landscape applications, including backfill in tree pits.

The higher phosphorus content recorded in the *Light Subsoil* sample may not be ideal for use as topsoil for wildflower seeding. Although, the lack of weed seed bank may enable the material to be considered suitable for this purpose.

5.3 Estimated Topsoil Volumes

Estimated topsoil volumes for each individual field covered within the survey are shown on the schedule presented in Appendix 5.

These volumes have been calculated using the average topsoil depth within each survey zone. The average topsoil depths have been calculated using the supplied Reading Agricultural Consultants ALC data and the topsoil depths recorded listed above in Table 9 in Section 3.4.

In total, calculations indicate an estimated 819,313m^3 of topsoil to be available across the site (in-situ).

A bulking factor would need to be applied to the calculated topsoil volume once excavated. For soils, this factor can range between approximately +15 to +30% depending on a number factors (e.g. vegetation content, soil texture or soil moisture content), at the time of excavation. The contractor would need to determine the bulking factor allowance with respect to any operational measures or commercial considerations.

Further investigation is recommended to confirm the extent of the identified topsoil types and associated volumes.

5.4 Landscape Bunds

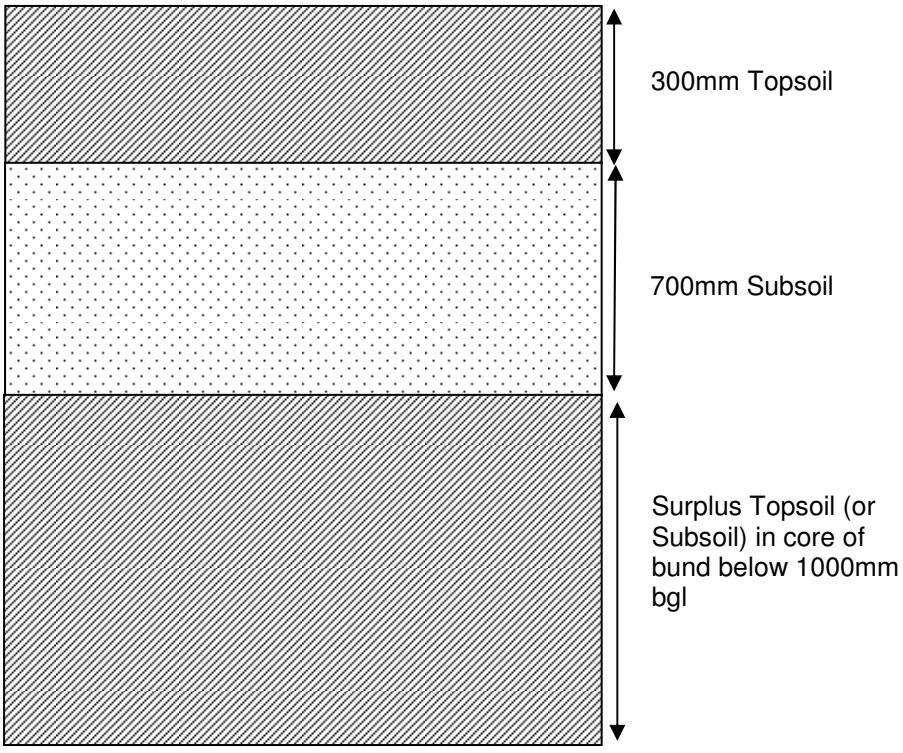
If it is intended to re-use surplus topsoil within landscape bunds, consideration should be given to the following options.

Soil Profile Construction

To reduce the risk of anaerobism within the rooting zone of new planting, it would be advisable for the lower part of landscape rooting zone (i.e. from 300mm bgl to 1000mm bgl) to be formed from *subsoil*.

Surplus topsoil could potentially be re-used within the core of the bund (geotechnical properties permitting), if they are greater than 1.0m in height. This could then be covered by a layer of subsoil to within 300mm of the finished surface. A further layer of topsoil would then be placed over the subsoil for plants to grow into. This is demonstrated in Figure 1 below.

Figure 1. Example Soil Profile Build-Up for Landscape Bunds



Deep Ripping

To improve aeration to the outer soil layer (0-600mm) across the bund soil and repair structural damage caused during placement, the soils will need to be deep ripped. The ripping could be undertaken using a tracked dozer with 3 No. winged tines (600mm deep and provisionally 800mm apart) or a tracked excavator fitted with a rigid tine attachment.

Shallow Cultivations

A second phase of shallower cultivation(s) (300mm deep) would be required to prepare the surface soils for seeding and planting. Provisionally we would suggest the use of a chisel plough (e.g. 'Shakerator') and power harrow, but the soils should be inspected in advance to confirm the most appropriate treatments and equipment.

5.5 Drainage Considerations

Given the heavy texture of the majority of the site soils and presence of mottling in the subsoils, the drainage performance of the soil profile is restricted and this will be exacerbated following intensive earthworks. As such, there is a risk of tree pits and possibly also shrub beds acting as sumps for surface draining water. To avoid this, appropriate modifications should be incorporated into their design. This may including mounding around trees or groups of trees, or installing soakage layers / positive drainage as necessary / feasible.

Drainage assistance (e.g. French drains or slot drains) may also be required in areas where surface draining water may collect, e.g. at the toe of slopes or alongside pathways. It should be noted that positive drainage will require a suitable outfall.

5.6 Hard Landscape Tree Planting

The site soils would not be considered suitable for use as load bearing substrates for any hard landscape tree planting in their own right. If a crate system is used, the *Light Soil Profile* soils may have potential for backfilling the cells, depending on the nature of the system proposed. The *Main Soil Profile* soils would not be suitable for such purposes.

5.7 Surface Preparation Prior to Topsoil Stripping

The bulk of the vegetation should be removed prior to topsoil stripping in order to prevent anaerobic decay of vegetation within the topsoil stockpiles and in any permanent landscape bunds.

Note, horsetail (*Equisetum arvense*) was recorded along the eastern edges of field refs. ALM 4 and ALM5. This is an invasive and persistent weed that does not respond to herbicide treatments. If the topsoil from this zone (and from any other areas where this plant may be present) is re-used, there is potential for the re-emergence and infestation of this plant, particularly if the ground is left bare and the plant is not kept in check by other specimens. Therefore, consideration would need to be given to control of this plant within the landscape maintenance programme or affected soils could potentially be buried within the core of landscape bunds

5.8 Re-use of the Site Soils

The following section considers the potential to re-use the available soils for soft landscape construction. It is important to note that for all planting and seeding, the soils must have an adequate structural condition and species should be tolerant of moisture retentive soils (except for the Light Topsoil / Light Subsoil).

The suitability of the site soils for a range of general landscape types is summarised on Table 11 and Table 12 below. The summary considers the use of the soils for *soft landscape* planting environments only.

Note these do not take into account the demands of individual species.

Table 11: Topsoil Suitability

Planting Environment	***Main Topsoil***	***Light Topsoil***	***Amelioration / Notes***
Larger rootballed trees (extra heavy standard to semi mature)	X	✓	*Light Topsoil* - compost and/or fertiliser application
Small rootballed trees (up to heavy standard)	✓	✓	*Main Topsoil* – fertiliser application *Light Topsoil* - compost and/or fertiliser application
Containerised shrubs	✓	✓	
Bare root specimens	✓	✓	
Amenity grass	✓	✓	Fertiliser application
Species-rich wildflower seeding	O	O	Post-seeding management may be required
Marginal planting	✓#	✓#	

✓ = *Topsoil* suited to this landscape type provided suitable species are selected and any nutrient deficiencies are remedied through application of an appropriate fertiliser where necessary.

O = *Topsoil* may be suitable for wildflower seeding provided a potentially lower level of floristic diversity is acceptable. Lower fertility topsoils present on site may be prioritised for this landscape type.

X = *Topsoil* not suited to this landscape type.

= The suitability of the site topsoils for marginal planting would depend on the desirable moisture regime for these areas, any ecological design requirements (e.g. to support invertebrates) and water quality requirements (i.e. fertility levels, sediment loading etc).

Table 12: Subsoil Suitability

Planting Environment	***Main Subsoil***	***Light Subsoil***	***Amelioration / Notes***
Larger rootballed trees (extra heavy standard to semi mature)	X	✓	Drainage assistance may be required depending on species requirements and soil structure following the earthworks In *Light Soil Profile* areas, the need for drainage assistance may be dependent on the depth of this profile
Small rootballed trees (up to heavy standard)	O	✓	
Containerised shrubs	O	✓	
Bare root specimens	✓	✓	
Amenity grass	✓	✓	
Species-rich wildflower seeding (*as subsoil*)	✓	✓	
Species-rich wildflower seeding (*as topsoil*)	✓	✓	Subsoil may require an application of compost if used as *topsoil* for this landscape type
Marginal planting	✓#	✓#	

✓ = *Subsoil* suited to this landscape type provided the soil is adequately structured, aerated and drained and suitable species are selected.

O = *Subsoil* may be suitable for this landscape type, provided consideration is given to improving the drainage potential.

X = *Subsoil* not suited to this landscape type.

= The suitability of the site subsoils for marginal planting would depend on the desirable moisture regime for these areas, any ecological design requirements (e.g. to support invertebrates) and water quality requirements (i.e. fertility levels, sediment loading etc).

5.9 Soil Structure & Physical Degradation

It is essential to provide a structured, uncompacted profile for the successful establishment and subsequent growth of plants and grass. Adequate soil structure is a key element for healthy plant growth to ensure aeration and drainage within the rootzone. If the site's development programme requires the soils to be disturbed by activities such as excavation, storage and respreading, soil structure can easily be destroyed by compaction. Any damage to soil structure will reduce the drainage rate of the site soils.

Almost all soils are physically degraded during intensive handling and the potential quality and the ultimate suitability of the topsoil for re-use will depend on how well their soil structure is preserved during the earthworks phase. The soils will be particularly prone to structural damage if handled and moved when wet (especially the heavier texture *Main Soil Profile* soils). In this situation, the larger (air containing) soil pores are destroyed and replaced by smaller (water retentive) pores. This will restrict gaseous exchange with the atmosphere and cause the topsoil to become anaerobic (oxygen depleted). In addition, the lack of larger pores prevents effective drainage and results in an increased risk of waterlogging.

Waterlogged and anaerobic conditions, if they persist, can be severely detrimental to plants in two main ways. Firstly, aerobic bacteria are replaced by anaerobic bacteria that produce ammonia and methane gases which are harmful to plants. Secondly, without oxygen plant roots are unable to take up water and nutrients.

5.10 Soil Handling & Programming

If the site soils are to be re-used successfully, structural degradation must be kept to a minimum. In order to achieve this, it is best practice for soil to only be handled when it is reasonably dry and non-plastic in consistency. The most appropriate time to carry out the topsoil strip will therefore be during the summer months (May/June to September/October), and then only when the topsoil is dry. If the topsoil is dry when it goes into the temporary stockpile, it can be kept dry until it is respread. This also applies to any subsoils that are excavated and stockpiled.

If the development's programme requires the topsoils to be stripped and stockpiled when wet, it is inevitable that significant damage is likely to occur to the soil's structure. This damage will be potentially irreparable (particularly in the short to medium term), and planning the programme of earthworks should therefore be carefully considered by the project team at the earliest stage.

Even if the topsoil is stripped when wet, it may still be possible to repair the damage provided there is sufficient time and dry weather after re-spreading. It will therefore be essential that the *Topsoil Respreading Phase* take place during a summer season, to allow enough time for the soil to dry out effectively and be thoroughly cultivated before soil cultivation and planting/seeding takes place in autumn (grass seeding) and winter (planting).

If the project's programme results in topsoil having to be stripped and stockpiled when wet, and then respread for planting/seeding in the wetter/colder, winter or following spring months, there is unlikely to be any opportunity to recondition and prepare the topsoil to address the structural degradation caused by the stripping/stockpiling process. Planting into such adverse conditions is likely to result in poor plant establishment rates and possibly plant failures.

The best scenario for re-using topsoil would be to strip and stockpile it when dry, as it will then be dry when it is to be re-used. When dry, the topsoil will be relatively easy to spread and cultivate, and should re-aerate rapidly. If the topsoil is stockpiled when wet, the soil will suffer from physical degradation that will have to be repaired before further work is carried out. This remediation work will be difficult to achieve in the short term, requiring favourable weather conditions and possibly a series of cultivations.

5.11 Soil Resource Plan

Careful management of topsoil and subsoil is an important aspect for the sustainable use of soils. With reference to the DEFRA's *Construction Code of Practice for the Sustainable Use of Soils on Construction Sites* (2009), it is recommended that a **Soil Resource Plan** is prepared.

The Soil Resource Plan would include the following:

- Maps showing further differentiation on topsoil and subsoil types as necessary (see 'Further Work' below), and the areas to be stripped and left in-situ
- Methods for stripping, stockpiling, respreading and ameliorating the soils
- Schedule of volumes for each material
- Soil treatment techniques to ensure a well structured, uncompacted rooting zone is provided for future landscape construction.
- Soil amelioration measures including options to improve the quality of the soils by adding fertiliser, compost or sand, etc.

6.0 FURTHER WORK

In light of the findings from this Soil Resource Survey, there are a number of areas which would warrant further investigations and/or input. These include the following.

- Further investigation of the Light Soil Profile zone to pinpoint its extent and transition to the heavier textured soils. The depth of this soil profile in different parts of its extent could significantly influence soakage for example.
- Higher resolution assessment of soil fertility across the site is recommended to determine spatial variations in soil fertility and determine specific amelioration requirements (e.g. compost and fertiliser applications). This information will also confirm which site soils are best suited for species-rich wildflower grassland habitats. This should be undertaken 'out of season' when crop establishment does not restrict access.
- Further analysis of soil fertility status may also be required once the topsoils have been stripped and stockpiled.
- Additional trial holes in areas remaining to be surveyed ('Browne', 'Wake' and 'Byrne' land) once restrictions on access are lifted following the crop harvest. This information will confirm the topsoil depths in these zones and enable samples to be taken for composition assessment.
- Given the clay dominated nature of the site subsoils, the soakage potential of the ground is likely to be low. However, soakage tests are recommended, especially for any zones of new tree planting to determine any necessary drainage requirements, particularly if large semi-mature specimens or demanding species are to be selected.

We would like to thank Ashfield Land Management Ltd and Barry Chinn Associates Ltd for entrusting our practice with this commission. We trust this report meets with your approval and provides the necessary information. Please do not hesitate to contact the undersigned if we can be of further assistance.

Ceri Spears
BSc MSc MISoilSci
Senior Associate

For & on behalf of Tim O'Hare Associates LLP

Report Qualifications

Our interpretation of the soil conditions is based on observations made during our site investigation and the results of laboratory tests. This report presents our site observations and test results and our interpretation of those observations and results. On any site there may be variations in soil conditions between these exploratory positions. We can therefore not accept any responsibility for soil conditions that have not been exposed by this investigation.

This investigation considers the re-use of the site soils for landscape purposes for the Rail Central project, Milton Malsor, Northamptonshire. It should not therefore be relied on for alternative end-uses or for other schemes. This report has been prepared solely for the benefit of our client Ashfield Land Management Ltd. No warranty is provided to any third party and no responsibility or liability will be accepted for any loss or damage in the event that this report is relied upon by a third party or is used in circumstances for which it was not originally intended.

Appendix 1

Site Plan – Field References

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	Ashfield Land Management		
Project:	Rail Central, Milton Malsor		
Job ref no.:	TOHA/17/4023/CS		
Drawing no.:	4023/1		
Drawing title	Soil Resource Survey – Field References		
Date:	July '17	Scale:	NTS
Drawn by:	CS	Checked by:	TOH

Tim O'Hare Associates LLP
Howbery Park Wallingford Oxfordshire OX10 8BA
T: 01491 822653 F:01491 822644 E:info@toha.co.uk
www.toha.co.uk

Appendix 2

Land Use Summary at Time of Survey

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Title:	**Land Use Record (at Time of Survey)**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Survey Area Ref.	Field Ref/ No.	Land Use (e.g. arable / pasture etc)	Vegetation Type / Crop
ALM	ALM 1	Arable	Beans
	ALM 2	Arable	Beans
	ALM 3	Arable	Beans
	ALM 4	Arable	Beans
	ALM 5	Arable	Beans
	ALM 6	Arable	Beans
	ALM 7	Livestock - Cattle	Grass
	ALM 8	Livestock - Cattle	Grass / Scrub
	ALM 9	Arable	Beans
	ALM 10	Livestock - Sheep & Cattle	Grass
Treharne	TRE 1	Arable	Sugar beet
	TRE 2	Arable	Cereals
	TRE 3	Pasture	Grass
	TRE 4	Livestock - Cattle / Sheep	Grass
	TRE 5	Arable	Oil Seed Rape
	TRE 6	Pasture	Grass
	TRE 7	Pasture	Hay (recently cut)
	TRE 8	Pasture	Hay (recently cut)
	TRE 9	Arable	Cereals
	TRE 10	Arable	Cereals
	TRE 11	Arable	Beans
	TRE 12	Arable	Cereals
Browne	BRW 1	*Unsurveyed*	*Unsurveyed*
	BRW 2	*Unsurveyed*	*Unsurveyed*
Halestrap	HAL 1	Arable	Oil Seed Rape
	HAL 2	Arable	Oil Seed Rape
Fossett	FOS 1	Arable	Oil Seed Rape
	FOS 2	Uncultivated	Scrub
	FOS 3	Horse Paddock	Grass
	FOS 4	Arable	Beans
	FOS 5	Arable	Beans
Milosevic	MIL 1	Pasture	Semi-Improved Grassland
Wakelin	WLN 1	Arable	Oil Seed Rape
	WLN 2	Arable	Oil Seed Rape
	WLN 3	Arable	Oil Seed Rape
	WLN 4	Arable	Oil Seed Rape
	WLN 5	Arable	Oil Seed Rape
HC PCC	HCP 1	Pasture	Improved Grassland
Byrne	BYN 1	*Unsurveyed*	*Unsurveyed*
Wake	WKE 1	*Unsurveyed*	*Unsurveyed*
	WKE 2	*Unsurveyed*	*Unsurveyed*
	WKE 3	*Unsurveyed*	*Unsurveyed*
	WKE 4	*Unsurveyed*	*Unsurveyed*

Appendix 3

Site Plan – Trial Hole Locations

THx

Approximate Trial Hole location

TIM O'HARE ASSOCIATES

SOIL & LANDSCAPE CONSULTANCY

Client:	Ashfield Land Management Ltd		
Project:	Rail Central, Milton Malsor		
Job ref no.:	TOHA/17/4023/CS		
Drawing no.:	4023/2		
Drawing title	Soil Resource Survey – Trial Hole Locations		
Date:	June '17	Scale:	NTS
Drawn by:	RF	Checked by:	CS

Tim O'Hare Associates LLP
Howbery Park Wallingford Oxfordshire OX10 8BA
T: 01491 822653 E:info@toha.co.uk
www.toha.co.uk

Appendix 4

Topsoil Types Plan

Main Topsoil
(approximate extent)

Light Topsoil
(approximate extent)

Areas within
application boundary
unsurveyed by
TOHA/RAC/ADAS

Site Boundary

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	Ashfield Land Management Ltd		
Project:	Rail Central, Milton Malsor		
Job ref no.:	TOHA/17/4023/CS		
Drawing no.:	4023/3		
Drawing title	Soil Resource Survey – Topsoil Types		
Date:	July '17	Scale:	NTS
Drawn by:	RF	Checked by:	CS

Tim O'Hare Associates LLP
Howbery Park Wallingford Oxfordshire OX10 8BA
T: 01491 822653 E:info@toha.co.uk
www.toha.co.uk

Appendix 5

Topsoil Volume Schedule

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management Ltd**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Title:	**Topsoil Volume Schedule**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Survey Area Ref.	Field Ref/ No.	Area (m^2)	Average Topsoil Depth (m)*	Estimated Topsoil Volume (m^3)
ALM	ALM 1	**81484**	0.34	27704
	ALM 2	**82089**	0.34	27910
	ALM 3	**38393**	0.32	12094
	ALM 4	**66510**	0.34	22281
	ALM 5	**46766**	0.28	13094
	ALM 6	**88737**	0.30	26177
	ALM 7	**71484**	0.25	17871
	ALM 8	**35627**	0.34	11935
	ALM 9	**23875**	0.34	8118
	ALM 10	**58314**	0.26	15162
Treharne	TRE 1	**47934**	0.26	12463
	TRE 2	**54495**	0.37	20163
	TRE 3	**10752**	0.40	4301
	TRE 4	**68626**	0.33	22647
	TRE 5	**38426**	0.29	11143
	TRE 6	**8614**	0.30	2584
	TRE 7	**46067**	0.32	14742
	TRE 8	**44582**	0.34	15158
	TRE 9	**81234**	0.32	25995
	TRE 10	**54468**	0.35	19064
	TRE 11	**77587**	0.32	24440
	TRE 12	**92729**	0.35	32455
Browne	BRW 1	**32828**	0.30	9848
	BRW 2	**119847**	*0.30*	35954
Halestrap	HAL 1	**168809**	*0.30*	50643
Fossett	FOS 1	**66158**	0.29	18855
	FOS 2	**57457**	0.34	19535
	FOS 3	**80301**	0.32	25696
	FOS 4	**125484**	0.30	37645
	FOS 5	**32984**	0.29	9565
Milosevic	MIL 1	**30622**	0.28	8574
Wakelin	WLN 1	**58012**	0.28	16069
	WLN 2	**43904**	0.29	12732
	WLN 3	**50466**	0.32	16149
	WLN 4	**90631**	0.29	26283
	WLN 5	**152773**	0.30	45832
HC PCC	HCP 1	**88962**	0.31	27223
Byrne	BYN 1	**67741**	*0.30*	20322
Wake	WKE 1	**49276**	0.25	12319
	WKE 2	**32089**	0.29	9402
	WKE 3	**34008**	0.32	10747
	WKE 4	**61390**	0.30	18417
TOTAL		**2662536**		**819313**

* Average topsoil depth calcualted using the supplied Reading Agricultural Consultants ALC data and the topsoil depths recorded listed in Section 3.4 of TOHA Soil Resource Survey Report

Area figures supplied by Barry Chinn Associates

Depth in italics = assumed depth - area unsurveyed by TOHA, RAC or ADAS

Appendix 6

Laboratory Analysis Results

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**TRE 4-6**	**WLN**	**ALM1 TH52**	**ALM4**	**ALM6**
Soil Type			**Main Topsoil**	**Main Topsoil**	**Light Topsoil**	**Main Topsoil**	**Main Topsoil**
		Accreditation					
Clay (<0.002mm)	%	UKAS	35	38	19	39	43
Silt (0.002-0.063mm)	%	UKAS	34	48	23	42	41
Sand (0.063-2.0mm)	%	UKAS	31	14	58	19	16
Texture Class (UK Classification)	--	UKAS	CL	ZC	SCL	C	C
Stones (2-20mm)	% DW	GLP	1	0	2	1	0
Stones (20-50mm)	% DW	GLP	0	0	0	0	0
Stones (>50mm)	% DW	GLP	0	0	0	0	0
pH Value (1:2.5 water extract)	units	UKAS	6.4	7.0	7.2	8.0	6.3
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	964	301	209	282	150
Electrical Conductivity (1:2 $CaSO_4$ extract)	uS/cm	UKAS	2398	2211	2085	2101	2040
Exchangeable Sodium Percentage	%	UKAS	0.3	0.3	0.4	0.4	0.6
Organic Matter (LOI)	%	UKAS	8.0	5.1	5.0	4.8	6.0
Total Nitrogen (Dumas)	%	UKAS	0.39	0.24	0.22	0.21	0.31
C : N Ratio	ratio	UKAS	12	12	13	13	11
Extractable Phosphorus	mg/l	UKAS	14	20	25	27	18
Extractable Potassium	mg/l	UKAS	247	197	132	121	132
Extractable Magnesium	mg/l	UKAS	147	134	121	63	122

CL = CLAY LOAM
ZC = SILTY CLAY
SCL = SANDY CLAY LOAM
C = CLAY

Ceri Spears
BSc MSc MISoilSci
Senior Associate

Results of analysis should be read in conjunction with the report they were issued with

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**ALM1 TH53**	**ALM2**	**ALM3**	**ALM5**	**ALM7**	**ALM8 TH45+46**	**ALM9**
Soil Type			**Light Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**
		Accreditation							
pH Value (1:2.5 water extract)	units	UKAS	7.8	7.0	6.6	7.0	6.6	6.0	6.8
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	179	133	244	469	293	191	113
Organic Matter (LOI)	%	UKAS	3.6	5.0	4.0	5.9	16.4	16.4	5.2
Total Nitrogen (Dumas)	%	UKAS	0.16	0.25	0.20	0.29	0.66	0.69	0.27
C : N Ratio	ratio	UKAS	13	12	12	12	14	14	11
Extractable Phosphorus	mg/l	UKAS	11	23	19	11	29	11	14
Extractable Potassium	mg/l	UKAS	120	115	92	115	222	173	67
Extractable Magnesium	mg/l	UKAS	43	100	113	149	316	274	90

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Ceri Spears
BSc MSc MISoilSci
Senior Associate

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**ALM8**	**HCP1**	**TRE 7-8**	**TRE 9-12**	**FOS 1**	**FOS 4+5**
Soil Type			**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**	**Main Topsoil**
		Accreditation						
pH Value (1:2.5 water extract)	units	UKAS	7.8	6.8	6.9	6.5	7.5	7.4
Calcium Carbonate	%	UKAS	5	nt	nt	nt	nt	nt
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	322	375	294	977	405	264
Organic Matter (LOI)	%	UKAS	5.3	4.9	5.0	5.3	4.8	4.8
Total Nitrogen (Dumas)	%	UKAS	0.27	0.25	0.25	0.25	0.23	0.24
C : N Ratio	ratio	UKAS	12	11	12	12	12	12
Extractable Phosphorus	mg/l	UKAS	10	20	14	17	53	16
Extractable Potassium	mg/l	UKAS	156	154	113	119	81	103
Extractable Magnesium	mg/l	UKAS	88	102	102	134	126	147

nt = not tested

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**TRE 1**	**FOS 2**	**HAL 1**	**MIL1**
Soil Type			**LightTopsoil**	**Main Topsoil**	**Light Topsoil**	**Main Topsoil**
		Accreditation				
Clay (<0.002mm)	%	UKAS	19	26	14	41
Silt (0.002-0.063mm)	%	UKAS	21	28	13	46
Sand (0.063-2.0mm)	%	UKAS	60	46	73	13
Texture Class (UK Classification)	--	UKAS	SCL	CL	SL	ZC
pH Value (1:2.5 water extract)	units	UKAS	6.1	6.3	6.7	7.0
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	894	139	228	98
Organic Matter (LOI)	%	UKAS	5.3	3.8	3.1	6.2
Total Nitrogen (Dumas)	%	UKAS	0.26	0.19	0.15	0.31
C : N Ratio	ratio	UKAS	12	12	12	12
Extractable Phosphorus	mg/l	UKAS	39	11	23	4
Extractable Potassium	mg/l	UKAS	262	47	36	37
Extractable Magnesium	mg/l	UKAS	150	80	45	160

ZC = SILTY CLAY
SCL = SANDY CLAY LOAM
CL = CLAY LOAM
SL = SANDY LOAM

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**TH8+TH37**
Soil Type			**Light Topsoil**
		Accreditation	
Clay (<0.002mm)	%	UKAS	11
Silt (0.002-0.05mm)	%	UKAS	12
Very Fine Sand (0.05-0.15mm)	%	UKAS	14
Fine Sand (0.15-0.25mm)	%	UKAS	31
Medium Sand (0.25-0.50mm)	%	UKAS	29
Coarse Sand (0.50-1.0mm)	%	UKAS	2
Very Coarse Sand (1.0-2.0mm)	%	UKAS	1
Total Sand (0.05-2.0mm)	%	UKAS	77
Texture Class (UK Classification)	--	UKAS	SL
pH Value (1:2.5 water extract)	units	UKAS	5.5
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	217
Organic Matter (LOI)	%	UKAS	3.5
Total Nitrogen (Dumas)	%	UKAS	0.14
C : N Ratio	ratio	UKAS	15
Extractable Phosphorus	mg/l	UKAS	23
Extractable Potassium	mg/l	UKAS	84
Extractable Magnesium	mg/l	UKAS	63

SL = SANDY LOAM

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Topsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**ALM 10**	**TRE 2**	**TRE 11**
Soil Type			**Main Topsoil**	**Main Topsoil**	**Main Topsoil**
		Accreditation			
pH Value (1:2.5 water extract)	units	UKAS	nt	nt	7.6
Organic Matter (LOI)	%	UKAS	6.2	4.9	5.8

nt = not tested

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Subsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**TRE 4-6**	**TRE 9-12**	**TH8 + TH37**	**WLN**	**MIL1**	**ALM3**	**ALM4**	**ALM6**
Soil Type			**Main Subsoil**	**Main Subsoil**	**Light Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**
		Accreditation								
Clay (<0.002mm)	%	UKAS	41	40	9	35	40	30	47	32
Silt (0.002-0.063mm)	%	UKAS	38	48	12	57	51	45	33	32
Sand (0.063-2.0mm)	%	UKAS	21	12	79	8	9	25	20	36
Texture Class (UK Classification)	--	UKAS	C	ZC	LS	ZCL	ZC	CL	C	CL
Stones (2-20mm)	% DW	GLP	2	0	2	0	0	0.4	0.1	0.1
Stones (20-50mm)	% DW	GLP	1	0	0	0	0	0	0	0
Stones (>50mm)	% DW	GLP	0	0	0	0	0	0	0	0
pH Value (1:2.5 water extract)	units	UKAS	7.3	6.7	6.2	7.3	7.3	7.0	8.2	6.9
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	529	366	216	255	142	190	222	111
Organic Matter (LOI)	%	UKAS	1.6	2.1	2.1	2.1	2.4	2.3	2.9	2.8
Extractable Phosphorus	mg/l	UKAS	5	4	23	6	2	2	13	5
Extractable Potassium	mg/l	UKAS	159	94	48	185	84	90	119	68
Extractable Magnesium	mg/l	UKAS	282	271	35	342	420	263	97	92

ZC = SILTY CLAY
ZCL = SILTY CLAY LOAM
C = CLAY
LS = LOAMY SAND

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Subsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**ALM1**	**ALM2**	**ALM4**	**ALM5**	**ALM7**	**ALM8 TH45+46**	**ALM9**	**ALM8 TH40**
Soil Type			**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**
		Accreditation								
Clay (<0.002mm)	%	UKAS	32	32	38	53	68	58	36	51
Silt (0.002-0.063mm)	%	UKAS	36	55	47	40	29	38	57	39
Sand (0.063-2.0mm)	%	UKAS	32	13	15	7	3	4	7	10
Texture Class (UK Classification)	--	UKAS	CL	ZCL	ZC	C	C	C	ZC	C
Stones (2-20mm)	% DW	GLP	2	0	1	1	0	1	1	1
Stones (20-50mm)	% DW	GLP	1	0	0	0	0	0	0	0
Stones (>50mm)	% DW	GLP	0	0	0	0	0	0	0	0
pH Value (1:2.5 water extract)	units	UKAS	7.7	7.0	7.3	7.6	6.8	6.3	7.2	7.4
Calcium Carbonate	%	UKAS	nt	nt	nt	nt	nt	nt	nt	7
Electrical Conductivity (1:2.5 water extract)	uS/cm	UKAS	54	70	243	92	155	140	112	195
Organic Matter (LOI)	%	UKAS	2.5	2.4	2.1	2.8	3.1	3.0	2.2	2.6

CL = CLAY LOAM
ZCL = SILTY CLAY LOAM
ZC = SILTY CLAY
C = CLAY

nt = not tested

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Ceri Spears
BSc MSc MISoilSci
Senior Associate

TIM O'HARE ASSOCIATES
SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Subsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			TRE 1 550+	TRE 12	FOS2	ALM4	FOS 5
Soil Type			Parent Material	Main Subsoil	Main Subsoil	Main Subsoil	Main Subsoil
		Accreditation					
Clay (<0.002mm)	%	UKAS	22	26	24	30	24
Silt (0.002-0.063mm)	%	UKAS	40	33	30	33	45
Sand (0.063-2.0mm)	%	UKAS	38	41	46	37	31
Texture Class (UK Classification)	--	UKAS	CL	CL	CL	CL	CL
Organic Matter (LOI)	%	UKAS	1.9	2.1	1.9	2.1	nt

CL + CLAY LOAM

nt = not tested

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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SOIL & LANDSCAPE CONSULTANCY

Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Subsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**ALM 10**	**TRE 1**	**HCP1**	**FOS1**	**FOS 4+5**	**HAL 1**	**ALM8**
Soil Type			**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Main Subsoil**	**Light Subsoil**	**Parent Material**
		Accreditation							
pH Value (1:2.5 water extract)	units	UKAS	nt	nt	6.9	7.7	7.0	5.6	7.7
Organic Matter (LOI)	%	UKAS	2.7	2.2	2.1	1.9	2.2	2.2	1.6

nt = not tested

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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Client:	**Ashfield Land Management**
Project:	**Rail Central, Milton Malsor, Northamptonshire**
Job:	**Soil Resource Survey**
Soil Type:	**Subsoil**
Date:	**June 2017**
Job Ref No:	**TOHA/17/4023/CS**

Sample Reference			**TRE 7-8**
Soil Type			**Main Subsoil**
		Accreditation	
pH Value (1:2.5 water extract)	units	UKAS	8.0
Calcium Carbonate	%	UKAS	10.4

Ceri Spears
BSc MSc MISoilSci
Senior Associate

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Appendix 7

Topsoil Samples Fertility Summary

Rail Central – Topsoil Samples Fertility Summary

	TRE 4-6	WLN	ALM1 TH52	ALM4	ALM6	ALM1 TH53	ALM2	ALM3	ALM5	ALM7
Organic Matter	✓✓	✓	✓	✓	✓✓	o	✓	✓	✓✓	✓✓
Total Nitrogen	✓	✓	✓	✓	✓	o	✓	✓	✓	✓✓
Extractable Phosphorus	x	✓	✓	✓	✓	x	✓	✓	x	✓
Extractable Potassium	✓	✓	✓	✓	✓	o	x	x	x	✓
Extractable Magnesium	✓	✓	✓	✓	✓	o	✓	✓	✓	✓

	ALM8 TH45/46	ALM9	ALM8 TH40	HCP1	TRE 7-8	TRE 9-12	FOS 1	FOS 4+5	TRE 1	FOS 2
Organic Matter	✓✓	✓	✓	✓	✓	✓	✓	✓	✓	o
Total Nitrogen	✓✓	✓	✓	✓	✓	✓	✓	✓	✓	o
Extractable Phosphorus	x	x	x	✓	x	✓	✓✓	✓	✓	x
Extractable Potassium	✓	x	✓	✓	x	x	x	x	✓	xx
Extractable Magnesium	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

	HAL1	MIL1	TH8+TH37	ALM 10	TRE 2	TRE 11				
Organic Matter	o	✓	o	✓	✓	✓				
Total Nitrogen	x	✓	o	nt	nt	nt				
Extractable Phosphorus	✓	xx	✓	nt	nt	nt				
Extractable Potassium	xx	xx	x	nt	nt	nt				
Extractable Magnesium	o	✓	✓	nt	nt	nt				

✓✓ - well supplied; ✓ - adequately supplied; o - slightly deficient; x - deficient; xx - very deficient

nt = not tested