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David Smith Associates

Supplementary Geotechnical Investigation

The Corby Cube
George Street
Corby
NN17 1QG

Report No: 19.12.006a

May 2020

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Development	Existing Sheet Pile Wall
Project Address	The Corby Cube, George Street, Corby, NN17 1QG
Project Number	19.12.006a
Client	David Smith Associates

	Signature	**Name and Qualifications**
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For and on behalf of ListersGeo, trading name of Listers Geotechnical Consultants Ltd

Issue No	**Date**	**Status**
1	30th April 2020	Draft Report
2	14th May 2020	Final Report

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EXECUTIVE SUMMARY

Project Reference	19.12.006a
Site Location	The Corby Cube, George Street, Corby, NN17 1QG
OS Grid Reference	488009, 288461
Current Site Usage	An asphalt access ramp down to a basement used by Corby Cube.
Topography	The site itself is generally flat with an asphalt access ramp which runs down by approximately 5m over a distance of 55m towards the east to the basement.
Vegetation	There is a small area of topsoil in the northeast and along the southern boundary with several small hedges and plants. There are several small trees in the northeast.
Published Geology	The BGS indicates that the site is underlain by the Oadby Member, overlying the Lower Lincolnshire Limestone Member. There is a fault shown running northwest to southeast located some 100m to the northeast of the site. The down throw of the fault is to the southwest.
Ground Conditions Encountered	The intrusive investigation revealed that the general succession of strata was represented by Fill/Topsoil onto Made Ground down to between 0.60m and 1.50m, overlying the Oadby Member proven down to the full depth of the investigation at 6.00m.
Groundwater Encountered	Groundwater was not encountered in either of the boreholes during the fieldwork down to 6.0m depth below the existing ground level, for the short time that the holes were open. Subsequent monitoring has revealed that both the borehole installations were dry down to the base of the standpipes at 6.00m in December 2019 with groundwater at between 1.89m and 2.3m bgl on the 2nd April 2020. A trickle of water was released from sample location SL1 when the metal was removed whereas only a small dribble was released from SL2. Water appeared to be trickling from the relic slip surface and from larger gravel pieces within the clay.
Conclusions	The laboratory testing recorded high levels of total potential sulphate within the Oadby Member and elevated sulphate levels within the groundwater considered to be associated with the pyrite and soluble selenite noted within the soils. It is understood that the sulphate within the soil can become highly corrosive sulphuric acid due to the activity of bacteria and the presence of water and this process is considered to be the main likely cause for the corrosion of the sheet pile wall at the site.
Recommendations	We would recommend water pressure testing of the drainage surrounding the sheet pile walls to assess whether any leaks have occurred which could be adding water to the back of the sheet piled walls. Seasonal groundwater monitoring and permeability testing of soils to confirm the use of static groundwater conditions. High levels of sulphate have been recorded within the Oadby Member soils and groundwater which can affect buried concrete. The concrete class should have been carefully considered as part of the original design for the sheet pile capping beam and any other concrete associated with the development. We would therefore recommend that this is confirmed based on the findings of this report.

This executive summary should be read in conjunction with the main report.

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SUPPLEMENTARY GEOTECHNICAL INVESTIGATION REPORT

INTRODUCTION

A Supplementary Geotechnical Investigation has been undertaken for an assessment of the existing sheet pile walls for a basement car park ramp at The Corby Cube, George Street, Corby, NN17 1QG. A Site Location Plan is provided in Appendix A. The Ordnance Survey National Grid reference for the approximate centre of the site is 488009, 288461.

Instructions to undertake this supplementary geotechnical investigation were received from David Smith Associates, the client, in their email dated 23rd March 2020.

This report supplements a ground investigation previously undertaken by Soiltechnics, report number STC0751H, dated May 2006. The previous borehole logs and laboratory test results for the site have been provided by David Smith Associates, and we have relied on this information to aid our recommendations. However, the full report was not made available.

ListersGeo also prepared a Geotechnical Investigation Report under project reference 19.12.006, dated January 2020. This report focused on investigating possible causes of corrosion of a metal sheet piled wall that has been installed on the site. The findings of the previous reports have been incorporated into this report to provide an updated assessment.

This current report should be read in conjunction with the previous information for full details of the investigations undertaken at the site.

This report describes the work carried out by ListersGeo, the ground conditions encountered and discusses the geotechnical implications with regard to the existing sheet piled walls based on the findings of the fieldwork and subsequent laboratory testing.

This report has been prepared for the sole use of the client and their professional advisors. This report shall not be relied upon by third parties without the express written authority of ListersGeo. If an unauthorised third party comes into possession of this report, they must not rely on it and the authors owe them no duty of care and skill.

SCOPE OF THE INVESTIGATION

The scope of the investigation as requested by David Smith Associates, was to undertake a foundation pit on the rear face of the retaining wall, along with supplementary chemical testing of soil and ground water samples to further investigate the corrosion occurring on the face of the existing sheet pile walls for the basement car park ramp.

A geotechnical desk study and comments on foundation design are outside of the scope of work.

SITE INFORMATION AND WALKOVER SURVEY

A walkover survey of the site and its immediate surrounds was undertaken at the time of the original site investigation on the 10th December 2019 and during this phase of site works undertaken on the 2nd April 2020. A selection of site photographs is presented in Appendix A along with a plan showing the existing site layout.

The site lies in a predominantly commercial area and is currently occupied by an asphalt access ramp down to a basement.

The site consists of a rectangular parcel of land, measuring approximately 20m by 65m extending to approximately 1300m^2 in area.

The site itself is generally flat with an asphalt access ramp which runs down by approximately 5m over a distance of 55m towards the east to the basement used by Corby Cube. There are two anchored metal sheet pile retaining walls either side of the access ramp. The sheet piles are painted grey and are heavily rusted particularly in the joints for the deeper piles towards their base. There appears to be a cream/white residue in the areas of heavy rusting and the sheet piles appeared to be damp with small puddles of water at their base.

The majority of the site is covered in asphalt hardstanding with a small area of topsoil in the northeast and along the southern boundary with several small hedges and plants. There are several small trees in the northeast and an electric substation located in the southeastern corner of the site. There is an asphalt car park surrounding the site on all sides which is used for the swimming pool and leisure centre located some 80m to the north and The Corby Cube located 20m to the northeast of the site.

GEOLOGY

Published Geology

Reference to the British Geological Survey 1:50,000 scale map, Sheet 171 for Kettering dated 2002, and other published geological information on the area indicates that the site is underlain by Superficial geology, the Oadby Member of the Quaternary period above Bedrock geology, the Lower Lincolnshire Limestone Member of the Jurassic period.

There is a fault shown running northwest to southeast located some 100m to the northeast of the site. The downthrow of the fault is to the southwest.

Superficial Deposits

The Oadby Member is described by the BGS as 'brown and grey silty clay with chalk and flint fragments'. The thickness of the deposit beneath the site is unknown, but typically they are between 1m and 7m thick, and can be up to 20m thick in the region when associated with the infilling of former valleys.

Bedrock

The Lower Lincolnshire Limestone Member is described by the BGS as 'limestone dominated by low-energy calcilutite (>50% of clay/silt sized carbonate grains), and peloidal wackestone (mud-supported carbonate rock

that contains >10% grains) and packstone (grain supported carbonate rock that contains >1% mud-grade fraction)'. The thickness of the member beneath the site is unknown, but typically up to 12m thick in the region.

PREVIOUS WORK – SOILTECHNICS

A ground investigation was previously undertaken by Soiltechnics, report number STC0751H, dated May 2006. The previous borehole logs and laboratory test results for the site have been provided by the client, and we have relied on this information to aid our recommendations. However, the full report was not made available. The salient points relevant to this information are included here, but the full report should be referred to for more detail.

Ground Conditions

The previous exploratory work included four cable percussion borehole BH02C, BH03, BH04 and BH05 to depths between 12.24m and 17.50m depth. The location of the historical boreholes is unknown as there was no plan provided. The ground conditions encountered comprised Made Ground down to depths between 0.30m and 0.90m, onto stiff brown blue slightly sandy gravelly clay with gravel of chalk and flint interpreted as the Glacial Deposits (Oadby Member) down to depths between 12.20m and 17.20m depth. The boreholes all refused on limestone considered either to be a boulder within the Glacial Deposits or the bedrock of the Lincolnshire Limestone. The boreholes were recorded as dry with the exception of BH05 which encountered groundwater at 0.35m depth, possibly associated with perched groundwater within the Made Ground.

EXPLORATION AND TESTING

During the supplementary site works on the 2nd April 2020, two trial pits were put down. The previous investigation included two continuous tube sample boreholes, two dynamic probe tests and two samples of the sheet pile undertaken on the 10th and 16th December 2019.

The positions of all exploratory holes from both phases of the investigation undertaken by ListersGeo can be seen on the Exploratory Hole Location Plan and Section in Appendix A. The logs from this supplementary investigation are provided in Appendix B and the results from this supplementary investigation of the chemical laboratory testing are provided in Appendix C.

SAMPLING STRATEGY

The investigation was undertaken in accordance with the scope of works agreed with David Smith Associates.

TP101 was put down to the south of the sheet piled wall to further investigate the make up to the rear of the retaining wall. TP101 encountered a number of obstructions and services and following discussions with David Smith Associated, TP102 was excavated further to the east to obtain additional samples for testing.

METHODOLOGY

Prior to commencement of boring/testing, and in order to minimise the dangers from/to buried services, the proposed locations were scanned using a Cable Avoidance Tool.

Trial pits were excavated with a 3-tonne tracked excavator and using insulated hand digging tools down to depths of between 1.01m and 1.65m bgl.

Conclusions given in this report are based on data obtained from these sources, but it should be noted that variations, which affect these conclusions, may inevitably occur between and beyond the test locations. Also, water levels may vary seasonally and with other factors.

GROUND CONDITIONS

The intrusive investigation for this and the previous ListersGeo investigation revealed that the general succession of strata was represented by Fill/Topsoil onto Made Ground down to 0.60m and 1.50m depth, overlying the Oadby Member proven down to the full depth of the investigation at 6.00m.

Our Ground Model for the site is as follows:

TOPSOIL

Encountered in TP101, TP102 and CT02, from ground level down to 0.22m. Represented by soft brown slightly sandy slightly gravelly organic clay with gravel of quartz and roots.

FILL

Encountered in CT01, from ground level down to 0.25m. Represented by block paving down to 0.15m, onto asphalt down to 0.25m, overlying medium dense grey very sandy gravel of igneous subbase down to 0.60m depth.

TP101 was terminated on cement-concrete, referred to as concrete throughout this report, which was present from ground level down to a depth of around 1m with further details presented in the Existing Foundation section of this report.

MADE GROUND

Encountered in both boreholes CT01 and CT02 and TP101 and TP102, from around 0.20m and 0.60m, down to depths of between 0.60m and 1.50m depth. Represented in general by either firm dark brown and grey silty slightly sandy clay with pockets of black silt and gravel of concrete, sandstone and ironstone (CT01) or medium dense reddish brown very sandy gravel of quartz (CT02). In TP102, a 0.4m thick layer of grey brown gravelly clay with gravel of brick and flint was found to overlie a layer of gravel sub-base from 0.6m to 1.1m bgl. This may also be classed as Fill, but for the purposes of this report has been classed as Made Ground.

OADBY MEMBER

Encountered in both boreholes CT01 and CT02 and TP102 from depths of between 0.60m and 1.50m and proven down to the base of the boreholes at a maximum depth of 6.00m. Represented in general as an upper layer encountered down to 4.00m depth, comprising stiff fissured orange brown and grey silty slightly sandy gravelly clay with low cobble content, with rare relict roots and gravel of sandstone, ironstone, limestone and chalk. Reddish brown staining was encountered on fissure surfaces from 2.50m to 4.00m depth, occasional fine selenite with associated cream silt from 2.00m to 4.00m and a pyrite nodule was encountered at 2.25m in CT02.

The lower layer encountered from 4.00m to 6.00m depth, generally comprised very stiff dark grey silty slightly sandy gravelly clay with gravel of siltstone, chalk, limestone and flint. Rare reddish brown staining on fissure surfaces was encountered at 4.75m depth in CT01 and a pyrite nodule was encountered at 5.50m depth in CT02.

The soil behind the sheet pile sample locations SL1 and SL2 was encountered as the lower layer of the Oadby Member, as described above. A black layer only a few mm thick was noted on the surface of the fine-grained soils behind the metal sheet piled wall, at both sample locations. A possible relic slip surface was noted approximately 110mm behind the wall at sample location SL1. It is possible that this was formed during deposition of the Oadby Member, although it is considered more likely that it formed during the installation of the sheet pile.

The results of the dynamic probing indicate that the penetration resistance of the Oadby Member is interpreted to indicate generally high to very high strength soils, with a general increase of strength with depth.

GROUNDWATER

Groundwater was not encountered in either of the boreholes or the trial pits during the fieldwork down to 6.0m depth below the existing ground level, for the short time that the holes were open.

Monitoring in December 2019 revealed that both the borehole installations were dry down to the base of the standpipes at 6.00m depth. However, groundwater monitoring on the 2nd April 2020 recorded groundwater at 1.89m in CT01 and 2.30m in CT02. The level of the groundwater appeared to roughly correlate with the corrosion on the face of the retaining wall.

A trickle of water was released at sample location SL1 when the metal was removed, whereas only a small dribble was released from SL2. Water appeared to be trickling from the relic slip surface and from around larger gravel pieces within the clay.

EXISTING FOUNDATIONS

TP101 was located to the south of the retaining wall, as shown on the plans to further investigate its construction. The trial pit had to be located between ties/anchors which are understood to form part of the retaining wall. A number of services were also noted to run parallel with the wall and the pit was therefore excavated between the wall and the services.

Concrete was encountered from surface and extended for 0.44m away from the wall. The pit was then excavated down 1.01m and further concrete was found at the base which extended beneath the services present around 0.7m away from the top of the retaining wall. The rear of the sheet piled retaining wall could therefore not be examined due to the presence of the concrete.

SOIL TESTING

Five samples of the Made Ground and twelve samples of the Oadby Member were collected on site during this supplementary investigation and the previous investigation were tested for a range of chemical determinands. The majority of the samples to be tested were recovered from the two boreholes CT01 and CT02 and TP102, with one sample taken from behind the sheet pile wall at SL1.

The suite of testing carried out on the samples was decided upon following consultation with the Chemical Laboratory to attempt to assess the cause for the corrosion of the existing sheet piled walls.

The test suite included a range of:

- pH
- Redox potential
- Chloride, fluoride, nitrate, nitrite, sulphide, ammonium, calcium, potassium, magnesium, sodium, phosphate and sulphate
- Organic matter
- Sulphate reducing bacteria
- Acid and water-soluble sulphur, Total Potential Sulphate and Total Sulphur.

Unless explicitly stated on the laboratory report, the soil samples were tested to obtain 'Total' values within the soil.

A water sample was also recovered from the monitoring well installed in CT02 and was tested for pH, Sulphur, Sulphate and Sulphide.

The results of the tests from this investigation are included in Appendix C.

GEOTECHNICAL ENGINEERING CONCLUSIONS

The exploratory work from this investigation encountered Fill/Topsoil, onto Made Ground down to between 0.60m and 1.50m, overlying the Oadby Member proven to the full depth of the investigation at 6.00m.

The corrosion of the sheet pile wall is likely to form from many different factors that can influence degradation. Several of these factors are discussed below:

Soil Type

The Oadby Member was encountered as an upper layer encountered down to 4.00m depth, comprising stiff fissured orange brown and grey silty slightly sandy gravelly clay with low cobble content, with rare relic roots and gravel of sandstone, ironstone, limestone and chalk. Reddish brown staining was encountered on fissure surfaces from 2.50m to 4.00m depth, occasional fine selenite with associated cream silt from 2.00m to 4.00m and a pyrite nodule was encountered at 2.25m in CT02.

The lower layer encountered from 4.00m to 6.00m depth, generally comprised very stiff dark grey silty slightly sandy gravelly clay with gravel of siltstone, chalk, limestone and flint. Rare reddish brown staining on fissure surfaces was encountered at 4.75m depth in CT01 and rare pyrite nodules were encountered at 5.50m depth in CT02.

The testing of the soil samples from the boreholes recorded varied levels of sulphate from 300mg/kg from within the Made Ground, up to 20,000mg/kg in CT02 at 3.0m depth where the selenite crystals were encountered. The soil sample which was taken from behind the sheet pile wall recorded extremely high sulphate at 45,000mg/kg which may indicate that the sulphate from the soluble selenite is being transported by water to the face of the sheet pile wall. These results are discussed further in the Sulphate section of this report.

The selenite crystals are composed of calcium sulphate and the pyrite nodules are of a sulphide mineral composed of iron and sulphur. Oxidation of pyrite releases toxic metals / metalloids which can react with water to create iron sulphide and corrosive sulphuric acid. The selenite crystals and pyrite nodules encountered within the Oadby member may therefore be associated with the cause of the corrosion of the sheet piles.

Presence of water

Groundwater was not encountered in either of the boreholes or trial pits during the fieldwork down to 6.0m depth below the existing ground level. Monitoring undertaken in December 2019 found the monitoring wells to be dry down to 6.0m bgl. However, subsequent monitoring on the 2nd April 2020 recorded groundwater at 1.89m depth in CT01 and 2.3m depth in CT02.

We understand that the sheet piled wall was installed first and then the soil was excavated between the sheet piled walls, to form the ramp down to the basement. Therefore, it is anticipated that there is no backfill behind the walls and the back of the metal sheets would be up against the in-situ soils that have not been significantly disturbed. This theory was verified when the samples of the sheet piled walls were removed, and the Oadby Member soils were encountered directly behind the metal sheets.

During the walkover, a cream/white residue was noted in the areas of heavy rusting and the sheet piles appeared to be damp with small puddles of water at their base.

The Oadby Member was generally encountered as a fine-grained soil, such deposits are typically relatively impermeable and hence are unlikely to provide an amenable pathway for groundwater to the back of the sheet piled wall. However, the Oadby Member can contain subordinate lenses of sand and gravel which are typically permeable and may therefore provide a pathway for groundwater. No significant lenses of coarse-grained soils were identified during the investigation. However, the Oadby Member was encountered as silty slightly sandy gravelly clay and fissured with the upper Oadby Member encountered with reddish brown staining which may indicate that water has likely infiltrated through the soils.

There is a fault indicated on the geological maps some 100m to the north of the site. Although considered unlikely this fracture may allow increased water to the face of the sheet pile walls depending upon its exact location and potentially smaller associated faulting.

During the sampling of the sheet pile wall, a trickle of water was released from sample SL1 when the metal was removed, whereas only a small dribble was released from SL2. Water appeared to be trickling from the relic slip surface and from larger gravel pieces within the clay. Be it only a small amount, there appeared to be more water at SL1 which was taken from a heavily rusted area when compared to SL2 from an area away from the heavy rust. Groundwater has also been encountered within the monitoring wells at depths of around 2m depth, during monitoring in April 2020, and this appears to broadly correlate with the level of corrosion on the face of the sheet piles.

Sulphate

Various sulphate and pH tests were carried out on nineteen soil samples recovered from the exploratory holes across the site. The values recorded are summarised in the table below:

Stratum	**Water-soluble Sulphate SO_4 (g/l)**	**Acid Soluble Sulphate (%)**	**Total Sulphate (% SO_4)**	**Total Potential Sulphate (%SO_4)**	**Number tested**
Made Ground	<0.01 to 0.027	<0.01 to 0.1	0.028 to 0.45	0.08 to 1.35	5
Oadby Member	<0.01 to 0.093	0.014 to 0.73	0.036 to 4.5	0.11 to 13.5	14

The sample of groundwater recorded sulphur levels of 600 mg/l and sulphate levels of 1,800mg/l. Based on the anticipated low permeability of the soils encountered, the groundwater has been considered to be static.

Whilst not directly relatable to metal, the water-soluble results provide a Design Sulphate Class of DS-1 based on the results of the ten water soluble sulphate tests undertaken. However, the Total Potential Sulphate (TPS) gives a classification of DS-5 and the groundwater result a classification of DS-3. Given the higher TPS values a rating of DS-4 will apply, where the Oadby has the potential to oxidise. The rating has been limited in

accordance with BRE SD1, C5.1.2, Step 8. The above assessment provides an Aggressive Chemical Environment for Concrete (ACEC) class of AC-3s.

pH

The level of pH is considered to be a factor in relation to the level of corrosion with pH values below 7.5 indicating high and below 4 indicating very high corrosion potential. The level of pH of the soils was recorded between 7.8 and 11.5 and therefore the pH of the soil does not appear to be a significant factor.

The pH of the sample of groundwater recovered from the monitoring well in CT02 was 7.9 pH units which appears similar to those encountered in the soil.

Redox Potential

Redox potential is essentially a measure of the degree of aeration of the soil. A high redox potential indicates a high level of oxygen (Arriba-Rodrigues et al 2018). The value of redox potential depends on the dissolves oxygen content in the pore water and provides some information about the conditions in which the reducing bacteria of the soil could grow sulphate.

The relationship between the redox potential and corrosion in soils is shown below (Starkey and Wight 1946):

Level of Potential Corrosivity	Soil Redox Potential (mV)
Slight	200 – 400
Moderate	100 – 200
Severe	>400 or <100

(Starkey and Wight 1946)

The redox potential results carried out on the soil samples from the two boreholes and the one sample of the Oadby Member from behind the sheet pile recorded values between 60mV and 170mV. The results generally indicate a moderate level of potential corrosivity and therefore a relatively low level of oxygen within the soil. The only sample which recorded a severe potential corrosivity was taken from CT01 at 0.60m from ground level in the Made Ground which is at a much higher level than the rust identified on the sheet piles at the base of the ramp.

Bacteria

It is considered that corrosion could occur due to the presence and activity of microorganisms. There have been cases of extremely rapid corrosion rates due to bacterial activity, and it has become increasingly evident that the majority of metal alloys are susceptible to this type of corrosion (Arriba-Rodrigues et al 2018).

The organic matter testing carried out on the soil samples taken from the two boreholes and the sample of soil from behind the sheet pile wall recorded organic matter between 0.6% and 1.5% with a slightly higher organic matter of 2.4% recorded from the sample taken from behind the sheet piled wall. The increased level of organic matter recorded from the sample from behind the sheet pile wall may be indicating that there is increased bacterial activity in this area which may be associated with the corrosion of the sheet piled wall.

The testing indicated that sulphate reducing bacteria was present in all the soil samples taken from the two boreholes and the sample of soil taken from behind the sheet pile wall, with the exception of the sample taken from CT02 at 5.50m depth.

Resistivity

The level of resistivity of soils is considered to be related to the potential for corrosion with high resistivity soils considered to be less corrosive than low resistivity soils. Resistivity testing was not carried out during this investigation. Although, it is considered that the fine-grained Oadby Member soils are likely to be of low resistivity.

Calcium

The high level of calcium recorded in the soils between 13,000mg/kg and 76,000mg/kg may be related to the selenite crystals (calcium sulphate dihydrate) noted within the Oadby Member or to the limestone gravel within it and as indicated beneath. The higher values appeared to be recorded at depths between 1.00m and 3.00m where the selenite was generally encountered in the boreholes. A high value 76,000mg/kg of calcium was recorded within the soil sample taken from behind the sheet pile wall.

CONCLUSION

The laboratory testing recorded high levels of sulphate and very high levels of Total Potential Sulphate within the Oadby Member considered to be associated with the pyrite and soluble selenite noted within the soils. Groundwater has also been shown to be present at around the level of the corrosion and testing has shown it to have a relatively high sulphate content. It is understood that the sulphate within the soil can form highly corrosive sulphuric acid due to the activity of bacteria and the presence of water and this process is considered to be main likely cause for the corrosion of the sheet pile wall at the site.

RECOMMENDATIONS

We would recommend water pressure testing of the drainage surrounding the sheet pile walls to assess whether any leaks have occurred which could be adding water to the back of the sheet piled walls.

Groundwater monitoring could be undertaken to monitor for seasonal variations in groundwater level along with permeability testing to confirm the modelled presence of static groundwater conditions.

High levels of sulphate have been recorded within the Oadby Member soils which can affect buried concrete. The concrete class should have been carefully considered as part of the original design for the sheet pile capping beam and any other concrete associated with the development. We would therefore recommend that the current design is checked to confirm that is meets the appropriate the Design Sulphate Class and the Aggressive Chemical Environment for Concrete (ACEC) class in accordance with BRE Special Digest 1, Concrete in Aggressive Ground, 2005.

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3. Foundations, BS 8004:2015.
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5. Methods to Evaluate Corrosion in Buried Steel Structures: A Review, Lorena-de Arriba-Rodrigues, Joaquin Villanueva-Balsera, Francisco Ortega-Fernandez and Fernando Rodriguez-Perez, 9 May 2018.
6. BRE Special Digest 1, Concrete in Aggressive Ground, 2005.

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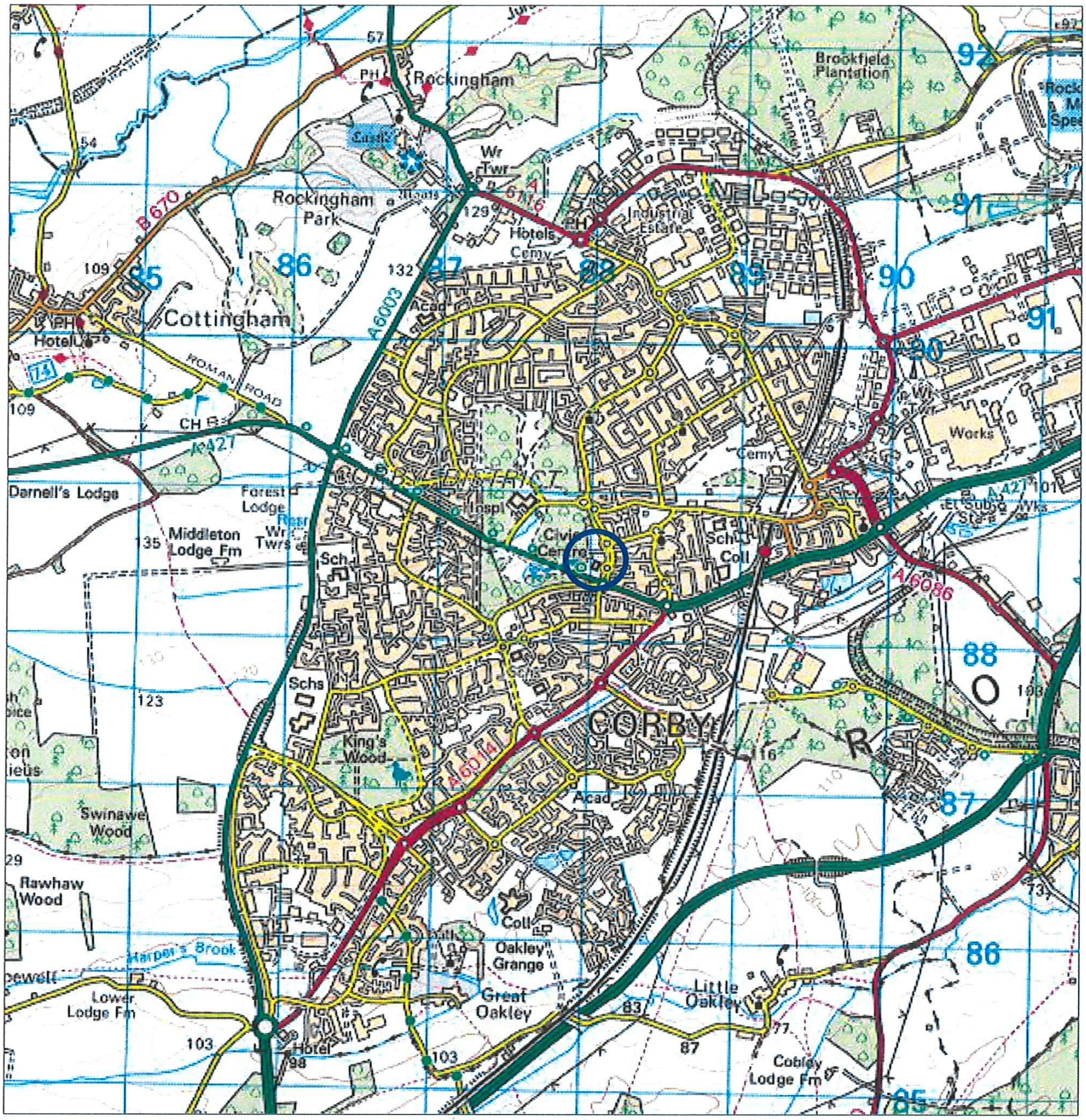
APPENDIX A
PLANS & PHOTOGRAPHS

Extract of 1:50,000 Ordnance Survey Explorer Map



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Key: Approximate Site Location

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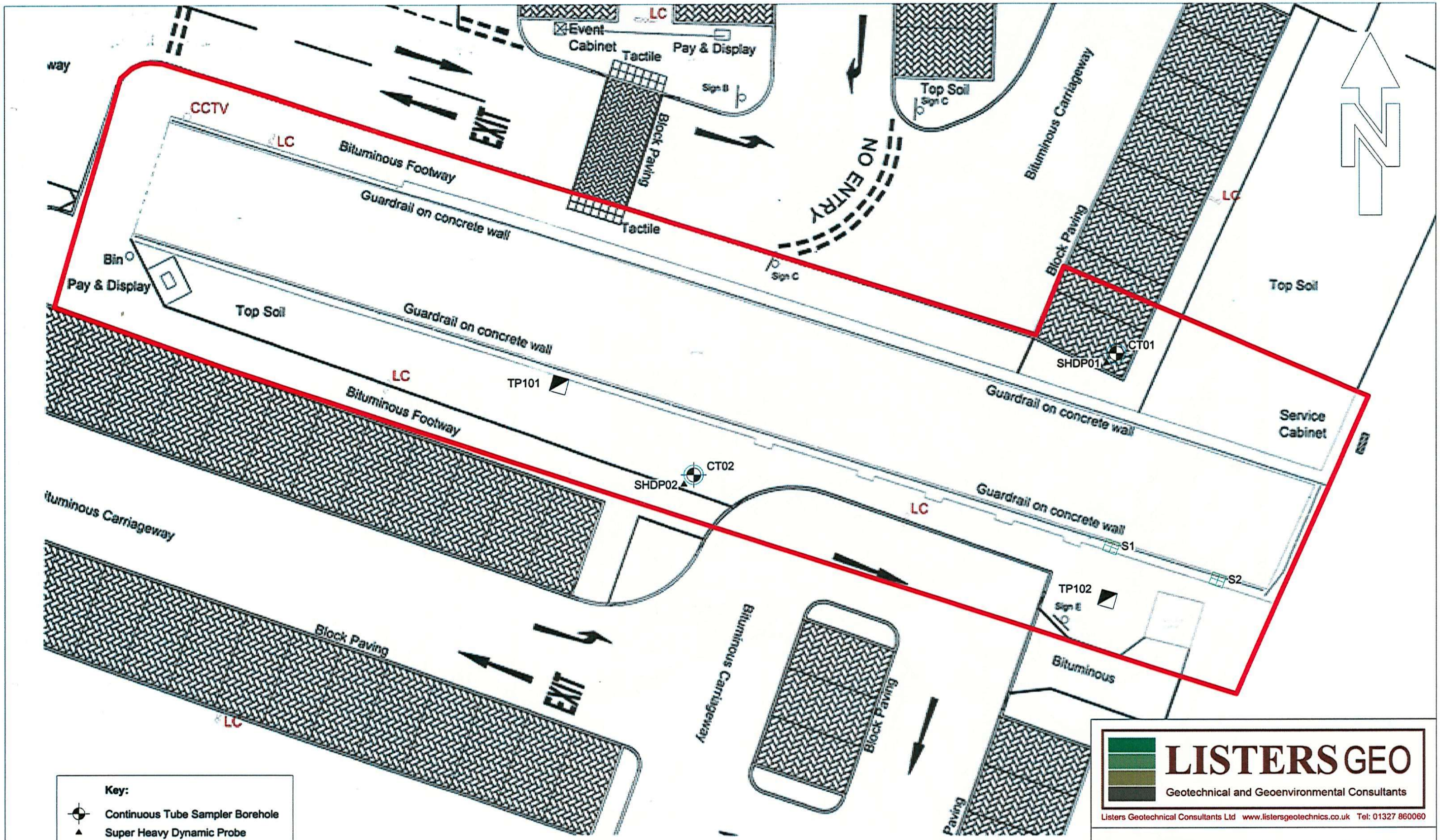
Title:	Site Location Plan	
Site:	The Corby Cube, George Street, Corby, NN17 1QG	
Scale: NTS	**Job No:** 19.12.006a	**Drawn By:** HC

N



Key:

- Continuous Tube Sampler Borehole
- Super Heavy Dynamic Probe
- Machine Excavated Trial Pit
- Sample - Sheet Pile Wall
- Installation
- Approxmiate Site Boundary

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Listers Geotechnical Consultants Ltd www.listersgeotechnics.co.uk Tel: 01327 860060

Title: Exploratory Hole Location Plan - Existing Site Layout		
Site: The Corby Cube, George Street, Corby, NN17 1QG		
Scale: NTS	Job No: 19.12.006a	Drawn By: HC

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Photo 1: View to the east from the west of the site showing the asphalt ramp down to the basement

Photo 2: View to the east from in the southwest of the site showing the southern side of the ramp and looking towards the location of TP101 and TP102.

SITE PHOTOGRAPHS	Report: 19.12.006a

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Photo 3: View to the east from in the northwest of the site showing the northern side of the ramp.

Photo 4: View to the northwest from in the southeast of the site showing the southern side of the ramp and looking towards the location of TP102 (right hand side of the photograph).

SITE PHOTOGRAPHS	Report: 19.12.006a

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Geotechnical and Geoenvironmental Consultants

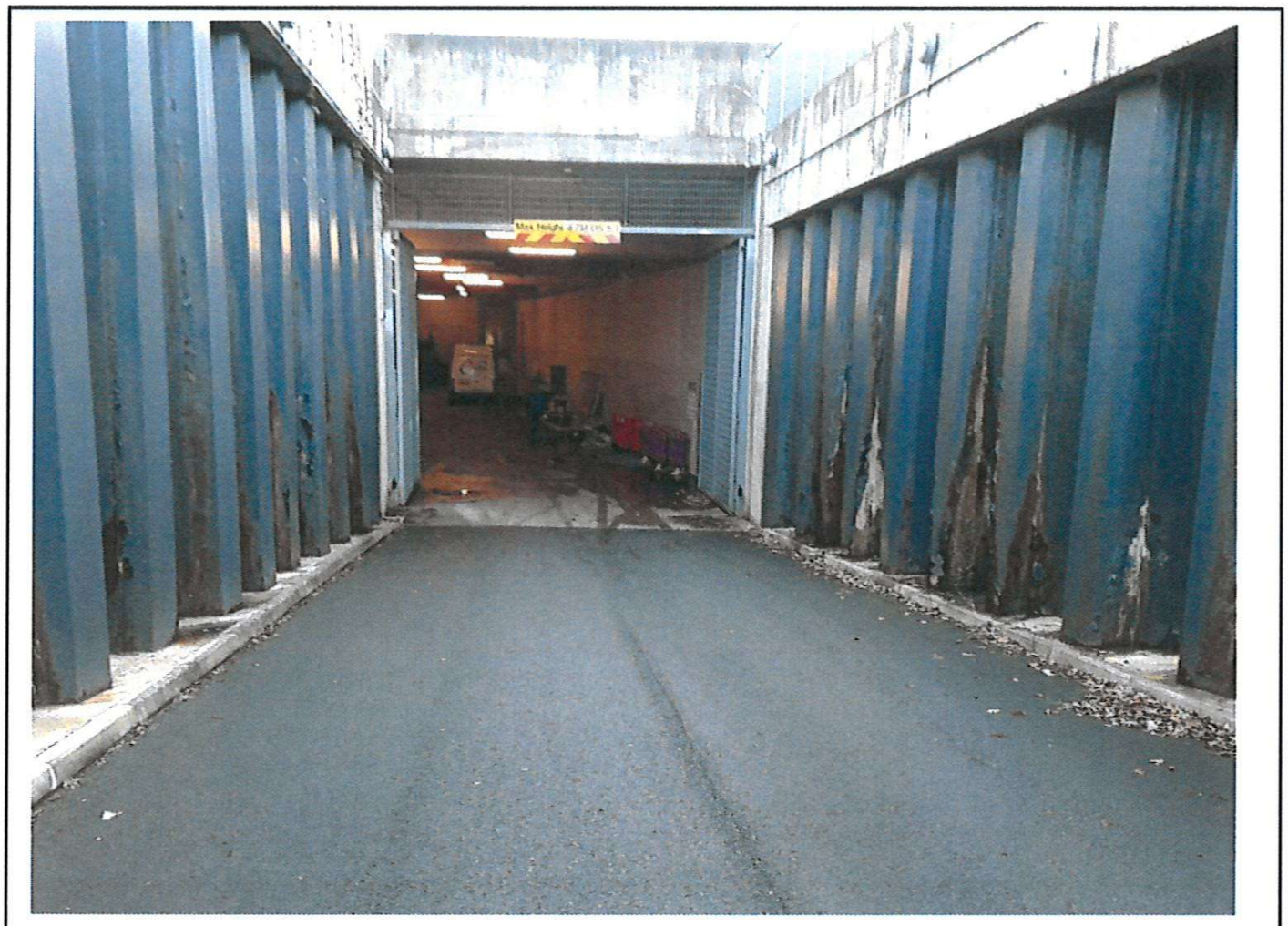

Photo 5: View to the east from in the east showing the sheet piled walls at the base of the ramp

Photo 6: Showing the cream/white residue and water at base of the sheet piled wall

SITE PHOTOGRAPHS	Report: 19.12.006a

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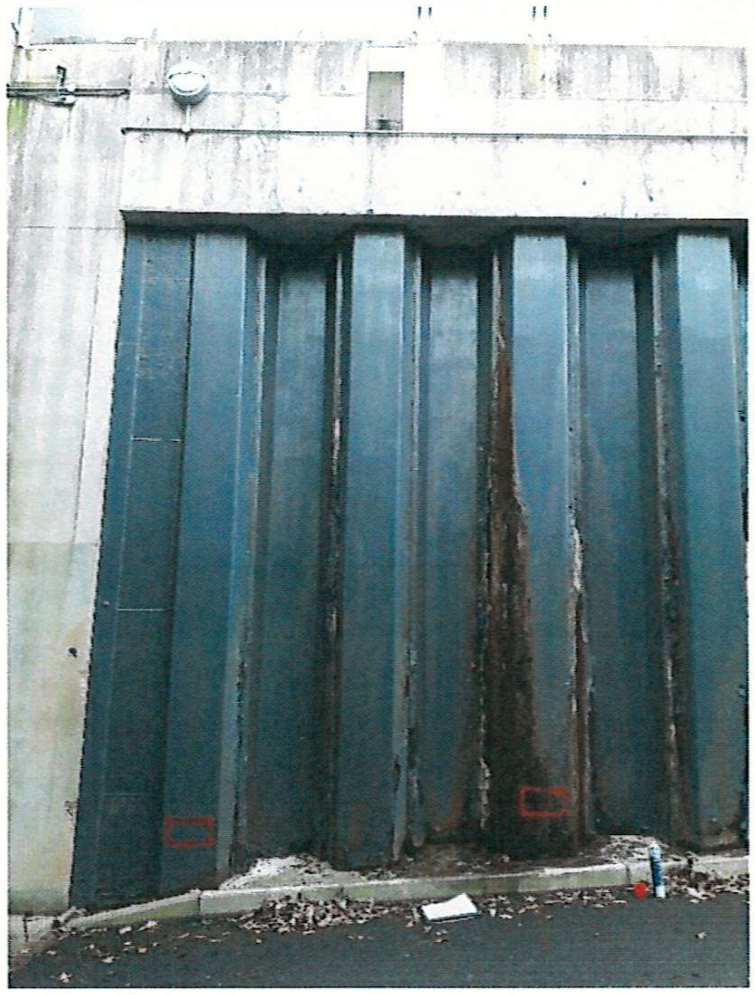

Photo 7: View to the south showing the sheet pile wall sample locations

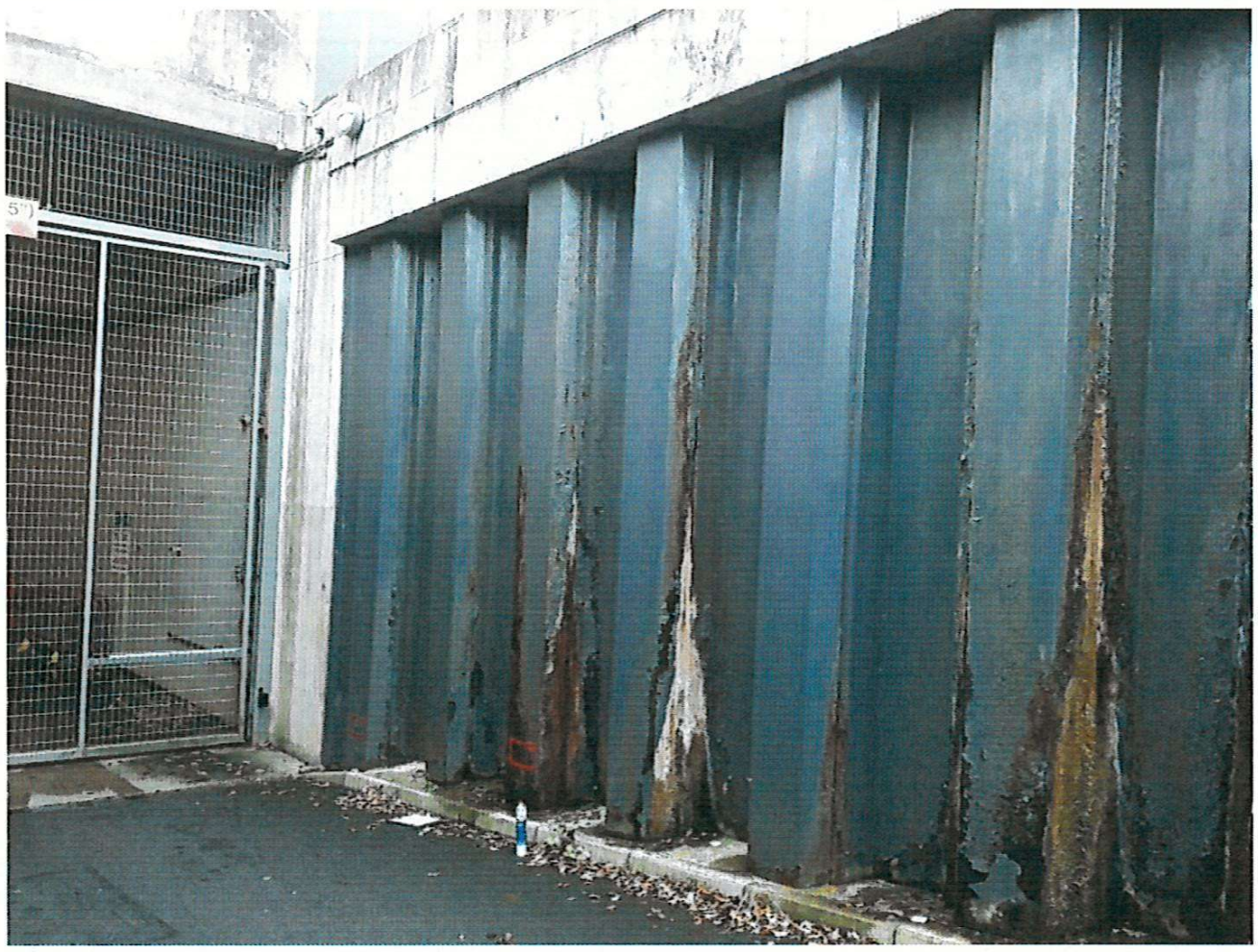

Photo 8: View to the southeast showing the southern sheet pile wall at the base of the ramp

SITE PHOTOGRAPHS	Report: 19.12.006a

Photo 9: View to the northeast showing the northern sheet pile wall

Photo 10: View to the southwest from the east of the site showing the southern sheet pile wall

SITE PHOTOGRAPHS	Report: 19.12.006a

Photo 11: Showing S2 with the metal sheet pile wall sample removed

Photo 12: Showing S1 with the metal sheet pile wall sample removed

SITE PHOTOGRAPHS	Report: 19.12.006a

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Photo 13: Showing S2 with the soil sample removed

Photo 14: Showing S1 with the soil sample removed

SITE PHOTOGRAPHS	Report: 19.12.006a

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Photo 15: Sample from CT01 at 2.50m showing possible fine selenite crystals

Photo 16: Sample from CT02 at 3.00m showing selenite crystals above the propelling pencil

SITE PHOTOGRAPHS	Report: 19.12.006a

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Photo 17: Sample from CT02 at 3.75m showing reddish brown staining

Photo 18: Sample from CT02 at 5.50m showing crinoid and pyrite nodule

SITE PHOTOGRAPHS	Report: 19.12.006a

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Photo 19: Photograph of TP101 showing the concrete and service run present in TP101

Photo 20: Photograph of TP102 showing the Made Ground and Oadby Member Soils at depth.

SITE PHOTOGRAPHS	Report: 19.12.006a

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APPENDIX B
FIELDWORK AND TESTING

LISTERS GEO
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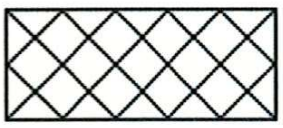
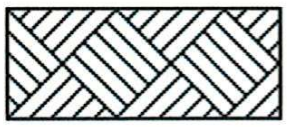
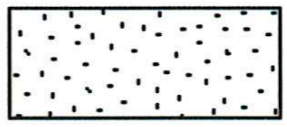
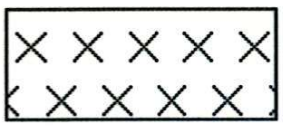
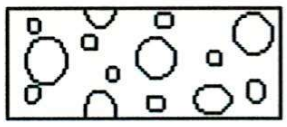
LEGEND - Soils

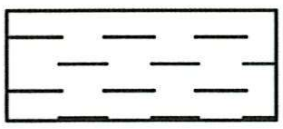

Made Ground

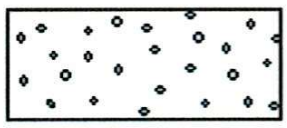

Topsoil

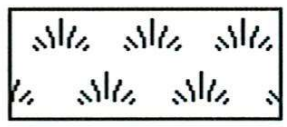

Sand


Silt

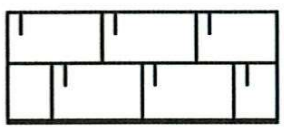

Boulders and Cobbles

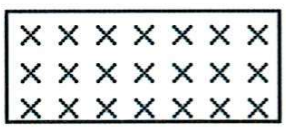

Clay

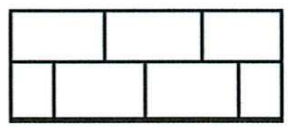

Gravel

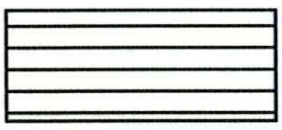

Peat

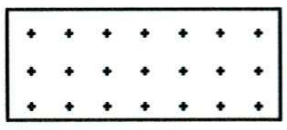
LEGEND - Rocks (Sedimentary)


Chalk


Siltstone

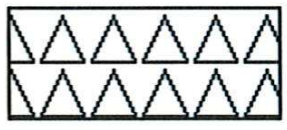

Limestone


Mudstone


Sandstone


Coal


Conglomerate


Breccia

LOG ABREVIATIONS

W	Water Sample	▽	Water Strike
B	Bulk Sample	▼	Water (Standing Level)
D	Disturbed Sample	PP	Pocket Penetrometer
J	Jar Sample	HV	Hand Vane
U	Undisturbed Sample	SPT	Standard Penetration Test
(No. of blows shown in brackets for U100 samples)		CPT	Cone Penetration Test
WAC	Waste Acceptance Criteria Sample	CBR	California Bearing Ratio
		*	Extrapolated Value

Pocket penetrometer testing provides values of unconfined compressive strength. The results have been converted to an approximate equivalent shear strength which should be used with due circumspection. As the pocket penetrometer tends to overestimate shear strength, we have used an appropriate reduction factor.

LOG KEY

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Geotechnical and Geoenvironmental Consultants

Trial Pit Log

Trial Pit No:
TP101

Project Reference: 19.12.006a
Project Location: The Corby Cube, George Street, Corby, NN17 1QG

Co-ords: -
Level: -mAOD
Date: 02/04/2020

Logged By:
Adam J
to BS5930:2015

Foundation Profile	Stratum Description	Depth (m)	Legend	Samples
Metal Rail 0.46m 0.44m Concrete 1.01m 0.26m to left hand edge of service, 0.82m to furthest edge of service Service	GL TOPSOIL Soft dark brown slightly sandy slightly gravelly orgnaic CLAY with rare roots. Gravel is fine to coarse sub-rounded to angular quaertzite 0.20 MADE GROUND Medium dense reddish brown very sandy fine to coarse angular GRAVEL End of Trial Pit at 1.05m 1.05			D - 0.50m D - 1.00m

Method of excavation: Mini digger
Trial Pit Dimentions: 1.10m x 1.26m x 1.05m
Stability: Stable sides
Groundwater: None encountered
Remarks: Backfilled with arisings on completion

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Trial Pit Log

Trial Pit No. TP102

Project Location: The Corby Cube, George Street, Corby, NN17 1QG

Co-ords: 488022E - 288454N

Level:

Dates: 02/04/2020

Project Number: 19.12.006a

Logged By: Adam Jones to BS 5930:2015

Water Strikes	Sample and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth (m)	Type	Result				
	0.20	D		0.22			TOPSOIL Grass over grey brown organic slightly sandy slightly gravelly silty CLAY with frequent roots. Gravel is fine to medium subangular gravel of quartz.
	0.50	D		0.60			MADE GROUND Soft to firm grey brown gravelly CLAY with occasional roots. Gravel is subangular or brick and flint
	1.00	D		1.10			MADE GROUND Fine to medium angular igneous aggregate GRAVEL subbase (dense)
	1.50	D					OADBY MEMBER (UPPER) Stiff light grey mottled brown slightly silty slightly gravelly CLAY. Gravel is fine to medium of flint and chalk with some patches of sandy clay.
	1.60	D		1.65			End of Trial Pit at 1.65m

Method of excavation: Mini tracked excavator **Dimensions:** 0.6m (w) x 2.1m (l) x 1.65m (d)

Stability: Some instability in Made Ground

Groundwater:

Remarks: Roots visible to 0.7m

ISO 9001 REGISTERED FIRM

AGS Association of Geotechnical & Geoenvironmental Specialists

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Geotechnical and Geoenvironmental Consultants

APPENDIX C
LABORATORY TESTING RESULTS AND TABLES

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Final Report

Report No.:	20-09450-1
Initial Date of Issue:	01-Apr-2020
Client	Listers Geotechnical Consultants
Client Address:	Slapton Hill Barn, Blakesley Road Slapton Towcester Northamptonshire NN12 8QD
Contact(s):	Tom Johnson
Project	19.12.006a Corby
Quotation No.:	Q18-12046
Order No.:	19.12.006a
No. of Samples:	8
Turnaround (Wkdays):	5
Date Approved:	01-Apr-2020
Approved By:	
Details:	Glynn Harvey, Technical Manager

Date Received:	26-Mar-2020
Date Instructed:	26-Mar-2020
Results Due:	01-Apr-2020

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 19.12.006a Corby

Client: Listers Geotechnical Consultants					20-09450	20-09450	20-09450	20-09450	20-09450	20-09450	20-09450	20-09450
Quotation No.: Q18-12046			**Chemtest Sample ID.:**		992240	992241	992242	992243	992244	992245	992246	992247
			Sample Location:		CT01	CT01	CT01	CT01	CT02	CT02	CT02	CT02
			Sample Type:		SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Top Depth (m):		0.60	2	2.5	4	0.20	1	2	5
			Bottom Depth (m):		1	2.50	3	4.50	0.60	1.50	2.50	5.50
			Date Sampled:		10-Dec-2019	10-Dec-2019	10-Dec-2019	10-Dec-2019	10-Dec-2019	10-Dec-2019	10-Dec-2019	10-Dec-2019
Determinand	**Accred.**	**SOP**	**Units**	**LOD**								
Moisture	N	2030	%	0.020	1.6	14	10	11	0.42	13	13	18
Acid Soluble Sulphur	N		%	0.010	[B] 0.10	[B] 0.024	[B] 0.73	[B] 0.17	[B] < 0.010	[B] 0.019	[B] 0.40	[B] 0.060
Water Soluble Sulphur	N		%	0.010	0.027	0.015	0.093	0.042	< 0.010	< 0.010	0.080	0.043
Oxidisable Sulphides as SO4	N		%	0.030	[B] 1.0	[B] 0.16	[B] 2.9	[B] 2.1	[B] 0.060	[B] 0.091	[B] 3.6	[B] 2.6
Total Potential Sulphate as SO4	N	2175	%	0.030	[B] 1.4	[B] 0.23	[B] 5.1	[B] 2.6	[B] 0.084	[B] 0.15	[B] 4.8	[B] 2.8
pH	U	2010		4.0	[B] 11.5	[B] 8.9	[B] 7.9	[B] 7.9	[B] 9.2	[B] 8.2	[B] 7.8	[B] 7.9
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.41	0.22	1.4	0.63	0.087	0.089	1.2	0.64
Total Sulphur	U	2175	%	0.010	[B] 0.45	[B] 0.077	[B] 1.7	[B] 0.87	[B] 0.028	[B] 0.049	[B] 1.6	[B] 0.92
Sulphate (Acid Soluble)	U	2430	%	0.010	[B] 0.31	[B] 0.073	[B] 2.2	[B] 0.52	[B] 0.024	[B] 0.056	[B] 1.2	[B] 0.18

Chemtest
The right chemistry to deliver results

Deviations

In accordance with UKAS Policy on Deviating Samples TPS 63. Chemtest have a procedure to ensure 'upon receipt of each sample a competent laboratory shall assess whether the sample is suitable with regard to the requested test(s)'. This policy and the respective holding times applied, can be supplied upon request.The reason a sample is declared as deviating is detailed below. Where applicable the analysis remains UKAS/MCERTs accredited but the results may be compromised.

Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
992240			CT01	10-Dec-2019	B	Plastic Tub 500g
992241			CT01	10-Dec-2019	B	Plastic Tub 500g
992242			CT01	10-Dec-2019	B	Plastic Tub 500g
992243			CT01	10-Dec-2019	B	Plastic Tub 500g
992244			CT02	10-Dec-2019	B	Plastic Tub 500g
992245			CT02	10-Dec-2019	B	Plastic Tub 500g
992246			CT02	10-Dec-2019	B	Plastic Tub 500g
992247			CT02	10-Dec-2019	B	Plastic Tub 500g

Chemtest
The right chemistry to deliver results

Test Methods

SOP	Title	Parameters included	Method summary
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.

Chemtest
The right chemistry to deliver results

Report Information

Key

U	UKAS accredited
M	MCERTS and UKAS accredited
N	Unaccredited
S	This analysis has been subcontracted to a UKAS accredited laboratory that is accredited for this analysis
SN	This analysis has been subcontracted to a UKAS accredited laboratory that is not accredited for this analysis
T	This analysis has been subcontracted to an unaccredited laboratory
I/S	Insufficient Sample
U/S	Unsuitable Sample
N/E	not evaluated
<	"less than"
>	"greater than"

Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com

Chemtest
The right chemistry to deliver results
Chemtest Ltd.
Depot Road
Newmarket
CB8 0AL
Tel: 01638 606070
Email: info@chemtest.com

UKAS TESTING
2183

Amended Report

Report No.:	20-10118-2		
Initial Date of Issue:	14-Apr-2020	**Date of Re-Issue:**	29-Apr-2020
Client	Listers Geotechnical Consultants		
Client Address:	Slapton Hill Barn, Blakesley Road Slapton Towcester Northamptonshire NN12 8QD		
Contact(s):	Adam Jones		
Project	19.12.006a - 2 The Corby Cube - 2		
Quotation No.:	Q18-12046	**Date Received:**	06-Apr-2020
Order No.:	19.12.006a - 2	**Date Instructed:**	07-Apr-2020
No. of Samples:	3		
Turnaround (Wkdays):	5	**Results Due:**	15-Apr-2020
Date Approved:	14-Apr-2020		
Approved By:			
Details:	Glynn Harvey, Technical Manager		

Chemtest
The right chemistry to deliver results

Results - Soil

Project: 19.12.006a - 2 The Corby Cube - 2

Client: Listers Geotechnical Consultants		**Chemtest Job No.:**			20-10118	20-10118
Quotation No.: Q18-12046		**Chemtest Sample ID.:**			995531	995532
Order No.: 19.12.006a - 2		Client Sample Ref.:			MG	Clay
		Sample Location:			TP102	TP102
		Sample Type:			SOIL	SOIL
		Top Depth (m):			0.50	1.50
		Bottom Depth (m):			0.50	1.50
		Date Sampled:			02-Apr-2020	02-Apr-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**		
Moisture	N	2030	%	0.020	13	14
Acid Soluble Sulphur	N		%	0.010	0.019	0.014
Water Soluble Sulphur	N		%	0.010	0.017	0.013
Oxidisable Sulphides as SO4	N		%	0.030	0.13	0.065
Total Potential Sulphate as SO4	N	2175	%	0.030	0.18	0.11
pH	U	2010		4.0	8.7	8.3
Sulphate (2:1 Water Soluble) as SO4	U	2120	g/l	0.010	0.26	0.19
Total Sulphur	U	2175	%	0.010	0.061	0.036
Sulphate (Acid Soluble)	U	2430	%	0.010	0.058	0.043

Chemtest
The right chemistry to deliver results

Results - Water

Project: 19.12.006a - 2 The Corby Cube - 2

Client: Listers Geotechnical Consultants			**Chemtest Job No.:**		20-10118
Quotation No.: Q18-12046			**Chemtest Sample ID.:**		995533
Order No.: 19.12.006a - 2			Client Sample Ref.:		GW
			Sample Location:		CT02
			Sample Type:		WATER
			Top Depth (m):		2.30
			Date Sampled:		02-Apr-2020
Determinand	**Accred.**	**SOP**	**Units**	**LOD**	
pH	U	1010		N/A	7.9
Sulphur	N	1220	mg/l	1.0	600
Sulphate	U	1220	mg/l	1.0	1800
Sulphide	U	1325	mg/l	0.050	[B] < 0.050

Chemtest
The right chemistry to deliver results

Deviations

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Sample:	Sample Ref:	Sample ID:	Sample Location:	Sampled Date:	Deviation Code(s):	Containers Received:
995533	GW		CT02	02-Apr-2020	B	Coloured Winchester 1000ml
995533	GW		CT02	02-Apr-2020	B	EPA Vial 40ml

Chemtest
The right chemistry to deliver results

Test Methods

SOP	Title	Parameters included	Method summary
1010	pH Value of Waters	pH	pH Meter
1220	Anions, Alkalinity & Ammonium in Waters	Fluoride; Chloride; Nitrite; Nitrate; Total; Oxidisable Nitrogen (TON); Sulfate; Phosphate; Alkalinity; Ammonium	Automated colorimetric analysis using 'Aquakem 600' Discrete Analyser.
1325	Sulphide in Waters	Sulphides	Automated colorimetric analysis by 'Aquakem 600' Discrete Analyser using N,N–dimethyl-pphenylenediamine.
2010	pH Value of Soils	pH	pH Meter
2030	Moisture and Stone Content of Soils(Requirement of MCERTS)	Moisture content	Determination of moisture content of soil as a percentage of its as received mass obtained at <37°C.
2120	Water Soluble Boron, Sulphate, Magnesium & Chromium	Boron; Sulphate; Magnesium; Chromium	Aqueous extraction / ICP-OES
2175	Total Sulphur in Soils	Total Sulphur	Determined by high temperature combustion under oxygen, using an Eltra elemental analyser.
2430	Total Sulphate in soils	Total Sulphate	Acid digestion followed by determination of sulphate in extract by ICP-OES.

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Comments or interpretations are beyond the scope of UKAS accreditation
The results relate only to the items tested
Uncertainty of measurement for the determinands tested are available upon request
None of the results in this report have been recovery corrected
All results are expressed on a dry weight basis
The following tests were analysed on samples as received and the results subsequently corrected to a dry weight basis TPH, BTEX, VOCs, SVOCs, PCBs, Phenols
For all other tests the samples were dried at < 37°C prior to analysis
All Asbestos testing is performed at the indicated laboratory
Issue numbers are sequential starting with 1 all subsequent reports are incremented by 1

Sample Deviation Codes

A - Date of sampling not supplied
B - Sample age exceeds stability time (sampling to extraction)
C - Sample not received in appropriate containers
D - Broken Container
E - Insufficient Sample (Applies to LOI in Trommel Fines Only)

Sample Retention and Disposal

All soil samples will be retained for a period of 45 days from the date of receipt
All water samples will be retained for 14 days from the date of receipt
Charges may apply to extended sample storage

If you require extended retention of samples, please email your requirements to:
customerservices@chemtest.com