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LAND AT CONINGTON ROAD, BOROUGH OF LEWISHAM, LONDON: GEOARCHAEOLOGICAL ASSESSMENT OF BOREHOLES

Prepared for Cotswold Archaeology

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SUMMARY

In November 2016, ARCA performed a watching brief on geotechnical boreholes and trial pits drilled and excavated by Delta-Simons Environmental Consultants Limited on Land at Conington Road, Borough of Lewisham, London. The White Chalk Subgroup bedrock sub-cropped between +0.55m OD and +8.75m OD. The Kempton Park Gravel Member was determined to sub-crop at between +6.49m OD and +4.29m OD. The Gravel is confined to the southern half of the site where it occupies an ancient channel of the River Ravensbourne. Heavily oxidised Fine Grained Alluvium overlay the gravels and was recorded only in one trial pit (TP203) at higher elevation in the north of the site (+8.01m OD). No organic remains were recovered. Thin strata of Head were recorded in the north of the site. The Fine Grained Alluvium and Head strata were truncated by modern Made Ground strata. The thickness of the Made Ground varied from 1.00m to 4.10m.

An assessment of the BGS borehole records in the environs of the site revealed two boreholes (TQ37NE1551 and TQ37NE1552) that record fine grained strata with organic material located to the immediate west of the site. These strata sub-cropped at a lower elevation to the Kempton Park Gravels on the site and as a consequence probably do not sub-crop on the site.

It is concluded that the deposits on the site have a low archaeological and palaeoenvironmental potential and it is recommended that no further work is required.

1. INTRODUCTION

1.1 In November 2016 at the request of Cotswold Archaeology, ARCA monitored a programme of geotechnical trial trenches and boreholes drilled by Delta–Simons Environmental Consultants Limited on land at Conington Road, Borough of Lewisham, London (henceforth known as the 'site'). The geotechnical works were in advance of a proposed housing development by Meyer Homes Limited.

1.2 This document assesses the stratigraphic sequence recovered from the site. It is arranged as follows: first a brief account is provided of the geographic, geological and methodological background to the geoarchaeological project; secondly the borehole stratigraphy is described in detail; thirdly the Quaternary geological setting of the site is discussed, and finally the potential of the sample resource in the boreholes to address the objectives outlined in Section 1.7 is assessed. A bibliography and appendices containing the locations of the boreholes, the lithostratigraphy of the boreholes on site and the BGS boreholes complete the document.

1.3 The site (see Figure. 1) is located on the banks of the River Ravensbourne, with Lewisham Way (the A20) *c.*130m to the south, and *c.*1.75km south of the River Thames. It occupies an irregular parcel of land of 0.92ha with Conington Road to the north and west, the rail line and Ravensbourne River along the south and buildings to the east. The river runs through the site, dividing it into two areas; 'Site A' is located to the south of the River Ravensbourne and the 'Site B' is located to the north of the river (Dowding 2016, 4). It is centred on NGR: 538056 176086. The southeastern area (Site A) lies at *c.*+7.20m OD on flat ground in the centre of the valley and across the river the land rises to *c.*+14m OD in the northeast at Conington Road. The site occupies therefore, a very narrow flood plain and the base of the east slope of the valley side. Elevation of the land then rises rapidly from Conington road to the east climbing the chalk of the valley side. West of the site the valley floor extends *c.*400m before the land rises. A tributary, the Quaggy River, joins the River Ravensbourne *c.*100m south of the site and is now canalised below ground. At the time of the work the site was a former car park (now disused) with a tarmacadam surface.

1.4 The British Geological Survey (BGS) map the site as lying on superficial alluvial deposits of unlithified clays, silts, peats, and

sand that date to the Holocene Epoch 10–0ka (thousand calendar years ago), and the Kempton Park Gravel Member that dates to the Middle Devensian Substage *c.*45 to 30ka (BGS 2016a; Gibbard 1994, 90). The contact between the two deposits is mapped southeast to northwest across the site, parallel to Conington Road and *c.*70m southwest from it. The alluvium lies towards the river and the Gravel to the east. The Kempton Park Gravel pinches out to the southeast on the site possibly due to a near surface bedrock high. To the west of the site and to the south at the confluence of the Quaggy River, extensive areas of the Kempton Park Gravel Member are mapped. On the site itself the area of Gravel is much reduced because the Ravensbourne River now flows close to the eastern valley side.

1.5 Underlying the alluvium and Gravel deposits is the bedrock which is formed by the Lewes Nodular Chalk Formation, Seaford Chalk Formation and Newhaven Chalk Formation (Undifferentiated) (BGS 2016 1:50 000 map). These Formations are part of the White Chalk Subgroup of the Upper Cretaceous and date to 100.5 – 66Ma (million years ago).

1.6 A watching brief at the Silk Mills site, located in the northeast of the present site and further north along Conington Road, revealed the weathered chalk bedrock at *c.*+8.18 – +9.78m OD. It was overlain by *c.*0.15 – 0.60m of alluvium heavily truncated by made ground (Menary and Lymer 2006, 9, Figs 4 and 5). Two worked flints were recovered from the alluvium, no palaeoenvironmental remains were reported. In the vicinity of Lewisham Station on the Lewisham Gateway site, Tynan (2016) recorded 3m of Made Ground in test pit 4 and the same depth in the Basement trench where it truncated alluvium (0.3m in thickness) that capped the Kempton Park Gravel Member. No additional geoarchaeological information was derived from Maeger's desk based assessment (2007), nor that of the Museum of London Archaeology (2016). To further the investigation of the Quaternary deposits within the environs of the site a survey was completed of BGS borehole records that will be discussed in Section 2.4 below (BGS 2016b).

1.7 The objectives of the geoarchaeological work at the site were to:

1.7.1 Determine the Holocene sedimentary sequence on the site.

1.7.2 Assess the archaeological, palaeoenvironmental and geoarchaeological potential of the Holocene sedimentary units encountered.

1.7.3 Make recommendations for further investigation of high potential strata at a later stage.

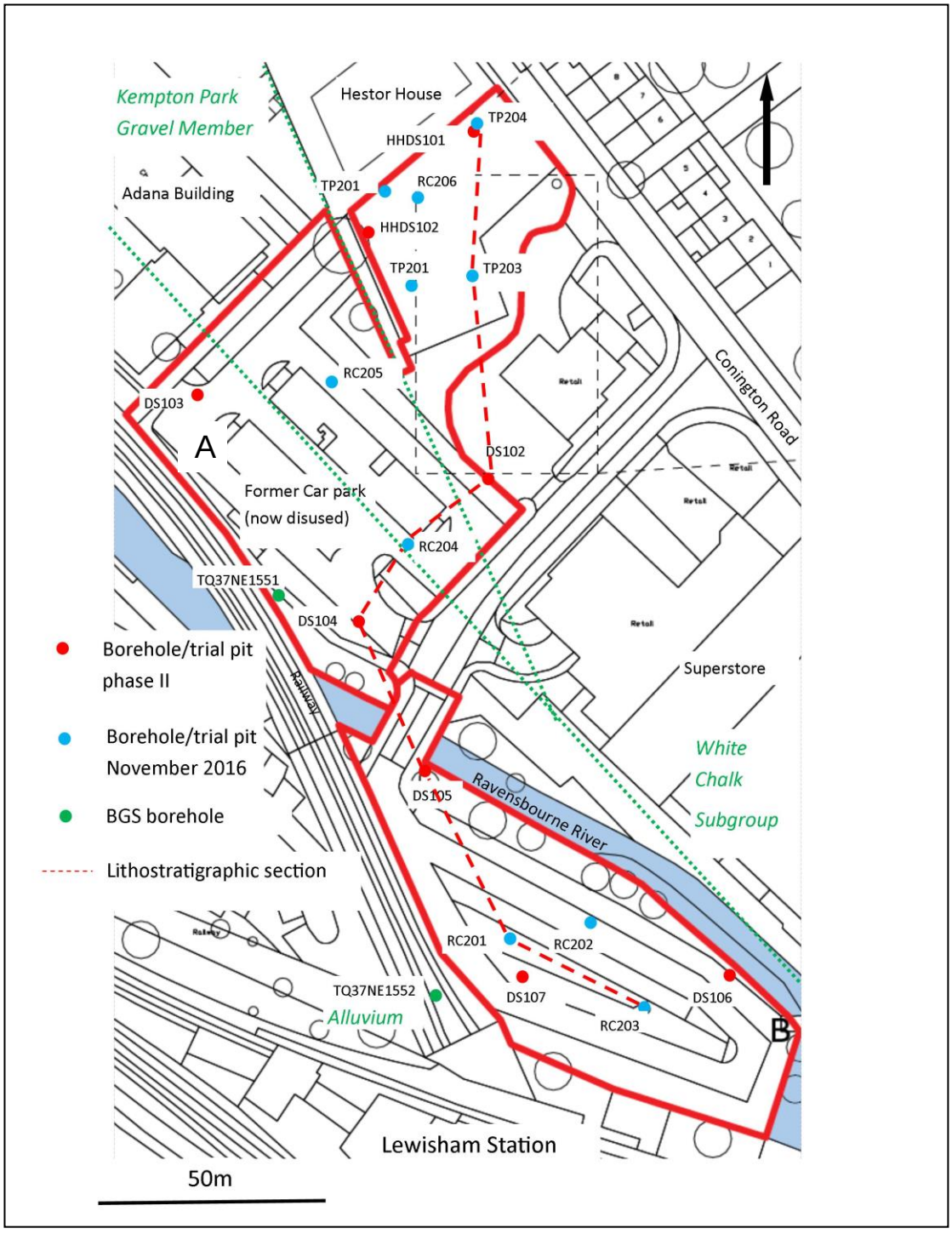

Figure 1. Site plan showing location of boreholes and trial pits. Geological contacts in dotted green lines. Courtesy Waterman Infrastructure & Environment Ltd. Contains British Geological Survey materials © NERC 2016

2. METHODOLOGY

2.1 In October to November 2016, Delta-Simons Environmental Consultants Limited under the direction of engineer Mr Will Capps, drilled six geotechnical dynamic sampler boreholes (RC201 to RC206) and excavated by machine four trial pits (TP201 to TP204). Borehole core samples and two trial pits were inspected and described on site by the author using standard geological criteria (Tucker 1982; Jones *et al* 1999; Munsell Color 2000). The strata were mineralogenic in lithology and no *in situ* organic remains were recovered. No artefacts were recovered. Keyword stratigraphic descriptions are presented in Appendix 3.

2.2 An earlier phase of ground investigation by Delta-Simons was carried out in July 2016 when six dynamic sampler boreholes were drilled (DS102 – DS107) to a maximum of 5m Below Ground Level (BGL) and two trial pits hand dug. The boreholes terminated either in the White Chalk Subgroup or the Kempton Park Gravel Formation (Delta-Simons 2016). The two trial pits HHDS101 and HHDS102 were terminated in Made Ground at 1.00m BGL and because they provided no additional information they are not discussed further.

2.3 Lithological descriptions and positional data from the site were combined within a RockWorks database to produce a lithostratigraphic cross section, an isopach model of the thickness of the Made Ground across the site, and a stratigraphic structure map of the sub-face of the Made Ground (see Figures 2, 3 and 4).

2.4 BGS borehole records were inspected in an area of *c.*20ha around the site to investigate the Quaternary geology. The northern limit was the junction of Conington Road with Morden Hill, to the south the Lewisham Shopping Centre, to the east the A2211 Lewisham Road, and to the west the Southeastern railway spur running west of Thurston Road. A total of 54 BGS borehole records were inspected, 33 were found to contain sufficient information (OD elevation and NGR location, and legible lithostratigraphic details) to enter into a RockWorks database (RockWare 2013). The RockWorks software package was then used to plot a sub-face model of the stratigraphic structure of the Made Ground strata and a lithostratigraphic cross section (see Figures 5 and 6).

2.5 Digital data from the work, which includes photographs and the RockWorks database, is held on the University of Winchester server.

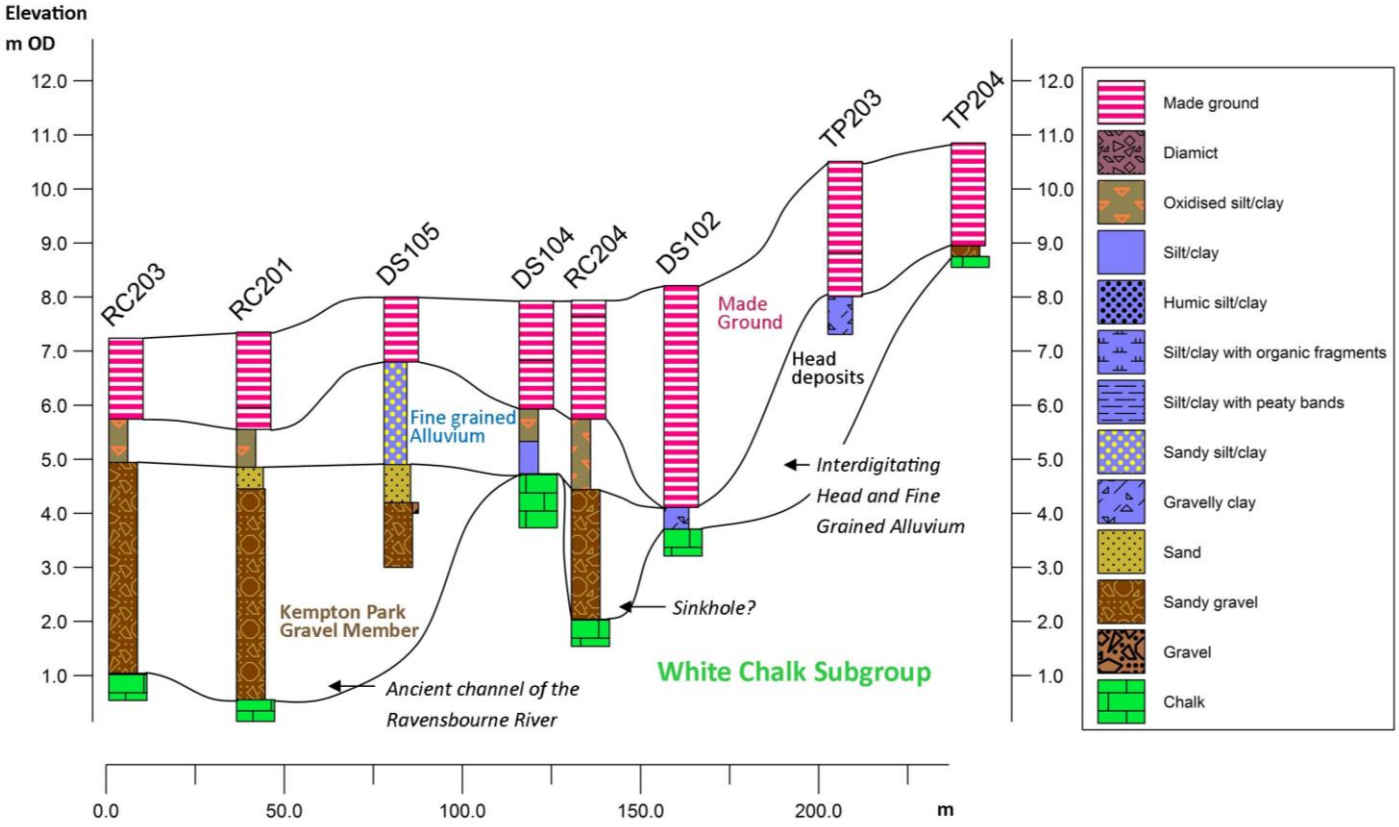

Figure 2. Lithostratigraphic section for the site.

3. BOREHOLE STRATIGRAPHY

The stratigraphy described in this section deals with the two phases of drilling by Delta-Simmons on the site: a total of 12 boreholes and six trial pits. Four major stratigraphic units (formal and informal members) were recorded in the borehole stratigraphy. These are reviewed below in chronological order and a discussion of the stratigraphy takes place in Section 4.

3.1 White Chalk Subgroup

3.1.1 The White Chalk Subgroup was recorded in eight boreholes RC201 to RC206, and DS102 and DS104; and in three trial pits TP201, TP202, and TP204. It sub-cropped between +0.55m OD (6.80m BGL) in RC201 and +8.75m OD (2.10m BGL) in TP204. The elevation of the bedrock rises from the base of an ancient river channel in the south to the channel bank and thence to

the valley side in the northeast of the site. A bedrock high is recorded in DS104 where the chalk sub-crops at +4.73m OD.

3.1.2 The White Chalk Subgroup is unconformably overlain by Quaternary sediments in all the boreholes and trial pits.

3.2 Kempton Park Gravel Member

3.2.1 The Kempton Park Gravel Member including overlying and conformable channel sands is recorded in seven boreholes RC201 to RC204; and DS105 to DS107. It sub-crops between +6.49m OD (1.00m BGL) in DS106 and +4.29m OD (2.90m BGL) in DS107. It is confined to the southern half of the site where it occupies an ancient channel of the Ravensbourne.

3.2.2 The Gravel Member is described as fine to medium sub angular to rounded flint gravel with a dark brown fine to coarse sand component.

3.2.3 The Gravel Member is overlain by Fine Grained Alluvium except in DS106 where it is truncated by Made Ground strata.

3.3 Fine Grained Alluvium

3.3.1 Fine Grained Alluvium is recorded in eight boreholes RC201 to RC205, and DS104, DS105 and DS107. It is also recorded in one trial pit TP203. The Alluvium sub-crops between +8.01m OD (2.50m BGL) in TP203 and +5.55m OD (1.80m BGL) in RC201. The stratum is confined to the south of the site except for TP203 where it is recorded at a high elevation in the north of the site.

3.3.2 The lithology of the Fine Grained Alluvium is a dark greyish brown (10 YR 4/2) silt/clay mottled yellowish brown with occasional to frequent fine to medium mineral grains. The stratum is heavily oxidised and grains and granules of orange iron oxide are frequent. The silt/clay may be very sandy as recorded in DS105.

3.3.3 The Fine Grained Alluvium is truncated by Made Ground strata.

3.4 Head

3.4.1 In the north of the site at higher elevation (the rising valley side) deposits of Head are recorded in two boreholes RC206 and DS102 and in two trial pits TP201 and TP204. It sub-crops

between +4.11m OD (4.1m BGL) in DS102 and +9.30m OD (1.2m BGL) in TP201.

3.4.2 The lithology of the Head deposits is a heterogeneous, poorly sorted and loose diamict of sub-rounded flint pebbles and dark brown (10 YR 3/3) fine to coarse sandy silt/clay.

3.4.3 The Head strata are truncated by unconformable Made Ground strata.

3.5 Made Ground

3.5.1 'Made Ground' is a term used by the BGS to describe superficial deposits of variable composition that are man-made (BGS 2016a).

3.5.2 Made Ground strata are recorded at the top of all the boreholes and trial pits on the site. The thickness of the strata lies between 1.00m in DS106 and 4.10m in DS102.

3.5.3 The lithology of the Made Ground in TP201, for example, is recorded as dark brown (10 YR 3/3) heterogeneous, fine to coarse sandy silt/clay with angular to sub rounded fine to coarse flint, chalk and brick pebbles and occasional brick cobbles. Bioturbation is frequent as evidenced by roots. Anthropogenic materials included plastic and concrete. Drillers' records also note tarmacadam and concrete surfaces (see Appendix 3).

3.5.4 Made Ground strata truncate the underlying strata.

4. ASSESSMENT

4.1 The Holocene Stratigraphy on the Site

4.1.1 The Kempton Park Gravel Member including overlying and conformable channel sands were laid down in an ancient channel of the River Ravensbourne that cut into the top of the White Chalk Subgroup in the Late Devensian. The Gravels attain a maximum thickness of 4.30m in RC201 on the west bank of the modern River in the south of the site. They sub-crop at a consistent elevation between +4.29m OD in DS107 and +4.94m OD in RC203, and are conformably overlain by Fine Grained Alluvium with the exception of DS106. In this borehole the sand overlying the gravels sub-crops at +6.49m OD and

possibly represents point bar deposits preserved on the cusp of the meander as the river evolved from a braided to a meandering planform at the end of the Late Glacial.

4.1.2 Towards the east bank of the buried channel a bedrock high (+4.73m OD) is recorded in DS104 (see Figure 2) and *c.*25m northeast in RC204 there is a sharp fall to +2.04m OD in the elevation of the chalk bedrock. This may represent a sinkhole in the channel base which is filled with gravel. The size of the depression is unknown, however, it does not extend northwards to RC205 where the elevation of the bedrock is +4.18m OD.

4.1.3 On the valley side at the north of the site Head is recorded at *c.* +9.00m OD. To the north of Conington Road Head is mapped overlying the chalk valley side. The BGS (2016) defines Head as a Quaternary Period polymict deposit that can be composed of gravel, sand and clay-sized material depending upon the upslope source. It may be stratified but only very poorly, and can be a product of a combination of various hillslope erosive processes – solifluction, hillwash and soil creep – or just one of these. The term Head is often used informally to denote Pleistocene processes (solifluction) in contrast to colluvium that results from more gentle and often human induced Holocene processes (French 2007, p332); there is no evidence for colluvium on the site. In DS102 the Head sub-crops at a low elevation +4.11m OD and probably represents the foot of a thin fan of deposit that lies against the chalk valley side and interdigitates with the Fine Grained Alluvium on the narrow flood plain (see Figure 2). The maximum thickness recorded for the Head is 1.00m in RC206 in the north of the site.

4.1.4 At the end of the Pleistocene climatic amelioration brought about a stabilisation of the land surface and an end to channel gravel aggradation. Colonisation by plants reduced the supply of sediment and stream flow energy fell as a result of milder winters and the shift from surface to ground water drainage succeeding the melting of the permafrost. The Ravensbourne River adopted a meandering habit and Fine Grained Alluvium was deposited across the narrow floodplain in times of flood. On the site this deposit is recorded as brown, mottled silt/clays that sub-crop at +8.01m OD (2.50m BGL) in TP203 as an isolated remnant in the north of the site, and at *c.*+6m OD in the centre and south of the site. The alluvium in TP203 sub-crops at a similar elevation to that described by Menary and Lymer (2006) that contained two worked flints (see Section 1.6).

4.1.5 The Fine Grained Alluvium on the site has been oxidised by redox reactions that take place as a result of a fluctuating water table. It is a post depositional phenomenon that is not conducive to the preservation of organic material. No evidence of organic material is recorded in the boreholes and trial pits. Nor is there any evidence for reduced grey clays that could contain plant remains. Two BGS borehole drilled in advance of the Docklands Light Railway and bordering the west of the site, however, do record evidence of organic matter (see Sections 4.2.2 – 4.2.4).

4.1.6 Made Ground strata truncate the Fine Grained Alluvium and the Head. From the evidence recorded the Made Ground strata are modern.

4.1.7 An isopach map has been produced to model the thickness of the Made Ground across the site (see Figure 3). This map displays in colour gradations the true stratigraphic thickness of the strata. It attempts to predict the depth to the top of the geological strata, be they Chalk, Head or Fine Grained Alluvium. The small number of boreholes and trial pits on the site, and their uneven distribution, are biases that must be taken into account when the model is used as a predictive tool.

4.1.8 A stratigraphic structure map has also been produced to model the sub-face of the Made Ground strata. This map predicts the elevation of the surface of the geological strata (Chalk, Head or Fine Grained Alluvium) with reference to Ordnance Datum (m OD) (see Figure 4). The same provisos regarding the number of boreholes and their distribution as discussed in Section 4.1.7 also apply.

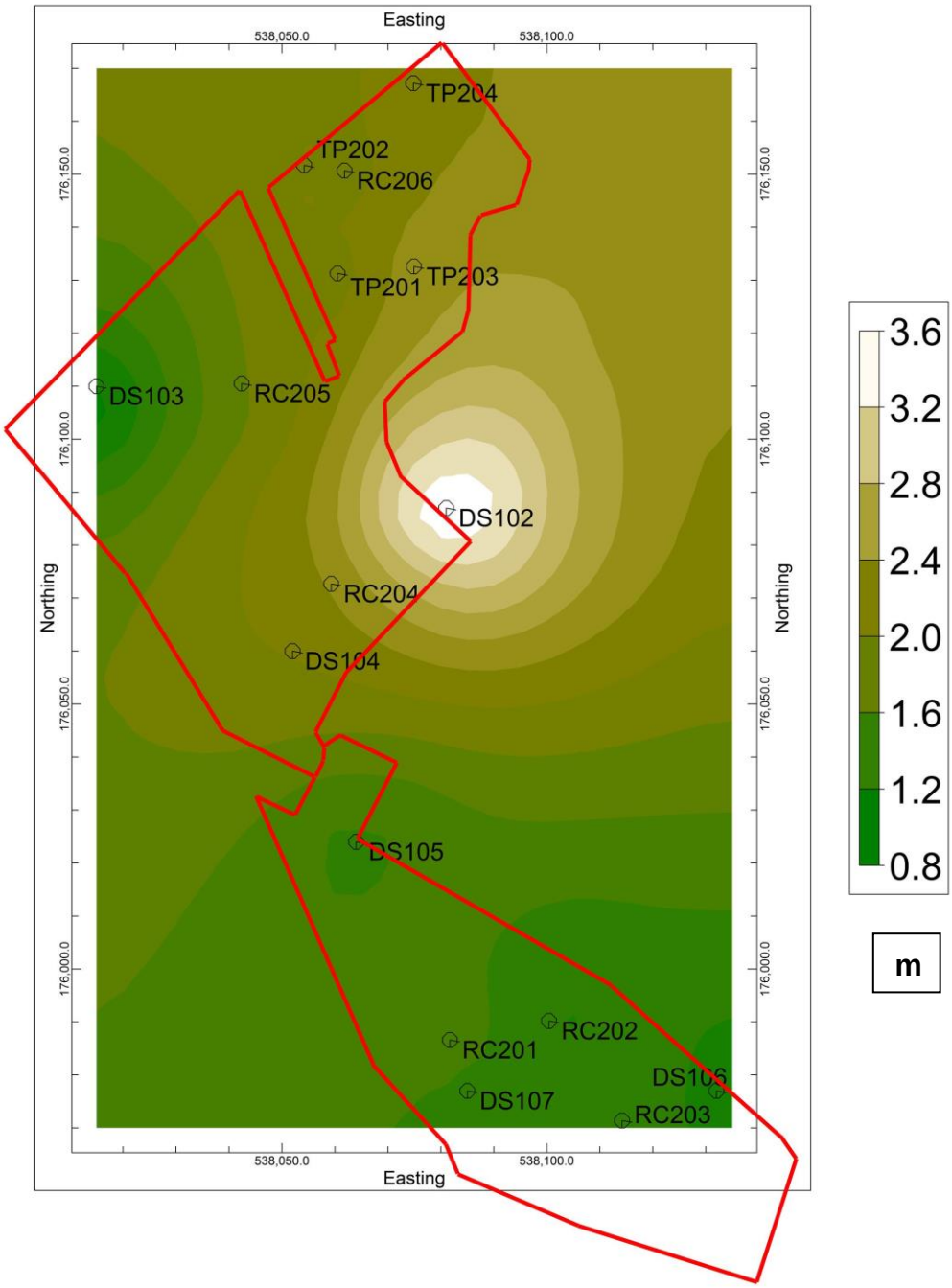

Figure 3. Isopach model of the thickness in metres of the Made Ground. Site boundary in red outline.

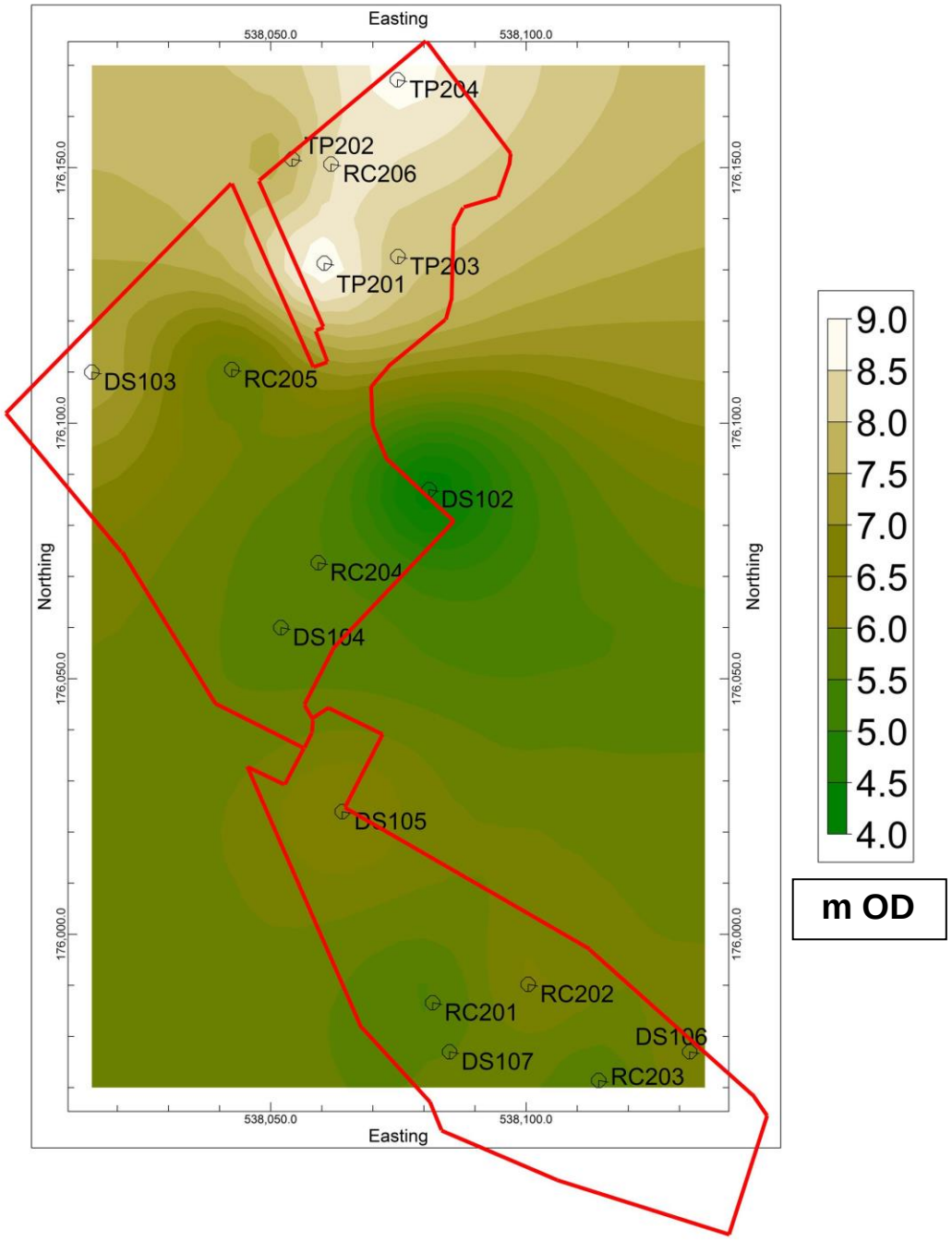

Figure 4. Stratigraphic structure map of the sub-face of the Made Ground. Site boundary in red outline.

4.2 The Site Environs: BGS Borehole Data

4.2.1 The lithostratigraphic section describes the stratigraphy from the southeast in the vicinity of the Lewisham Shopping Centre in the base of the valley at *c.*+7m OD, northwards via the site, and thence northeast up the valley side to terminate at *c.*+16m OD on Morden Hill (see Figures 5 and 6). In the base of the valley *c.*10m of channel gravels are recorded that have been recut by a later channel as evinced by borehole TQ37NE1553.

4.2.2 Overlying the Kempton Park Gravel Member are strata of Fine Grained Alluvium, and six of the 33 BGS boreholes recorded in the environs of the site indicate the presence of organic material. This is referred to variously as: 'rare organic lenses' in TQ37NE1549; 'traces of black organic material' in TQ37NE1550; 'frequent pockets of brown woody fibrous peat' in TQ37NE1551; 'pockets of black organic matter and roots' in TQ37NE1552; 'dark grey sometimes organic silty clay' in TQ37NE1553; and 'pockets of decaying organic matter' in TQ37NE4062. The first five of these records are from boreholes that trace the River Ravensbourne from south to north and were drilled as part of the Docklands Light Railway scheme. The sixth borehole lies 20m west of the river in the vicinity of Cornmill Gardens to the southwest of the area investigated (see Figures 5 and 6). The strata containing organic material sub-crop between +0.80m OD in TQ37NE1553 and +5.40m OD in TQ37NE4062.

4.2.3 Of immediate relevance to the site is borehole TQ37NE1551 (538027 176071) that lies on the west margin of the former car park (now disused) on the site next to the railway (see Figures 1 and 6). Here 'frequent pockets of brown woody fibrous peat' are recorded within 'very soft to soft dark grey sandy silty clay'. The stratum sub-crops at +3.20m OD (3.80m BGL) and is 0.7m thick. The fact that the organic material is recorded as 'pockets' may imply that it is not an *in situ* peat bed but allochthonous material.

4.2.4 Also of significance is borehole TQ37NE1551 (538064 175983) located to the west of the southern area of the site and again drilled in advance of the railway. Here 'pockets of black organic matter and occasional roots' are recorded in mottled grey silty clay. The alluvial stratum sub-crops at +3.80m OD (1.7m BGL) and is 1.3m thick. It is difficult to assess the nature of the organic material but as in the previous borehole, it may not be a

continuous bed. The stratum is relatively close to the modern surface and the presence of roots indicate bioturbation.

4.2.5 Head is recorded at the highest elevation on Morden Hill in the northeast where it attains *c.*2.75m in thickness.

4.2.6 Made Ground truncates the geological strata is present in all the boreholes along the section. It varies greatly in thickness from *c.*1m in TQ37NE1556 to 5.5m in TQ37NE1553.

4.2.7 Figure 5 is a stratigraphic structure map of the sub-face of the Made Ground strata within the larger area investigated outside the confines of the site. It predicts the elevation of the underlying strata based upon the BGS data and the site data. There are, however, lacunae within the area investigated particularly to the west of the River Ravensbourne which mitigates the confidence of the model in this location.

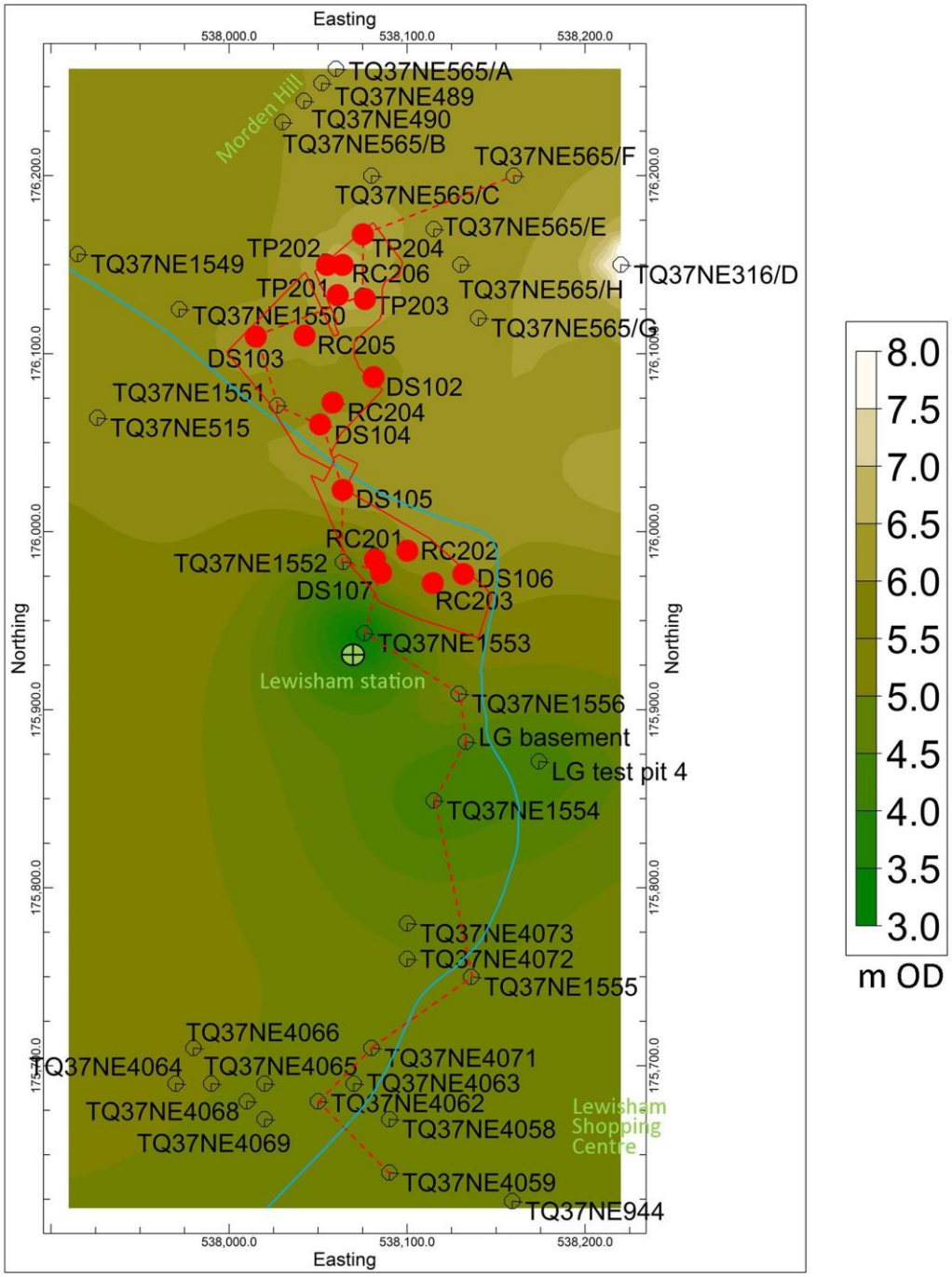

Figure 5. Stratigraphic structure model of the Made Ground in environs of the site. Site boreholes and trial pits in red, the Ravensbourne River marked in blue, lithostratigraphic section in dashed red line. BGS boreholes also plotted, and Lewisham Gateway data. Site boundary in solid red outline. Contains British Geological Survey materials © NERC 2016

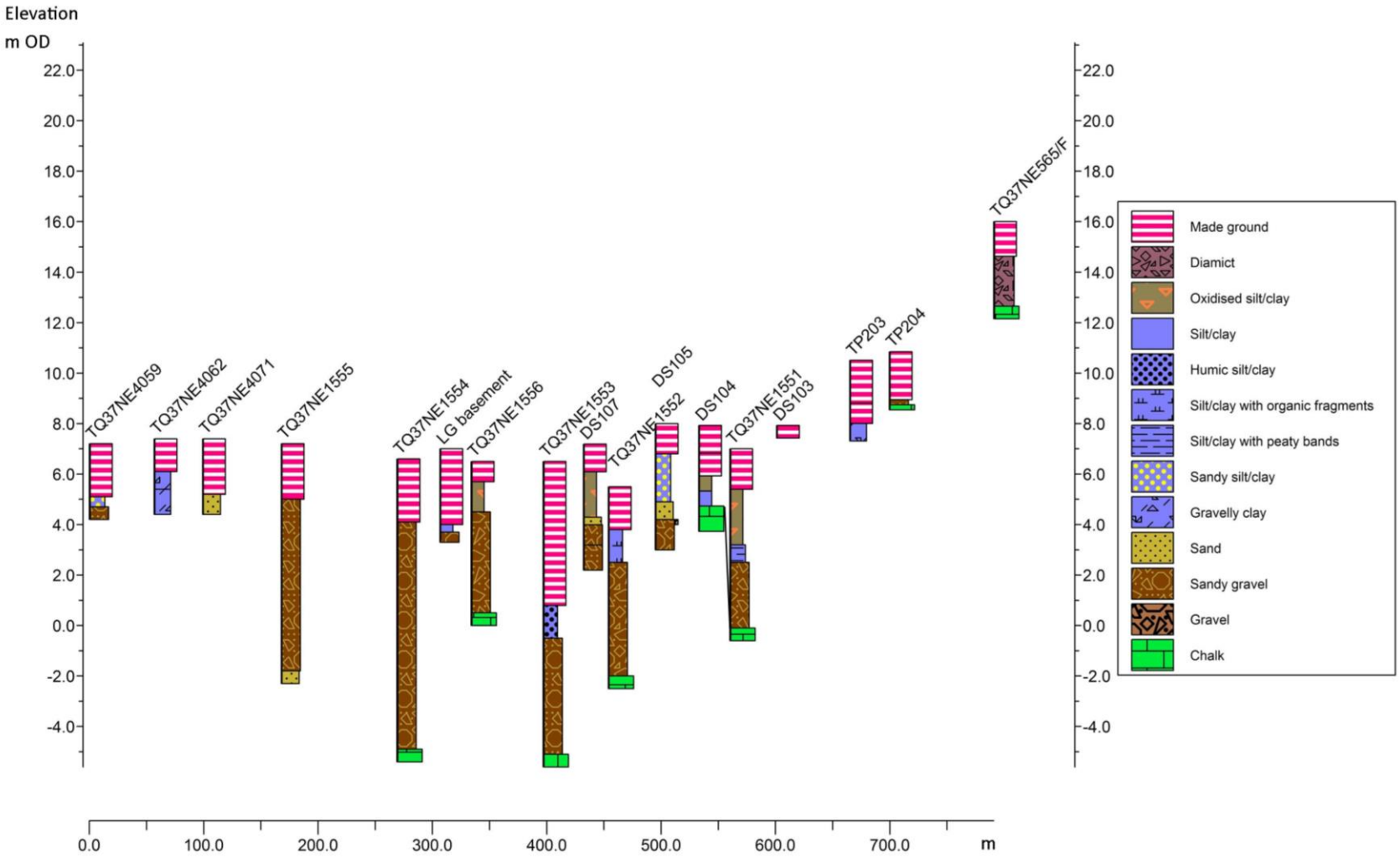

Figure 6. Lithostratigraphic section from Lewisham Shopping Centre in the south to Morden Hill in the north. Contains British Geological Survey materials © NERC

5 GEOARCHAEOLOGICAL SIGNIFICANCE AND RECOMMENDATIONS

5.1 The Kempton Park Gravel Member has *low archaeological potential*. The braided river environment was not conducive to human occupation even though people were present at the time the Gravel Member was laid down. The Gravel Member may contain lenses and beds of fine grained material that could contain biological remains, although none where recorded in this work. It is concluded therefore that the Gravels have a *low palaeoenvironmental potential.*

5.2 The Fine Grained Alluvium recorded at the site is heavily oxidised and not conducive to the preservation of palaeoenvironmental proxies such as diatoms and pollen, nor organic material such as peat. Thus, Fine Grained Alluvium containing organic material was not recorded in any of the boreholes or trial pits on the site (a total of 18). However, two BGS boreholes to the west of the site do record organic material, but the alluvium containing this organic material sub-crops at a much lower level than at the Conington Road site: +3.20m in TQ37NE1551 and +3.80m OD in TQ37NE1552. It is suggested that this deposit to the west was laid down at a later date, perhaps filling the base of an eroded channel in the underlying gravel.

5.3 As a result of the arguments in 5.2 the Fine Grained Alluvium on the site is assessed as having a *low palaeoenvironmental potential.*

5.4 Residual post-medieval material may be present at the site. This may come from the Silk Mills site that overlaps the northern area of the Conington Road site. Two worked flints recovered from high elevation alluvium have been recorded from the Silk Mills site (Menary and Lymer 2006, 9, Figs 4 and 5). However, from the work discussed in this report there is no evidence of archaeological material and therefore the site is assessed as having a *low archaeological potential.*

5.5 No boreholes for the purpose of geoarchaeological investigation are recommended on the site.

6. ACKNOWLEDGEMENTS

ARCA would like to thank Mr Will Capps of Delta-Simons and Dr Eleanor Standley of the University of Oxford for their help during the course of this project.

7. BIBLIOGRAPHY

BGS (2016a) British Geological Survey lexicon of named rock units. http://www.bgs.ac.uk/lexicon/ (Accessed 12/12/16)

BGS (2016b) The BGS Borehole record viewer http://mapapps.bgs.ac.uk/geologyofbritain/home.html (Accessed 12/12/16)

Campbell, S., Hunt, C.O., Scourse, J.D., Keen, D.H. and Croot, D.G. (1999) 'Southwest England', in Bowen, D.Q. (ed.) *A revised correlation of Quaternary deposits in the British Isles*. Geological Society Special Report 23, London, 66-78

Delta-Simons. (2016) *Phase II Environmental Assessment Report Conington Road, Lewisham For Meyer Homes Limited*. Unpublished report. Delta-Simons Project No. 16-0393.01

Dowding, K. (2016) *Conington Road, Borough of Lewisham, London Archaeological Desk-Based Assessment*. Unpublished report by Cotswold Achaeology. CA Project: 770423 CA Report: 16414.

French, H.M. (2010) *The Periglacial Environment.* Third edition Wiley.

Gibbard, P. (1994) *The Pleistocene history of the Lower Thames Valley*. Cambridge: Cambridge University Press.

Jones, A.P., Tucker, M.E. and Hart, J.K. (1999) 'Guidelines and recommendations', in Jones, A.P., Tucker, M.E. and Hart, J.K. (eds.) *The description and analysis of Quaternary stratigraphic field sections*. Quaternary Research Association technical guide **7**, London, 27 – 76

Maeger, R. (2007) *Land at Conington Road Lewisham London SE13. Archaeological Desk Based Assessment*. Unpublished report by London Planning Authority London Borough of Lewisham.

Menary, C. and Lymer, K. (2006) *Silk Mills, Conington Road, Lewisham, SE13, London Borough of Lewisham. An archaeological*

watching brief report. Unpublished report by Museum of London Archaeology Service.

Museum of London Archaeology (2016) *Lewisham Retail Park*. Unpublished Desk Based Assessment LAG23/474

Munsell Color (2000) *Munsell soil color charts*. Munsell Color, New Windsor (NY)

Rockware (2013) RockWorks v15. http://www.rockware.com (Accessed 15 April 2014)

Tucker, M.E. (2011) *Sedimentary rocks in the field*. Wiley, Chichester.

Tynan, A. (2016) *Lewisham Gateway Development, London Borough of Lewisham: An Archaeological Watching Brief Report*. Unpublished report by AOC Archaeology Group. AOC Project No: 32650

APPENDIX 1: BOREHOLE LOCATIONS ON SITE

Borehole	Easting	Northing	Elevation m OD
DS102	538081	176087	8.21
DS103	538015	176110	7.93
DS104	538052	176060	7.93
DS105	538064	176024	8.00
DS106	538132	175977	7.49
DS107	538085	175977	7.19
RC201	538081.7	175986.6	7.35
RC202	538100.4	175990.2	7.67
RC203	538114.2	175971.4	7.24
RC204	538059.3	176072.7	7.94
RC205	538042.4	176110.5	7.68
RC206	538061.8	176150.7	10.41
TP201	538060.5	176131.3	10.5
TP202	538054.2	176151.7	9.88
TP203	538074.9	176132.6	10.51
TP204	538074.8	176167.2	10.85

APPENDIX 2: BGS BOREHOLE LOCATIONS

Borehole	Easting	Northing	Elevation m OD
TQ37NE1549	537915	176156	5.5
TQ37NE1550	537972	176125	7.5
TQ37NE1551	538027	176071	7
TQ37NE1552	538064	175983	5.5
TQ37NE1553	538076	175943	6.5
TQ37NE1554	538115	175849	6.6
TQ37NE1555	538136	175750	7.2
TQ37NE1556	538129	175909	6.5
TQ37NE316/D	538220	176150	16.76
TQ37NE4058	538090	175670	7.2
TQ37NE4059	538090	175640	7.2
TQ37NE4062	538050	175680	7.4
TQ37NE4063	538070	175690	7.4
TQ37NE4064	537970	175690	7.6
TQ37NE4065	537990	175690	7.6
TQ37NE4066	537980	175710	7.6
TQ37NE4067	538020	175690	7.5
TQ37NE4068	538010	175680	7.5
TQ37NE4069	538020	175670	7.4
TQ37NE4071	538080	175710	7.4
TQ37NE4072	538100	175760	7.2
TQ37NE4073	538100	175780	7.2

TQ37NE489	538052	176252	14.5
TQ37NE490	538042	176242	14
TQ37NE515	537926	176064	5.5
TQ37NE565/A	538060	176260	14.75
TQ37NE565/B	538030	176230	11
TQ37NE565/C	538080	176200	12
TQ37NE565/E	538115	176170	12.5
TQ37NE565/F	538160	176200	16
TQ37NE565/G	538140	176120	12
TQ37NE565/H	538130	176150	12.5
TQ37NE944	538159	175624	7.6
Lewisham Gateway basement	538133	175882	7
Lewisham Gateway test pit 4	538174	175871	7

APPENDIX 3: LITHOSTRATIGRAPHY OF THE BOREHOLES ON SITE (DRILLERS' RECORDS, LITHOLOGY KEY WORDS BY ARCA)

Borehole	Top m	Base m	Lithology	Comments
DS102	0.00	4.10	Made ground	MADE GROUND: Tarmacadam. Concrete. Greyish brown very sandy GRAVEL. Sand is fine to coarse Gravel is angular to subangular fine to medium brick, limestone and concrete.
DS102	4.10	4.50	Gravelly clay	Soft orangish brown silty gravelly CLAY. Gravel is fine to medium subangular to angular limestone. (POSSIBLE ALLUVIUM)
DS102	4.50	5.00	Chalk	Recovered as structureless CHALK composed of cream with rare orange veins slightly gravelly silt. Gravel is angular to subangular fine to medium flint. (WEATHERED LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
DS103	0.00	0.50	Made ground	MADE GROUND: Tarmacadam. Concrete. Greyish brown very sandy GRAVEL. Sand is fine to coarse Gravel is angular to subangular fine to medium brick, limestone and concrete.
DS104	0.00	1.10	Made ground	MADE GROUND: Greyish brown very sandy GRAVEL. Sand is fine to coarse Gravel is angular to subangular fine to medium brick, limestone and concrete.
DS104	1.10	2.00	Made ground	MADE GROUND: Dark brown mottled orange silty gravelly CLAY. Sand is fine to coarse.

				Gravel is angular to subangular fine to coarse medium brick and limestone.
DS104	2.00	2.60	Oxidised silt/clay	Soft to firm brown mottled orange very sandy CLAY. Band of sand at 2.5-2.6 m bgl. (POSSIBLE ALLUVIUM)
DS104	2.60	3.20	Silt/clay	Soft grey silty CLAY. (POSSIBLE ALLUVIUM)
DS104	3.20	4.20	Chalk	Recovered as structureless CHALK composed of cream with rare orange veins slightly gravelly silt. Gravel is angular to subangular fine to medium flint. (WEATHERED LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
DS105	0.00	1.20	Made ground	MADE GROUND: Tarmacadam. Concrete. Brown gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to coarse brick and concrete.
DS105	1.20	3.10	Sandy silt/clay	Soft greyish brown mottled orange sandy CLAY. (POSSIBLE ALLUVIUM)
DS105	3.10	3.80	Sand	Light brown silty SAND. (KEMPTON PARK GRAVEL FORMATION)
DS105	3.80	4.00	Gravel	Black and white fine to medium angular to subangular chalk GRAVEL. Slight organic odour. KEMPTON PARK GRAVEL FORMATION)
DS105	3.80	5.00	Sandy gravel	Orangish brown sandy fine to medium rounded to subangular flint and limestone

				GRAVEL. Sand is fine to coarse. (KEMPTON PARK GRAVEL FORMATION)
DS106	0.00	1.00	Made ground	MADE GROUND: Tarmacadam. Concrete. Brown gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to coarse brick and concrete.
DS106	1.00	3.00	Sand	Orangish brown mottled orange silty fine to coarse SAND. (KEMPTON PARK GRAVEL FORMATION)
DS106	3.00	4.00	Sandy gravel	Orangish brown sandy angular to subangular fine to coarse flint GRAVEL. Sand is fine to coarse.
DS107	0.00	1.10	Made ground	MADE GROUND: Tarmacadam. Concrete. Greyish brown GRAVEL. Gravel is angular to subangular fine to coarse flint, limestone concrete.
DS107	1.10	2.90	Oxidised silt/clay	Soft to firm brown mottled orange sandy CLAY. (POSSIBLE ALLUVIUM)
DS107	2.90	3.20	Sand	Dark brown gravelly fine to coarse SAND. Gravel is fine to medium subangular to rounded flint gravel. (KEMPTON PARK GRAVEL FORMATION)
DS107	3.20	4.00	Sandy gravel	Brown very sandy fine to coarse angular to subangular flint GRAVEL. (KEMPTON PARK GRAVEL FORMATION
DS107	4.00	5.00	Sandy gravel	Orangish brown sandy fine to medium subangular to rounded flint and limestone

				GRAVEL. Sand is fine to coarse. (KEMPTON PARK GRAVEL FORMATION)
RC201	0.00	1.40	Made ground	MADE GROUND. Tarmacadam.Greyish brown slightly clayey very gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to coarse and of mixed lithologies including brick, concrete and flint.
RC201	1.40	1.80	Made ground	MADE GROUND: Brown sandy slightly gravelly CLAY. Sand is fine to medium. Gravel is angular to subrounded fine to medium predominantly flint with rare brick.
RC201	1.80	2.50	Oxidised silt/clay	Firm light brown with orange mottling sandy CLAY. (ALLUVIAL DEPOSITS)
RC201	2.50	2.90	Sand	Light brown clayey fine SAND.
RC201	2.90	6.80	Sandy gravel	Medium dense to dense yellowish brown sandy angular to subrounded fine to coarse flint GRAVEL. Sand is fine to coarse. Cream silty slightly gravelly subangular flint COBBLES. Gravel is subangular fine to coarse flint and chalk.
RC201	6.80	7.20	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
RC202	0.00	1.00	Made ground	MADE GROUND: Tarmacadam. Greyish brown slightly clayey very gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to coarse and of mixed lithologies including

				brick, concrete and flint.
RC202	1.00	1.60	Oxidised silt/clay	Brown clayey fine to coarse SAND (ALLUVIAL DEPOSITS)
RC202	1.60	2.80	Oxidised silt/clay	Firm brown mottled grey and orange slightly sandy CLAY. Sand is fine to coarse (ALLUVIAL DEPOSITS)
RC202	2.80	6.50	Sandy gravel	Very loose dark brown fine to coarse SAND and angular to rounded flint GRAVEL.
RC202	6.50	7.50	Gravel	Yellowish cream silty angular to subangular chalk and flint GRAVEL. (HEAD DEPOSITS)
RC202	7.50	8.00	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
RC203	0.00	1.50	Made ground	MADE GROUND: Tarmacadam. Dark brown very gravelly SAND. Sand is fine to coarse. Gravel is angular to subangular fine to medium and of mixed lithologies including brick, concrete, tarmac and flint.
RC203	1.50	2.30	Oxidised silt/clay	Stiff grey mottled orange sandy slightly gravelly CLAY. Sand is fine. Gravel is angular to rounded fine flint. (ALLUVIAL DEPOSITS)
RC203	2.30	6.20	Sandy gravel	Medium dense orangish brown sandy angular to subangular fine to coarse flint GRAVEL. Sand is fine to coarse.
RC203	6.20	6.70	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)

RC204	0.00	0.30	Made ground	MADE GROUND: Greyish brown sandy GRAVEL. Sand is fine to coarse. Gravel is angular to subangular fine to predominantly coarse. Subbase.
RC204	0.30	2.20	Made ground	MADE GROUND: Brown sandy gravelly CLAY. Sand is fine to medium. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint brick and concrete.
RC204	2.20	3.50	Oxidised silt/clay	Firm brown with rare orange mottling sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse flint. (ALLUVIAL DEPOSITS)
RC204	3.50	5.90	Sandy gravel	Medium dense brown clayey sandy angular to subrounded fine to coarse flint GRAVEL. Sand is fine to coarse. (HEAD DEPOSITS)
RC204	5.90	6.40	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
RC205	0.00	1.80	Made ground	MADE GROUND: Dark brown very sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint, brick and concrete.
RC205	1.80	3.50	Gravelly clay	Stiff to very stiff light brown sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse flint and chalk.

				(ALLUVIAL DEPOSITS)
RC205	3.50	4.00	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
RC206	0.00	1.30	Made ground	MADE GROUND: Brown very sandy gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint brick and concrete.
RC206	1.30	2.30	Sand	Medium dense light brown clayey gravelly fine to coarse SAND. Gravel is subrounded to rounded fine to predominantly coarse flint. (HEAD DEPOSITS)
RC206	2.30	2.80	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
TP201	0.00	0.30	Made ground	MADE GROUND: Light brown very sandy gravelly CLAY with occasional brick cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including brick, concrete and flint.
TP201	0.30	1.20	Made ground	MADE GROUND: Dark brown sandy slightly gravelly CLAY with occasional brick cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse flint, chalk and brick. Frequent roots and twigs. Rare anthropogenic materials including plastic and

				pottery. *Dark brown (10 YR 3/3) heterogeneous, fine to coarse sandy silt/clay with angular to sub rounded fine to coarse flint, chalk and brick pebbles and occasional brick cobbles. Bioturbation is frequent as evidenced by roots. Anthropogenic materials included plastic and concrete.*
TP201	1.20	1.90	Sand	Orangish brown slightly gravelly fine to coarse SAND with rare subrounded flint cobbles. Gravel is subrounded fine to coarse flint. (HEAD DEPOSITS) *10 YR 3/3 Dark brown, heterogenous, loose diamict of gravelly silt/clay with high component of fine to coarse sand and as described above.*
TP201	1.90	2.40	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
TP202	0.00	1.00	Made ground	MADE GROUND: Brown chalky very sandy slightly gravelly CLAY. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint, brick and concrete. Occasional anthropogenic materials including geogrid and plastic.
TP202	1.00	2.70	Made ground	MADE GROUND: Dark brown sandy gravelly CLAY with

				occasional brick and concrete cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint, brick and concrete. Occasional anthropogenic materials including fibre board, suspected asbestos cement board fragment and plastic.
TP202	2.70	3.20	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)
TP203	0.00	1.70	Made ground	MADE GROUND: Brown very sandy slightly gravelly CLAY with occasional concrete boulders and brick cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint, brick and concrete. Occasional anthropogenic materials including reinforcement bar, plastic barrier and bags.
TP203	1.70	2.50	Made ground	MADE GROUND: Brown clayey sandy GRAVEL with abundant brick cobbles and angular to subangular concrete boulders.
TP203	2.50	3.20	Gravelly clay	Stiff light brown slightly sandy gravelly CLAY with occasional flint cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine

				to coarse flint and fine chalk. (ALLUVIAL DEPOSITS)
TP204	0.00	1.90	Made ground	MADE GROUND: Brown very sandy gravelly CLAY with frequent brick and concrete cobbles. Sand is fine to coarse. Gravel is angular to subrounded fine to coarse and of mixed lithologies including flint, brick and concrete. Occasional anthropogenic materials including plastic, wire and sawn timber.
TP204	1.90	2.10	Sandy gravel	Brown clayey sandy GRAVEL
TP204	2.10	2.30	Chalk	(LEWES NODULAR CHALK FORMATION, SEAFORD CHALK FORMATION AND NEWHAVEN CHALK FORMATION)

APPENDIX 4: LITHOSTRATIGRAPHY OF THE BGS BOREHOLES

Borehole	**Top**	**Base**	**Lithology**	**Comments**
TQ37NE1549	0.00	0.80	Made ground	
TQ37NE1549	0.80	1.80	Silt/clay with organic fragments	rare organic lenses
TQ37NE1549	1.80	6.80	Sandy gravel	
TQ37NE1549	6.80	7.30	Chalk	
TQ37NE1550	0.00	1.90	Made ground	
TQ37NE1550	1.90	3.50	Silt/clay	
TQ37NE1550	3.50	4.40	Silt/clay with organic	traces of black organic material

			fragments	
TQ37NE1550	4.40	6.40	Sandy gravel	
TQ37NE1550	6.40	6.90	Chalk	
TQ37NE1551	0.00	1.60	Made ground	
TQ37NE1551	1.60	3.80	Oxidised silt/clay	
TQ37NE1551	3.80	4.50	Silt/clay with peaty bands	frequent pockets of woody peat
TQ37NE1551	4.50	7.10	Sandy gravel	
TQ37NE1551	7.10	7.60	Chalk	
TQ37NE1552	0.00	1.70	Made ground	
TQ37NE1552	1.70	3.00	Silt/clay with organic fragments	pockets of black organic matter and roots
TQ37NE1552	3.00	7.50	Sandy gravel	
TQ37NE1552	7.50	8.00	Chalk	
TQ37NE1553	0.00	5.70	Made ground	
TQ37NE1553	5.70	7.00	Humic silt/clay	dark grey sometimes organic silty clay
TQ37NE1553	7.00	11.60	Sandy gravel	
TQ37NE1553	11.60	12.10	Chalk	
TQ37NE1554	0.00	2.50	Made ground	
TQ37NE1554	2.50	11.50	Sandy gravel	
TQ37NE1554	11.50	12.00	Chalk	
TQ37NE1555	0.00	2.20	Made ground	
TQ37NE1555	2.20	9.00	Sandy gravel	
TQ37NE1555	9.00	9.50	Sand	thanet beds
TQ37NE1556	0.00	0.80	Made ground	
TQ37NE1556	0.80	2.00	Oxidised silt/clay	

TQ37NE1556	2.00	6.00	Sandy gravel	
TQ37NE1556	6.00	6.50	Chalk	
TQ37NE316/D	0.00	0.15	Made ground	
TQ37NE316/D	0.15	1.52	Gravelly clay	head
TQ37NE316/D	1.52	2.02	Chalk	weathered chalk
TQ37NE4058	0.00	2.00	Made ground	
TQ37NE4058	2.00	2.65	Sandy silt/clay	
TQ37NE4058	2.65	3.00	Sandy gravel	
TQ37NE4059	0.00	2.10	Made ground	
TQ37NE4059	2.10	2.50	Sandy silt/clay	
TQ37NE4059	2.50	3.00	Sandy gravel	
TQ37NE4062	0.00	1.30	Made ground	
TQ37NE4062	1.30	2.00	Gravelly clay	
TQ37NE4062	2.00	3.00	Gravelly clay	pockets of decaying organic matter
TQ37NE4063	0.00	1.85	Made ground	
TQ37NE4063	1.85	2.00	Gravelly clay	
TQ37NE4063	2.00	3.00	Sandy gravel	
TQ37NE4064	0.00	1.60	Made ground	
TQ37NE4064	1.60	3.00	Sandy gravel	
TQ37NE4065	0.00	0.10	Made ground	
TQ37NE4065	0.10	2.40	Gravelly clay	
TQ37NE4065	2.40	3.00	Sandy gravel	
TQ37NE4066	0.00	1.35	Made ground	
TQ37NE4066	1.35	3.00	Sandy gravel	
TQ37NE4067	0.00	1.45	Made ground	

TQ37NE4067	1.45	2.50	Sandy gravel	
TQ37NE4068	0.00	0.20	Made ground	
TQ37NE4068	0.20	2.60	Gravelly clay	
TQ37NE4068	2.60	3.00	Sandy gravel	
TQ37NE4069	0.00	2.10	Made ground	
TQ37NE4069	2.10	2.60	Sandy gravel	
TQ37NE4071	0.00	2.20	Made ground	
TQ37NE4071	2.20	3.00	Sand	
TQ37NE4072	0.00	1.65	Made ground	
TQ37NE4072	1.65	3.00	Sandy gravel	
TQ37NE4073	0.00	2.20	Made ground	
TQ37NE4073	2.20	3.00	Gravel	
TQ37NE489	0.00	2.13	Made ground	
TQ37NE489	2.13	6.55	Diamict	head
TQ37NE489	6.55	7.00	Chalk	
TQ37NE490	0.00	2.13	Made ground	
TQ37NE490	2.13	4.14	Sandy silt/clay	subsoil/head over the chalk upslope: not alluvium
TQ37NE490	4.14	5.48	Diamict	head
TQ37NE490	5.48	6.00	Chalk	
TQ37NE515	0.00	7.90	Made ground	
TQ37NE515	7.90	8.80	Silt/clay	
TQ37NE515	8.80	9.40	Sandy gravel	
TQ37NE515	9.40	9.90	Chalk	
TQ37NE565/A	0.00	0.30	Made ground	

TQ37NE565/A	0.30	4.72	Diamict	head
TQ37NE565/A	4.72	5.22	Chalk	
TQ37NE565/B	0.00	2.60	Made ground	
TQ37NE565/B	2.60	5.00	Sandy silt/clay	subsoil/head over the chalk upslope: not alluvium
TQ37NE565/B	5.00	5.50	Chalk	
TQ37NE565/C	0.00	0.61	Made ground	
TQ37NE565/C	0.61	3.96	Sandy silt/clay	subsoil/head over the chalk upslope: not alluvium
TQ37NE565/C	3.96	4.50	Chalk	
TQ37NE565/E	0.00	1.37	Made ground	
TQ37NE565/E	1.37	1.87	Chalk	
TQ37NE565/F	0.00	1.37	Made ground	
TQ37NE565/F	1.37	3.35	Sandy silt/clay	subsoil/head over the chalk upslope: not alluvium
TQ37NE565/F	3.35	3.85	Chalk	
TQ37NE565/G	0.00	0.30	Made ground	
TQ37NE565/G	0.30	1.00	Chalk	
TQ37NE565/H	0.00	0.61	Made ground	
TQ37NE565/H	0.61	1.50	Sandy silt/clay	subsoil/head over the chalk upslope: not alluvium
TQ37NE565/H	1.50	2.00	Chalk	
TQ37NE944	0.00	2.00	Made ground	
TQ37NE944	2.00	12.20	Sandy gravel	
Lewisham Gateway basement	0.00	3.00	Made ground	

Lewisham Gateway basement	3.00	3.30	Silt/clay	
Lewisham Gateway basement	3.30	3.70	Sandy gravel	
Lewisham Gateway test pit 4	0.00	3.00	Made ground	