Archaeological Monitoring and Recording Report: Edmonton EcoPark, Laydown Area East

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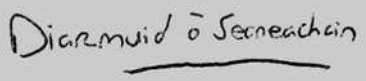
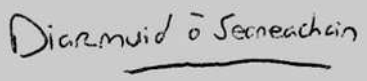
 Peter Vellet BA (Hons.) PCIfA	 Diarmuid O'Seaneachain BA PhD MCIfA	 Diarmuid O'Seaneachain BA PhD MCIfA

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Revision History

Revision	Date	Amendment
01	09.09.2019	Addition of interim dendro-chronological analysis results
02	20.10.2020	Inclusion of Geoarchaeological & Palaeoenvironmental Assessment Report (Batchelor, Young, Lincoln and Hill, 2020)

Summary

From March to July 2019 ADAS carried out an archaeological watching brief for Buckingham Group Contracting Ltd of groundworks required for the construction and installation of services infrastructure preceding the development of temporary car parking and a materials laydown area centred on National Grid Reference TQ 36104 92434. The Laydown Area will serve the main construction work of the proposed Edmonton EcoPark development as part of the wider North London Heat and Power Project.

The Laydown Area was divided into Laydown Area East and Laydown Area West. While the majority of the groundworks were located within Laydown Area East, groundworks were also carried out along the northern boundary of Laydown Area West as part of the Laydown Area East phase of work.

The results of the archaeological monitoring indicated a low potential for significant archaeological features and deposits to survive across Laydown Area East and along the northern boundary of Laydown Area West. The general absence of archaeological features and deposits recorded may partially be attributed to the relatively limited impact of the groundworks. Nevertheless, the monitored areas indicated that significant truncation of the Site had previously occurred down to the alluvial sequence observed across the Site. The artefacts recovered in-situ from the alluvium exposed during the archaeological monitoring were all likely deposited during the Post-medieval to Modern period. Residual material including a single sherd of Roman pottery and a fragmented later Medieval roof tile was also recovered.

The programme of archaeological monitoring focused on a total of twenty-two trenches across both Laydown Area East and Laydown Area West. The trenches consisted of linear elements (pipe and duct trenches), substantial fixed excavations (cess pool and attenuation tank) and smaller fixed excavations (manholes, soak-aways, substation and chemical and fuel stores).

A general stratigraphic sequence was observed across the entirety of the Laydown Area. This sequence consisted of made ground overlying an alluvial sequence, which in turn overlay natural gravels. The full stratigraphic sequence was not observed in every trench due to varying formation levels for each individual element of the groundworks.

Of the twenty-two monitored trenches, fifteen locations exposed the general stratigraphic sequence. Trenches 8, 9 and 12-16 involved groundworks where the formation level was within the made ground and the alluvial sequence and natural geology was not exposed.

The results of the geoarchaeological fieldwork and deposit modelling integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, revealed a sequence of Late Devensian gravel, overlain by Holocene alluvial sediments (including sporadic Peat and Tufa deposits), capped by modern Made Ground. A single radiocarbon date from the top of the Peat suggests that

accumulation took place during the Neolithic period, most likely over a period of up to a few hundred years. By comparison, up to 3m of these deposits are recorded on the nearby Advent Way site, dating from the Late Devensian to Bronze Age period. During the period of Peat formation, the floodplain surface was dominated by alder carr woodland with willow, and an understorey of sedges and grasses and aquatics. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime.

However, on the basis of the limited concentration and preservation of palaeoenvironmental remains, and the absence of: (1) further material suitable for radiocarbon dating, (2) any evidence for anthropogenic activity, and (3) any evidence for palaeoenvironmental change during the period of peat formation, no further work geo-archaeological analysis or assessment has been recommended (Batchelor, Young, Lincoln and Hill, 2020).

Acknowledgements

This archaeological watching brief was commissioned by Buckingham Group Contracting Ltd, and thanks are due in this regard. Fieldwork was carried out by Stephanie Dalby, Peter Vellet, Andrew Brown, Pierre Manisse, Josh Hargreaves and Kyle Beaverstock. The report and supporting illustrations were prepared Peter Vellet, and checked by Diarmuid O'Seaneachain. The archive was compiled by Peter Vellet.

1 Introduction

Project Background

1.1 From March to July 2019 ADAS carried out an archaeological watching brief for Buckingham Group Contracting Ltd of groundworks required for the construction and installation of services infrastructure preceding the development of temporary car parking and a materials laydown area (Laydown Area East). The Laydown Area will serve the main construction work of the proposed Edmonton Eco Park development as part of the wider North London Heat and Power Project (NLHPP).

1.2 The wider application for the NLHPP extends over twenty-two hectares and comprises the existing waste management site known as the Edmonton EcoPark, part of Ardra Road, land around the existing water pumping station at Ardra Road, Deephams Farm Road, part of Lee Park Way and land to the west of the River Lea Navigation, and land to the north of Advent Way and east of the River Lea Navigation (ADAS, 2019).

1.3 The Laydown Area was divided into Laydown Area East, hereafter referred to as 'the Site', and Laydown Area West. While the majority of the groundworks monitored were located within the boundary of Laydown Area East, a number of deeper groundworks were also carried out along the northern boundary of Laydown Area West and were archaeologically monitored as part of the Laydown Area East phase of work.

1.4 The objective of the watching brief was to record all archaeological remains exposed during groundworks within Laydown Area East and along the northern boundary of Laydown Area West centred on National Grid Reference (NGR) TQ 36104 92434 (Figure 1).

1.5 The works were carried out in order to fulfil the commitments outlined in Schedule 2, Paragraph 6 and 16 of a Development Consent Order (DCO) for the NLHPP and in the Construction Code of Practice (CoCP) regarding Archaeology (section 6; Arup 2016b).

1.6 The outlined commitments contained in the DCO and the general archaeological requirements contained in the CoCP were summarized in the Written Scheme of Investigation (WSI) and will not be reproduced here (ADAS, 2019).

1.7 Mr Sandy Kidd, the Local Authority Archaeologist with the Greater London Archaeological Advisory Service *(GLAAS)*, recommended archaeological monitoring should be carried out during deeper groundworks for the Laydown Area East phase of the NLHPP. It was also recommended that a programme of geoarchaeological investigation should be implemented to coincide with the archaeological monitoring. Both recommendations were made in an email communication sent to the client on January 22nd 2019.

1.8 It was considered that deeper groundworks carried out during this part of the proposed development had a low to moderate potential to impact upon unknown buried archaeological remains of Prehistoric and Romano-British date (ARUP, 2015). It was also considered that there was a limited potential for material of palaeo-environmental interest to be present in the alluvium and Lea Valley Gravels which will be impacted by the deeper excavations on the Site (Young, 2019).

1.9 RSK ADAS Ltd were instructed to prepare a WSI to carry out the required archaeological works and record any archaeological remains during the monitoring of the groundworks (ADAS, 2019).

1.10 The archaeological monitoring and geoarchaeological investigation carried out during the Laydown Area East phase of construction work will form part of a phased programme of archaeological and geo-archaeological work that will be integrated into the wider NLHPP development project. The results of each stage of archaeological fieldwork will contribute towards research objectives encompassing the wider project.

1.11 The fieldwork followed the *Standard and guidance for an archaeological watching brief* (CIfA, 2020), *the Management of Archaeological Projects 2* (English Heritage, 1991), the *Management of Research Projects in the Historic Environment* (MORPHE): *Project Manager's Guide* (Historic England, 2015) and the ADAS Technical Manual (ADAS, 2019). The fieldwork also followed the Historic England and Greater London Archaeological Advisory Service (GLAAS) Guidelines for Archaeological Projects in Greater London.

1.12 In carrying out this work Buckingham Group Contracting Ltd complied with the commitments outlined in the DCO and the general archaeological requirements in the CoCP for the North London Heat and Power Project.

The Site, Location and Geology

1.13 The programme of groundworks on the Site comprised the construction and installation of services infrastructure preceding the development of temporary car parking and a materials laydown area (Laydown Area East). The Laydown Area will serve the main construction work of the proposed Edmonton Eco Park development as part of the wider NLHPP.

1.14 The initial phase of groundworks involved the de-vegetation of Laydown Area East and the removal of existing bunds. This was followed by a general ground reduction of between 0.50 m and 1 m of topsoil and made ground across Laydown Area East to facilitate site access and the construction of a site compound. A thin layer of Type 1 hard standing was then deposited across the Site to provide a stable working surface for the remainder of the groundworks. These phases of groundworks were not subject to archaeological monitoring as it was considered that they would only affect modern made ground of no archaeological interest (ADAS, 2019).

1.15 Prior to the commencement of the watching brief, it was understood that the following deeper groundworks would take place across the Laydown Area to facilitate construction and installation of services infrastructure:

- Excavation for 25 manholes to between 2.5 and 4 m in depth and connecting slot drains and surface water drainage pipes,
- Excavation for a pump chamber 4 m in diameter and up to 6 m in depth,
- Excavations up to 4 m in depth for hydrobrake, interceptor and foul storage/cess pit (total area excavation approximately 20 square metres),
- Excavation for storm attenuation tank approximately 3.4 m in diameter and up to 4 m deep,
- Excavation for an oil interceptor across 4 m X 10 m area up to c. 5 m in depth,
- Excavation for a pump station across a 7 square metre area up to 7 m deep,
- Excavation for a valve chamber up to 2 m deep,
- Excavation for an outfall control chamber up to 2 m deep.

1.16 A programme of archaeological monitoring of certain elements of the deeper groundworks was carried out (Figure 2). Following discussion with Mr Sandy Kidd, the Local Authority Archaeologist with GLAAS, it was agreed that sufficient monitoring of deeper groundworks had been achieved in an email communication sent to the client on June 26th 2019.

1.17 Those elements of the deeper groundworks that underwent archaeological monitoring across the Laydown Area included:

- Pumping chamber,
- 4 manholes and connecting drainage pipes between manhole 02 and 03, manhole 06 and 10, manhole 10 and 24 and manhole 10 and the cess pool,
- Storm attenuation tank,
- Cess pool (hydrobrake, interceptor and foul storage/cess pit),
- Q-max slot drains,
- Potable water pipe trenches,
- Electricity duct trenches,
- Substation,
- Chemical and fuel stores,
- Seven soak-aways to facilitate ground water management.

1.18 The underlying bedrock geology is recorded as London Clay Formation – Clay, Silt and Sand. This is overlain by superficial deposits of Clay, Silt, Sand and Gravel Alluvium. Kempton Park Gravel Member superficial deposits are recorded immediately east of the Site (BGS, 2019).

1.19 A geo-technical ground investigation was conducted of the Laydown Area (East and West) in 2017. This comprised the excavation of four boreholes and fifteen trial pits. The results of the single borehole (BH1) and nine trial pits (1-8 and 15) within Laydown Area East indicated made ground deposits from ground level to between 1 and 3.80 m below ground level (Harrison Group Environmental, 2017).

1.20 Trial Pit 14 was the closest to the Laydown Area East works to be carried out in Laydown Area West. The results of this trial pit show made ground deposits measuring 2.20 m thick, overlying 1.80 m of alluvium. Kempton Park Gravel Member superficial deposits were observed at 3 m in depth (Harrison Group Environmental, 2017)

1.21 The borehole and trial pits consistently revealed alluvial deposits, measuring between 1 and 2.10 m thick, underlying made ground deposits. Kempton Park Gravel Member superficial deposits were consistently observed underlying the alluvium (Harrison Group Environmental, 2017).

1.22 Two exceptions to this pattern were identified. Trial Pit 3 exposed 0.40 m of alluvium overlying Kempton Park Gravel Member superficial deposits, while Trial Pit 6 exposed made ground to a depth of 3.80 m. Both of these pits were thought to be located along a former course of the River Lea, which ran through the Site before being infilled in the mid-20th century (Harrison Group Environmental, 2017).

1.23 A geoarchaeological review of the ground investigation report (Harrison Group Environmental, 2017) was carried out and formed an appendix to the Written Scheme of Investigation produced by ADAS. The geo-archaeological desk-based review identified the Kempton Park Gravel Member superficial deposits as belonging to Lea Valley Gravel of Gibbard (Young, 2019).

2 Objectives

Aims and Scope

2.1 The primary aims of the wider North London Heat and Power Project are:

- to identify how Palaeo-environmental and landscape evolution (Theme 1), settlement pattern and boundaries (Theme 2) and the use and management of the Lea Valley River Channels (Theme 3) influenced human history and the development of London as a world city (Arup 2020); and
- to test and refine the pre-determination deposit model recovering palaeo-environmental sequences where possible.

2.2 The specific aims of the Laydown Area East phase of work were:

- To ensure that the commitments outlined in the Construction Code of Practice (CoCP) regarding Archaeology (section 6) are met;
- To identify and record any unknown buried archaeological deposits, artefacts or palaeoenvironmental remains exposed during ground works deeper than 1 m across the Laydown Area;
- To inform a strategy to avoid or mitigate the impacts of the proposed development on any surviving archaeological remains, geoarchaeological deposits and palaeo-environmental remains identified; and
- To integrate the archaeological and geo-archaeological mitigation carried out during this stage of construction work with all subsequent stages.

2.3 The fieldwork took place within, and will contribute to the research objectives contained within the Lea Valley Mapping Project (Corcoran *et al* 2011). It will also contribute to the goals contained within the overall Research Framework for London Archaeology as set out in the Historic England and Greater London Archaeological Advisory Service (GLAAS) Guidelines for Archaeological Projects in Greater London (GLAAS 2015).

2.4 A general aim of the Laydown Area East phase of work was to ensure the results would be reported as appropriate.

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4 Geoarchaeological, Archaeological and Historical Context

Introduction

4.1 A geoarchaeological and archaeological desk-based assessment was commissioned by the North London Waste Authority in connection with the proposed North London Heat and Power Project (Arup, 2015 and MOLA, 2015).

4.2 The geoarchaeological, archaeological and historical context of the proposed scheme, including the Site, has been investigated by this desk-based assessment. It is not intended to replicate in full the findings of that report here, but a summary of the results are provided below.

4.3 A search was made of the online Historic Environment Record and of the National Heritage List for England (NHLE, 2019) for known heritage assets within a 1km Study Area around the Site. The results of this search outlined below.

4.4 All designated heritage assets are referred to in the text by their Historic England and/or HER reference numbers. The heritage assets recorded by the HER within the 1 km Study Area are referenced by their HER number.

Summary of Geoarchaeological Background

4.5 The desk-based assessment included a geoarchaeological deposit model which was focused solely on the main construction work of the North London Heat and Power Project, immediately to the west of the Site (MOLA, 2015).

4.6 The assessment identified three landscape zones (LZ) each with varying levels of archaeological and palaeo-environmental potential, the most relevant of which and closest to the Laydown Area was LZ 3. This was located on the western, south-eastern and southern areas of the main construction work and revealed peat and alluvial sequences that in places exceed circa 2 m in thickness. The report concluded that LZ 3 should be considered to have the highest palaeo-environmental potential across the main construction work (MOLA, 2015).

4.7 In the wider landscape the Lea Valley Mapping Project has divided the area into Landscape Zones characterized by their Holocene landscape history based largely on sedimentary evidence derived from borehole records (Corcoran *et al,* 2011). Historical discoveries of remains of palaeoenvironmental significance have been identified in the wider landscape around the site, including the discovery of a 5th century 'crannog' at Ikea Glover Drive 800m to the south-west of the Laydown Area East site boundary (Sandy Kidd pers. comm).

Summary of Archaeological and Historical Background

4.8 The desk-based assessment sourced information from Historic England (English Heritage at the time of writing), the Greater London HER (Historic Environment Record), online historical resources and the Archaeological Data Service (ADS). These sources recorded no World Heritage

Sites, Scheduled Monuments, Grade I or II* Listed Buildings, Conservation Areas, Designated Wrecks, Designated Battlefields or Registered Parks and Gardens within the 1 km Study Area (Arup, 2015).

4.9 A total of three Grade II Listed Buildings were identified immediately to the east of the Site, all of which are related to and include the Chingford Mill Pumping Station (NHLE site number 1250896, 1065574 and 1065575) (Arup, 2015).

4.10 A recent search of the National Heritage List for England (NHLE, 2019) revealed no additional designated heritage assets within the 1 km Study Area.

4.11 The desk-based assessment identified a total of sixty-six non-designated heritage assets within the 1 km Study Area. These included findspots, features and sites from the Palaeolithic to the Medieval periods. No significant remains from the Post-medieval and 20th century were identified within the Study Area (Arup, 2015).

4.12 A recent search of online Historic Environment Record data identified five other non-designated heritage assets with the 1 km Study Area which were of particular relevance to the buried archaeological potential of the Laydown Area East Site (Heritage Gateway, 2019).

4.13 A Palaeolithic handaxe (1136308) was recovered roughly 1 km to the south-west of the Site (Heritage Gateway, 2019).

4.14 Prehistoric and Roman pottery (405604, 405590 and 405587) was recovered during construction of a reservoir roughly 1 km to the north-east of the Site (Heritage Gateway 2019).

4.15 An undated possible river crossing (405591) was identified roughly 800 m to the north-east of the Site. This was comprised of a double line of 8 foot stakes embedded into the river gravels (Heritage Gateway, 2019).

Summary of Previous Archaeological Events

4.16 The desk-based assessment identified twenty-four previous archaeological events within the Study Area. These included desk-based assessments, geoarchaeological assessments and modelling and archaeological monitoring and fieldwork (Arup, 2015).

Historic Mapping and Aerial Photography Analysis

4.17 The desk-based assessment analysed ten historic Ordnance Survey maps and one historic aerial photograph, ranging from the late 19th century through to the early 21st century (Arup, 2015).

4.18 Of particular interest is the sinuous course of the River Lea, which is visible running through the Site on historic maps until at least 1938. By the time the historic aerial photograph was taken from between 1945 and 1950, the river had been diverted to the west with the River Lea Navigation and to the east with the River Lea Diversion. The natural course of the Lee has been infilled (Arup, 2015).

5 Methodology

Introduction

5.1 The fieldwork followed the methodology set out within the Written Scheme of Investigation (ADAS, 2019). An archaeologist was present during all deeper groundworks associated with the construction and installation of services infrastructure across Laydown Area East and the deeper excavations carried out along the northern part of the Laydown Area West.

5.2 Where archaeological and alluvial deposits were encountered written, graphic and photographic records were compiled in accordance with the Chartered Institute for Archaeologists *Standard and Guidance: Archaeological watching brief 2020.*

Artefacts, Human Remains, Treasure and Environmental Sampling

5.3 A small assemblage of pottery, ceramic building material (CBM) and glass was recovered during the course of the watching brief. The assemblage was sent for specialist assessment and the resulting report can be found in Appendix B.

5.4 A single trench (Trench 3) revealed two timber posts set vertically into the natural gravels. The timber posts were sent for specialist assessment, the results from which are presented below. The full specialist report resulting from the assessment can be found in Appendix C.

5.5 A programme of geoarchaeological investigation was carried out during the course of the watching brief, a summary of which is detailed below. The full specialist report resulting from the investigation can be found in Appendix D.

5.6 A subsequent programme of geoarchaeological and palaeoenvironmental assessment was carried out of samples collected during the geoarchaeological investigation. A summary of the assessment is detailed below and the full specialist report resulting from the assessment can be found in Appendix E.

5.7 No other archaeologically significant deposits were disturbed by the groundworks, so no bulk environmental sampling was undertaken during the archaeological monitoring.

Post-Excavation Analysis

5.8 The assessment of the finds assemblage indicated the Roman, Late Medieval and Modern periods were represented. The finds assemblage provides clear 19th century dating for alluvium 1006 and more tentative late 18th or early 19th century dating for 1007. Alluvial lens 1012 cannot be closely dated based on artefactual evidence; it may be contemporary to these layers or older. Sherds of residual Roman and late medieval pottery and roof tile in alluvium 1006 indicate local activity during these periods (Blinkhorn, Franklin and Koonce, 2019) (Appendix B).

5.9 A single trench (Trench 3) revealed two timber posts set vertically into the natural gravels. The posts were sent for assessment to establish viability for dendrochronological dating, although due to the small size of the timber posts this was not possible. Specialist analysis found that the posts were made of oak and roughly chopped to a very blunt point with some sort of tool. There were no distinctive woodworking marks and so it was not possible to determine what sort of tool was used (Miles, 2019)(Plates 13 and 14; Appendix C).

5.10 On May 28th 2019 geoarchaeological fieldwork was undertaken to support the archaeological monitoring of deeper groundworks within Laydown Area East. The fieldwork, which included two geoarchaeological boreholes (QBH1 and QBH2), was intended to clarify the nature of the sub-surface stratigraphy; clarify the nature, depth, extent and possible date of any alluvium and organic/peat deposits; and highlight the geoarchaeological and/or palaeoenvironmental potential of sequences obtained from Laydown Area East.

5.11 The results of the fieldwork revealed a sequence of Late Devensian gravel overlain by Holocene alluvial sediments including sporadic peat and tufa deposits. The alluvium was in turn overlain by modern made ground (Batchelor 2019) (Appendix D).

5.12 Following the results of the geoarchaeological fieldwork and deposit modelling (Batchelor, 2019), a programme of geoarchaeological and palaeoenvironmental assessment was undertaken of the sequences obtained from Laydown Area East. The assessment was intended to investigate whether the sequences contained any artefact or ecofact evidence for prehistoric or historic human activity and any evidence for natural and/or anthropogenic changes to the landscape (Batchelor, Young, Lincoln and Hill, 2020) (Appendix E).

5.13 The assessment included a single radiocarbon date of a waterlogged twig from the peat at 7.44 aOD within borehole QBH2, which suggested accumulation took place during the Neolithic period over a period of up to a few hundred years. Pollen analysis indicated that the floodplain surface was dominated by alder carr woodland with willow and an understorey of sedges and grasses and aquatics during the peat formation. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to have grown on the dryland, forming deciduous woodland with oak and lime (Batchelor, Young, Lincoln and Hill, 2020) (Appendix E).

Archives and Deposition

5.14 The archive is currently held by ADAS at their offices in Milton Park. A small assemblage of artefacts were recovered during the monitoring and will be deposited along with the paper archive with the Museum of London. The full archive will be deposited with the Museum of London within six months of the completion of the fieldwork under an accession number which will be issued upon deposition. A summary of information from this project, set out within

Appendix F, will be entered onto the OASIS database of archaeological projects in Britain. An OASIS form, ID reference adasuklt1-361515 has been provisionally completed and will be submitted at the time of completion.

ADAS Project Team

5.15 Fieldwork was undertaken by Stephanie Dalby, Peter Vellet, Andrew Brown, Pierre Manisse, Josh Hargreaves and Kyle Beaverstock. The report was written and the illustrations were prepared by Peter Vellet. The archive was compiled and prepared for deposition by Peter Vellet. The project was managed for ADAS by Diarmuid O'Seaneachain.

6 Results

6.1 This section provides an overview of the monitoring results; detailed summaries of the recorded contexts and finds are to be found in Appendix A.

6.2 The programme of archaeological monitoring focused on a total of twenty-two construction trenches across both Laydown Area East (the Site) and Laydown Area West. The trenches consisted of linear elements (pipe and duct trenches), substantial fixed excavations (cess pool and attenuation tank) and smaller fixed excavations (manholes, soak-aways, a substation and chemical and fuel stores).

6.3 As previously discussed, the groundworks initially consisted of a general ground reduction of between 0.50 m and 1 m of topsoil and made ground which was not subject to archaeological monitoring.

6.4 This was followed by a series of deeper groundworks for the construction and installation of services infrastructure which were under constant archaeological supervision. The groundworks were excavated using mechanical excavators fitted with flat bladed buckets, both of varying sizes. The works were completed over sixty-seven days from Wednesday 20th March to Thursday 18th July 2019. The weather was variable and consisted of cloudy, wet days and bright sunshine (Plates 1 - 12).

6.5 Deeper excavations across the Laydown Area were frequently inundated with ground water during the course of the archaeological monitoring. Ground water was observed at a depth of 2.50 m below ground level (bgl) along the northern boundary and 3.50 m bgl along the southern boundary of the Laydown Area.

6.6 A single service was identified in the Manhole 02 to Manhole 03 Pipe Trench (Trench 2). This comprised an electricity cable encased in concrete running perpendicular to the trench on a north to south alignment.

6.7 A general stratigraphic sequence was observed across the entirety of the Laydown Area. This sequence consisted of made ground overlying an alluvial sequence, which in turn overlay natural geology. The full stratigraphic sequence was not observed in every trench due to varying formation levels for each individual element of the groundworks.

6.8 Of the twenty-two monitored trenches, fifteen locations exposed the general stratigraphic sequence and are discussed in detail below. The remaining trenches involved groundworks for Manhole 10 to Manhole 24 (Trench 8), Manhole 10 to the Cess Pool (Trench 9), Potable Water (Trench 12), Electricity Ducts and the Substation (Trenches 13 and 14) and the Chemical and Fuel

Stores (Trenches 15 and 16). The formation level for these trenches was within the made ground and the alluvial sequence and natural geology was not exposed. For this reason, these trenches will not be discussed further.

6.9 Made ground 1002 was observed across the entirety of Laydown Area East and within the groundworks monitored in the Laydown Area West and consisted of multiple episodes of deposition. The made ground was predominantly a mid to dark brown sandy silty clay, although several distinct deposits or lenses of varying colour and consistency were noted. A varying quantity of detritus was noted throughout the deposit including plastic, wood, concrete, iron, pottery, CBM and glass. The detritus was spot dated as Post-Medieval to Early Modern during the course of the archaeological monitoring and was not retained for specialist assessment.

6.10 A second distinct deposit of made ground 1003 was identified in Trenches 10 (Cess Pool) and 22 (Manhole 24) and will be discusses in further detail below (Figures 5 and 8).

6.11 Natural geology 1016 was consistently observed across the entirety of Laydown Area East and the northern part of Laydown Area West. The deposit was a sandy gravel likely to be Kempton Park Gravel Member. The colour of the natural geology was variable and is discussed as part of each trench narrative below.

Trench 1 – Pumping Chamber (including Soak-Aways)

6.12 Trench 1 was the western most area monitored during the groundworks and was situated along the northern boundary of the Site within Laydown Area West (Figures 2 and 3). The trench involved the excavation of two soak-aways followed by a larger excavation over the footprint of the northern most soak-away for the Pumping Chamber. The soak-aways each measured 5 m in length by 5 m in width and 3.70 m in depth.

6.13 The excavation for the Pumping Chamber measured 7 m in length by 7 m in width and was initially reduced to the top of the natural gravels at 2 m bgl, at which point monitoring was discontinued.

6.14 The stratigraphic sequence was observed as 1.60 m of made ground 1002 overlying a dark grey silty clay alluvial deposit 1006 measuring 0.30 m thick. This in turn overlay at least 0.70 m of mid orange brown sandy gravel natural geology 1016 (Figure 8;).

6.15 No archaeological features, deposits or artefacts were observed in Trench 1.

Trench 2 – Manhole 02 to Manhole 03 Pipe Trench

6.16 Trench 2 was a west to east aligned excavation situated largely within Laydown Area West along the northern boundary of the Site between Manhole 02 (not monitored) and Manhole 03 (Figures

2 and 3). The pipe trench was 83 m in length by 1.50 m in width and was excavated to a depth of 4 m at the western extent (Manhole 02) and 3.60 m at the eastern extent (Manhole 03).

6.17 The stratigraphy followed the general stratigraphic sequence observed across all the groundworks monitored, with made ground 1002 overlaying a dark grey silty clay alluvial deposit 1006. A small number of dark brown peat lenses were observed within alluvial deposit 1006 in the eastern half of the trench. Alluvial deposit 1006 overlay a sandy gravel natural geology 1016 which varied in colour, including light greyish brown, light grey, mid orange brown and dark orange (Figure 4).

6.18 Made ground 1002 varied in thickness along the length of Trench 2. The deposit measured 2 m thick at the western extent of the trench, 0.90 m thick along the central portion of the trench and 2.80 m thick at the eastern extent of the trench.

6.19 A thin alluvial deposit 1004, measuring 9.80m in width and 0.20 m thick, was observed in the western half of Trench 2. The deposit was comprised of a mid-olive grey silty clay underlying made ground 1002 and overlying alluvial deposit 1006.

6.20 Alluvial deposit 1006 was equally variable in thickness, measuring 0.30 m thick at the western extent of the trench and 2.40 m thick at the centre point of the trench. The deposit thinned towards the eastern extent of the trench before dissipating roughly 1.50 m from the eastern end of Trench 2.

6.21 The upper horizon of the natural geology 1016 was observed as undulating and decreased in thickness from the western extent of the trench, where it measured at least 2 m thick, to the eastern extent of the trench, where it measured 0.65 m thick.

6.22 No archaeological features or deposits were observed along the length of Trench 2. Pottery, CBM and glass were recovered from alluvial deposit 1006 where the alluvium was observed at it greatest thickness near the centre of Trench 2. Fourteen sherds of 19th century pottery were recovered. The CBM comprised two fragments of sewer pipe dated from the 18th to 19th centuries. A single fragment of modern window glass was also recovered (Blinkhorn, Franklin and Koonce, 2019).

6.23 Two fragments of worked timber interpreted as probable modern railway sleepers were also recovered from alluvial deposit 1006 in Trench 2.

Trench 3 – Manhole 03

6.24 Trench 3 was situated at the eastern end of Trench 2 and measured 3m in length and width and 3.60 m in depth (Figures 2 and 3).

6.25 The stratigraphic sequence was observed as 2.80 m of made ground overlying a mid-orange brown sand gravel natural geology 1016 (Figures 4 and 7).

6.26 Following completion of the excavation of Manhole 03, destabilisation and collapse of the natural geology 1016 exposed two timber posts, 1014 and 1015. The posts were briefly observed in-situ prior to the collapse of the trench baulk. Both posts were positioned vertically and were entirely set within the natural gravels. There was no indication of a post hole associated with either post, suggesting the posts were driven into the ground. Both posts appeared to be roughly pointed at their base and had 'splintered' tops, possibly a result of being broken during removal (Figure 7; Plates 13 and 14).

6.27 The posts were sent for specialist assessment to establish viability for dendrochronological dating and were also assessed for tool marks and surface finish. The interim results of this assessment are provided in paragraph 5.1.8 and the final report of this assessment will be attached in Appendix C.

6.28 Apart from the undated timber posts, no archaeological features, deposits or artefacts were observed in Trench 3.

Trench 4 – Manhole 04

6.29 Trench 4 was located adjacent to the western end of Trench 5. The trench measured 3 m in length and width and 3.20 m in depth (Figures 2 and 3).

6.30 The stratigraphy followed the general stratigraphic sequence on site, whereby the modern Type 1 hard standing 1001 deposited for the groundworks on site overlay 1.20 m of made ground. This in turn overlay 1 m of dark grey silty clay alluvium 1006. No natural geology was observed in Trench 4.

6.31 No archaeological features, deposits or artefacts were observed in Trench 4.

Trench 5 – Attenuation Tank

6.32 Trench 5 was a substantial excavation measuring 43 m in length, 6 m in width and 3.30 m in depth along the northern boundary of the Site (Figures 2 and 3). The trench was initially excavated to a depth of 1.60 m before the installation of sheet piling and then final ground reduction to formation level.

6.33 The stratigraphy followed the general stratigraphic sequence on site, whereby the modern Type 1 hard standing 1001 deposited for the groundworks on site overlay 1.90 m of made ground. This in turn overlay a sequence of three alluvial deposits observed at the western extent of the trench. Dark grey silty clay alluvium 1006 overlay a mid-greyish brown sandy silty clay alluvium 1012,

which overlay a second dark grey silty clay alluvium 1013. It is likely that alluvial deposit 1012 represented an isolated lens within the predominant dark grey alluvium observed across the Site. Therefore, it is likely that alluvial deposits 1006 and 1013 are the same deposit (Figure 5).

6.34 The upper horizon of the light brownish yellow sandy gravel natural geology 1016 was observed as undulating within the trench, resulting in varying thickness for the overlying alluvial sequence. Alluvium 1006, observed at the western extent of the trench, extended deeper than the formation level of Trench 5 and measured at least 1.10 m thick. Alluvial deposit 1012 was observed overlying a higher level of the natural geology and measured 0.50 m thick, while alluvium 1013 ranged from 0.50 m to at least 1.10 m thick.

6.35 No archaeological features or deposits were observed within Trench 5, although artefactual material was recovered. A single sherd of Roman pottery identified as Hadham Oxidised ware and a fragmented roof tile of likely later Medieval date (14th to 15th century) were recovered from alluvial deposit 1006. A single fragment of very abraded brick was recovered from alluvial deposit 1012. While this could not be dated it could be contemporary with the roof tile from alluvial deposit 1006 (Blinkhorn, Franklin and Koonce, 2019).

Trench 6 – Manhole 06

6.36 Trench 6 was situated to the east of the Attenuation Tank (Trench 5) and measured 6 m in length, 4 m in width and 2.65 m bgl in depth (Figures 2 and 3).

6.37 The stratigraphic sequence in Trench 6 was observed as the modern Type 1 hard standing 1001 deposited for the groundworks on site overlying 1.45 m of made ground. This in turn overlay a mixed mid grey and mid yellowish brown silty clay alluvial deposit 1010, measuring 0.80 m thick, which overlay 0.15 m of dark grey silty clay alluvium 1013. The base of Trench 6 exposed mid to dark brownish orange sandy gravel natural geology 1016 (Figure 6).

6.38 No archaeological features, deposits or artefacts were observed in Trench 6.

Trench 7 – Manhole 06 to Manhole 10 Pipe Trench

6.39 Trench 7 was situated along the eastern boundary of the Site between Manhole 06 and 10. The trench was aligned north to south from Manhole 06 to Manhole 07 and then turned south-west from Manhole 07 towards Manhole 10 (Figures 2 and 3). The trench measured 100 m in length, 1.50 m in width and was excavated to a depth of 2.50 m at the northern extent and 1.80 m at the south-west extent.

6.40 The stratigraphy followed the general stratigraphic sequence observed on site, whereby the modern Type 1 hard standing 1001 deposited for the groundworks on site overlay 0.80 m of made ground 1002. This is turn overlay a sequence of four silty clay alluvial deposits. A light yellowish

brown alluvial deposit 1017 measuring 0.30 m thick overlay a 0.20 m thick light grey alluvial deposit 1018. This overlay a second light yellowish brown alluvium 1019 measuring 0.25 m thick. The lowest alluvial deposit in the sequence was a dark grey alluvium 1013 measuring 0.35 m thick. The alluvial sequence was observed overlying at least 0.40 m of mid orange brown sandy gravel natural geology 1016 (Figure 8).

6.41 The above sequence was largely representative of the stratigraphy observed along the length of Trench 7.

6.42 No archaeological features, deposits or artefacts were observed in Trench 7.

Trench 10 – Cess Pool

6.43 Trench 10 was a substantial excavation measuring 15 m in length and width and 4.50 m in depth and situated in the south-west corner of the Site (Figures 2 and 3). The trench was initially excavated to a depth of roughly 2 m before the installation of sheet piling and then final ground reduction to formation level.

6.44 The stratigraphy followed the general stratigraphic sequence on site, whereby the modern Type 1 hard standing 1001 deposited for the groundworks on site overlay two deposits of made ground. Trench 10 was one of two locations where a second distinct deposit of made ground 1003 was observed. Made ground 1002 measured 1.60 m thick, which overlay a mid-reddish brown silty clay made ground 1003 measuring 1 m thick. A dark grey silty clay alluvial deposit 1006 measuring 0.50 m thick underlay made ground 1003, although this was only observed along the eastern extent of the trench. This in turn overlay at least 1 m of mid yellowish brown sandy gravel natural geology (Figure 5).

6.45 No archaeological features, deposits or artefacts were observed in Trench 10.

Trench 11 – Q-max Pipe Trenches

6.46 Trench 11 included two separate east by west aligned pipe trenches situated in the centre of Laydown Area East (Figures 2 and 3). The northern pipe trench measured 58 m in length and 1 m in width and the southern pipe trench measured 41 m in length and 1 m in width. The pipe trenches were largely excavated to a depth of 0.85 m bgl within made ground 1002, although the western end of the southern pipe trench was excavated to a greater depth exposing the top of the alluvial sequence on site.

6.47 The stratigraphy at the western end of the southern pipe trench followed the general stratigraphic sequence on site, whereby the modern Type 1 hard standing 1001 deposited for the groundworks on site overlay 1.35 m of made ground 1002. The upper horizon of a dark grey silty clay alluvial deposit 1006 was observed at the base of the trench (Figure 8).

6.48 No archaeological features, deposits or artefacts were observed in Trench 11.

Trench 17 – Soak-Away, West of Holding Pond

6.49 Trench 17 was excavated immediately west of the large holding pond within Laydown Area West (Figures 2 and 3). The trench measured 5 m in length and width and was excavated to a depth of 3.70 m bgl.

6.50 The stratigraphy followed the general stratigraphic sequence on site, whereby 1.70 m of made ground 1002 overlay a sequence of two alluvial deposits. The upper deposit consisted of a mid-grey with light greyish orange mottles silty clay alluvium 1007, which measured 0.85 m thick. The lower deposits was a dark grey silty clay alluvium 1006, measuring 0.45 m thick. Alluvial deposit 1006 overlay a light grey sandy gravel natural geology (Figure 6).

6.51 No archaeological features or deposits were observed in Trench 17. A single hand finished base sherd of a cylindrical wind bottle dated form c1780 to 1820 was recovered from alluvial deposit 1007 (Blinkhorn, Franklin and Koonce, 2019).

Trench 18 – Soak-Away, North of Holding Pond (West)

6.52 Trench 18 was excavated to the north of the large holding pond within Laydown Area West (Figures 2 and 3). The trench measured 5 m in length and width and was excavated to a depth of 2.70 m bgl. Trenches 18 and 19 were excavated together, with Trench 18 situated immediately west of Trench 19.

6.53 The stratigraphy followed the general stratigraphic sequence on site, whereby 1.50 m of made ground 1002 overlay a sequence of two alluvial deposits. The upper deposit was a mixed light blue grey and light reddish brown silty clay alluvium 1005 measuring 0.70 m thick. The lower deposit was a dark grey silty clay alluvium 1006 measuring 0.30 m thick. At least 0.20 m of mid grey sandy gravel natural geology 1016 was exposed at the base of Trench 18 (Figure 6).

6.54 No archaeological features, deposits or artefacts were observed in Trench 18.

Trench 19 – Soak-Away, North of Holding Pond (East)

6.55 Trench 19 was excavated to the north of the large holding pond within Laydown Area West (Figures 2 and 3). The trench measured 5 m in length and width and was excavated to a depth of 3.30 m bgl. Trenches 18 and 19 were excavated together, with Trench 19 situated immediately east of Trench 18.

6.56 The stratigraphy followed the general stratigraphic sequence on site, whereby 1.50 m of made ground 1002 overlay a dark grey silty clay alluvium 1006 measuring 1.20 m thick. This in turn overlay at least 0.30 m of mid grey sandy gravel natural geology 1016 (Figure 6).

6.57 No archaeological features, deposits or artefacts were observed in Trench 19.

Trench 20 – Soak-Away, North of Manhole 02 to Manhole 03 Pipe Trench

6.58 Trench 20 was situated to the north of the Manhole 02 to Manhole 03 pipe trench within Laydown Area West (Figures 2 and 3). The trench measured 5 m in length and width and was excavated to a depth of 3.60 m bgl.

6.59 The stratigraphy followed the general stratigraphic sequence on site, whereby 3 m of made ground 1002 overlay a dark grey silty clay alluvium 1006 measuring 0.20 m thick. This in turn overlay at least 0.40 m of light brownish yellow sandy gravel natural geology 1016 (Figure 8).

6.60 No archaeological features, deposits or artefacts were observed in Trench 20.

Trench 21 – Soak-Away, East of Attenuation Tank

6.61 Trench 21 was situated to the east of the Attenuation Tank along the northern boundary of the Site (Figures 2 and 3). The trench measured 7 m in length and width and was excavated to a depth of 3.36 m bgl.

6.62 The stratigraphy followed the general stratigraphic sequence on site, whereby topsoil 1000 overlay made ground 1002. The made ground varied in thickness from 1.30 m at the western extent of the trench to 2 m at the eastern extent. This was likely the result of an undulation or natural hollow within the underlying alluvial sequence.

6.63 Made ground 1002 overlay a sequence of four alluvial deposits. The upper most deposit consisted of a mid-grey silty clay alluvium 1008 measuring 0.40 m at its thickest point. This overlay a light yellowish brown silty clay alluvium 1009, which measured 0.20 m at its thickest point. A more substantial alluvial deposit of mixed mid grey and mid yellowish brown silty clay 1010, which measured 0.70 m thick, underlay alluvial deposit 1009. The lowest alluvial deposit was a very dark grey and black silty clay with lenses of dark brown peat, which measured between 0.25 m and at least 0.35 m thick. This deposit was thicker at the eastern extent of the trench where it extended past the base of the trench. The base of the trench exposed at least 0.10 m of mixed dark brownish orange and light grey sandy gravel natural geology 1016 (Figure 8).

6.64 No archaeological features, deposits or artefacts were observed in Trench 21.

Trench 22 – Manhole 24

6.65 Trench 22 was situated along the southern boundary of the Site and measured 3 m in length and width and was excavated to a depth of 1.40 m bgl (Figures 2 and 3).

6.66 The stratigraphic sequence in Trench 22 was observed as the modern Type 1 hard standing 1001 deposited for the groundworks on site overlying two deposits of made ground. Trench 22 was one

of two locations where a second distinct deposit of made ground 1003 was observed. Made ground 1002 measured 0.80 m thick, which overlay a mid-reddish brown silty clay made ground 1003 measuring at least 0.40 m thick (Figure 8).

6.67 While no alluvial deposits were observed in Trench 22, the presence of the second distinct deposit of made ground 1003 warranted discussion for the purposes of developing a deposit model for the Site.

6.68 No archaeological features, deposits or artefacts were observed in Trench 2

7 Discussion and Conclusions

7.1 The results of the archaeological monitoring indicated a low potential for significant archaeological features and deposits to survive across Laydown Area East and along the northern boundary of Laydown Area West. The general absence of archaeological features and deposits recorded may partially be attributed to the relatively limited impact of the groundworks. Nevertheless, the monitored areas indicated that significant truncation of the Site had previously occurred down to the alluvial sequence observed across the Site. The artefacts recovered in-situ from the alluvium exposed during the archaeological monitoring were all likely deposited during the Post-medieval to Modern period. Residual material including a single sherd of Roman pottery and a fragmented later Medieval roof tile was also recovered.

7.2 The results of the geoarchaeological fieldwork and deposit modelling integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, revealed a sequence of Late Devensian gravel, overlain by Holocene alluvial sediments (including sporadic Peat and Tufa deposits), capped by modern Made Ground. A single radiocarbon date from the top of the Peat suggests that accumulation took place during the Neolithic period, most likely over a period of up to a few hundred years. By comparison, up to 3m of these deposits are recorded on the nearby Advent Way site, dating from the Late Devensian to Bronze Age period. During the period of Peat formation, the floodplain surface was dominated by alder carr woodland with willow, and an understorey of sedges and grasses and aquatics. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime.

7.3 However, on the basis of the limited concentration and preservation of palaeoenvironmental remains, and the absence of: (1) further material suitable for radiocarbon dating, (2) any evidence for anthropogenic activity, and (3) any evidence for palaeoenvironmental change during the period of peat formation, no further work geo-archaeological analysis or assessment has been recommended (Batchelor, Young, Lincoln and Hill, 2020).

7.4 The archaeological monitoring carried out indicated that the substantial deposit of made ground 1002 overlying the entirety of the Laydown Area varied in thickness, ranging from 3 m thick in Trench 20 to 0.80 m thick in Trench 22. No particular pattern to the change in thickness of the deposit existed and the variation appeared to be the result of an undulating landscape on which made ground 1002 was deposited.

7.5 A second distinct deposit of made ground 1003 was identified in Trenches 10 and 22 (Figures 5 and 8). This deposit was homogenous and largely sterile of detritus when compared to the

overlying made ground 1002. Trench 10 was situated directly over the original course of the River Lea and made ground 1003 was likely one of the initial deposits on the Site associated with the infilling and diversion of the river. The presence of made ground 1003 in the south-east corner of the Site (Trench 22) suggested the deposit was not strictly used to infill and divert the river but was part of the deposition of material to make the ground level up across Laydown Area East.

7.6 Historic maps and aerial photographs clearly show the sinuous course of the River Lea running through the Site until at least 1938. By the time historic aerial photography showing the Site was taken between 1945 and 1950, the river had been diverted to the west with the River Lea Navigation and to the east with the River Lea Diversion (Arup, 2015) (Figure 3).

7.7 The alluvial sequence underlying the made ground was dominated by a substantial dark grey silty clay alluvium 1006. This deposit was interrupted by what was likely an isolated alluvial lens 1012 in the north facing section of Trench 5 and was subsequently given a second context number 1013. The dark grey alluvium observed to the east of Trench 5 was identified as a continuation of 1013, although both 1006 and 1013 likely represent the same deposit. The dark grey and black alluvium 1011 in Trench 21 was likely also a continuation of alluvial deposit 1006 and 1013.

7.8 The deposit (1006, 1011 and 1013) varied in thickness across Laydown Area East and along the northern boundary of Laydown Area West, although a general decrease in thickness was observed from west to east across the monitored area. Overall, the three deposits ranged in thickness from 2.40 m to 0.20 m thick. The deposit likely represented a low energy protracted deposition of alluvial material on the flood plain adjacent to the original course of the River Lea. Historic maps from the late 19th century show the Laydown Area as a rural agricultural landscape (Arup, 2015) (Figure 3). The dark colour and humic smell of 1006, 1011 and 1013 suggested this deposit either formed during the late Post-Medieval period or was heavily impacted upon by later agricultural practice. Certainly pottery and CBM dated from the 18th and 19th centuries found 1.80 m below the upper horizon of alluvium 1006 in Trench 2 was not intrusive but may give an indicative date for this deposit. The sherd of Roman pottery and the fragmented later Medieval roof tile recovered from alluvial deposit 1006 were also clearly intrusive. The location of the artefacts at the western end of Trench 5 suggested they were situated on the eastern bank of the River Lea and were likely deposited on site through fluvial processes (Figure 3).

7.9 Alluvial deposits overlying the main deposit (1006, 1011 and 1013) were observed in Trenches 2, 6, 7, 17, 18 and 21. Alluvium 1004, 1007 and 1005 (Trenches 2, 17 and 18 respectively) likely represented isolated deposits infilling natural hollows in alluvium 1006. By contrast, the alluvial sequences observed along the eastern extent of the Site in Trenches 6, 21 and along Trench 7 likely represented more wide-spread and episodic deposition of alluvium. Moreover, the presence of these sequences only to the east of the original course of the River Lea suggested a difference

in the landscape between the flood plain to the east and west of the river. Certainly the variation in the horizon between the underlying alluvium (1006, 1011 and 1013) and the natural geology 1016 was evidence of this.

7.10 The upper horizon of the Lea Valley Gravels was observed at varying depths across the Laydown Area. In particular, the groundworks along the northern boundary of Laydown Area East and Laydown Area West allowed for a rough profile of this horizon to be reconstructed. The natural geology was observed at 1.60 m bgl in Trench 1 and steadily increased in depth to 2.80 m bgl in Trench 3. The horizon was observed to decrease in depth from this point to 2.20 m bgl in Trench 5 and further still to a minimum of 1.20 m bgl in Trench 7 along the eastern extent of the Site. While undulations in the upper horizon of the natural geology were observed across the Laydown Area, the general trend clearly demonstrates the original course of the River Lea with adjacent flood plains to the east and west.

7.11 Timber posts 1014 and 1015 identified in Trench 3 were positioned vertically and were entirely set within the natural gravel (Figure 7; Plates 13 and 14). There was no indication of a post hole associated with either post, suggesting the posts were driven into the ground. Both posts appeared to be roughly pointed at their base and had 'splintered' tops, possibly a result of being broken during removal. Historic maps indicated that Trench 3 was situated on the western bank of the original course of the River Lea and the timber posts were likely associated with either a jetty type structure or a fence line adjacent to the river. A historic Ordnance Survey map of the Laydown Area from 1914 (Old Maps, 2019) clearly shows three individual points labelled 'post' associated with the field in which posts 1014 and 1015 would have been situated (Figure 3).

7.12 These results indicate that the monitoring methodology used was effective in ensuring that harm to the historic environment as a result of the groundworks was mitigated or avoided.

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Appendix A: Context Descriptions

No.	Type	Trench	Description	Length (m)	Width (m)	Depth/ Thickness (m)
1000	Deposit	Site	Topsoil	-	-	0.30
1001	Deposit	Site	Type 1 hard standing	-	-	0.20 – 0.40
1002	Deposit	Site	Made ground	-	-	0.80 – 3.00
1003	Deposit	10, 22	Made ground	-	-	1.00
1004	Deposit	2	Mid olive-grey alluvium	-	-	0.20
1005	Deposit	18	Mixed alluvium	-	-	0.70
1006	Deposit	Site	Dark grey alluvium	-	-	0.20 – 2.40
1007	Deposit	17	Mid grey alluvium	-	-	0.85
1008	Deposit	21	Mid grey alluvium	-	-	0.40
1009	Deposit	21	Light yellowish brown alluvium	-	-	0.20
1010	Deposit	6, 21	Mixed alluvium	-	-	0.70
1011	Deposit	21	Dark grey to black alluvium	-	-	<0.45
1012	Deposit	5	Mid greyish brown alluvium	-	-	0.70
1013	Deposit	5-7	Dark grey alluvium	-	-	0.35 - <1.10
1014	Timber	3	Timber post	0.43	0.08	-
1015	Timber	3	Timber post	0.48	0.08	-
1016	Deposit	Site	Natural geology	-	-	-
1017	Deposit	7	Light yellowish brown alluvium	-	-	0.30
1018	Deposit	7	Light grey alluvium	-	-	0.20
1019	Deposit	7	Light yellowish brown alluvium	-	-	0.25

Appendix B: Finds Assessment

Edmonton EcoPark, Laydown Area East

Pottery, Glass & CBM Assessment

By: Paul Blinkhorn, Julie Franklin & Amy Koonce

Date: 23/07/2019

Client: RSK ADAS Limited

Headland Project Code: ADAS19

Client Site Code: ECO19

HEADLAND ARCHAEOLOGY Ltd

THE FINDS ASSEMBLAGE

Summary

The finds assemblage numbered 15 sherds (884g) of pottery, four sherds (606g) of ceramic building material and two sherds of glass. These were found in three separate deposits. The Roman, late medieval and modern periods are represented. The finds are summarised by deposit in Table 1 and a complete catalogue is given at the end.

Table 1. Summary of finds assemblage by deposit with spot dating (dating is for finds within these layers and does not necessarily date the layers themselves; small assemblages should be used with particular caution for dating purposes).

Tr	Feature Type	Feature No	Pottery (Rom)	Pottery (Rom)	Pottery (Mod)	Pottery (Mod)	Glass	CBM	CBM	Spot Date
-	-	-	Count	Wgt (g)	Count	Wgt (g)	Count	Count	Wgt (g)	-
2	alluvium	1006	1	161	14	723	1	3	443	19th+ with residual Roman and L Med
17	alluvium	1007	-	-	-	-	1	-	-	L18th/E19th
5	alluvial lens	1012	-	-	-	-	-	1	163	L Med-Mod
-	**Total**	-	**1**	**161**	**14**	**723**	**2**	**4**	**606**	-

Methodology

The report includes hand-collected finds only, no finds retrieved from sample contents were presented for study. The finds were collected, processed and packaged for long term storage in accordance with professional guidelines (CIfA 2014; Watkinson & Neal 1998). The finds were assessed and recorded by an appropriate specialist. The resultant data was then drawn together into one MS Access database. A copy of this data is given at the end of the report.

The pottery was examined visually, using x20 magnification where necessary. It was recorded according to standards set out by specialist bodies (Barclay et al 2016; Darling 1994; Slowikovski 2001). The Roman pottery was recorded using the conventions of the National Roman Fabric Reference Collection (Tomber & Dore 1998). The modern pottery was recorded using the fabric codes of the Museum of London Type-Series (eg Vince 1985).

Roman pottery

A single sherd (161g) of Hadham Oxidised ware (HAD OX) was retrieved from alluvium 1006. Such pottery is a common find at sites of the period in the region. It is a large sherd from the rim of a flanged bowl. It is burnt and very abraded, with most of the inner surface missing. It is clearly residual.

Modern pottery

The modern pottery numbered 14 sherds (723g) and was retrieved entirely from alluvium 1006. The range of fabric types is typical of sites in the region.

Fabric Code	Fabric	Dating	Sherds	Wgt (g)
REFW	Refined Whiteware	1800+	12	681
TPW3	Brown/Black Transfer-printed ware	1810-1900	2	42
Total	-	-	**14**	**723**

Table 2. Modern pottery type series

The modern material is a mixture of tablewares and utilitarian vessels such as storage jars. Two storage jars are stamped 'MALING NEWCASTLE' on the base. The Maling company ran from 1762 to 1963, with makers marks first appearing in 1817 (TMCS nd), thus these jars can be dated 1817-1963.

Glass

Two sherds of glass were retrieved from alluvium 1006 and 1007. The earliest, from 1007 is a hand finished base sherd of a cylindrical wine bottle dating c1780-1820. The sherd from alluvium 1006 is a small sherd of colourless modern window glass.

Ceramic building material

Four sherds of ceramic building material were retrieved from alluvium 1006 and alluvial lens 1012. Two of the sherds (315g) are from salt-glazed English Stoneware (ENGS) sewer pipes, and date from 1700-1900.

A sherd of roof tile from alluvium 1006 is earlier though clearly residual. It was in a fairly fine, red sandy fabric with a grey core. It is 12mm thick, with splashes of dark green glaze on one side, and traces of mortar on the other. It is most likely of later medieval (14th – 15th century) date.

The last find was a single fragment of brick from alluvial lens 1012. It is very coarse and appears hand-made, but it is also very abraded, and none of its original dimensions survive. It cannot be dated with any confidence but could be contemporary with the tile.

Discussion

The finds assemblage provides clear 19th-century dating for alluvium 1006 and more tentative late 18th or early 19th-century dating for 1007. Alluvial lens 1012 cannot be closely dated based on artefactual evidence; it may be contemporary to these layers or older. Sherds of residual Roman and late medieval pottery and roof tile in alluvium 1006 indicate local activity during these periods.

RECOMMENDATIONS FOR FURTHER WORK

As it stands, no further work is recommended on the finds. The assemblage is small and either of very recent date or from unsecure contexts and thus has no further analytical potential. Should further fieldwork be undertaken, then the assemblage should be re-evaluated in the light of any additional finds.

RECOMMENDATIONS FOR ARCHIVE

The sherd of Roman pottery and the sherd of medieval roof tile should be retained. Providing there is no further work on the site, it is recommended the remaining finds be discarded. The archive has been prepared in accordance with professional standards (AAF 2011) and the specific requirements of the Museum of London (MOL 2009).

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APPENDICES

Appendix 1. Finds catalogue

Context	Qty	Wgt (g)	Material	Object	Description	Spot Date
1006	1	3	Glass	Window	Small sherd of colourless glass, Th 2.8mm	Mod
1006	2	315	CBM	ENGS	salt-glazed, sherds from a sewer pipe	1700-1900
1006	1	161	Pottery (Rom)	HAD OX	flanged bowl, rim, burnt and very abraded	Rom
1006	12	681	Pottery (Mod)	REFW	includes adjoining sherds from two jars stamped 'MALING NEWCASTLE', various other sherds from tableware	1800-1900
1006	2	42	Pottery (Mod)	TPW3	rim sherds	1810-1900
1006	1	128	CBM	Roof Tile	red sandy fabric with a grey core, splashes of dark green glaze, Th 12mm	14th-15th
1007	1	70	Glass	Bottle	Cylindrical wine bottle. Hand finished base sherd, base diam 90mm. Green	1780-1820
1012	1	163	CBM	Brick	handmade, very abraded	LMedi?

Appendix C: Dendrochronology Assessment

Oxford Dendrochronology Laboratory
Report 2019/31

Report on 2 timber posts from Edmonton EcoPark, Laydown Area East, London

Dr D W H Miles FSA

Summary:

Two posts were excavated from Edmonton EcoPark by ADAS. The posts measured 0.43 m and 0.48 m long and are roughly 0.08 m in diameter. Both posts appear to have roughly pointed ends, while the top of the posts appeared to be splintered as though they were snapped, possibly during removal.

There were too few rings to allow dendrochronological analysis to be undertaken. No distinctive tool marks were discernible, and it was not possible to date the timber stylistically.

ECO19 – MH03 (1015) ECO19 – MH03 (1014)

Date sampled: 12th July 2019

Owner: Buckingham Group Contracting Ltd

Commissioner: Peter Vellet, ADAS

Historical Research:

Oxford Dendrochronology Laboratory
Mill Farm, Mapledurham, South Oxfordshire, RG4 7TX
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www.Oxford-DendroLab.com

October 2019

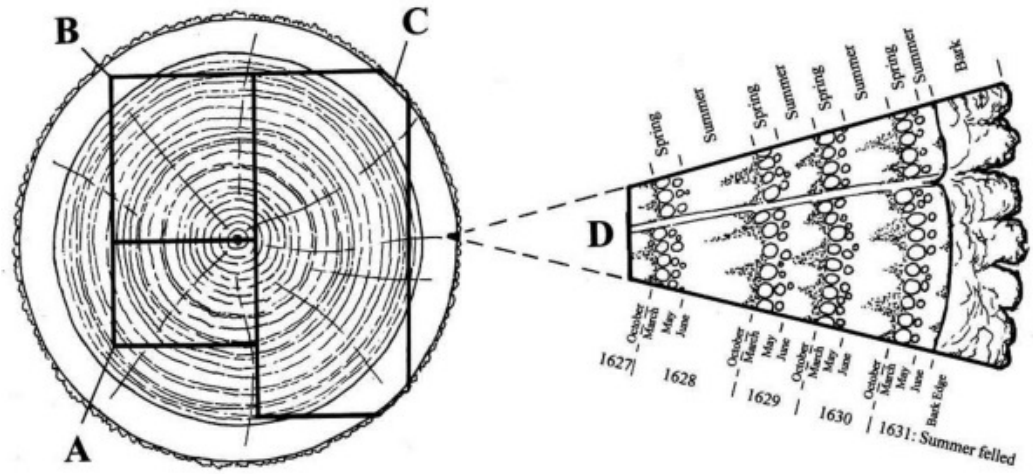
How Dendrochronology Works

Dendrochronology has over the past 30 years become one of the leading and most accurate scientific dating methods. Whilst not always successful, when it does work, it is precise, often to the season of the year. Tree-ring dating is well known for its use in dating historic buildings and archaeological timbers to this degree of precision. However more ancillary objects such as doors, furniture, panel paintings, and wooden boards in medieval book-bindings can sometimes be successfully dated.

The science of dendrochronology is based on a combination of biology and statistics. Fundamental to understanding how dendrochronology works is the phenomenon of tree growth. Essentially, trees grow through the addition of both elongation and radial increments. The elongation takes place at the terminal portions of the shoots, branches, and roots, while the radial increment is added by the cambium, the zone of living cells between the wood and the bark. In general terms, a tree can be best simplified by describing it as a cone, with a new layer being added to the outside each year in temperate zones, making it wider and taller.

An annual ring is composed of the growth which takes place during the spring and summer until about November when the leaves are shed and the tree becomes dormant for the winter period. For the European oak (*Quercus robur* and *Q. petraea*), as well as many other species, the annual ring is composed of two distinct parts - the spring growth or early wood, and the summer growth, or late wood. Early wood is composed of large vessels formed during the period of shoot growth which takes place between March and May, which is before the establishment of any significant leaf growth, and is produced by using most of the energy and raw materials laid down the previous year. Then, there is an abrupt change at the time of leaf expansion around May or June when hormonal activity dictates a change in the quality of the xylem and the summer, or late wood is formed. Here the wood becomes increasingly fibrous and contains much smaller vessels. Trees with this type of growth pattern are known as ring-porous, and are distinguished by the contrast between the open, light-coloured early wood vessels and the dense, darker-coloured late wood.

Dendrochronology utilises the variation in the width of the annual rings as influenced by climatic conditions common to a large area, as opposed to other more local factors such as woodland competition and insect attack. It is these climate-induced variations in ring widths that allow calendar dates to be ascribed to an undated timber when compared to a firmly-dated sequence which has shared a common period of growth with the sample being dated. If a tree section is complete to the bark edge, then when dated a precise date of felling can be determined. The felling date will be precise to the season of the year, depending on the degree of formation of the outermost ring. Therefore, a tree with bark which has the spring vessels formed but no summer growth can be said to have been felled in the spring, although it is not possible to say in which particular month the tree was felled.



Section of tree with conversion methods showing three types of sapwood retention resulting in **A** *terminus post quem*, **B** a felling date range, and **C** a precise felling date. Enlarged area **D** shows the outermost rings of the sapwood with growing seasons (Miles 1997, 42)

Another important consideration in dendrochronological studies is the presence (or absence) of sapwood. This is the band of growth rings immediately beneath the bark and comprises the living

growth rings which transport the sap from the roots to the leaves. This sapwood band is distinguished from the heartwood by the prominent features of colour change and the blocking of the spring vessels with tyloses, the waste products of the tree's growth. The heartwood is generally darker in colour, and the spring vessels are blocked with tyloses. The heartwood is dead tissue, whereas the sapwood is living, although the only really living, growing, cells are in the cambium, immediately beneath the bark. In European oak (*Quercus* spp), the difference in colour is generally matched by the change in the spring vessels. Generally the sapwood retains stored food and is therefore attractive to insect and fungal attack once the tree is felled and therefore is often removed during conversion.

Sapwood in European oaks tends to be of a relatively constant width and/or number of rings. By determining what this range is with an empirically or statistically-derived estimate is a valuable aspect in the interpretation of tree-ring dates where the bark edge is not present (Miles 1997). The narrower this range of sapwood rings, the more precise the estimated felling date range will be.

Methodology: The Dating Process

All timbers sampled were of oak (*Quercus* spp.) from what appeared to be primary first-use timbers, or any timbers which might have been re-used from an early phase. Those timbers which looked most suitable for dendrochronological purposes with complete sapwood or reasonably long ring sequences were selected. *In situ* timbers were sampled through coring, using a 16mm hollow auger. Details and locations of the samples are detailed in the summary table.

The dry samples were sanded on a linisher, or bench-mounted belt sander, using 60 to 1200 grit abrasive paper, and were cleaned with compressed air to allow the ring boundaries to be clearly distinguished. They were then measured under a x10/x30 microscope using a travelling stage electronically displaying displacement to a precision of 0.01mm. Thus each ring or year is represented by its measurement which is arranged as a series of ring-width indices within a data set, with the earliest ring being placed at the beginning of the series, and the latest or outermost ring concluding the data set.

The principle behind tree-ring dating is a simple one: the seasonal variations in climate-induced growth as reflected in the varying width of a series of measured annual rings is compared with other, previously dated ring sequences to allow precise dates to be ascribed to each ring. When an undated sample or site sequence is compared against a dated sequence, known as a reference chronology, an indication of how good the match is must be determined. Although it is almost impossible to define a visual match, computer comparisons can be accurately quantified. Whilst it may not be the best statistical indicator, a variant of the Student's (a pseudonym for W S Gosset) *t*-value has been widely used amongst British dendrochronologists. The cross-correlation algorithms most commonly used and published are derived from Baillie and Pilcher's CROS programme (Baillie and Pilcher 1973), although a faster version (Munro 1984) giving slightly different Baillie-Pilcher *t*-values is sometimes used for indicative purposes.

Generally, *t*-values over 3.5 should be considered to be significant, although in reality it is common to find demonstrably spurious t-values of 4 and 5 because more than one matching position is indicated. For this reason, dendrochronologists prefer to see some *t*-value ranges of 5, 6, or higher, and for these to be well replicated from different, independent chronologies with local and regional chronologies well represented. Users of dates also need to assess their validity critically. They should not have great faith in a date supported by a handful of *t*-values of 3's with one or two 4's, nor should they be entirely satisfied with a single high match of 5 or 6. Examples of spurious *t*-values in excess of 7 have been noted, so it is essential that matches with reference chronologies be well replicated, and that this is confirmed with visual matches between the two graphs. Matches with *t*-values of 10 or more between individual sequences usually signify samples having originated from the same parent tree.

In reality, the probability of a particular date being valid is itself a statistical measure depending on the *t*-values. Consideration must also be given to the length of the sequence being dated as well as those of the reference chronologies. A sample with 30 or 40 years growth is likely to match with high *t*-values at varying positions, whereas a sample with 100 consecutive rings is much more likely to match

significantly at only one unique position. Samples with ring counts as low as 50 may occasionally be dated, but only if the matches are very strong, clear and well replicated, with no other significant matching positions. This is essential for intra-site matching when dealing with such short sequences. Consideration should also be given to evaluating the reference chronology against which the samples have been matched: those with well-replicated components which are geographically near to the sampling site are given more weight than an individual site or sample from the opposite end of the country.

It is general practice to cross-match samples from within the same phase to each other first, combining them into a site master, before comparing with the reference chronologies. This has the advantage of averaging out the 'noise' of individual trees and is much more likely to obtain higher *t*-values and stronger visual matches. After measurement, the ring-width series for each sample is plotted as a graph of width against year on log-linear graph paper. The graphs of each of the samples in the phase under study are then compared visually at the positions indicated by the computer matching and, if found satisfactory and consistent, are averaged to form a mean curve for the site or phase. This mean curve and any unmatched individual sequences are compared against dated reference chronologies to obtain an absolute calendar date for each sequence. Sometimes, especially in urban situations, timbers may have come from different sources and fail to match each other, thus making the compilation of a site master difficult. In this situation samples must then be compared individually with the reference chronologies.

Therefore, when cross-matching samples with each other or against reference chronologies, a combination of both visual matching and a process of qualified statistical comparison by computer is used. The ring-width series were compared on an IBM compatible computer for statistical cross-matching using a variant of the Belfast CROS program (Baillie and Pilcher 1973). A version of this and other programmes were written in BASIC by D Haddon-Reece, and re-written in Microsoft Visual Basic by M R Allwright and P A Parker.

Summary of Assessment

Two timber posts were excavated. The first sample (ECO19 – MH03 (1015) had about 22 rings, and the second sample (ECO19 – MH03 (1014) had about 18 rings. Both samples contained the pith, and both appeared to have bark edge, although the first sample the outermost ring had been damaged during working or excavation.

Sample ECO19 – MH03 (1014) was found at TQ 36059 92489 at 2.90m bg1 to top of post (18 rings)
Sample ECO19 – MH03 (1015) was found at TQ 36059 92504 at 3.02m bg1 to top of post (22 rings)

The timbers were assessed for dendrochronological potential, but with far less than the minimum of 50 rings, there was no potential whatsoever for dating using standard dendrochronological methods.

The sections were sliced, and a disk frozen, after which it was prepared by planning to reveal the structure of the timber which could be inspected under the microscope. This has confirmed that the timber was indeed oak (*Quercus* spp.) and the timbers were both roundwood, most likely small branches. The diameters were between 80 – 90mm for (1014), and 90 – 100mm for (1015). The outermost 8 rings for (1014) and the outermost 6 rings for (1015) were sapwood. The centre section of the former had converted to heartwood and had turned black, whilst the innermost rings of the latter were lighter in colour and was in the process of turning into heartwood.

There were no distinctive woodworking marks on the main part of the timbers, the bark edge of (1014) was protected from damage by the bark, whereas the outer surface of (1015) did not have this protection and was abraded. They had been roughly chopped to a very blunt point with some sort of tool, but this was not preserved enough to be able to determine what sort of tool it was (see photographs below).

As to what the timbers were used for it is hard to say. It is unlikely to have been permanent fence posts as the majority of the timber would have been sapwood and would not have had much strength or

durability. Therefore, it was more likely to have been some sort of temporary or semi-permanent works of some sort.

As regards dating, the presence of 18 and 22 rings precluded any dendrochronological analysis. However, it would be possible to subject them to 14C analysis. Again, there being so few rings, it would not be feasible to wiggle-match two or more samples from the posts, therefore only one sample from each would at least give an indication of the historic period the timbers were initially used.

Acknowledgements

The dating was commissioned by Peter Vellet of ADAS on behalf of the owners.

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Top: ECO19 – MH03 (1015) Bottom: ECO19 – MH03 (1014)

Top: ECO19 – MH03 (1015) Bottom: ECO19 – MH03 (1014)

Top: ECO19 – MH03 (1015) Bottom: ECO19 – MH03 (1014)

ECO19 – MH03 (1015) ECO19 – MH03 (1014)

ECO19 – MH03 (1015) ECO19 – MH03 (1014)

ECO19 – MH03 (1015) ECO19 – MH03 (1014)

Appendix D: Geoarchaeological Fieldwork & Deposit Model Report

QUEST
QUATERNARY SCIENTIFIC

University of Reading

EDMONTON ECOPARK LAYDOWN AREA EAST, LOWER HILL LANE, ADVENT WAY, LONDON BOROUGH OF ENFIELD

Geoarchaeological Fieldwork & Deposit Model Report

NGR: TQ 3600 9240

Date: 12th July 2019

Written by: Dr C.R. Batchelor, Dr D.S. Young & Dr P. Lincoln

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CONTENTS

1. NON-TECHNICAL SUMMARY

A programme of geoarchaeological field investigations and deposit modelling was undertaken at Edmonton EcoPark, Laydown Area East, Lower Hall Lane, Advent Way, London Borough of Enfield in order to (1) clarify the nature of the sub-surface stratigraphy; (2) clarify the nature, depth, extent and possible date of any alluvium and organic/peat deposits; and (3) highlight the geoarchaeological and/or palaeoenvironmental potential of sequences obtained from the site.

The results of the geoarchaeological fieldwork and deposit modelling integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, have revealed a sequence of Late Devensian gravel, overlain by Holocene alluvial sediments (including sporadic Peat and Tufa deposits), capped by modern Made Ground.

Elsewhere in the nearby area, thicker Peat and Tufa deposits have been dated from the late Devensian (ca. 11,500 years ago) to the Bronze Age (ca. 4000 years ago). Such deposits have the potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate.

2. INTRODUCTION

2.1 Site context

This report summarises the findings arising out of the geoarchaeological fieldwork and deposit modelling undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Edmonton EcoPark, Laydown Area East, Lower Hall Lane, Advent Way, London, N18 3AG (National Grid Reference: TQ 3600 9240; Figures 1 & 2). Quaternary Scientific were commissioned by ADAS Ltd to undertake the geoarchaeological investigations. The site lies on the historic floodplain of the River Lea, lying in the lower valley of this river and bordered to the west by the River Lee Navigation, and the east by the diverted channel of the Lea. The site lies *ca*. 800m to the northwest of the Banbury Reservoir, and about 700m to the south of the William Girling Reservoir. The mouth of the River Lea (known as Bow Creek), at its confluence with the Thames, lies *ca*. 10km to the south. The British Geological Survey (1:50,000 Sheet 257 Romford 1996) shows the site underlain by Alluvium, described as comprising mainly sand, silt and clay with some gravel, resting on London Clay bedrock. In fact, the Holocene alluvium of the Lower Thames and its tributaries is almost everywhere underlain by Late Devensian Late Glacial Gravels (in the Lea valley, the Lea Valley Gravel of Gibbard, 1994).

The site lies within the area that has been investigated in the Lea Valley Mapping Project (Corcoran *et al*., 2011). In this project the Lea Valley has been divided into Landscape Zones characterised by their Holocene landscape history based largely on sedimentary evidence derived from borehole records. The Edmonton EcoPark, Laydown Area East site lies towards the eastern edge of Landscape Zone 4.5. In this Zone Corcoran *et al*. (2011) suggest that the Lea Valley Gravel surface lies at between *ca*. 7 and 9m OD, falling gradually from north to south. The areas of relatively low Gravel surface in this zone are described by Corcoran *et al*. (2011) as having the 'potential to preserve fine-grained deposits dating to the Late Pleistocene and Early Holocene', including Mesolithic peat horizons. Peat deposits are described as 'most common across a 1km area in LZ4.5 at the boundary with LZ4.4', *ca*. 500m to the north of the present site, 'at depths of a maximum of 2m'.

A geoarchaeological review of geotechnical records from a recent Site Investigation (by Harrison Group, 2017) and of the British Geological Survey (BGS) borehole archive (http://mapapps2.bgs.ac.uk/geoindex/home.html) (Young, 2019) indicates the site contains a sequence of London Clay bedrock overlain by Alluvium and Made Ground. This is consistent with that recorded by Corcoran *et al*. (2011) in Landscape Zone 4.5, with similar levels for the surface of the underlying Lea Valley Gravel (7.17 to 9.20m OD), and the alluvial sequence is in places described as 'organic' (TP2) or containing 'pockets of peat' (TP7 & TP8) (Figure 2).

2.2 Palaeoenvironmental and archaeological significance

The geotechnical records from the site thus indicate some variation in the height of the underlying gravel, and the type, thickness and potential age of the subsequent Holocene alluvial deposits (including peat) within the vicinity of the site. Such variations are significant as they represent different environmental conditions that would have existed in a given location. For example: (1) the varying surface of the gravel may represent the location of former channels and bars; (2) the presence of peat represents former terrestrial or semi-terrestrial land-surfaces, and (3) the alluvium represents periods of channel activity or changing hydrological conditions. Thus by studying the sub-surface stratigraphy across the site and wider area in more detail, it will be possible to build our understanding of the former landscapes and environmental changes that took place across space and time.

Organic-rich sediments (in particular peat) have high potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate. Significant vegetation changes include the Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the Late Neolithic/Early Bronze Age growth of elm on peat, and the general decline of wetland and dryland woodland during the Bronze Age. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating. Most locally, investigations carried out at Advent Way (Green et al., 2006) revealed thick deposits of marl, peat and tufa dating to the early Holocene (early Mesolithic) and the transition from cold climatic conditions of the Late Devensian to fully temperate conditions of the early Holocene.

Finally, areas of high gravel topography, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition).

2.3 Aims and objectives

On the basis of the geoarchaeological and palaeoenvironmental potential of the sequences, further investigation is warranted. Two geoarchaeological boreholes were therefore recommended as part of the geoarchaeological review (Young, 2019), targeted on the area of TP7/TP8 (QBH1) and distributed evenly across the site for deposit modelling purposes (QBH2). In addition, an archaeological watching brief on site groundworks was undertaken in tandem with the geoarchaeological works (Figure 3). The results of this exercise will be used to enhance the results of the deposit modelling.

Four research aims relevant to the geoarchaeological investigations are proposed:

1. To clarify the nature of the sub-surface stratigraphy;
2. To clarify the nature, depth, extent and possible date of any alluvium and organic/peat deposits;
3. To investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity;
4. To investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland);

In order to address the first two of these aims, the following objectives were undertaken:

1. To obtain two boreholes sequences from pre-determined locations
2. To describe the new boreholes under both field and laboratory-based conditions;
3. To use the stratigraphic data from new (both geoarchaeological and archaeological), and existing records to produce a deposit model of the major depositional units across the site, and characterise the sequence in more detail;
4. To assess the significance and potential of the collected sequences

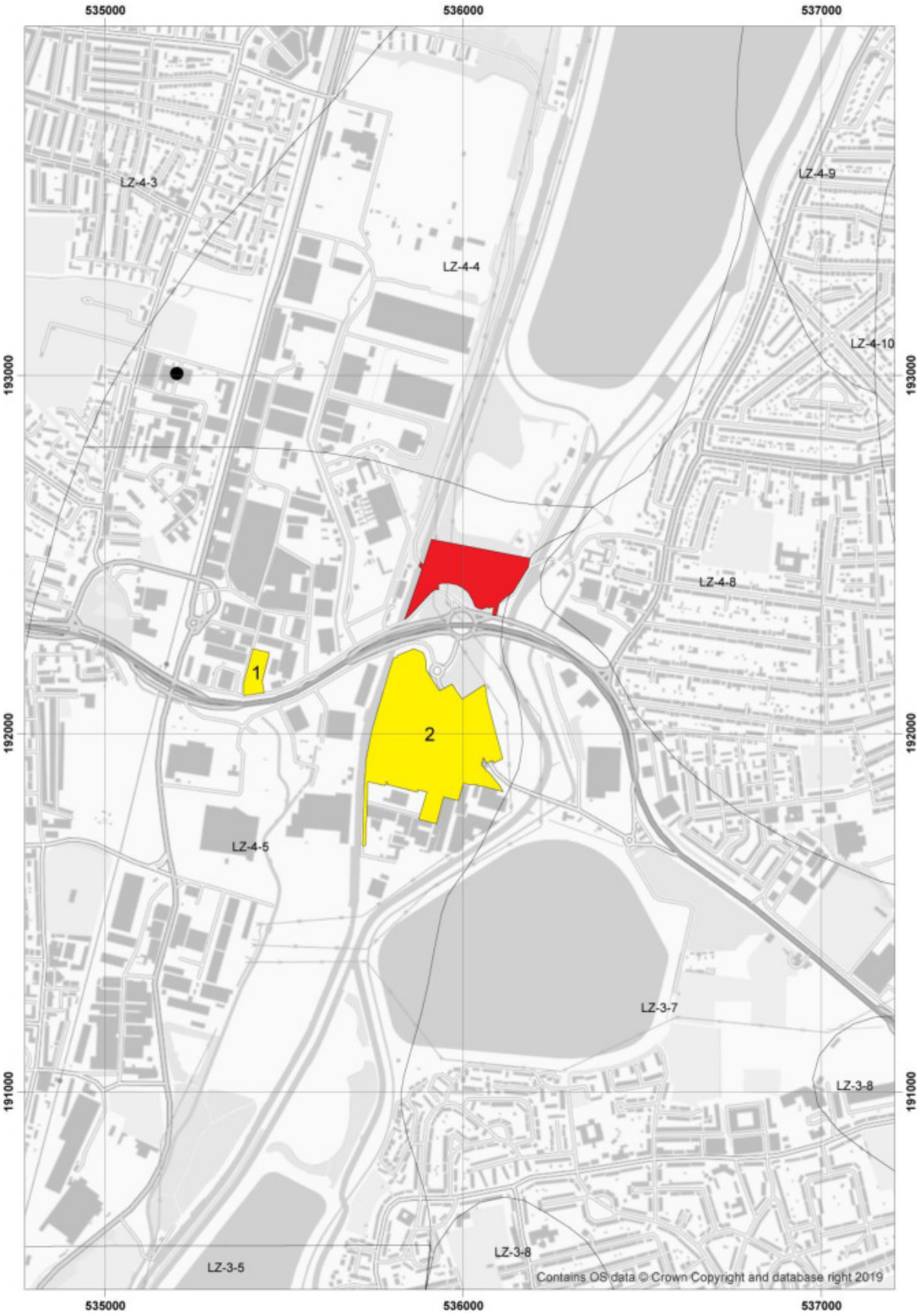

Figure 1: Location of the site at Edmonton EcoPark, Laydown Area East (red), and selected nearby sites: (1) Advent Way (Green et al., 2006), Stonehill Business Park (Young, 2014) and (3) Angel Road Pit (Waren, 1916). Showing the location of the proposed geoarchaeological boreholes and Corcoran *et al.* (2011) Landscape Zones (data provided by Museum of London Archaeology).

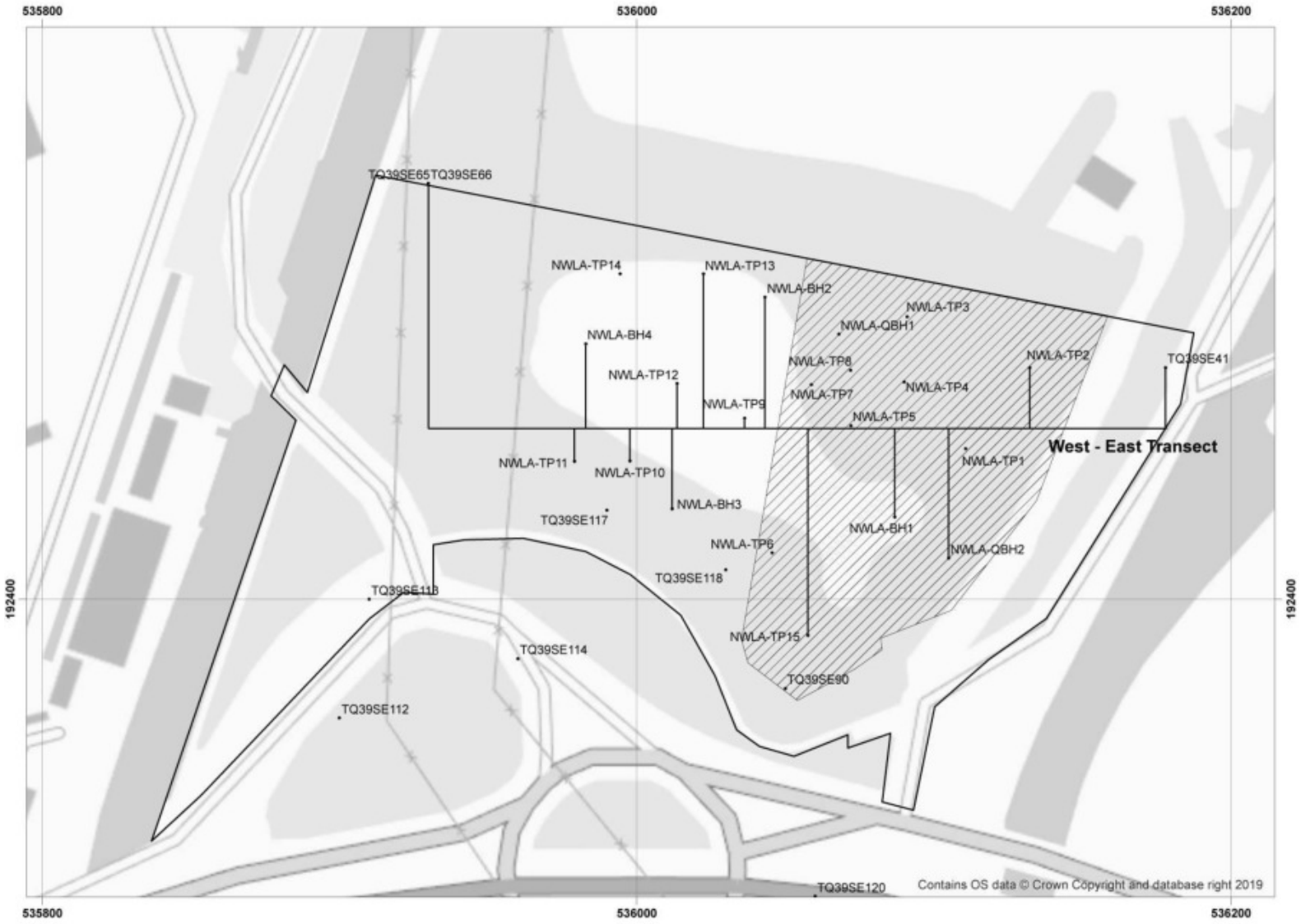

Figure 2: Location of the existing geotechnical records at the Laydown Area East site

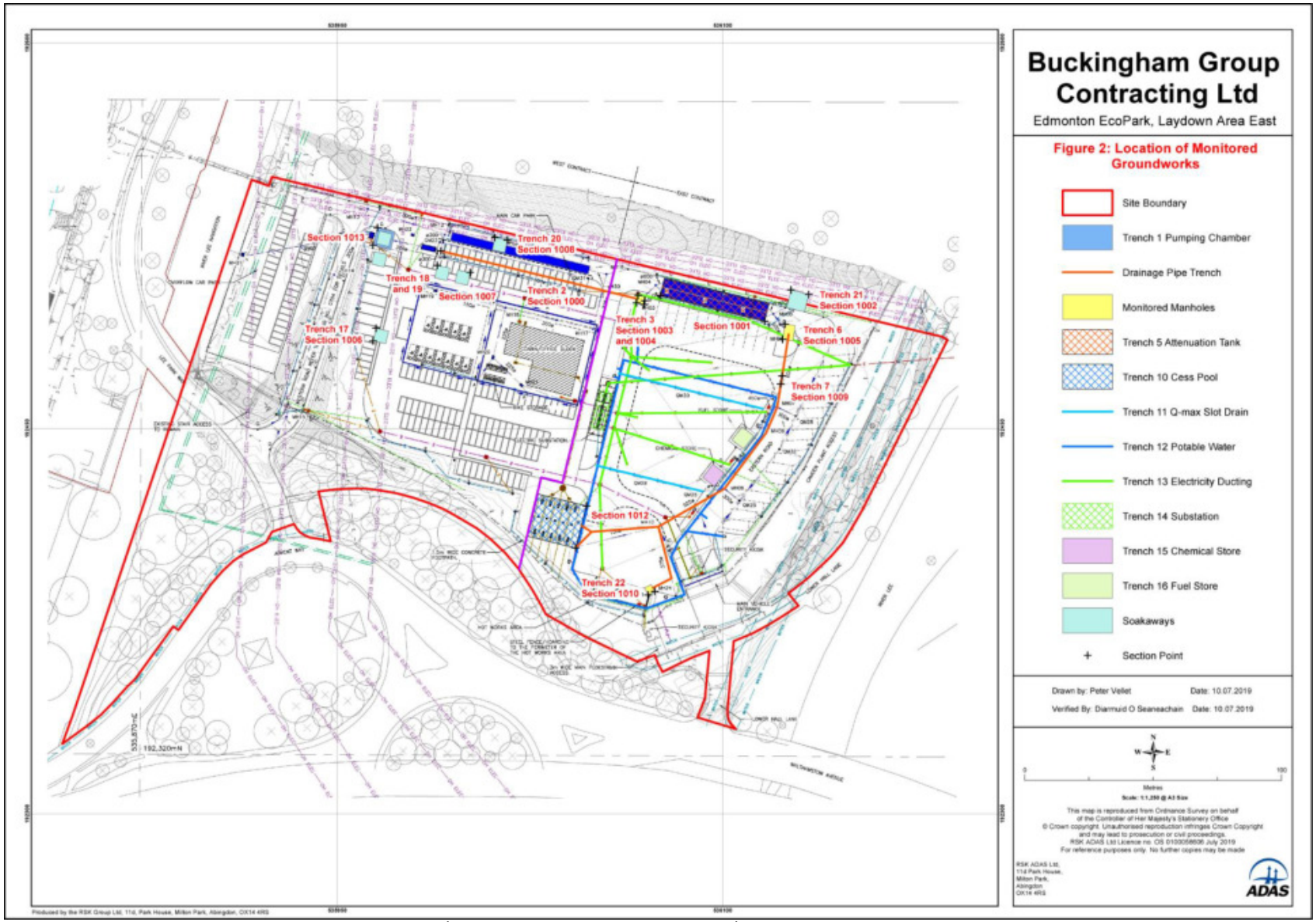

Figure 3: Location of Monitored Groundworks (reproduced from ADAS, 2019)

3. METHODS

3.1 Field investigations

A total of two geoarchaeological boreholes (QBH1 to QBH2) were put down at the site by Quaternary Scientific (University of Reading) in May 2019 (see Table 1 and Figure 2). The borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring technique is a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The spatial data for the new geoarchaeological boreholes were recorded by the developer using a DGPS and are displayed in Table 1.

Table 1: Spatial data for the new geoarchaeological boreholes at Edmonton EcoPark, Laydown Area East

Name	Easting	Northing	Elevation (m OD)	Total depth (m)
QBH1	536068.034	192489.220	10.924	4
QBH2	536104.954	192413.824	10.199	3

3.2 Lithostratigraphic descriptions

The lithostratigraphy of the core samples was described in the field or laboratory using standard procedures for recording unconsolidated sediment and organic sediments, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts) (Tröels-Smith, 1955). The procedure involved: (1) cleaning the sample using a scalpel; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel (Grana glareosa; Gg), fine sand (Grana arenosa; Ga), silt (Argilla granosa; Ag) and clay (Argilla steatoides); (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse. The results of the lithostratigraphic descriptions of the boreholes are displayed in Tables 2 to 5.

3.3 Deposit modelling

The deposit model was based on a review of 27 borehole and test-pit records from the site (see Figure 2), incorporating the 2 new geoarchaeological boreholes, 19 geotechnical records and 6 British Geological Survey (BGS) online archive boreholes (http://mapapps2.bgs.ac.uk/geoindex/home.html). Further records were incorporated from the nearby area, including the sites of Advent Way (Green et al., 2006) and Stonehill Business Estate (Young, 2014). Deposit modelling was undertaken following the guidelines in Carey *et al.*, (2018). The deposit modelling was undertaken using RockWorks 16 geological utilities software and ArcMap 10.4. The term 'deposit modelling' describes any method used to depict the sub-surface arrangement of geological deposits, but particularly the use of computer software to create contoured maps or three dimensional representations of contacts between stratigraphic units. The first requirement is to classify the recorded borehole sequences into uniformly identifiable stratigraphic units. At the Tayfen Road site, the sedimentary units were classified into five groupings: (1) Bedrock, (2) Gravel, (3) Peat, (4) Alluvium and (5) Made Ground. A two-dimensional stratigraphic profile was generated for selected sequences across the site along a west-east transect (Figure 4). Models of surface

height (using an inverse-distance weighted (IDW) algorithm with a 50m cut-off filter) were generated for the Bedrock (Figure 5), Gravel (Figure 6), and Alluvium (Figure 8), with thickness models for the Peat (Figure 7), Total Alluvium (Figure 9) and Made Ground (Figures 10).

How effectively Rockworks portrays the relief features of stratigraphic contacts or the thickness of sediment bodies depends on the number of data points (boreholes/test pits) per unit area, and the extent to which these points are evenly distributed across the area of interest. The portrayal is also affected by the significance assigned to these data points, in terms of the extent of the area around the point to which the data are deemed to apply. This can be predetermined for each data set, and in the present case the value chosen for each data point (borehole) is equivalent to an area of 50m radius for all models (the 'cut-off filter'). The boreholes are relatively well distributed over the area of investigation. In general, reliability improves towards the core area of boreholes where mutually supportive data are likely to be available from several adjacent data points. Reliability is also affected by the quality of the stratigraphic records, which in turn are affected by the nature of the sediments and/or their post-depositional disturbance during previous stages of land-use on the site. Finally, because of the 'smoothing' effect of the modelling procedure, the modelled levels of stratigraphic contacts may differ slightly from the levels recorded in borehole logs.

4. RESULTS & INTERPRETATION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS & DEPOSIT MODELLING

The results of the lithostratigraphic descriptions of boreholes QBH1 to QBH1 are shown in Tables 2 and 3, with a two-dimensional stratigraphic profile for selected sequences across the site along a west-east transect shown in Figure 4. Deposit models for the surface elevation and thickness of selected units are shown in Figures 5 to 10.

The full sequence of sediments at the Laydown Area East site includes:

Made Ground (widely present)
Alluvium (widely present; in places described as organic)
Peat (sporadically present)
Gravel (the Lea Valley Gravel)
Bedrock (London Clay)

4.1 London Clay

Within the Laydown Area East part of the site the surface of the underlying bedrock (the London Clay) is recorded at 5.09m OD in borehole BH1; the remainder of the interventions within this area did not reach the bedrock, although it is recorded at similar levels of between 5.26 (BH4) and 5.46m OD (BH2) elsewhere, indicating a gentle slope towards the southeast (Figures 4 & 5). A British Geological Survey (BGS) borehole (TQ39SE90) records the surface of the bedrock at 6m OD in the south-eastern area of the site, although elevation data for this borehole is approximate and is not considered reliable here. More widely, the surface of the London Clay is recorded between 4 and 6m OD, rising to 9m OD towards the far east of the modelled area (TQ39SE130). This rise marks the edge of the Lea Valley floodplain as mapped by the BGS.

4.2 Lea Valley Gravel

The bedrock at the site is overlain by a unit of sandy gravel, interpreted here as the Lea Valley Gravel of Gibbard (1985), deposited during the Late Devensian (10-15,000 years before present) within a high energy braided river environment. Within Laydown Area East, the surface of this unit is relatively even in the context of a braided river environment, recorded at between 7.14 (NWLA-QBH1; Table 2) / 7.28 (NWLA-QBH2; Table 3) and 8.45m OD (TP5) (Figures 4 & 6). Across the rest of the site, the Gravel surface is recorded at between 7.17 (TP13) and 9.20m OD (TQ39SE65).

Across the wider modelled area, the Gravel surface undulates further; lower surfaces are recorded just to the south of the EcoPark site at 6.5m OD in TQ39SE120, on the eastern part of the Stonehill Business Park site between 6.7 and 7.0m OD (e.g. SHQBH2, SHQBH4) and on the Advent Way site at 6m OD (e.g. AW-BH1 & BH3). High surfaces between 9 and 10m OD are recorded towards the north and south of Stonehill Business Park (e.g. TQ39SE469, SHBH3) and in select BGS boreholes towards the south-east (e.g. TQ39SE153).

4.4 Peat and Tufa

Units of Peat and Tufa are sporadically recorded across the modelled area, immediately overlying the Gravel surface. Peats are indicative of a transition towards semi-terrestrial (marshy) conditions on the floodplain, supporting the growth of sedge fen/reed swamp and/or woodland communities across the floodplain. By comparison, tufa deposits suggest development in a quiet water environment in which episodes of more active water movement were regularly experienced. Formation in a substantial shallow lake occupying a depression on the floodplain seems likely, probably at a distance from the main channel of the river but subject to regular flooding.

In Laydown Area East, a relatively thin complex of Peat and Tufa was recorded in new geoarchaeological borehole NWLA-QBH2 measuring 32cm in thickness (Figures 4 & 7). Distinct Peat horizons were also recorded in TQ39SE41 and TQ39SE117 on the EcoPark site each measuring around 60cm in thickness. Pockets or lenses of Peat were also recorded in the lowermost part of the Alluvium (see 4.4) during the geotechnical (e.g. TP7 & TP8) and archaeological watching brief (e.g. context 1011; Trench 21 – see Figure 3) (ADAS, 2019). Where these are recorded within Laydown Area East, they are generally present between 2.00 and 3.00m below ground level (bgl).

Across the wider area, thin Peat horizons are sporadically recorded in borehole records to the south of the site in BGS boreholes and on the Stonehill Business Park site (e.g. TQ39SE114, TQ39SE112, TQ39SE109, SHCP3, TQ39SE358 & TQ39SE360). Thicker Peat units and substantial horizons of Tufa are more commonly recorded further east however. On the Advent Way site, these reach between 1 and 2m in thickness (Figure 7), and radiocarbon dating of these horizons indicate they date to between *ca*. 11,500 and 4000 cal BP equating to the beginning of the Mesolithic to Bronze Age (or early to middle Holocene) (Green et al., 2006). These results provide a suggestion of the possible age of the far thinner Peat and Tufa deposits recorded sporadically on the current site.

Whether the Peat and Tufa deposits were originally more widespread across the site and wider modelled area is unknown. Greater accumulations may for example have been eroded by subsequent human activity, and/or as the River Lea migrated across the floodplain during the course of the Holocene. Indeed, the 1914 OS map indicates a former course of the Lea traversed the site from north to south across the western part of Laydown Area East (Figure 11).

4.3 Alluvium

Overlying the Peat (where present) or Lea Valley Gravel elsewhere across the site and wider area, are deposits of Holocene Alluvium, typical of accumulation on the floodplain, derived from either low to moderate energy fluvial activity (sandy/gravelly material) or at a distance from any active channels (silty or clayey material). The alluvium is generally mineral rich, and often coarse-grained (sandy and in places slightly gravelly). As above, certain sequences from the Laydown Area East are described as organic (TP2) or containing pockets of peat (TP7 and TP8). In the wider area of the site, organic or peaty sediments are also described in test pits TP10 and TP12.

The geoarchaeological boreholes and archaeological watching brief also reveal that these alluvial deposits sometimes contain finds such as pottery, CBM and glass akin, suggesting that at least some of the Alluvial deposits may date to the post-medieval period. It should be highlighted, that as a result of this, distinguishing the alluvium from the overlying Made Ground in certain records is not always a straight-forward task.

The surface of the alluvium is recorded at between 8.23 (TP3) and 9.97m OD (TP4) within Laydown Area East, and between 8.34 (TP9) and 9.56m OD (TP11) across the rest of the site. This is a similar range of heights to that recorded across the wider modelled area (Figure 8).

The combined thickness of the Peat / Tufa (outlined above) and Alluvium varies between ca. 0.5 and 2m across Laydown Area East and up to 3m elsewhere across the modelled area (e.g. Advent Way site) (Figure 9).

4.4 Made Ground

A unit of modern Made Ground caps the alluvial sequence, in thicknesses of between 1.0 (TP4) and 3.0m (TP3) (Figure 10). In places the Made Ground directly overlies the Gravel, entirely truncating the alluvial sequence (e.g. QBH1, TP6). It is of note that both of these locations lie within the confines of the projected former channel traversing the site (Figure 11). Thus, these Made Ground deposits may be the result of infilling rather than truncation.

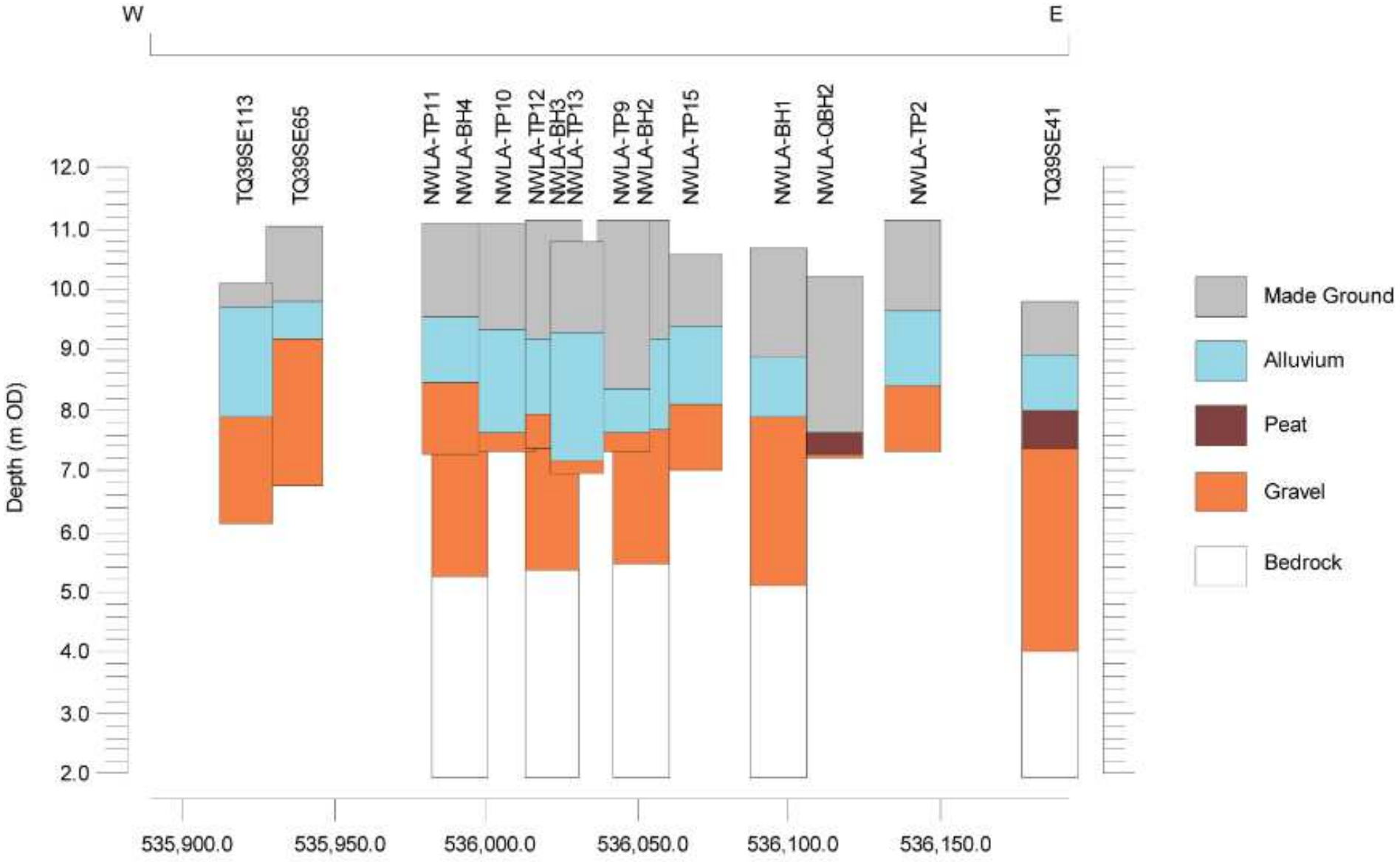

Figure 4: West-East transect of selected sequences across the site.

Figure 5: Surface of the Bedrock (m OD)

Figure 6: Surface of the Gravel (m OD)

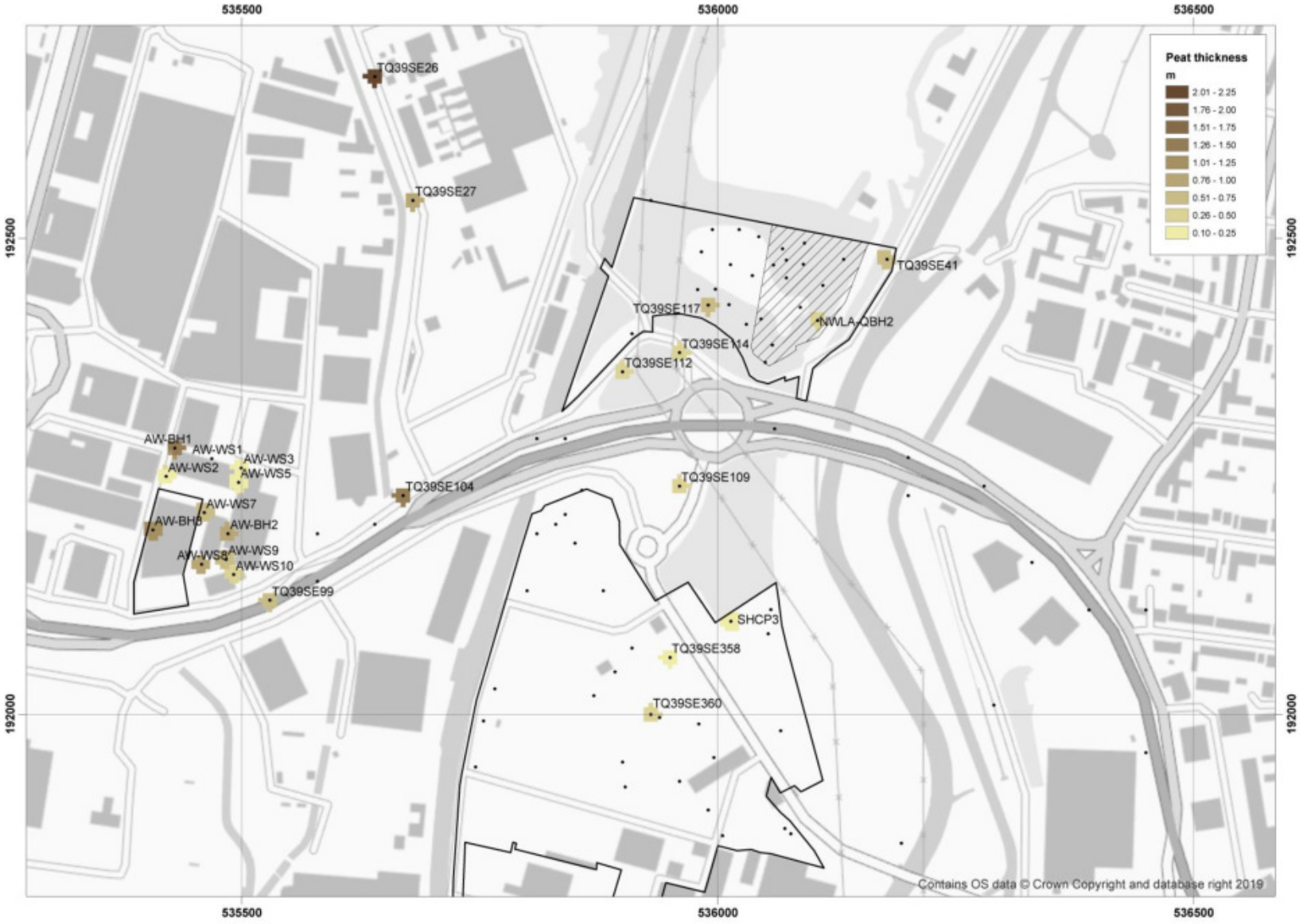

Figure 7: Thickness of the Peat (m)

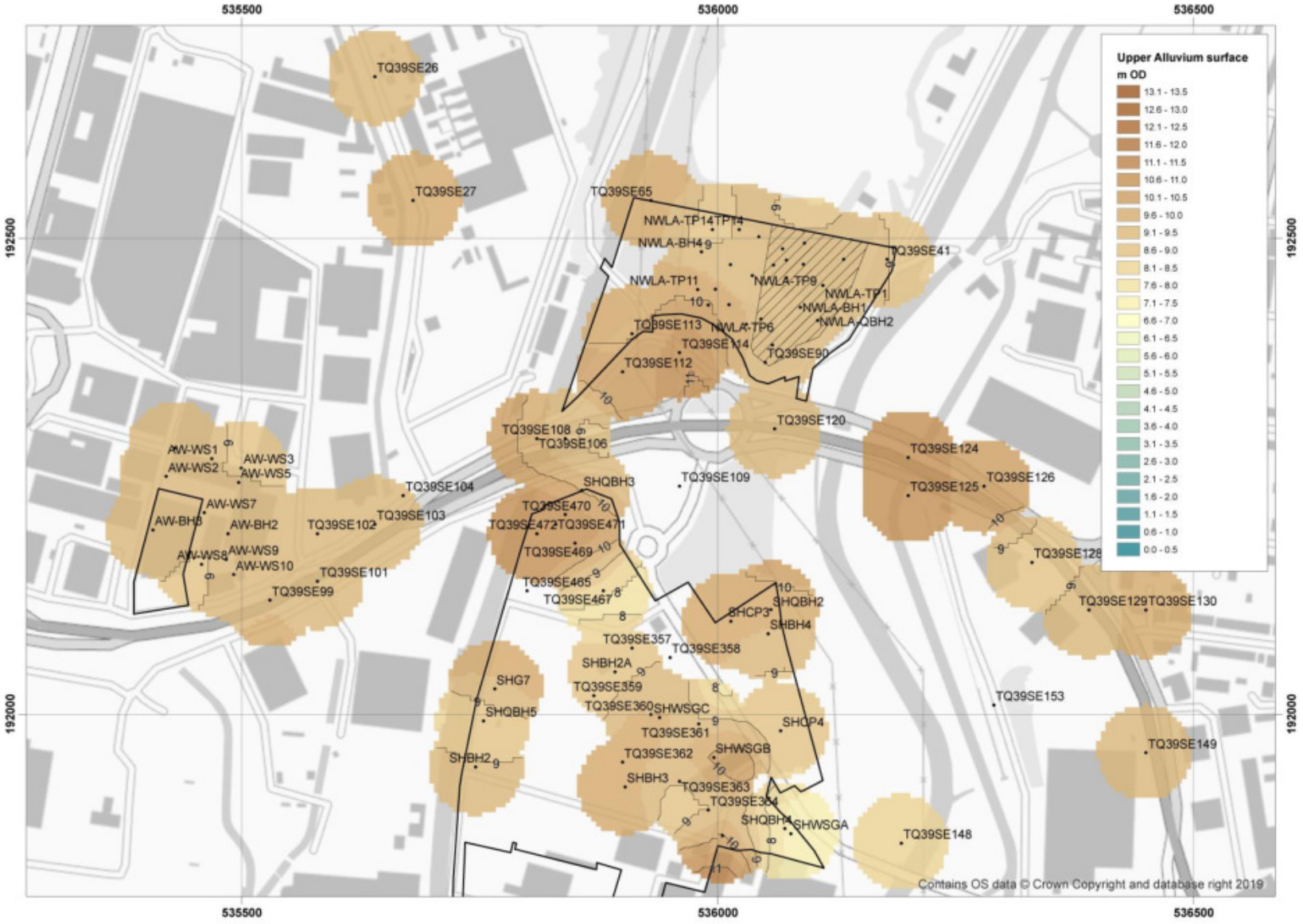

Figure 8: Surface of the Alluvium (m OD)

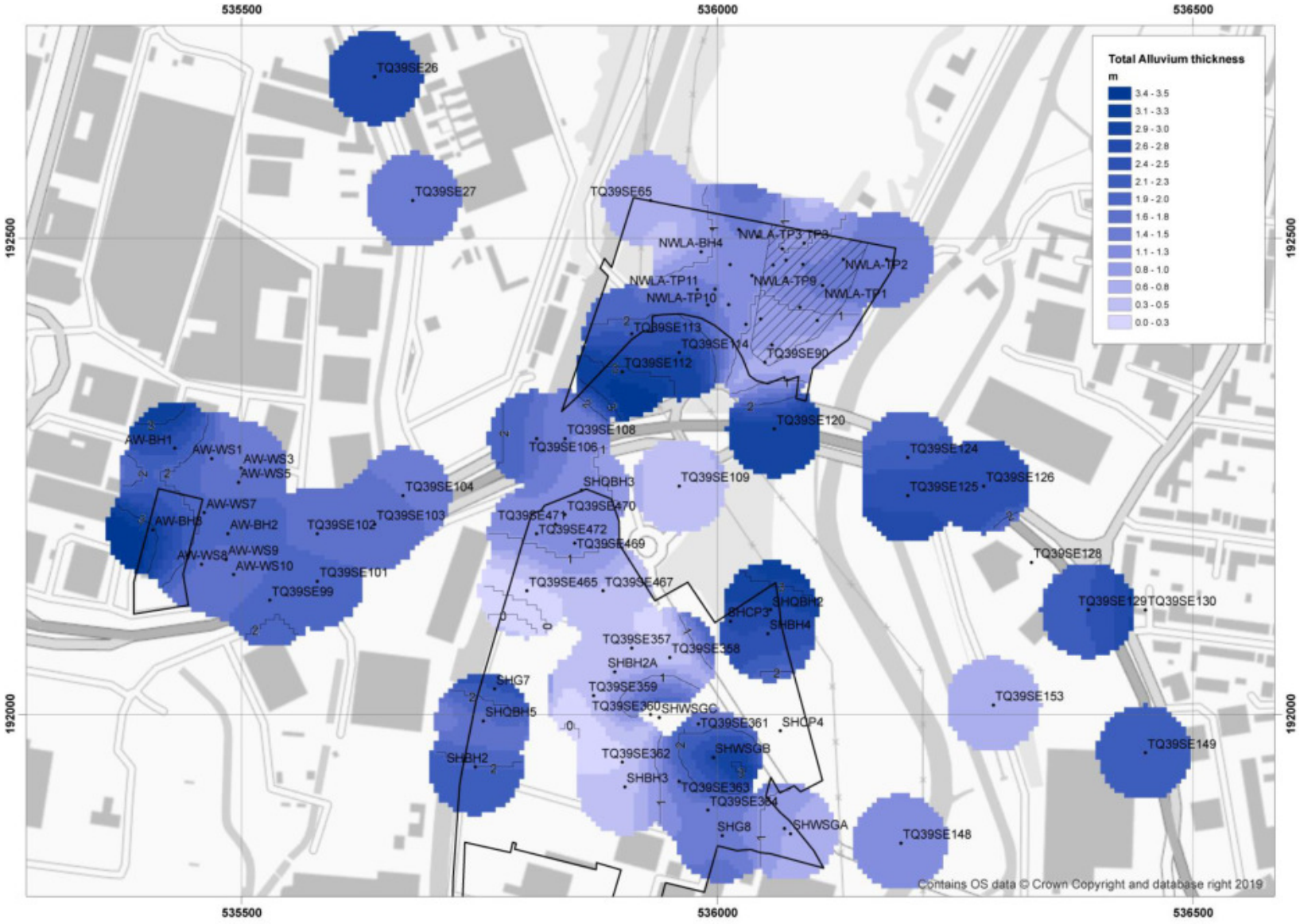

Figure 9: Thickness of the Total Alluvium (m)

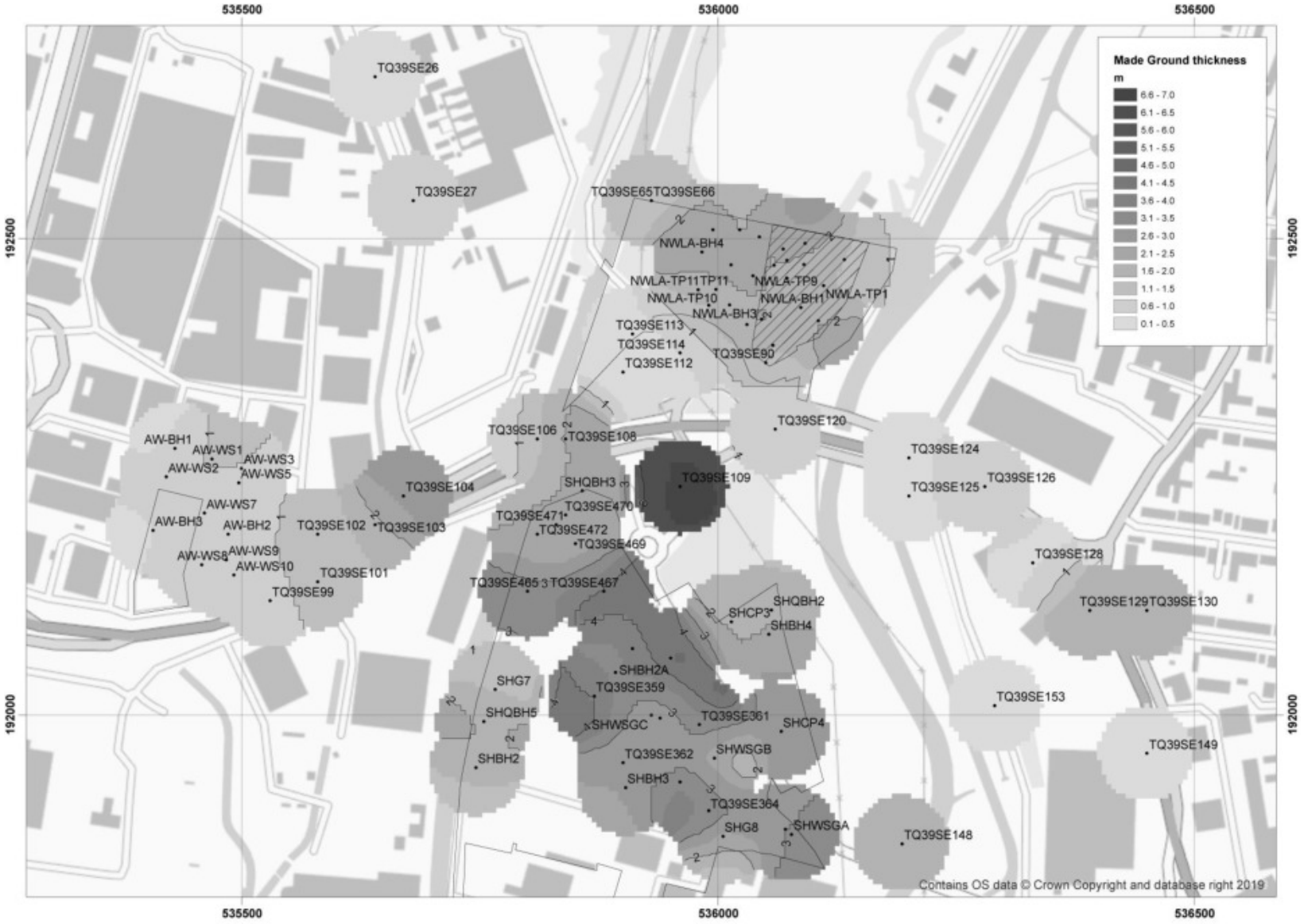

Figure 10: Thickness of the Made Ground (m)

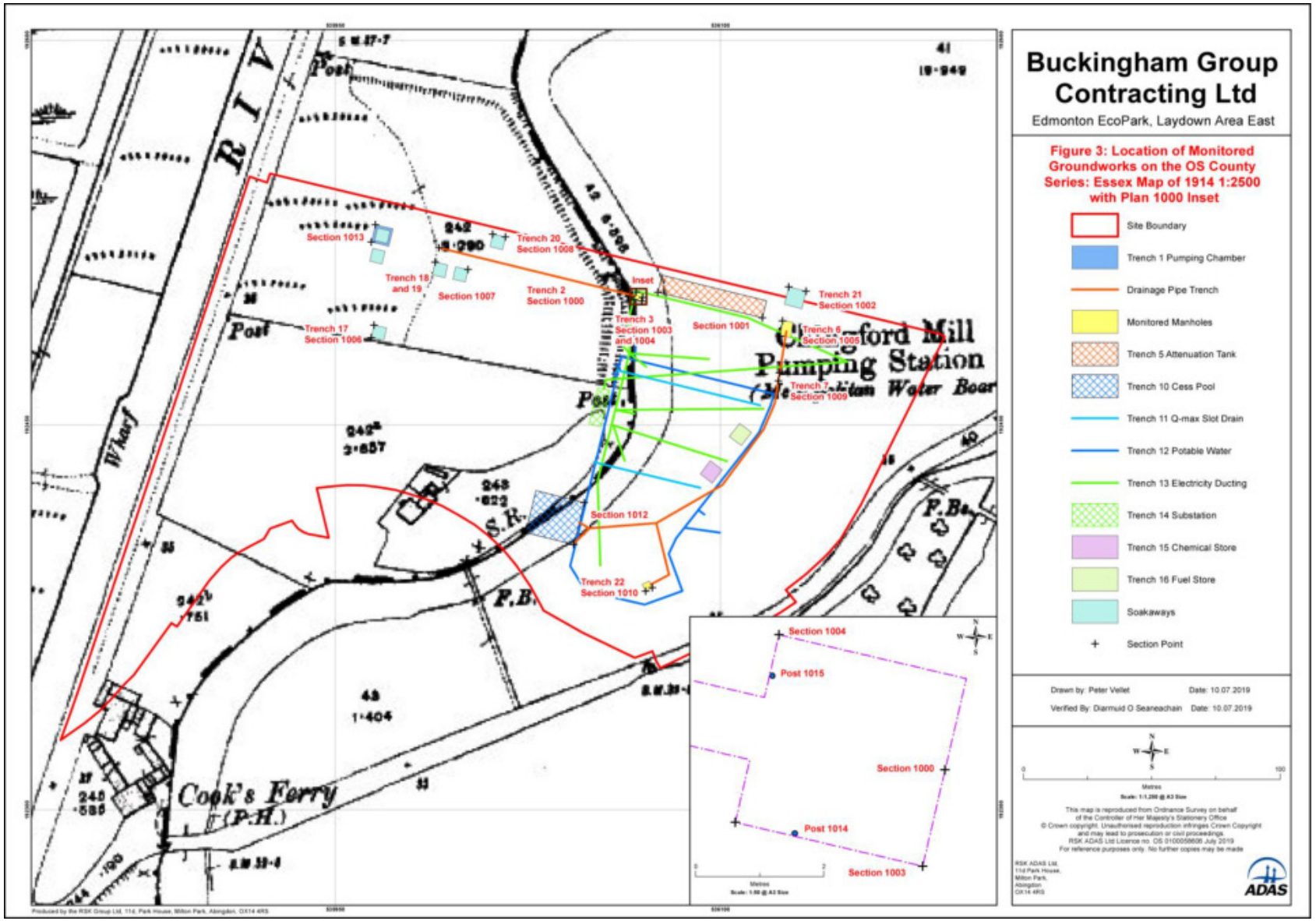

Figure 11: Location of Monitored Groundworks on the OS County Series: Essex Map of 1914 1:2500 with Plan 1000 Inset (reproduced from ADAS, 2019)

Table 2: Results of the lithostratigraphic descriptions of borehole QBH1

Depth (m OD)	Depth (m bgl)	Description	Interpretation
10.92 to 9.75	0.00 to 1.17	Made ground	MADE GROUND
9.75 to 9.56	1.17 to 1.36	10YR 4/3; As2 Ga1 Gs1 Gg+; Brown gravelly sandy clay with organic detritus and brick fragments. Sharp contact into:	
9.56 to 9.13	1.36 to 1.79	10YR 5/4 to 10YR 5/2; As3 Ag1 Gs+ Gg+; Yellowish to greyish brown silty clay containing brick and charcoal. Sharp contact into:	
9.13 to 8.92	1.79 to 2.00	10YR 2/2; Sh2 Ga1 Ag1 As+ Gg+; Very dark brown diamict with brick, charcoal and ceramic.	
8.92 to 8.85	2.00 to 2.07	10YR 2/2; Sh2 Ga1 Ag1 As+ Gg+; Very dark brown diamict with brick and charcoal. Sharp contact into:	
8.85 to 7.92	2.07 to 3.00	10 YR 4/2; Ag3 As1 Ga+ Gg+ Dg+; dark greyish brown clayey sandy silt with gastropod shells and brick fragments.	
7.92 to 7.67	3.00 to 3.25	VOID	
7.67 to 7.51	3.25 to 3.41	10YR 4/2; Ag3 As1 Ga+ Gg+ Dg+; dark greyish brown clayey sandy silt with gastropod shells and brick fragments. Sharp contact into:	
7.51 to 7.14	3.41 to 3.78	5Y 4/1; Gg3 As1 Ga+; Gray clayey clast-supported gravel containing brick fragments. Sharp contact into:	
7.14 to 6.92	3.78 to 4.00	2.5Y 4/3; Gg3 Gs1; Sand and gravel	LEA VALLEY GRAVEL

Table 3: Results of the lithostratigraphic descriptions of borehole QBH2

Depth (m OD)	Depth (m bgl)	Description	Interpretation
10.19 to 8.54	0.00 to 1.65	10YR 4/3; As3 Ag1 Gg+ Ga+ Brown silty sandy clay with isolated gravel clasts. Sharp and sub-horizontal contact into:	MADE GROUND
8.54 to 8.30	1.65 to 1.89	2.5Y 4/3; Gs2 Gg2 As+; Olive brown gravelly coarse sand. Sharp and sub-horizontal contact into:	ALLUVIUM
8.30 to 8.19	1.89 to 2.00	2.5Y 4/2; As3 Ag1 Ga+; Dark greyish brown silty sandy clay. Sharp contact into:	
8.19 to 8.09	2.00 to 2.10	10YR 4/3; As3 Ag1 Gg+ Ga+ Brown silty sandy clay with isolated gravel clasts. Sharp and sub-horizontal contact into:	
8.09 to 7.95	2.10 to 2.24	2.5Y 5/1; Gs2 Gg2; Gray sand and gravel. Sharp sub-horizontal contact into:	
7.95 to 7.91	2.24 to 2.28	2.5Y 4/3; Gs2 Gg2 As+; Gravelly coarse sand. Sharp contact into:	
7.91 to 7.60	2.28 to 2.59	5Y 3/2; As2 Ga1 Gg1 Ag+; Dark olive grey diamict consisting of sandy gravelly clay. Sharp contact into:	
7.60 to 7.45	2.59 to 2.74	2.5Y 6/3; Gs2 Ga2 Gg+ Dg+; Light yellowish brown friable carbonate-rich sand with isolated gravel clasts and gastropod shells. Sharp contact into:	TUFA SANDS
7.45 to 7.41	2.74 to 2.78	5Y 3/2; Sh3 Ag1 Dh+ Gg+ humo 3; dark olive grey well humified silty peat containing herbaceous material and isolated gravel clasts. Sharp contact into:	PEAT
7.41 to 7.39	2.78 to 2.80	5Y 6/2; Ga3 Gs1 Dg+; Light olive grey friable carbonate-rich sand with gastropod shells. Sharp contact into:	TUFA SANDS
7.39 to 7.34	2.80 to 2.85	5Y 4/2; Sh2 Ga1 Gs+ Dg+; Gravel-rich well humified sandy peat containing highly	PEAT

Depth (m OD)	Depth (m bgl)	Description	Interpretation
		fragmented gastropod shells. Sharp contact into:	
7.34 to 7.28	2.85 to 2.91	5Y 3/2; Sh3 Ag1 Dh+ humo 4; Dark olive grey very well humified sandy silty peat. Sharp contact into:	
7.28 to 7.19	2.91 to 3.00	2.5Y 4/3; Gg2 Gs2; Olive brown sand and gravel.	LEA VALLEY GRAVEL

5. DISCUSSION & CONCLUSIONS

The aim of the geoarchaeological investigations at the Laydown Area East site were to (1) to clarify the nature of the sub-surface stratigraphy; (2) to clarify the nature, depth, extent and possible date of any alluvium and organic/peat deposits; and (3) highlight the geoarchaeological and/or palaeoenvironmental potential of sequences obtained from the site. The results of the geoarchaeological fieldwork and deposit modelling integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, have revealed a sequence of Late Devensian gravel, overlain by Holocene alluvial sediments (including sporadic peat and tufa deposits), capped by modern Made Ground.

The results of the modelling indicate that the Late Devensian Lea Valley Gravel surface across the EcoPark (and specifically Laydown Area East) ranges between 7.17 and 9.2m OD, falling within the range of heights provided by Corcoran et al. (2011) for Landscape Zone 4.5. Across the wider modelled area however, the surface varies between *ca.* 6.0 and 9.9m OD; more than indicated by the Corcoran et al. model. The higher and low gravel surfaces are likely to represent islands and channels on the floodplain respectively; typical of a braided river environment.

Thin deposits of Peat and Tufa sporadically overlie the Gravel on the eastern part of Laydown Area East and the EcoPark site, and more widely across the modelled area to the south and west. Up to 3m of these deposits are recorded on the Advent Way site, dating from the Late Devensian to Bronze Age period. These dates provide a suggestion of the potential age of the deposits on the current site. Furthermore, as highlighted in section 2.2, organic-rich sediments (in particular peat) have high potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate.

The Alluvium overlying the Lea Valley Gravel or Peat (where present) generally varies between 0.5 and 2m thick. It is typical of accumulation on the floodplain, derived from either low to moderate energy fluvial activity (sandy/gravelly material) or at a distance from any active channels (silty or clayey material). It occasionally includes peat lenses and/or anthropogenic material such as CBM, pottery and ceramic. As such it seems likely that at least some of the alluvium dates to the post medieval period.

Made Ground caps the sequence, occasionally resting directly on the Lea Valley Gravel Those sequences in which the Made Ground rests directly on the Lea Valley Gravel tends to be within the confines of a former course of the Lea which is mapped as traversing the site from north to south across the western part of Laydown Area East.

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Appendix E: Geoarchaeological & Palaeoenvironmental Assessment Report

QUEST
QUATERNARY SCIENTIFIC

University of Reading

EDMONTON ECOPARK LAYDOWN AREA EAST, LOWER HILL LANE, ADVENT WAY, LONDON BOROUGH OF ENFIELD

Geoarchaeological & Palaeoenvironmental Assessment Report

NGR: TQ 3600 9240

Date: 16th October 2020

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CONTENTS

1. NON-TECHNICAL SUMMARY

Following the results of the geoarchaeological borehole survey and deposit modelling at the Edmonton EcoPark, Laydown Area East site (Batchelor et al., 2019), a programme of geoarchaeological and palaeoenvironmental assessment was undertaken in order to (1) investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity; (2) investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland); and (3) make recommendations for any further palaeoenvironmental analysis.

The results of the geoarchaeological fieldwork and deposit modelling integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, have revealed a sequence of Late Devensian gravel, overlain by Holocene alluvial sediments (including sporadic Peat and Tufa deposits), capped by modern Made Ground. A single radiocarbon date from the top of the Peat suggests that accumulation took place during the Neolithic period, most likely over a period of up to a few hundred years. By comparison, up to 3m of these deposits are recorded on the nearby Advent Way site, dating from the Late Devensian to Bronze Age period. During the period of Peat formation, the floodplain surface was dominated by alder carr woodland with willow, and an understorey of sedges and grasses and aquatics. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime.

However, on the basis of the limited concentration and preservation of palaeoenvironmental remains, and the absence of: (1) further material suitable for radiocarbon dating, (2) any evidence for anthropogenic activity, and (3) any evidence for palaeoenvironmental change during the period of peat formation, no further work is recommended. However, the results from the combined geoarchaeological and palaeoenvironmental investigations have provided valuable insights into the landscape, vegetation and hydrological history of the site, which can be integrated with future work on the EcoPark site and nearby area.

2. INTRODUCTION

2.1 Site context

This report summarises the findings arising out of the geoarchaeological and palaeoenvironmental assessment undertaken by Quaternary Scientific (University of Reading) in connection with the proposed development of land at Edmonton EcoPark, Laydown Area East, Lower Hall Lane, Advent Way, London, N18 3AG (National Grid Reference: TQ 3600 9240; Figures 1 & 2). Quaternary Scientific were commissioned by ADAS Ltd to undertake the geoarchaeological investigations. The site lies on the historic floodplain of the River Lea, lying in the lower valley of this river and bordered to the west by the River Lee Navigation, and the east by the diverted channel of the Lea. The site lies *ca*. 800m to the northwest of the Banbury Reservoir, and about 700m to the south of the William Girling Reservoir. The mouth of the River Lea (known as Bow Creek), at its confluence with the Thames, lies *ca*. 10km to the south. The British Geological Survey (1:50,000 Sheet 257 Romford 1996) shows the site underlain by Alluvium, described as comprising mainly sand, silt and clay with some gravel, resting on London Clay bedrock. In fact, the Holocene alluvium of the Lower Thames and its tributaries is almost everywhere underlain by Late Devensian Late Glacial Gravels (in the Lea valley, the Lea Valley Gravel of Gibbard, 1994).

The site lies within the area that has been investigated in the Lea Valley Mapping Project (Corcoran *et al.*, 2011). In this project the Lea Valley has been divided into Landscape Zones characterised by their Holocene landscape history based largely on sedimentary evidence derived from borehole records. The Edmonton EcoPark, Laydown Area East site lies towards the eastern edge of Landscape Zone 4.5. In this Zone Corcoran *et al*. (2011) suggest that the Lea Valley Gravel surface lies at between *ca*. 7 and 9m OD, falling gradually from north to south. The areas of relatively low Gravel surface in this zone are described by Corcoran *et al*. (2011) as having the 'potential to preserve fine-grained deposits dating to the Late Pleistocene and Early Holocene', including Mesolithic peat horizons. Peat deposits are described as 'most common across a 1km area in LZ4.5 at the boundary with LZ4.4', *ca*. 500m to the north of the present site, 'at depths of a maximum of 2m'.

The results of a recent geoarchaeological fieldwork and deposit modelling exercise (Batchelor et al., 2019) integrating the results of previous geotechnical investigations and concurrent archaeological watching brief, have revealed Late Devensian Gravels, the surface of which range between 7.2 and 9.2m OD across the EcoPark (and specifically Laydown Area East). These are within the range of heights provided by Corcoran et al. (2011) for Landscape Zone 4.5. Across the wider modelled area however, the surface varies between *ca*. 6.0 and 9.9m OD; more than indicated by the Corcoran et al. model. The Gravels are overlain by Holocene alluvial sediments (including sporadic Peat and Tufa deposits), capped by modern Made Ground. Elsewhere in the nearby area, thicker Peat and Tufa deposits have been dated from the late Devensian (ca. 11,500 years ago) to the Bronze Age (ca. 4000 years ago).

2.2 Palaeoenvironmental and archaeological significance

Previous work on the site thus indicates some variation in the height of the underlying gravel, and the type, thickness and potential age of the subsequent Holocene alluvial deposits (including peat). Such variations are significant as they represent different environmental conditions that would have existed in a given location. For example: (1) the varying surface of the gravel may represent the location of former channels and bars; (2) the presence of peat represents former terrestrial or semi-terrestrial land-surfaces, and (3) the alluvium represents periods of channel activity or changing hydrological conditions. Thus by studying the sub-surface stratigraphy across the site and wider area in more detail, it will be possible to build our understanding of the former landscapes and environmental changes that took place across space and time.

The Holocene alluvial deposits, and in particular the peat and tufa, have the potential to provide a detailed reconstruction of past environments on both the wetland and dryland. In particular, they provide the potential to increase knowledge and understanding of the interactions between hydrology, human activity, vegetation succession and climate. Significant vegetation changes include the Mesolithic/Neolithic decline of elm woodland, the Neolithic colonisation and decline of yew woodland; the Late Neolithic/Early Bronze Age growth of elm on peat, and the general decline of wetland and dryland woodland during the Bronze Age. Such investigations are carried out through the assessment/analysis of palaeoecological remains (e.g. pollen, plant macrofossils & insects) and radiocarbon dating. Most locally, investigations carried out at Advent Way (Green et al., 2006) revealed thick deposits of marl, peat and tufa dating to the early Holocene (early Mesolithic) and the transition from cold climatic conditions of the Late Devensian to fully temperate conditions of the early Holocene.

Finally, areas of high gravel topography, soils and peat represent potential areas that might have been utilised or even occupied by prehistoric people, evidence of which may be preserved in the archaeological (e.g. features and structures) and palaeoenvironmental record (e.g. changes in vegetation composition).

2.3 Aims and objectives

On the basis of the geoarchaeological and palaeoenvironmental potential of the sequences, further investigation is warranted. Two geoarchaeological boreholes were therefore recommended as part of the geoarchaeological review (Young, 2019), targeted on the area of TP7/TP8 (NLWA-QBH1) and distributed evenly across the site for deposit modelling purposes (NLWA-QBH2). In addition, an archaeological watching brief on site groundworks was undertaken in tandem with the geoarchaeological works (Figure 3). The results of this exercise will be used to enhance the results of the deposit modelling.

Four research aims relevant to the geoarchaeological investigations are proposed:

1. To clarify the nature of the sub-surface stratigraphy;
2. To clarify the nature, depth, extent and possible date of any alluvium and organic/peat deposits;
3. To investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity;
4. To investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland);

The first two of these aims were predominantly fulfilled during the previous geoarchaeological fieldwork and deposit modelling stage (Batchelor et al., 2019). This report seeks to date the deposits and fulfil the remaining aims of the project. In order to do this, the following objectives were undertaken:

1. To radiocarbon date the base and top of the peat/tufa deposits in order to ascertain the age of peat accumulation and cessation;
2. To assess the palaeobotanical remains (pollen, waterlogged wood and seeds) to establish their concentration and preservation, and to provide a provisional reconstruction of the vegetation history of the site;
3. To assess the diatoms to establish their concentration and preservation, and to provide an indication of the palaeohydrology (e.g. marine, brackish or freshwater) of the site
4. To assess the zooarchaeological remains (insects, Ostracoda and Mollusca) to establish their concentration and preservation, and to provide information on the general environmental conditions, climatic change and hydrology of the site.

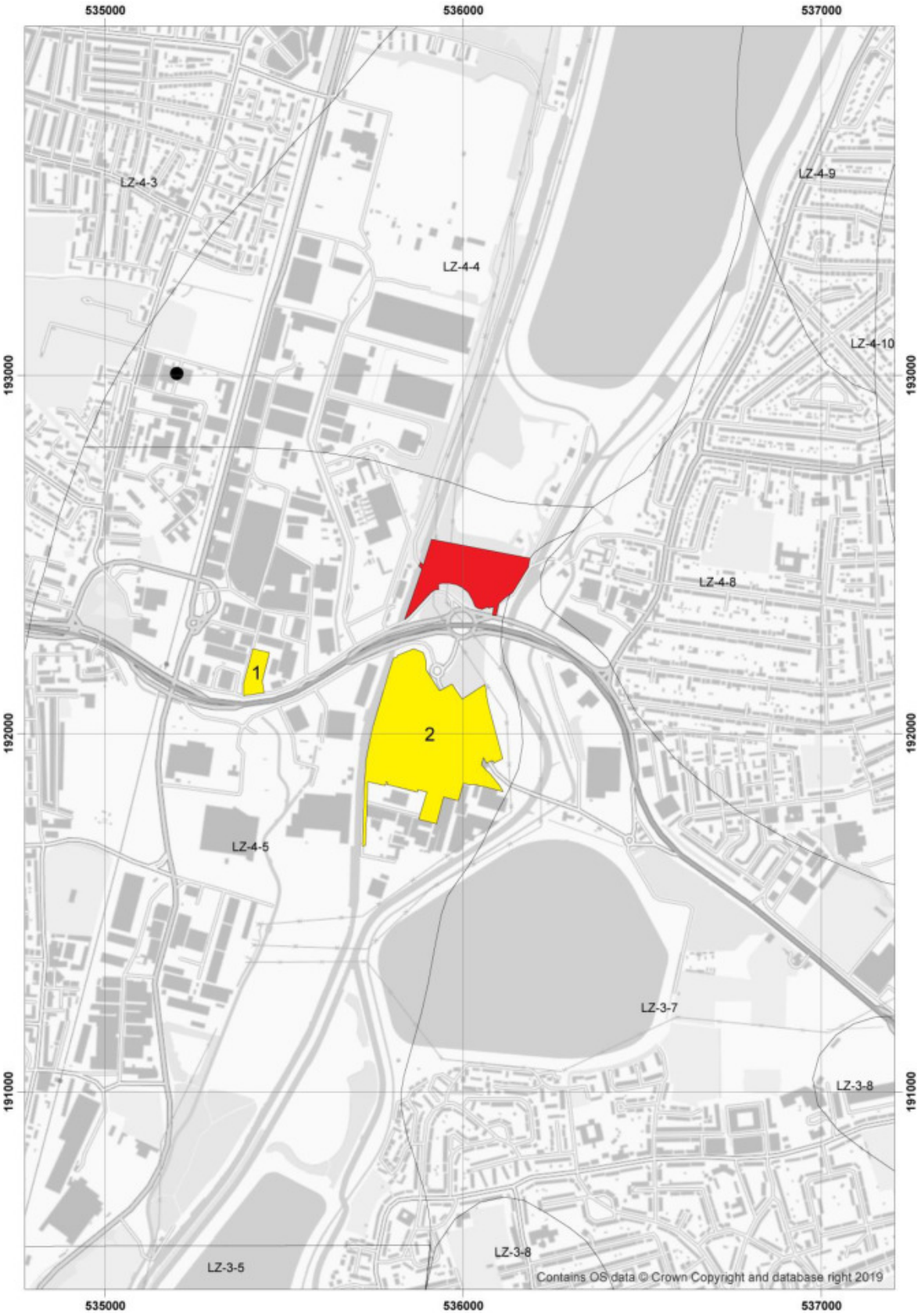

Figure 1: Location of the site at Edmonton EcoPark, Laydown Area East (red), and selected nearby sites: (1) Advent Way (Green et al., 2006), Stonehill Business Park (Young, 2014) and (3) Angel Road Pit (Waren, 1916). Showing the location of the proposed geoarchaeological boreholes and Corcoran *et al.* (2011) Landscape Zones (data provided by Museum of London Archaeology).

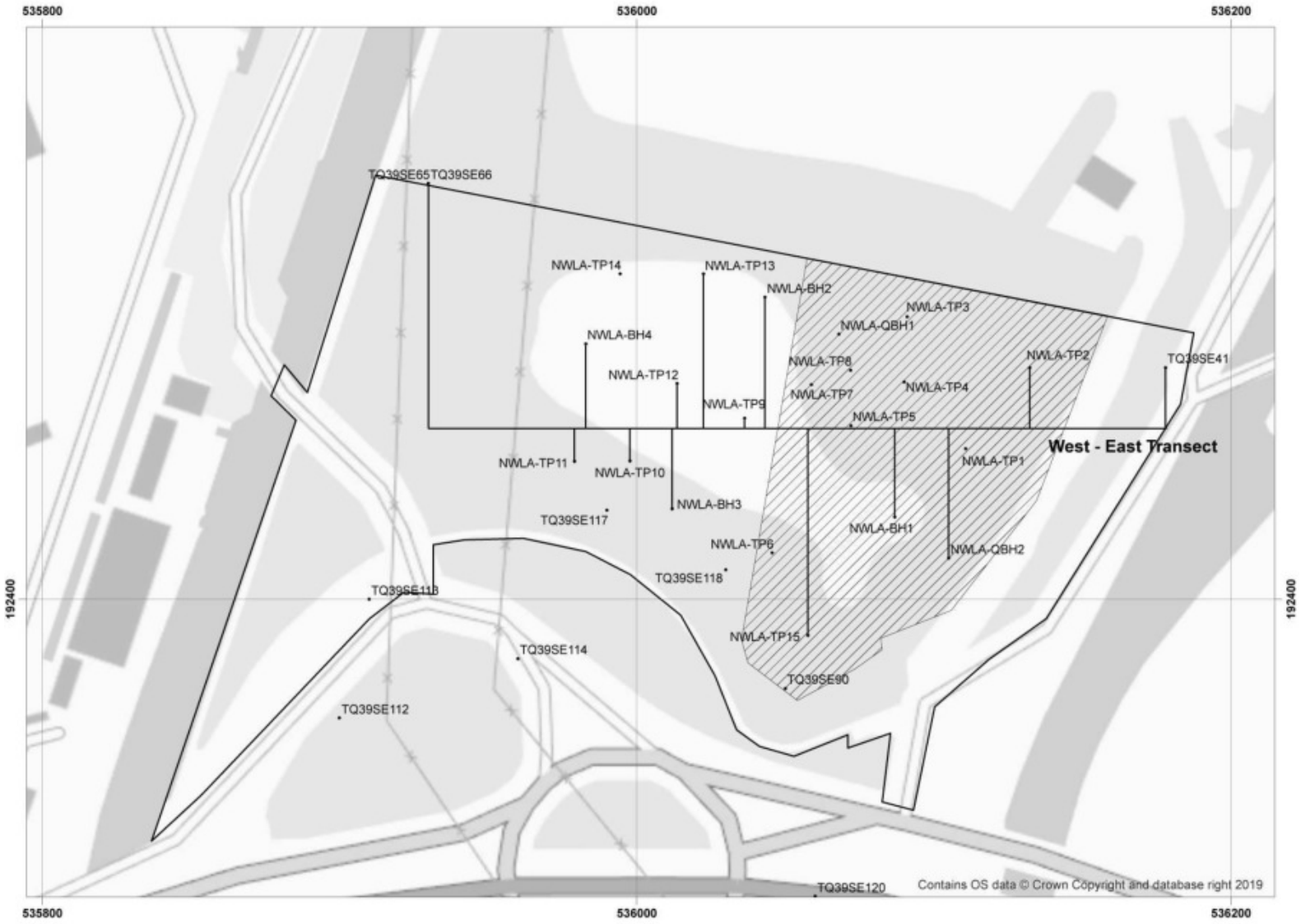

Figure 2: Location of the existing geotechnical records at the Laydown Area East site

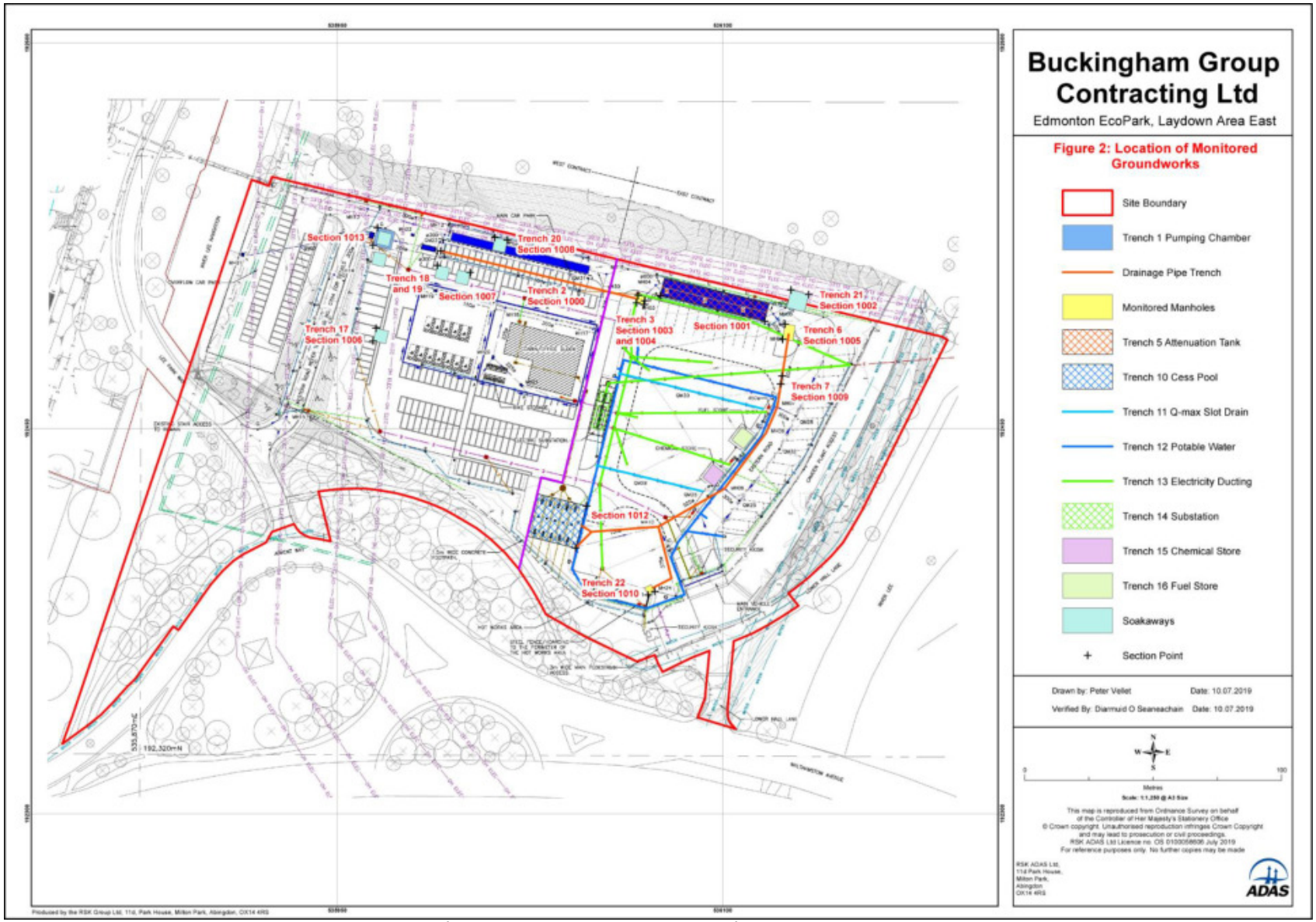

Figure 3: Location of Monitored Groundworks (reproduced from ADAS, 2019)

3. METHODS

3.1 Field investigations

A total of two geoarchaeological boreholes (NLWA-QBH1 to NLWA-QBH2) were put down at the site by Quaternary Scientific (University of Reading) in May 2019 (see Table 1 and Figure 2). The borehole core samples were recovered using an Eijkelkamp window sampler and gouge set using an Atlas Copco TT 2-stroke percussion engine. This coring technique is a suitable method for the recovery of continuous, undisturbed core samples and provides sub-samples suitable for not only sedimentary and microfossil assessment and analysis, but also macrofossil analysis. The spatial data for the new geoarchaeological boreholes were recorded by the developer using a DGPS and are displayed in Table 1.

Table 1: Spatial data for the new geoarchaeological boreholes at Edmonton EcoPark, Laydown Area East

Name	Easting	Northing	Elevation (m OD)	Total depth (m)
NLWA-QBH1	536068.034	192489.220	10.924	4
NL-WA QBH2	536104.954	192413.824	10.199	3

3.2 Lithostratigraphic descriptions

The lithostratigraphy of the core samples was described in the field or laboratory using standard procedures for recording unconsolidated sediment and organic sediments, noting the physical properties (colour), composition (gravel, sand, clay, silt and organic matter) and inclusions (e.g. artefacts) (Tröels-Smith, 1955). The procedure involved: (1) cleaning the sample using a scalpel; (2) recording the physical properties, most notably colour using a Munsell Soil Colour Chart; (3) recording the composition; gravel (Grana glareosa; Gg), fine sand (Grana arenosa; Ga), silt (Argilla granosa; Ag) and clay (Argilla steatoides); (4) recording the degree of peat humification and (5) recording the unit boundaries e.g. sharp or diffuse. The results of the lithostratigraphic descriptions of the boreholes are displayed in Tables 2 to 5.

3.3 Deposit modelling

The deposit model was based on a review of 27 borehole and test-pit records from the site (see Figure 2), incorporating the 2 new geoarchaeological boreholes, 19 geotechnical records and 6 British Geological Survey (BGS) online archive boreholes (http://mapapps2.bgs.ac.uk/geoindex/home.html). Further records were incorporated from the nearby area, including the sites of Advent Way (Green et al., 2006) and Stonehill Business Estate (Young, 2014). Deposit modelling was undertaken following the guidelines in Carey *et al.*, (2018). The deposit modelling was undertaken using RockWorks 16 geological utilities software and ArcMap 10.4. The term 'deposit modelling' describes any method used to depict the sub-surface arrangement of geological deposits, but particularly the use of computer software to create contoured maps or three dimensional representations of contacts between stratigraphic units. The first requirement is to classify the recorded borehole sequences into uniformly identifiable stratigraphic units. At the Tayfen Road site, the sedimentary units were classified into five groupings: (1) Bedrock, (2) Gravel, (3) Peat, (4) Alluvium and (5) Made Ground. A two-dimensional stratigraphic profile was generated for selected sequences across the site along a west-east transect (Figure 4). Models of surface

height (using an inverse-distance weighted (IDW) algorithm with a 50m cut-off filter) were generated for the Bedrock (Figure 5), Gravel (Figure 6), and Alluvium (Figure 8), with thickness models for the Peat (Figure 7), Total Alluvium (Figure 9) and Made Ground (Figures 10).

How effectively Rockworks portrays the relief features of stratigraphic contacts or the thickness of sediment bodies depends on the number of data points (boreholes/test pits) per unit area, and the extent to which these points are evenly distributed across the area of interest. The portrayal is also affected by the significance assigned to these data points, in terms of the extent of the area around the point to which the data are deemed to apply. This can be predetermined for each data set, and in the present case the value chosen for each data point (borehole) is equivalent to an area of 50m radius for all models (the 'cut-off filter'). The boreholes are relatively well distributed over the area of investigation. In general, reliability improves towards the core area of boreholes where mutually supportive data are likely to be available from several adjacent data points. Reliability is also affected by the quality of the stratigraphic records, which in turn are affected by the nature of the sediments and/or their post-depositional disturbance during previous stages of land-use on the site. Finally, because of the 'smoothing' effect of the modelling procedure, the modelled levels of stratigraphic contacts may differ slightly from the levels recorded in borehole logs.

3.4 Radiocarbon dating

Due to an absence of suitable material, only one sample of waterlogged twig wood was submitted from NLWA-QBH2 for radiocarbon dating from the middle of the Peat at 7.44m OD. The sample was submitted for AMS radiocarbon dating to the BETA Analytic Radiocarbon Dating Facility, Miami, Florida. The results have been calibrated using OxCal v4.2 (Bronk Ramsey, 1995; 2001) and the IntCal13 atmospheric curve (Reimer *et al.,* 2020). The results are displayed in Table 4 & Figure 4.

3.5 Pollen assessment

Five subsamples from borehole NLWA-QBH2 were extracted for an assessment of pollen content. The pollen was extracted as follows: (1) sampling a standard volume of sediment (1ml); (2) adding one tablet of the exotic clubmoss *Lycopodium clavatum* to provide a measure of pollen concentration in each sample; (3) deflocculation of the sample in 1% Sodium pyrophosphate; (4) sieving of the sample to remove coarse mineral and organic fractions (>125µ); (5) acetolysis; (6) removal of finer minerogenic fraction using Sodium polytungstate (specific gravity of 2.0g/cm^3); (7) mounting of the sample in glycerol jelly. Each stage of the procedure was preceded and followed by thorough sample cleaning in filtered distilled water. Quality control is maintained by periodic checking of residues, and assembling sample batches from various depths to test for systematic laboratory effects. Pollen grains and spores were identified using the University of Reading pollen type collection and the following sources of keys and photographs: Moore *et al* (1991); Reille (1992). The assessment procedure consisted of scanning the prepared slides, and recording the concentration and preservation of pollen grains and spores, and the principal taxa on four transects (10% of the slide) (Table 5).

3.6 Diatom assessment

A total of four samples from borehole NLWA-QBH2 were submitted for an assessment of diatom presence. 0.5g of sediment was required for the diatom sample preparation. Depending on the dominance of either minerogenics or organics, samples chosen for assessment were first treated with sodium hexametaphosphate and left overnight, to assist in minerogenic deflocculation. Samples were then treated with hydrogen peroxide (30% solution) to remove organic material. Samples were finally sieved using a 10µm mesh to remove fine minerogenic sediments. The residue was transferred to a plastic vial, from which a slide was prepared for subsequent assessment. A minimum of four slide traverses were undertaken across each slide sample. The results of the assessment are displayed in Table 6.

3.7 Macrofossil assessment

Two small bulk samples from the base and top of the Peat, were extracted and processed for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca. The results of the assessment are shown in Table 7. The extraction process involved the following procedures: (1) measuring the sample volume by water displacement, and (2) processing the sample by wet sieving using 300µm and 1mm mesh sizes. Each sample was scanned under a stereozoom microscope at x7-45 magnifications, and sorted into the different macrofossil classes. The concentration and preservation of remains was estimated for each class of macrofossil, whilst preliminary identifications of the waterlogged seeds (see Table 7) have been made using modern comparative material and reference atlases (e.g. Martin & Barkley, 2000; NIAB, 2004; Cappers *et al.* 2006). Nomenclature used follows Stace (2005).

4. RESULTS & INTERPRETATION OF THE LITHOSTRATIGRAPHIC DESCRIPTIONS, DEPOSIT MODELLING & RADIOCARBON DATING

The results of the lithostratigraphic descriptions of boreholes NLWA-QBH1 and NLWA-QBH2 are shown in Tables 2 and 3, with a two-dimensional stratigraphic profile for selected sequences across the site along a west-east transect shown in Figure 4. Deposit models for the surface elevation and thickness of selected units are shown in Figures 5 to 10.

The full sequence of sediments at the Laydown Area East site includes:

Made Ground (widely present)
Alluvium (widely present; in places described as organic)
Peat (sporadically present)
Gravel (the Lea Valley Gravel)
Bedrock (London Clay)

4.1 London Clay

Within the Laydown Area East part of the site the surface of the underlying bedrock (the London Clay) is recorded at 5.09m OD in borehole BH1; the remainder of the interventions within this area did not reach the bedrock, although it is recorded at similar levels of between 5.26 (BH4) and 5.46m OD (BH2) elsewhere, indicating a gentle slope towards the southeast (Figures 4 & 5). A British Geological Survey (BGS) borehole (TQ39SE90) records the surface of the bedrock at 6m OD in the south-eastern area of the site, although elevation data for this borehole is approximate and is not considered reliable here. More widely, the surface of the London Clay is recorded between 4 and 6m OD, rising to 9m OD towards the far east of the modelled area (TQ39SE130). This rise marks the edge of the Lea Valley floodplain as mapped by the BGS.

4.2 Lea Valley Gravel

The bedrock at the site is overlain by a unit of sandy gravel, interpreted here as the Lea Valley Gravel of Gibbard (1985), deposited during the Late Devensian (10-15,000 years before present) within a high energy braided river environment. Within Laydown Area East, the surface of this unit is relatively even in the context of a braided river environment, recorded at between 7.14 (NLWA-QBH1; Table 2) / 7.28 (NLWA-QBH2; Table 3) and 8.45m OD (TP5) (Figures 4 & 6). Across the rest of the site, the Gravel surface is recorded at between 7.17 (TP13) and 9.20m OD (TQ39SE65).

Across the wider modelled area, the Gravel surface undulates further; lower surfaces are recorded just to the south of the EcoPark site at 6.5m OD in TQ39SE120, on the eastern part of the Stonehill Business Park site between 6.7 and 7.0m OD (e.g. SHQBH2, SHQBH4) and on the Advent Way site at 6m OD (e.g. AW-BH1 & BH3). High surfaces between 9 and 10m OD are recorded towards the north and south of Stonehill Business Park (e.g. TQ39SE469, SHBH3) and in select BGS boreholes towards the south-east (e.g. TQ39SE153).

4.4 Peat and Tufa

Units of Peat and Tufa are sporadically recorded across the modelled area, immediately overlying the Gravel surface. Peats are indicative of a transition towards semi-terrestrial (marshy) conditions on the floodplain, supporting the growth of sedge fen/reed swamp and/or woodland communities across the floodplain. By comparison, tufa deposits suggest development in a quiet water environment in which episodes of more active water movement were regularly experienced. Formation in a substantial shallow lake occupying a depression on the floodplain seems likely, probably at a distance from the main channel of the river but subject to regular flooding.

In Laydown Area East, a relatively thin complex of Peat and Tufa was recorded in new geoarchaeological borehole NLWA-QBH2 measuring 32cm in thickness (Figures 4 & 7). Distinct Peat horizons were also recorded in TQ39SE41 and TQ39SE117 on the EcoPark site each measuring around 60cm in thickness. Pockets or lenses of Peat were also recorded in the lowermost part of the Alluvium (see 4.4) during the geotechnical (e.g. TP7 & TP8) and archaeological watching brief (e.g. context 1011; Trench 21 – see Figure 3) (ADAS, 2019). Where these are recorded within Laydown Area East, they are generally present between 2.00 and 3.00m below ground level (bgl).

Due to an absence of suitable material, it was not possible to radiocarbon date the base of the 32cm thick unit at the base of NLWA-BH2. However, a date of 5470-5310 cal BP (3520-3360 cal BC) was obtained from a wood fragment towards the top of the Peat at 7.44m OD. This suggests that the Peat and Tufa deposits accumulated during the Neolithic period, most likely over a period of up to a few hundred years.

Across the wider area, thin Peat horizons are sporadically recorded in borehole records to the south of the site in BGS boreholes and on the Stonehill Business Park site (e.g. TQ39SE114, TQ39SE112, TQ39SE109, SHCP3, TQ39SE358 & TQ39SE360). Thicker Peat units and substantial horizons of Tufa are more commonly recorded further east however. On the Advent Way site, these reach between 1 and 2m in thickness (Figure 7), and radiocarbon dating of these horizons indicate they date to between *ca.* 11,500 and 4000 cal BP equating to the beginning of the Mesolithic to Bronze Age (or early to middle Holocene) (Green et al., 2006). The Peat and Tufa deposits thus appear to have accumulated during the latter part of this period.

Whether the Peat and Tufa deposits were originally more widespread across the site and wider modelled area is unknown. Greater accumulations may for example have been eroded by subsequent human activity, and/or as the River Lea migrated across the floodplain during the course of the Holocene. Indeed, the 1914 OS map indicates a former course of the Lea traversed the site from north to south across the western part of Laydown Area East (Figure 11).

4.3 Alluvium

Overlying the Peat (where present) or Lea Valley Gravel elsewhere across the site and wider area, are deposits of Holocene Alluvium, typical of accumulation on the floodplain, derived from either low to moderate energy fluvial activity (sandy/gravelly material) or at a distance from any active channels

(silty or clayey material). The alluvium is generally mineral rich, and often coarse-grained (sandy and in places slightly gravelly). As above, certain sequences from the Laydown Area East are described as organic (TP2) or containing pockets of peat (TP7 and TP8). In the wider area of the site, organic or peaty sediments are also described in test pits TP10 and TP12.

The geoarchaeological boreholes and archaeological watching brief also reveal that these alluvial deposits sometimes contain finds such as pottery, CBM and glass akin, suggesting that at least some of the Alluvial deposits may date to the post-medieval period. It should be highlighted, that as a result of this, distinguishing the alluvium from the overlying Made Ground in certain records is not always a straight-forward task.

The surface of the alluvium is recorded at between 8.23 (TP3) and 9.97m OD (TP4) within Laydown Area East, and between 8.34 (TP9) and 9.56m OD (TP11) across the rest of the site. This is a similar range of heights to that recorded across the wider modelled area (Figure 8).

The combined thickness of the Peat / Tufa (outlined above) and Alluvium varies between ca. 0.5 and 2m across Laydown Area East and up to 3m elsewhere across the modelled area (e.g. Advent Way site) (Figure 9).

4.4 Made Ground

A unit of modern Made Ground caps the alluvial sequence, in thicknesses of between 1.0 (TP4) and 3.0m (TP3) (Figure 10). In places the Made Ground directly overlies the Gravel, entirely truncating the alluvial sequence (e.g. NLWA-QBH1, TP6). It is of note that both of these locations lie within the confines of the projected former channel traversing the site (Figure 11). Thus, these Made Ground deposits may be the result of infilling rather than truncation.

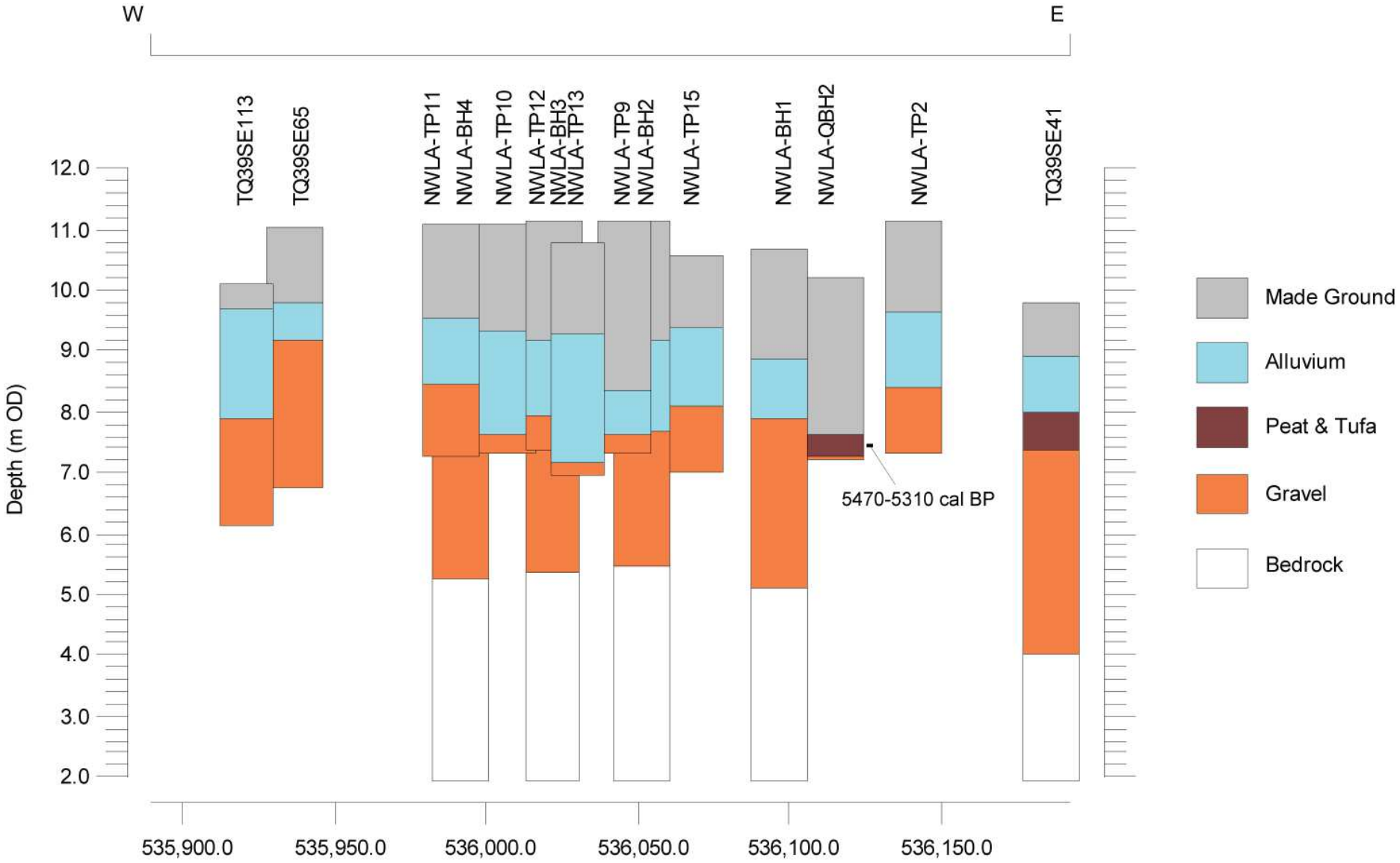

Figure 4: West-East transect of selected sequences across the site.

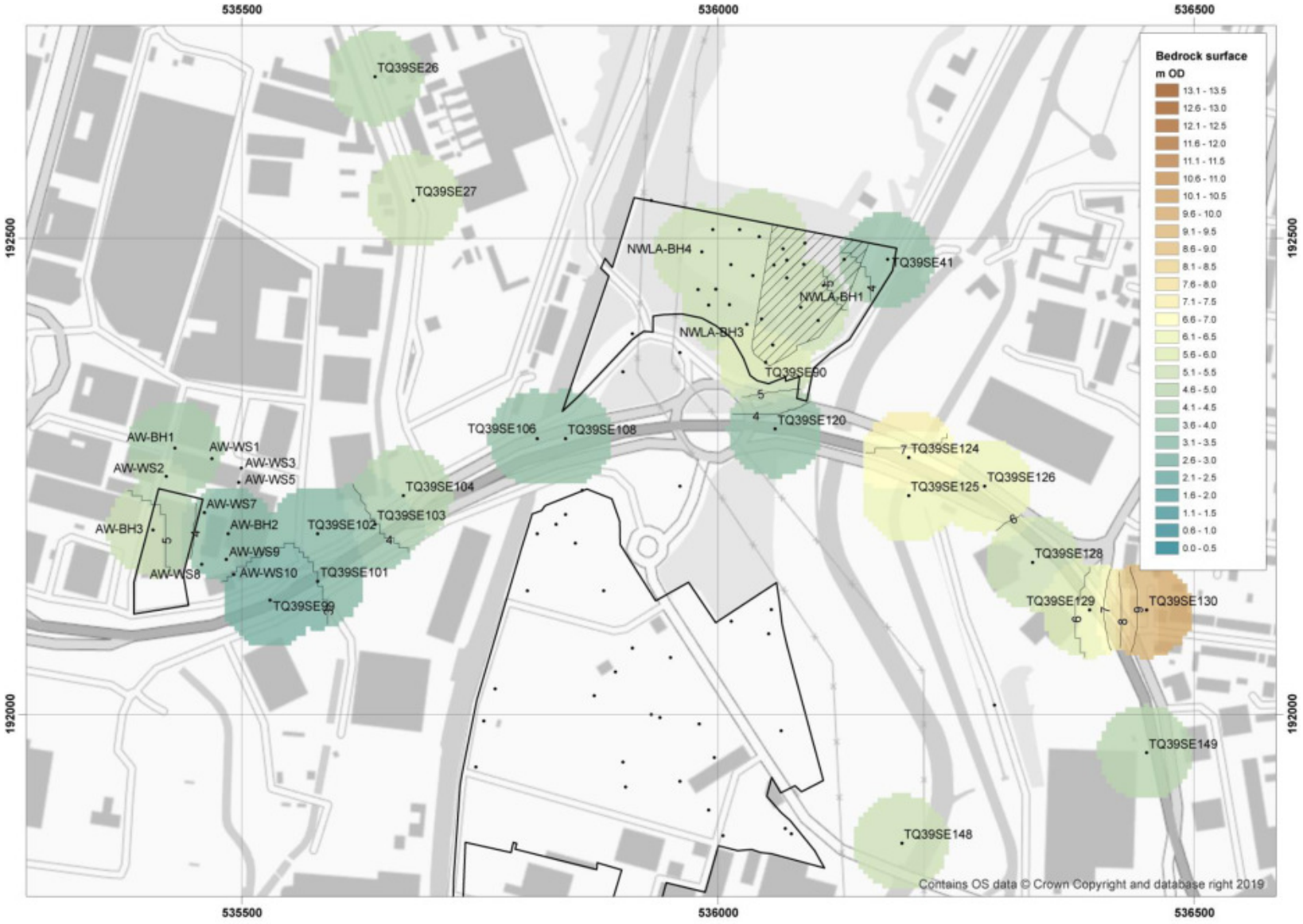

Figure 5: Surface of the Bedrock (m OD)

Figure 6: Surface of the Gravel (m OD)

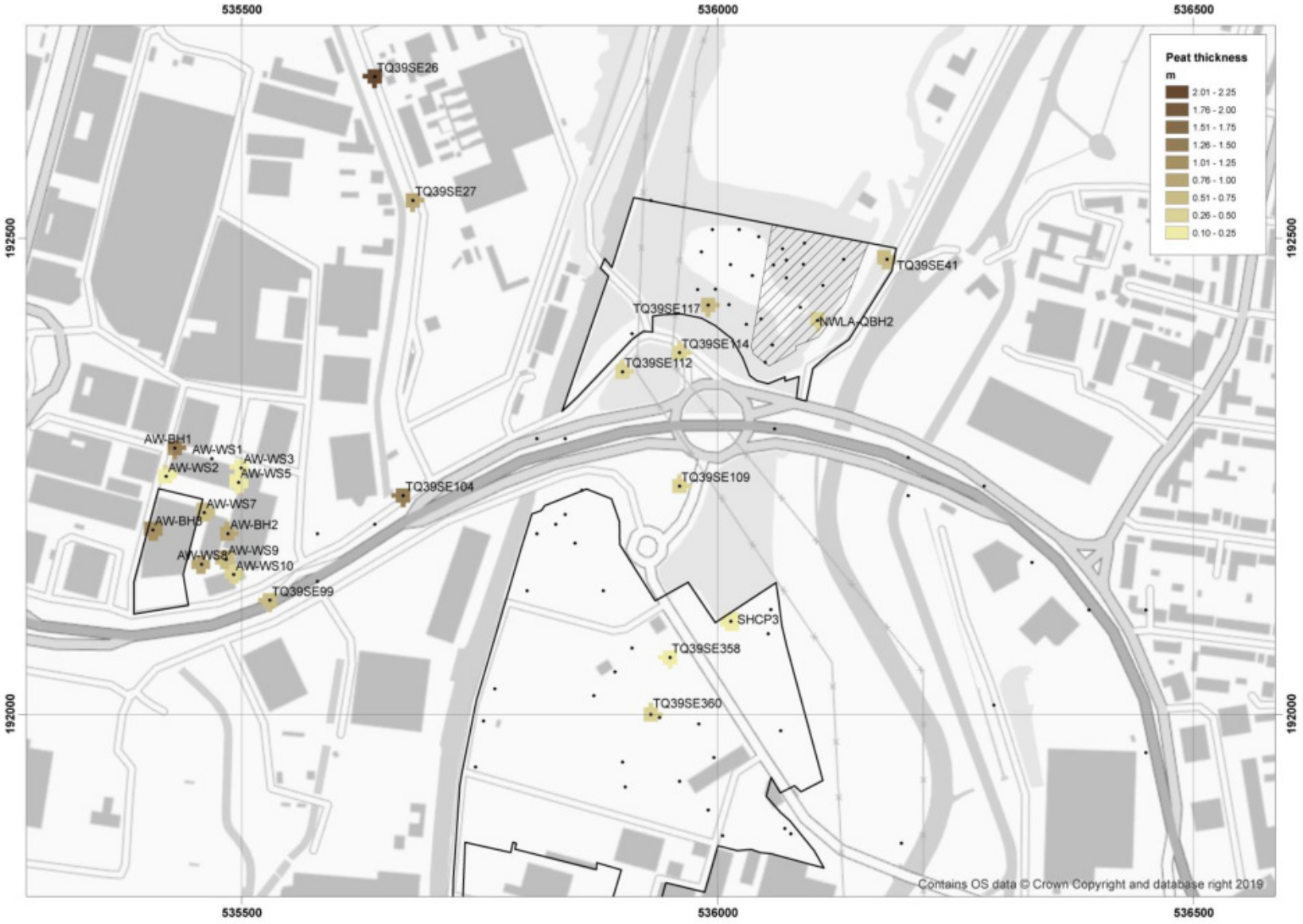

Figure 7: Thickness of the Peat (m)

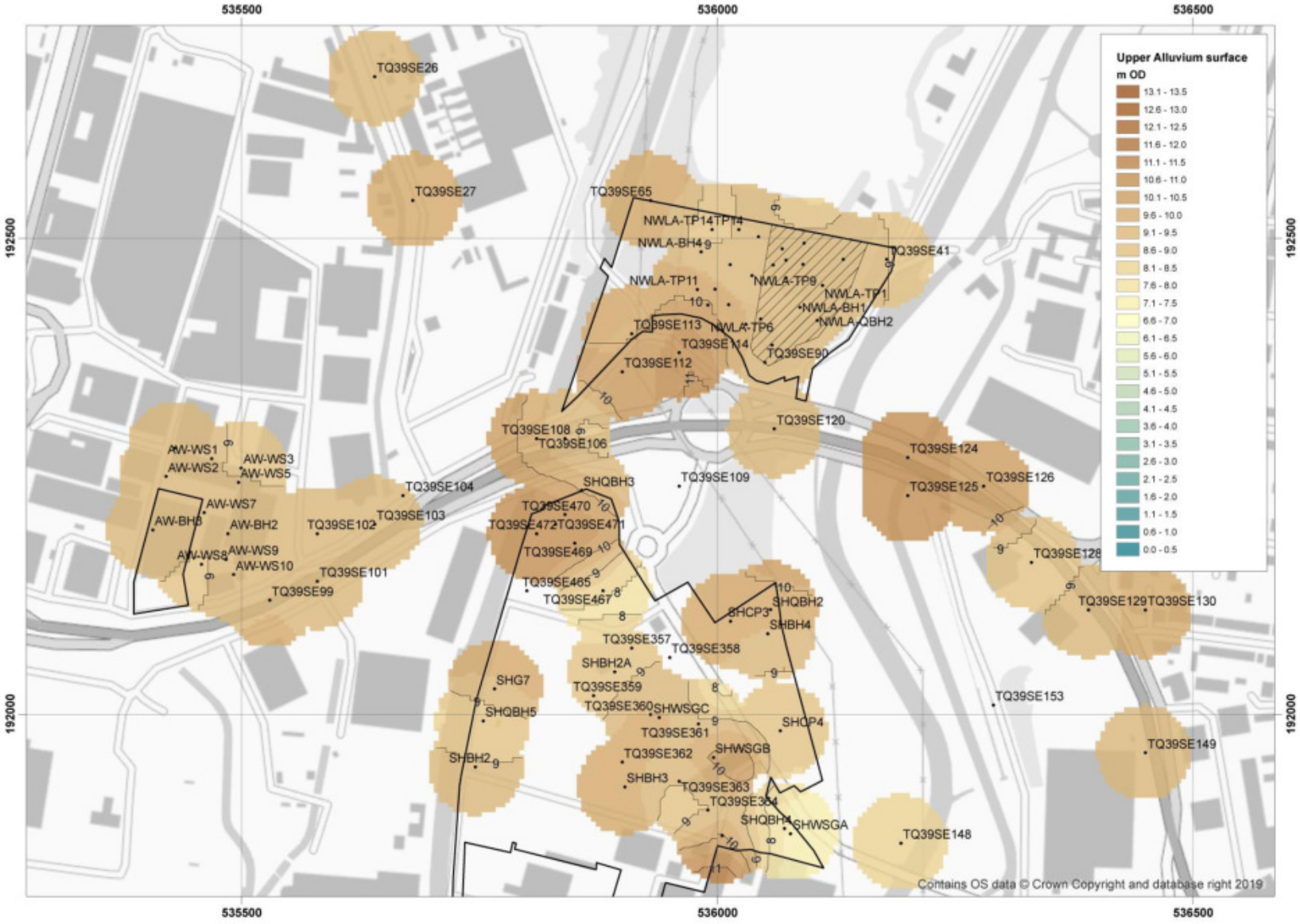

Figure 8: Surface of the Alluvium (m OD)

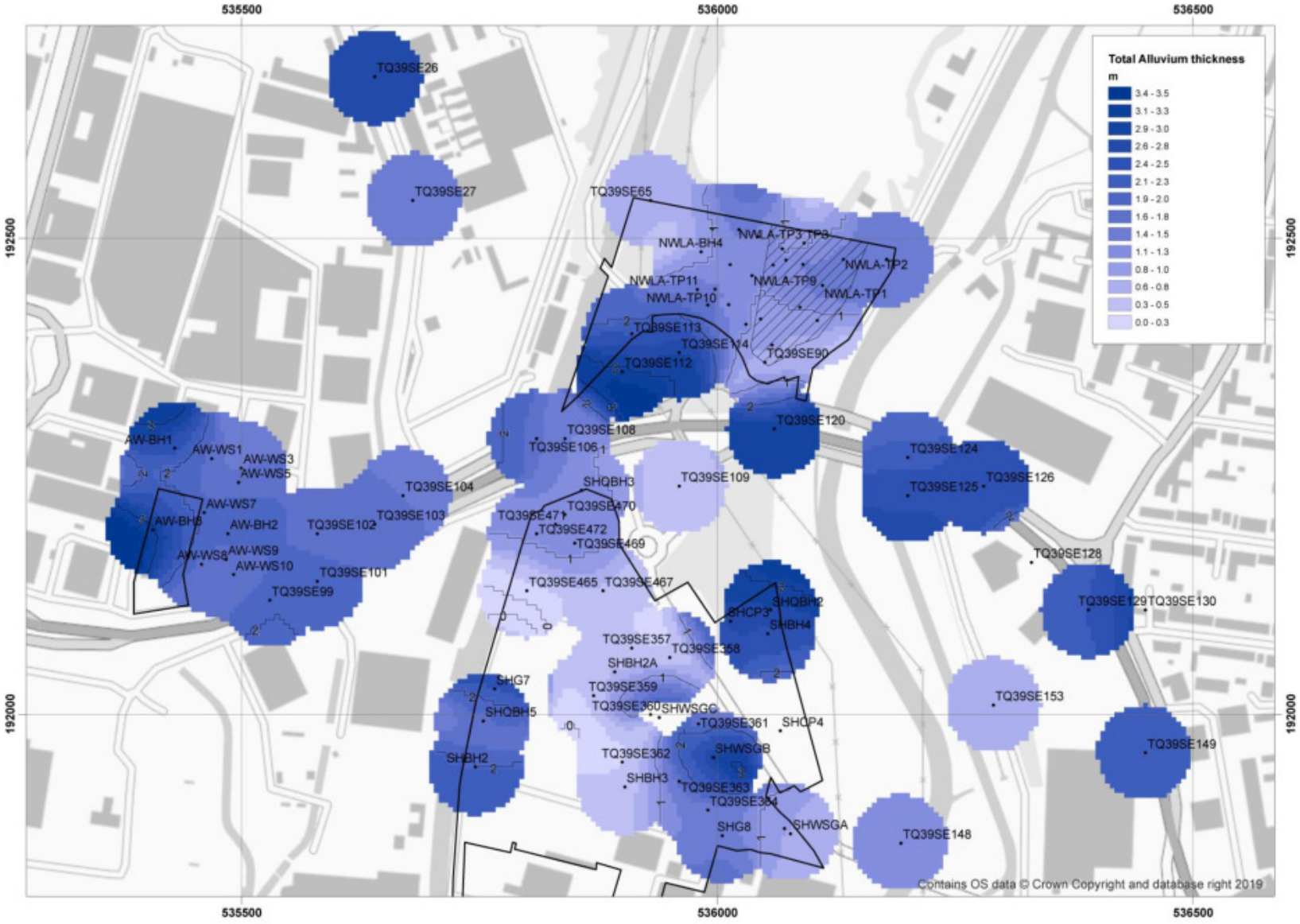

Figure 9: Thickness of the Total Alluvium (m)

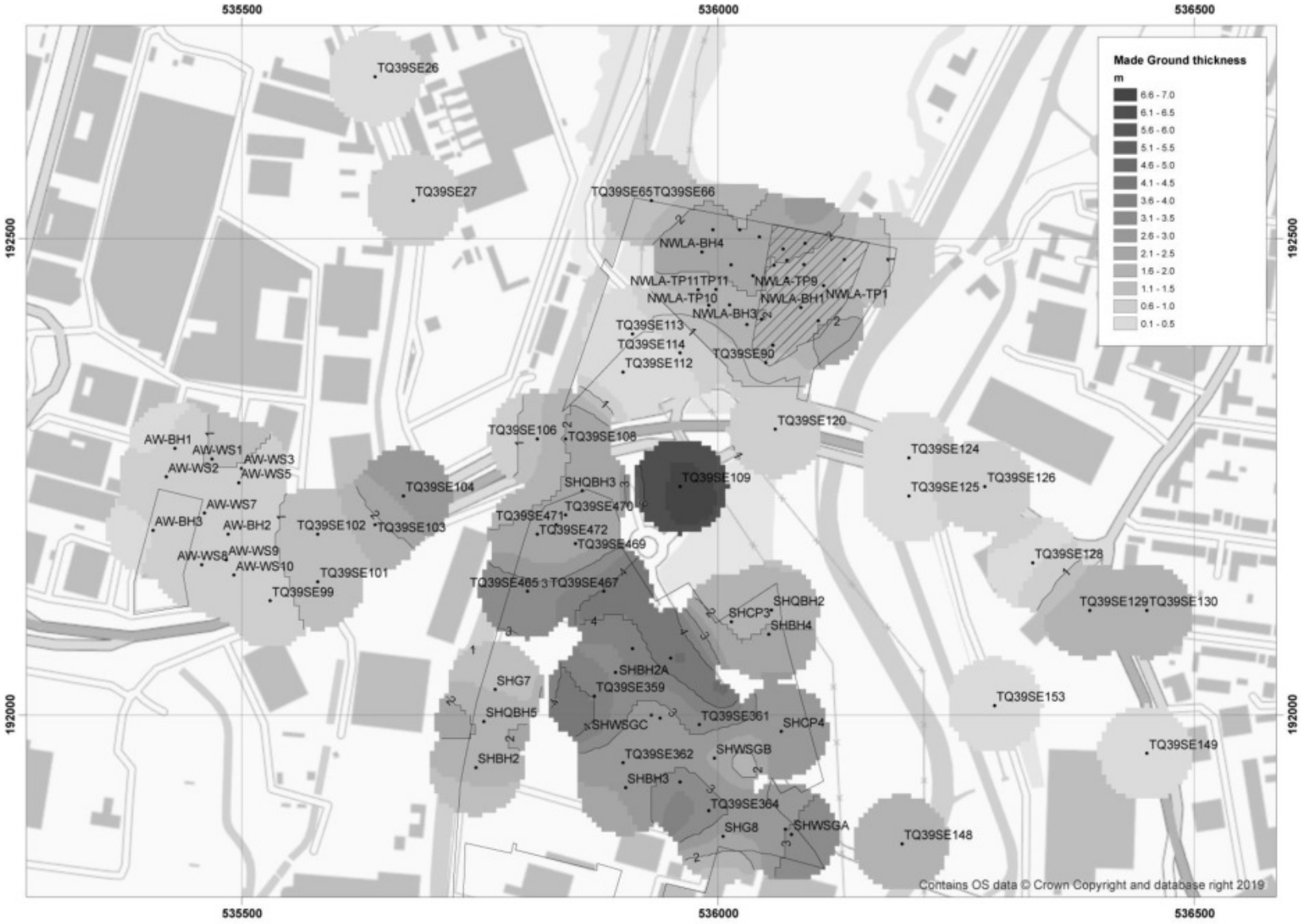

Figure 10: Thickness of the Made Ground (m)

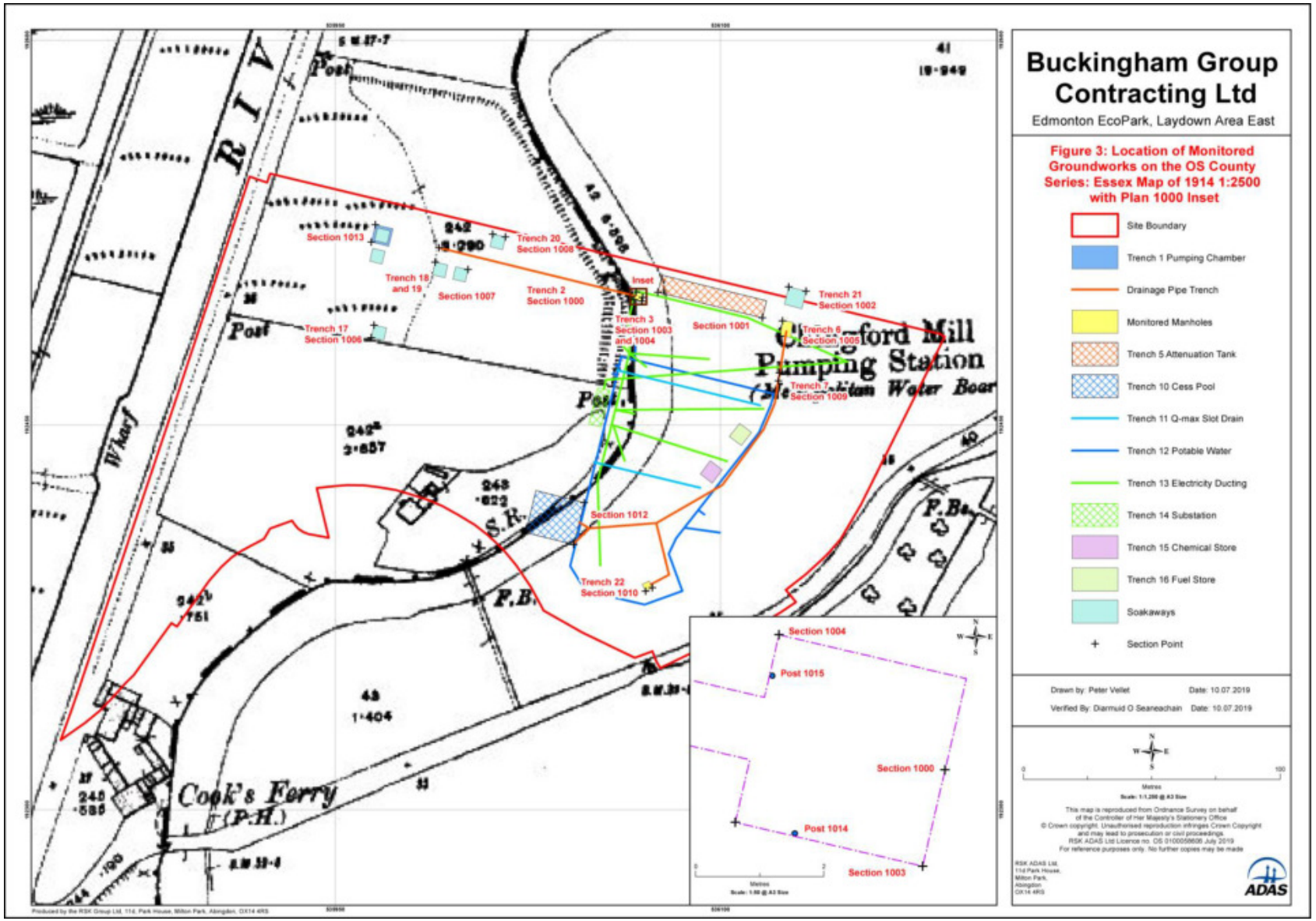

Figure 11: Location of Monitored Groundworks on the OS County Series: Essex Map of 1914 1:2500 with Plan 1000 Inset (reproduced from ADAS, 2019)

Table 2: Results of the lithostratigraphic descriptions of borehole NLWA-QBH1

Depth (m OD)	Depth (m bgl)	Description	Interpretation
10.92 to 9.75	0.00 to 1.17	Made ground	MADE GROUND
9.75 to 9.56	1.17 to 1.36	10YR 4/3; As2 Ga1 Gs1 Gg+; Brown gravelly sandy clay with organic detritus and brick fragments. Sharp contact into:	
9.56 to 9.13	1.36 to 1.79	10YR 5/4 to 10YR 5/2; As3 Ag1 Gs+ Gg+; Yellowish to greyish brown silty clay containing brick and charcoal. Sharp contact into:	
9.13 to 8.92	1.79 to 2.00	10YR 2/2; Sh2 Ga1 Ag1 As+ Gg+; Very dark brown diamict with brick, charcoal and ceramic.	
8.92 to 8.85	2.00 to 2.07	10YR 2/2; Sh2 Ga1 Ag1 As+ Gg+; Very dark brown diamict with brick and charcoal. Sharp contact into:	
8.85 to 7.92	2.07 to 3.00	10 YR 4/2; Ag3 As1 Ga+ Gg+ Dg+; dark greyish brown clayey sandy silt with gastropod shells and brick fragments.	
7.92 to 7.67	3.00 to 3.25	VOID	
7.67 to 7.51	3.25 to 3.41	10YR 4/2; Ag3 As1 Ga+ Gg+ Dg+; dark greyish brown clayey sandy silt with gastropod shells and brick fragments. Sharp contact into:	
7.51 to 7.14	3.41 to 3.78	5Y 4/1; Gg3 As1 Ga+; Gray clayey clast-supported gravel containing brick fragments. Sharp contact into:	
7.14 to 6.92	3.78 to 4.00	2.5Y 4/3; Gg3 Gs1; Sand and gravel	LEA VALLEY GRAVEL

Table 3: Results of the lithostratigraphic descriptions of borehole NLWA-QBH2

Depth (m OD)	Depth (m bgl)	Description	Interpretation
10.19 to 8.54	0.00 to 1.65	10YR 4/3; As3 Ag1 Gg+ Ga+ Brown silty sandy clay with isolated gravel clasts. Sharp and sub-horizontal contact into:	MADE GROUND
8.54 to 8.30	1.65 to 1.89	2.5Y 4/3; Gs2 Gg2 As+; Olive brown gravelly coarse sand. Sharp and sub-horizontal contact into:	ALLUVIUM
8.30 to 8.19	1.89 to 2.00	2.5Y 4/2; As3 Ag1 Ga+; Dark greyish brown silty sandy clay. Sharp contact into:	
8.19 to 8.09	2.00 to 2.10	10YR 4/3; As3 Ag1 Gg+ Ga+ Brown silty sandy clay with isolated gravel clasts. Sharp and sub-horizontal contact into:	
8.09 to 7.95	2.10 to 2.24	2.5Y 5/1; Gs2 Gg2; Gray sand and gravel. Sharp sub-horizontal contact into:	
7.95 to 7.91	2.24 to 2.28	2.5Y 4/3; Gs2 Gg2 As+; Gravelly coarse sand. Sharp contact into:	
7.91 to 7.60	2.28 to 2.59	5Y 3/2; As2 Ga1 Gg1 Ag+; Dark olive grey diamict consisting of sandy gravelly clay. Sharp contact into:	
7.60 to 7.45	2.59 to 2.74	2.5Y 6/3; Gs2 Ga2 Gg+ Dg+; Light yellowish brown friable carbonate-rich sand with isolated gravel clasts and gastropod shells. Sharp contact into:	TUFA SANDS
7.45 to 7.41	2.74 to 2.78	5Y 3/2; Sh3 Ag1 Dh+ Gg+ humo 3; dark olive grey well humified silty peat containing herbaceous material and isolated gravel clasts. Sharp contact into:	PEAT
7.41 to 7.39	2.78 to 2.80	5Y 6/2; Ga3 Gs1 Dg+; Light olive grey friable carbonate-rich sand with gastropod shells. Sharp contact into:	TUFA SANDS
7.39 to 7.34	2.80 to 2.85	5Y 4/2; Sh2 Ga1 Gs+ Dg+; Gravel-rich well humified sandy peat containing highly	PEAT

Depth (m OD)	Depth (m bgl)	Description	Interpretation
		fragmented gastropod shells. Sharp contact into:	
7.34 to 7.28	2.85 to 2.91	5Y 3/2; Sh3 Ag1 Dh+ humo 4; Dark olive grey very well humified sandy silty peat. Sharp contact into:	
7.28 to 7.19	2.91 to 3.00	2.5Y 4/3; Gg2 Gs2; Olive brown sand and gravel.	LEA VALLEY GRAVEL

Table 4: Results of the radiocarbon dating of borehole NLWA-QBH2

Laboratory code / Method	Material and location	Depth (m OD)	Uncalibrated radiocarbon years before present (BP)	Calibrated age BC/AD (BP) (2-sigma, 95.4% probability)	δ13C (‰)
BETA-565342 AMS	Top of the Peat	7.41 to 7.44	4660 ± 30	3520-3360 cal BC 5470-5310 cal BP	-28.2

5. RESULTS & INTERPRETATION OF THE POLLEN ASSESSMENT

Samples were taken for pollen assessment at high resolution through the Peat deposits; tufa sands have limited pollen preservation potential, so were avoided.

The results of the assessment indicate an absence or limited concentration of pollen in three of the samples assessed at 7.30, 7.34 and 7.42m OD. However, higher concentrations were recorded in the samples from 7.38 and 7.44m OD. The samples are characterised by high values of tree and shrub pollen: alder (*Alnus*) dominates with oak (*Quercus*), hazel (*Corylus* type), and lesser amounts of lime (*Tilia*), elm (*Ulmus*), ash (*Fraxinus*), willow (*Salix*) and ivy (Hedera). The herbaceous assemblage is includes sedges (Cyperaceae), grasses (Poaceae), daisies (Asteraceae), dandelions (Lactuceae), pinks (Caryophyllaceae) and dock/sorrel (*Rumex* undifferentiated). Aquatics comprise individual grains of bur-reed (Sparganium type) and pondweed (Potamogeton type). Spores most frequently include ferns (Filicales) and Polypodium vulgare (polypody). Microcharcoal is generally absent or recorded in negligible concentrations.

The results of the assessment indicate a peat surface dominated by alder carr woodland with willow, and an understorey of sedges and grasses and aquatics. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to grown on the dryland forming mixed deciduous woodland with oak and lime. There is no evidence for any anthropogenic activity during the period of peat formation; nor is there any evidence for any significant change in vegetation composition.

Table 5: Results of the pollen assessment from NLWA-QBH2

	Depth (m OD)	7.44	7.42	7.38	7.34	7.30
Latin name	Common name					
Trees						
Alnus	alder	56	11	15		2
Quercus	oak	20	1	12		
Pinus	pine	1	1	3		4
Tilia	lime	5		2		1
Ulmus	elm	3		1		
Fraxinus	ash	1				
Shrubs						
Corylus type	e.g. hazel	10		9		
Hedera	ivy			1		
Salix	willow	1		1		
Herbs						
Cyperaceae	sedge family	1		3		2
Poaceae	grass family	5		4		
Asteraceae	daisy family	2		1		
Lactuceae	dandelion family			1		
Caryophyllaceae	pinks	1				
Rumex undifferentiated	dock / sorrel	1				
Aquatics						
Sparganium type	bur-reed			1		
Potamogeton type	pondweed		1			
Spores						
Sphagnum	moss					1
Filicales	ferns	2		9		
Polypodium vulgare	polypody	1		1		
Total Land Pollen (grains counted)		107	13	53	0	9
Concentration*		5	2	3	0	2
Preservation**		4	4	4	0	2
Microcharcoal Concentration***		1	0	0	0	0
Suitable for further analysis		YES	NO	YES	NO	NO

*Key: *Concentration: 0 = 0 grains; 1 =1-75 grains, 2 = 76-150 grains, 3 =151-225 grains, 4 = 226-300, 5 =300+ grains per slide; **Preservation: 0 = absent; 1 = very poor; 2 = poor; 3 = moderate; 4 = good; 5 = excellent; ***Microcharcoal Concentration: 0 = none, 1= negligible, 2 = occasional, 3 = moderate, 4 = frequent, 5 = abundant*

6. RESULTS & INTERPRETATION OF THE DIATOM ASSESSMENT

A total of four samples were submitted for an assessment of diatom presence from borehole NLWA-QBH2. A list of the samples is provided below. The samples are from the Peat and Tufa deposits, and overlying Alluvium. A summary of the main diatom presence-absence assessment results is provided in Table 6.

Diatoms were only present in the Alluvium. Samples from within the peat and interbedded tufa sands were found to be barren of diatoms.

Only benthic taxa were encountered within the sample from 7.66-7.67m OD. Those species encountered were occasional fragments of *Synedra* sp and a single frustule of *Gomphonema ovilaceum*. Any palaeoenvironmental interpretations based on such a restricted assemblage are tenuous at best. In general, *Synedra* sp are freshwater taxa but can be found in some saline brackish settings, whilst *Gomphonema ovilaceum* is more often associated with freshwater contexts. The overall poor abundance and diversity limits their palaeoenvironmental value.

Table 6: Results of the diatom assessment of samples from borehole NLWA-QBH2

Depth (m OD)	Stratigraphy	Diatoms encountered
7.66-7.67	ALLUVIUM	*Synedra sp.* *Gomphonema ovilaceum*
7.44-7.45	PEAT	None
7.39-7.40	TUFA	None
7.29-7.30	PEAT	None

7. RESULTS & INTERPRETATION OF THE MACROFOSSIL ASSESSMENT

Two small bulk samples (each measuring 50ml in volume) were extracted and processed from NLWA-QBH2 for the recovery of macrofossil remains, including waterlogged plant macrofossils, wood, insects and Mollusca. The results of the assessment are shown in Table 7. The samples were focussed on the Peat deposits between 7.28 and 7.33m OD and 7.41 and 7.45m OD.

The concentration of identifiable biological remains in both samples was low. Mollusca, in both fragments and present as whole specimens, were present in low to moderate quantities in both samples, whilst insects were present in low concentrations in the sample from 7.41 to 7.45m OD. A very low concentration of charcoal, less than 2mm in diameter and therefore not suitable for identification, was present in the sample from 7.28 to 7.33m OD along with two waterlogged seeds of *Brassica/ Sinapis* sp. (cabbages/mustard). Waterlogged wood was present in low concentrations in the sample from 7.41 to 7.45m OD. Fragments of tufa were observed in both samples.

The seed assemblage in the samples is too small to attempt a full environmental interpretation, but *Brassica/ Sinapis* sp. are often found in areas of waste or disturbed ground. Given the nature and age of the deposits, it is possible that this is related to natural erosion of the riverbanks, and colonisation of the bare ground surface.

Table 7: Results of the macrofossil assessment of samples from borehole NLWA-QBH2

			Charred					Waterlogged		Mollusca		Bone			
Depth (m OD)	Volume processed (ml)	Fraction	Charcoal (>4mm)	Charcoal (2-4mm)	Charcoal (<2mm)	Seeds	Chaff	Wood	Seeds	Whole	Fragments	Large	Small	Fragments	Insects
7.41 to 7.45	0.05	>300µm	-	-	-	-	-	1	-	2	2	-	-	-	1
7.28 to 7.33	0.05	>300µm	-	-	1	-	-	-	1	1	2	-	-	-	-

Key: 0 = Estimated Minimum Number of Specimens (MNS) = 0; 1 = 1 to 25; 2 = 26 to 50; 3 = 51 to 75; 4 = 76 to 100; 5 = 101+

8. DISCUSSION & CONCLUSIONS

The aims of the geoarchaeological and palaeoenvironmental assessment at the Laydown Area East site were to (1) investigate whether the sequences contain any artefact or ecofact evidence for prehistoric or historic human activity; (2) investigate whether the sequences contain any evidence for natural and/or anthropogenic changes to the landscape (wetland and dryland); and (3) make recommendations for any further palaeoenvironmental analysis (if necessary).

The results of the modelling indicate that the Late Devensian Lea Valley Gravel surface across the EcoPark (and specifically Laydown Area East) ranges between 7.17 and 9.2m OD, falling within the range of heights provided by Corcoran et al. (2011) for Landscape Zone 4.5. Across the wider modelled area however, the surface varies between *ca*. 6.0 and 9.9m OD; more than indicated by the Corcoran et al. model. The higher and low gravel surfaces are likely to represent islands and channels on the floodplain respectively; typical of a braided river environment.

Thin deposits of Peat and Tufa sporadically overlie the Gravel on the eastern part of Laydown Area East and the EcoPark site, and more widely across the modelled area to the south and west. Due to an absence of suitable material, it was not possible to radiocarbon date the base of the thin complex of Peat and Tufa in borehole NLWA-QBH2. However, a date of 5470-5310 cal BP (3520-3360 cal BC) was obtained from a wood fragment towards the top of the Peat at 7.44m OD. This suggests that the Peat and Tufa deposits accumulated during the Neolithic period, most likely over a period of up to a few hundred years. By comparison, up to 3m of these deposits are recorded on the nearby Advent Way site, dating from the Late Devensian to Bronze Age period.

During the period of Peat formation, the floodplain surface was dominated by alder carr woodland with willow, and an understorey of sedges and grasses and aquatics. Hazel, ash and elm may have occupied the peat surface with alder but are more likely to have grown on the dryland forming mixed deciduous woodland with oak and lime. There is no evidence for any anthropogenic activity during the period of peat formation; nor is there any evidence for any significant change in vegetation composition. No interpretations can be made about the hydrology of the Peat due to an absence of diatom remains from the Peat.

The Alluvium overlying the Lea Valley Gravel or Peat (where present) generally varies between 0.5 and 2m thick. It is typical of accumulation on the floodplain, derived from either low to moderate energy fluvial activity (sandy/gravelly material) or at a distance from any active channels (silty or clayey material). It occasionally includes peat lenses and/or anthropogenic material such as CBM, pottery and ceramic. As such it seems likely that at least some of the alluvium dates to the post medieval period. Reconstruction of the hydrological history of the site is tenuous at best, because of the restricted diatom assemblage. However, the two taxa tend to be associated more with freshwater environments.

Made Ground caps the sequence, occasionally resting directly on the Lea Valley Gravel Those sequences in which the Made Ground rests directly on the Lea Valley Gravel tends to be within the

confines of a former course of the Lea which is mapped as traversing the site from north to south across the western part of Laydown Area East.

On the basis of the limited concentration and preservation of palaeoenvironmental remains, and the absence of: (1) further material suitable for radiocarbon dating, (2) any evidence for anthropogenic activity, and (3) any evidence for palaeoenvironmental change during the period of peat formation, no further work is recommended. However, the results from the combined geoarchaeological and palaeoenvironmental investigations have provided valuable insights into the landscape, vegetation and hydrological history of the site, which can be integrated with future work on the EcoPark site and nearby area.

9. REFERENCES

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Appendix F: Oasis Report Form

OASIS ID: adasuklt1-361515

Project details

Project name	Edmonton EcoPark, Laydown Area East
Short description of the project	Archaeological monitoring of deeper groundworks associated with the Laydown Area East phase of the Edmonton EcoPark Development.
Project dates	Start: 20-05-2019 End: 18-07-2019
Previous/future work	No / Yes
Any associated project reference codes	ECO19 - Sitecode
Type of project	Recording project
Site status	None
Significant Finds	TIMBER POSTS Uncertain
Significant Finds	POTTERY Post Medieval
Investigation type	"'Watching Brief"'
Prompt	Planning condition

Project location

Country	England
Site location	GREATER LONDON ENFIELD EDMONTON Edmonton EcoPark, Laydown Area East

Postcode	E4 8JG
Study area	37500 Square metres
Site coordinates	TQ 36104 92434 51.613770977399 -0.034030970499 51 36 49 N 000 02 02 W Point

Project creators

Name of Organisation	RSK ADAS Ltd
Project brief originator	Consultant
Project design originator	Peter Vellet
Project director/manager	Diarmuid O Seaneachain
Project supervisor	Diarmuid O Seaneachain

Project archives

Physical Archive recipient	Museum of London
Physical Contents	"Ceramics"
Digital Archive recipient	Museum of London
Digital Media available	"GIS","Text"
Paper Archive recipient	Museum of London
Paper Media available	"Context sheet","Diary","Plan","Report","Section"

Project bibliography 1

Publication type	Grey literature (unpublished document/manuscript)

Title	Archaeological Monitoring and Recording Report: Edmonton EcoPark, Laydown Area East
Author(s)/Editor(s)	Vellet, P
Date	2019
Issuer or publisher	RSK ADAS Ltd
Entered by	Peter Vellet (peter.vellet@adas.co.uk)
Entered on	30 July 2019

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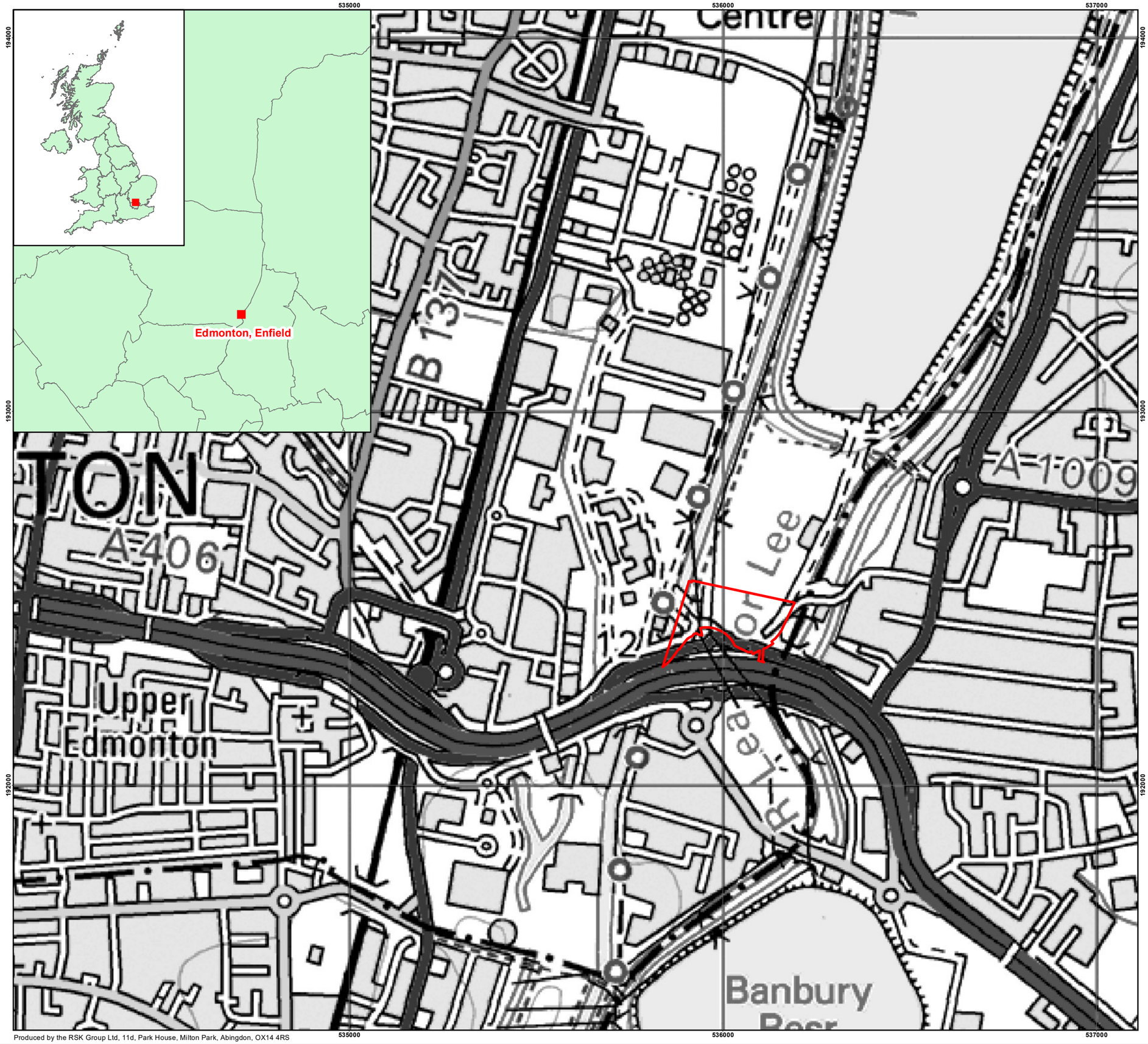
Edmonton EcoPark, Laydown Area East

Figure 1: Site Location



Site Boundary

Drawn by: Peter Vellet Date: 09.07.2019

Verified By: Diarmuid O Seaneachain Date: 10.07.2019

N
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0 500

Metres

Scale: 1:10,000 @ A3 Size

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Milton Park,
Abingdon
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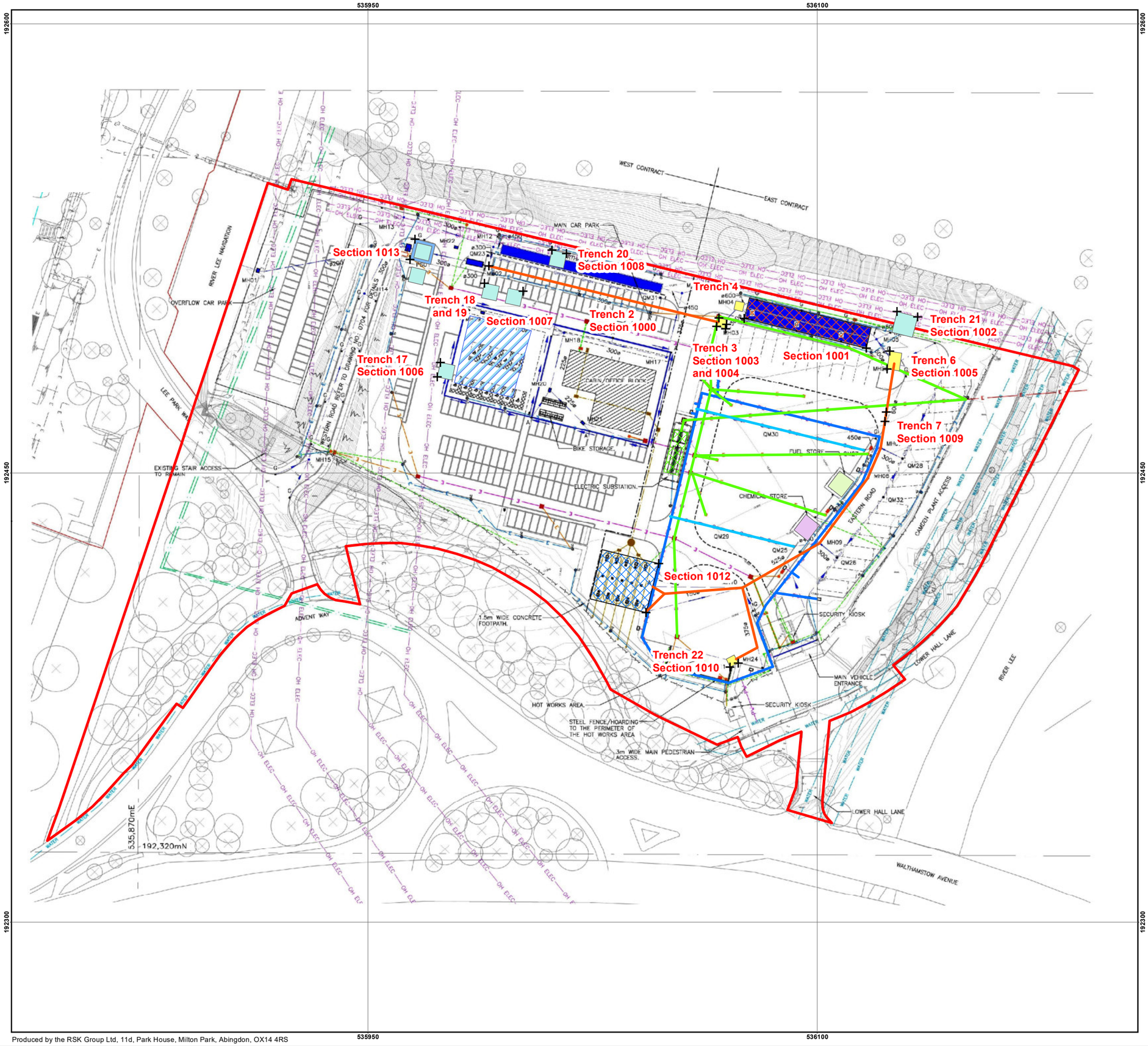
Figure 2: Location of Monitored Groundworks



- Site Boundary
- Trench 1 Pumping Chamber
- Drainage Pipe Trench
- Monitored Manholes
- Trench 5 Attenuation Tank
- Trench 10 Cess Pool
- Trench 11 Q-max Slot Drain
- Trench 12 Potable Water
- Trench 13 Electricity Ducting
- Trench 14 Substation
- Trench 15 Chemical Store
- Trench 16 Fuel Store
- Soakaways
- Holding Pond
- \+ Section Point

Drawn by: Peter Vellet Date: 30.07.2019

Verified By: Diarmuid O Seaneachain Date: 30.07.2019

N W E S

0 100

Metres

Scale: 1:1,250 @ A3 Size

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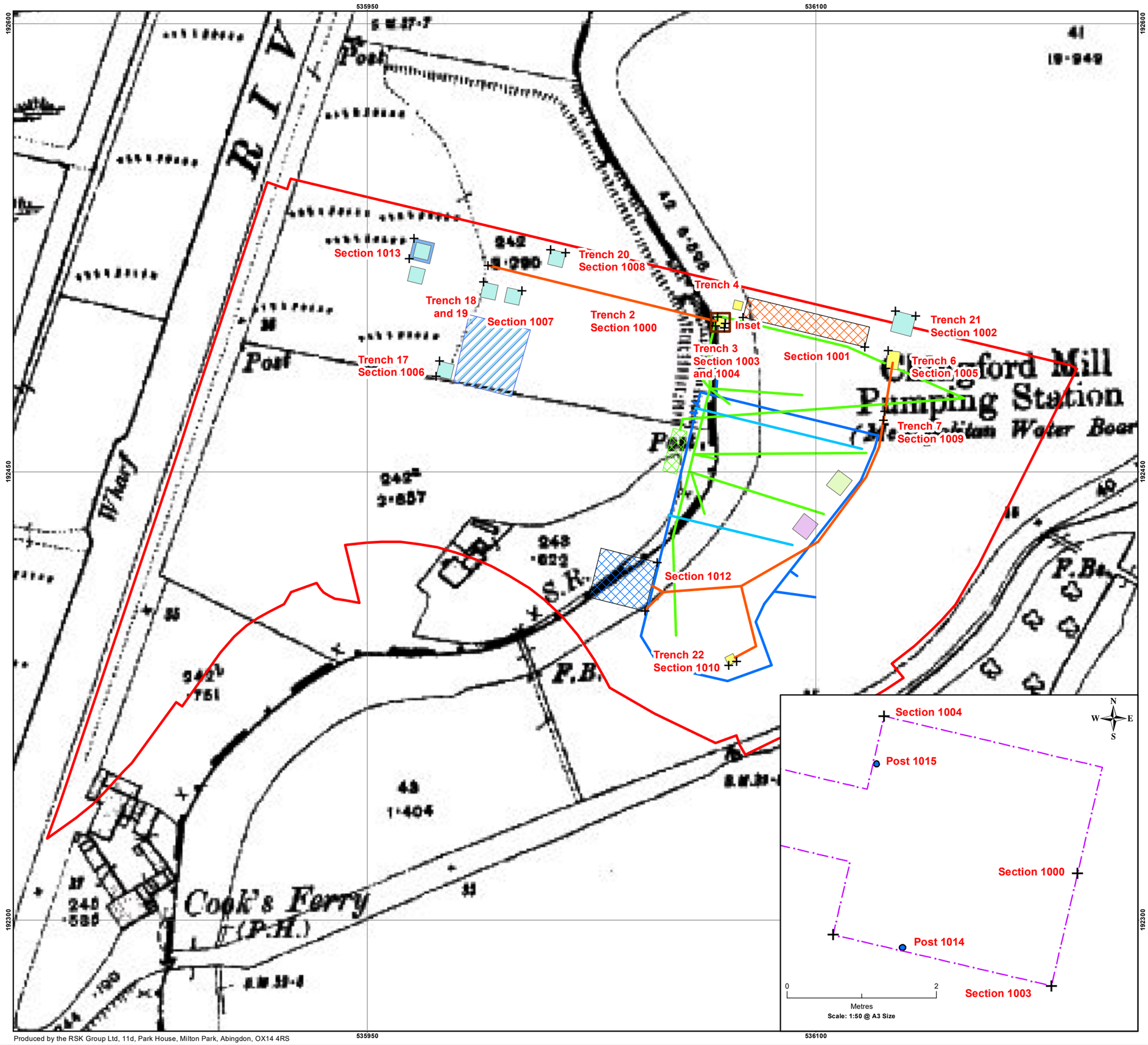
Figure 3: Location of Monitored Groundworks on the OS County Series: Essex Map of 1914 1:2500 with Plan 1000 Inset



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- Site Boundary
- Trench 1 Pumping Chamber
- Drainage Pipe Trench
- Monitored Manholes
- Trench 5 Attenuation Tank
- Trench 10 Cess Pool
- Trench 11 Q-max Slot Drain
- Trench 12 Potable Water
- Trench 13 Electricity Ducting
- Trench 14 Substation
- Trench 15 Chemical Store
- Trench 16 Fuel Store
- Soakaways
- Holding Pond
- Section Point

Drawn by: Peter Vellet Date: 30.07.2019

Verified By: Diarmuid O Seaneachain Date: 30.07.2019

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Metres

Scale: 1:1,250 @ A3 Size

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South Facing Section of Trenches 2 and 3

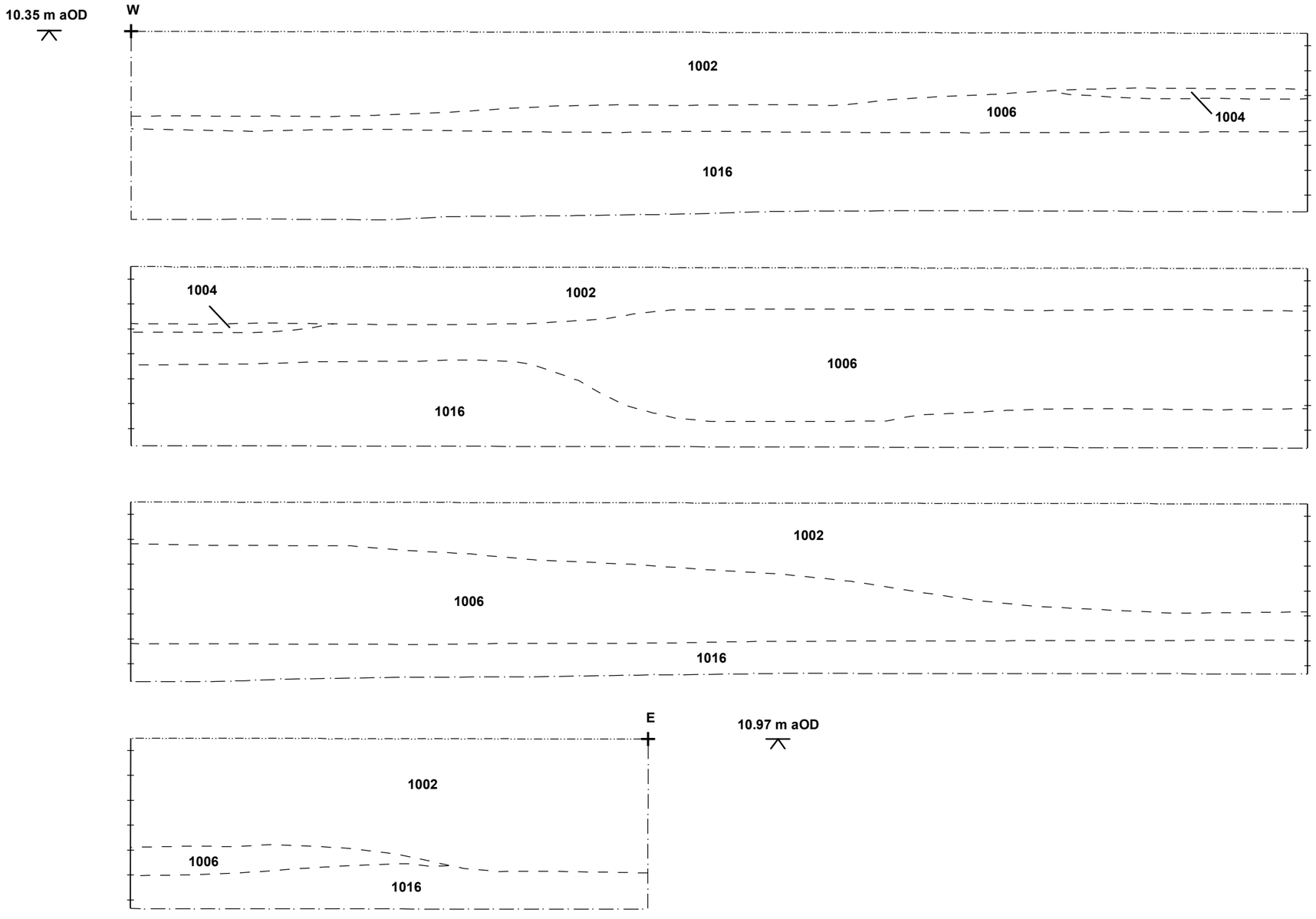

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Figure 4: Section 1000

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Verified By: Diarmuid O'Seaneachain Date: 30.07.2019

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Metres

Scale 1:100 at A3 size

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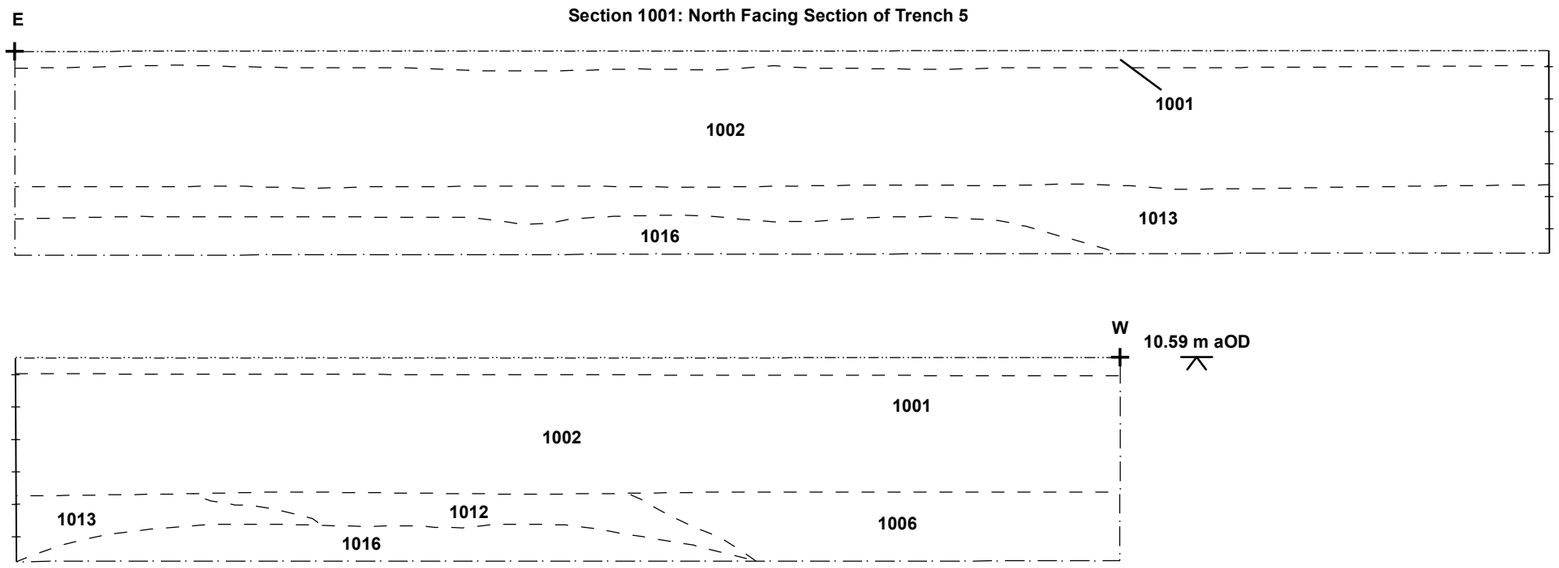

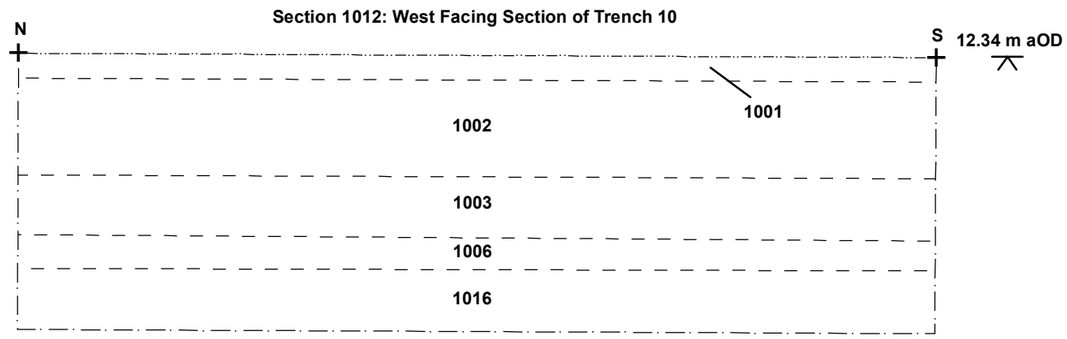

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Figure 5: Sections 1001 and 1012

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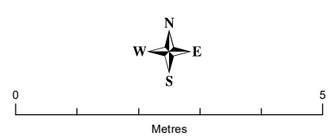

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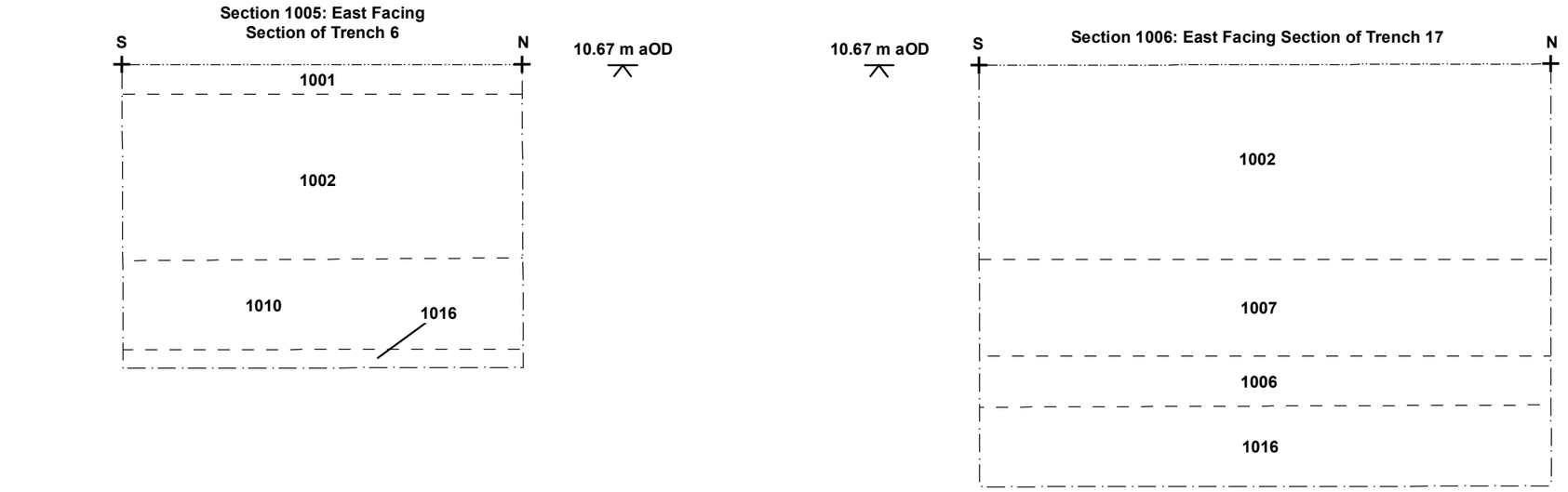

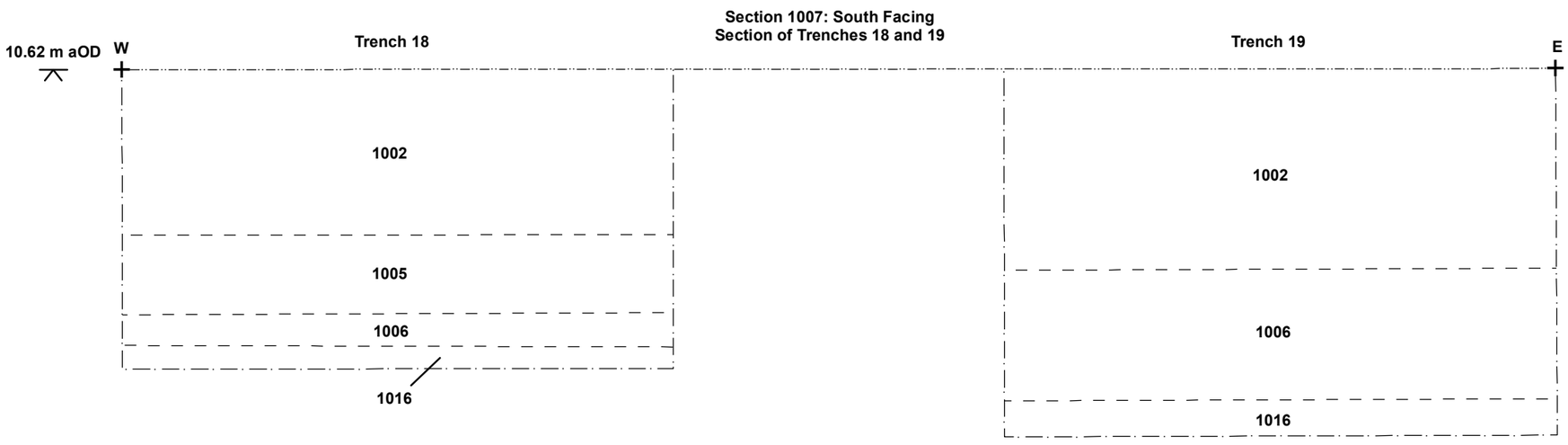

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Figure 6: Sections 1005 - 1007

Drawn by: Peter Vellet Date: 30.07.2019

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Metres

Scale 1:50 at A3 size

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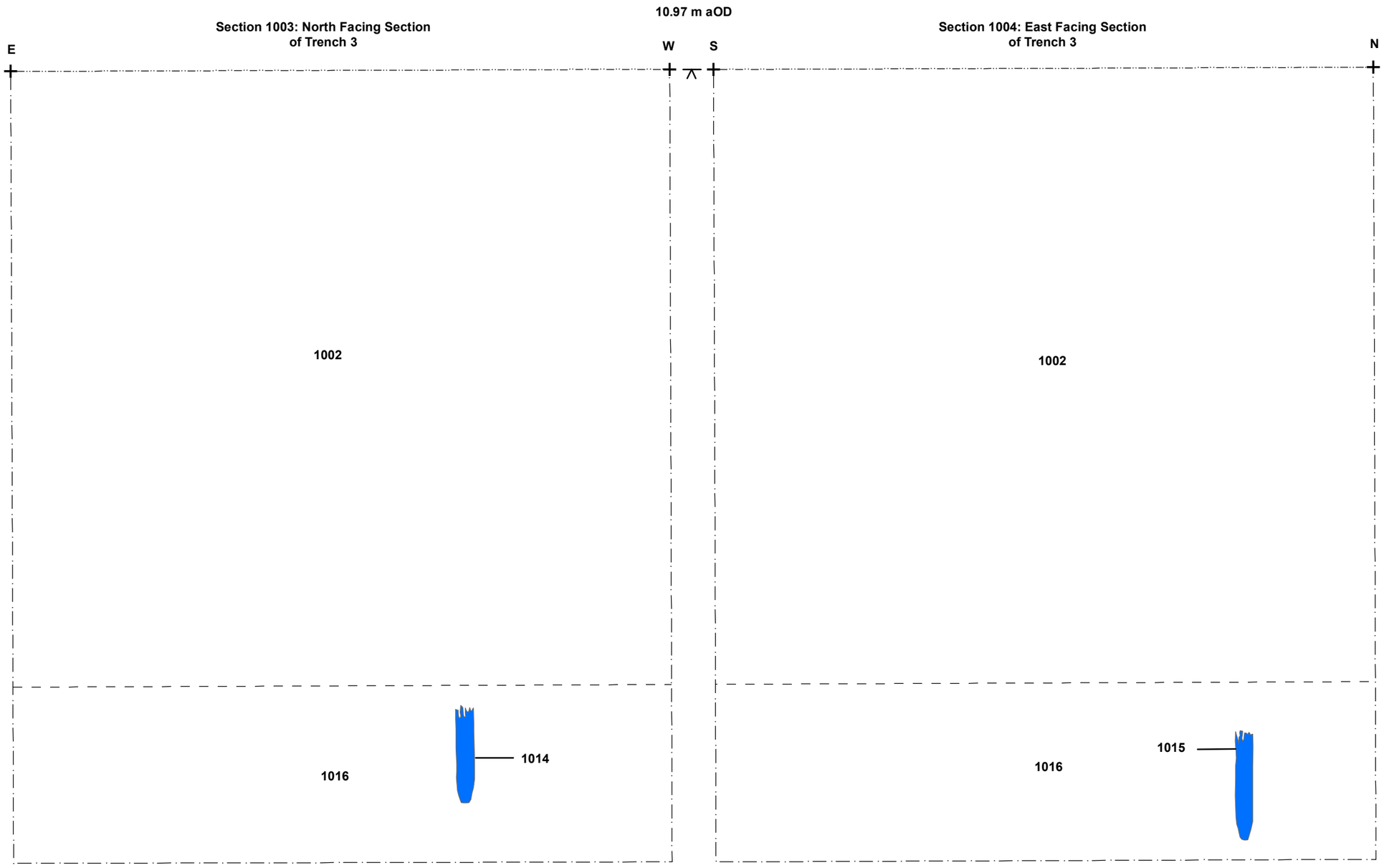

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Figure 7: Sections 1003 and 1004

Timber Post

Drawn by: Peter Vellet Date: 30.07.2019

Verified By: Diarmuid O'Seaneachain Date: 30.07.2019

N W E S

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Metres

Scale 1:20 at A3 size

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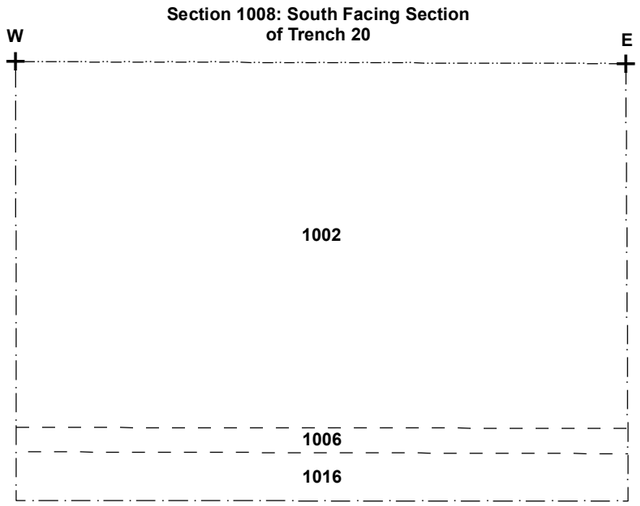

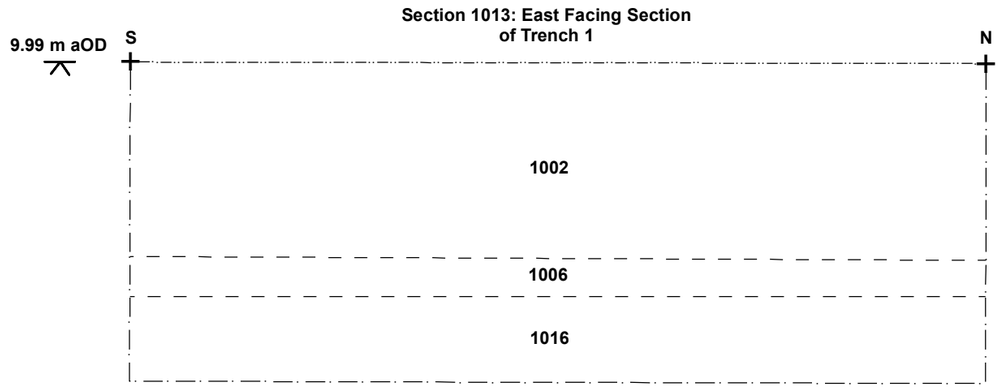

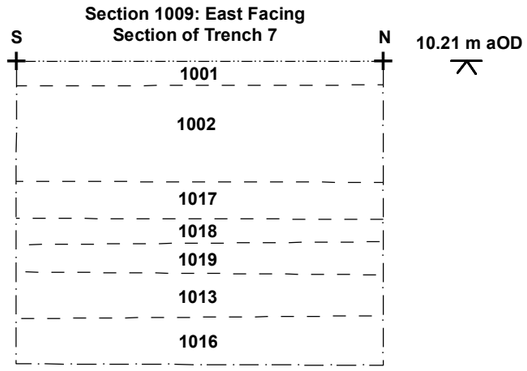

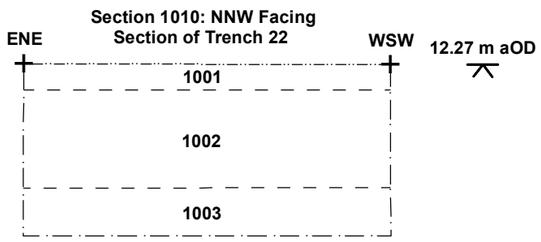

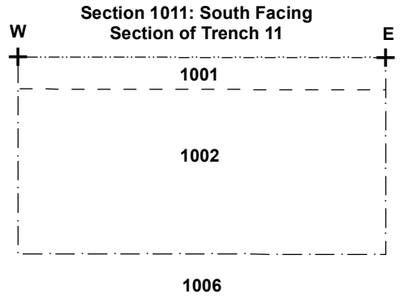

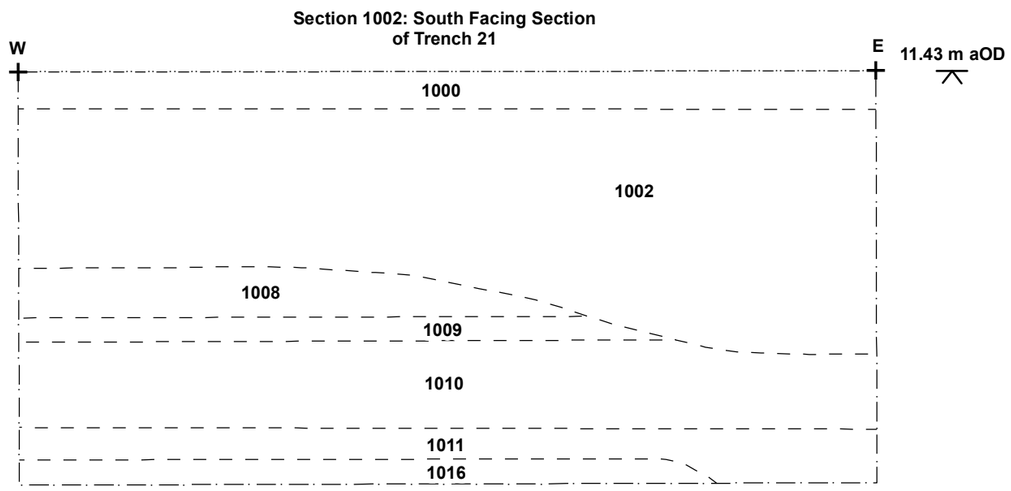

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Figure 8: Sections 1002, 1008 - 1011 and 1013

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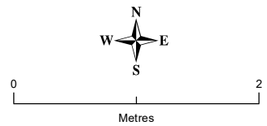
Verified By: Diarmuid O'Seaneachain Date: 30.07.2019



Scale 1:50 at A3 size

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Plates

Plate 1: East facing section 1013 of Trench 1, looking west

Plate 2: North facing view of western extent of Trench 2, looking south (Section 1000)

Plate 3: General view of Trench 2 showing in-situ pottery in Alluvium 1006, looking south-east

Plate 4: South facing section 1000 of Trench 2, looking north-east

Plate 5: South facing section 1000 of Trench 2 showing eastern limit of alluvium 1006, looking north

Plate 6: North facing section 1001 of Trench 5, looking south-east

Plate 7: East facing section 1005 of Trench 6, looking west

Plate 8: East facing section 1009 of Trench 7, looking west

Plate 9: West facing section 1012 (partial) of Trench 10, looking east

Plate 10: East facing section 1006 of Trench 17, looking west

Plate 11: South facing section 1007 of Trench 18, looking north

Plate 12: South facing section 1002 of Trench 21, looking north

Plate 13: Timber post 1014 (bottom) and 1015 (top) after initial dendrochronological assessment

Plate 14: Timber post 1014 (right) and 1015 (left) after initial dendrochronological assessment