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GLOUCESTER QUAYSIDE: GEOARCHAEOLOGICAL ASSESSMENT OF BOREHOLE STRATIGRAPHY

Prepared for Cotswold Archaeology Ltd

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CONTENTS

LIST OF FIGURES

SUMMARY

This document reports on the geoarchaeological significance of strata exposed in borehole cores collected from the Gloucester Quayside site between September 2017 and January 2019. The cores were obtained from 27 boreholes using Pioneer 2 drilling rigs equipped for dynamic sampling. The strata sampled were then described by ARCA geoarchaeologists at Geotechnical Engineering's facility at Quedgeley, Gloucester. The resultant lithostratigraphic data were transcribed into a RockWorks 15 (geological utilities software) database that also held other local borehole records, including data from the geoarchaeological borehole survey at the former HMP Gloucester site. Composite cross sections and deposit models were generated. Cores from two boreholes were subject to portable XRF measurements.

The sedimentary sequence found in the boreholes is divided into five stratigraphic units. These units are from youngest to oldest:

1. *Made Ground (post-dating AD1800)*
2. *Archaeological Strata (Holocene, pre-dating AD1800).*
3. *Elmore Member (Holocene alluvium).*
4. *Power House Member (Pleistocene terrace gravels).*
5. *Blue Lias and Charmouth Mudstone Formation (Lias Group bedrock*

The bedrock lies between -0.55m and +7.50m OD. It has a pronounced NNW dip and there is an incised ancient channel of the River Severn on the west of the site that trends NNE/SSW. The northwest point of this channel immediately south of Quay Street appears to coincide with a late Roman Quay.

Deposits of the Power House Member are slight in the ancient channel and unevenly developed elsewhere. They reach a maximum thickness of 1.28m.

Fine grained alluvial deposits fill the channel to a depth of c. *9.20m and thin eastwards as the bedrock rises. An ash wood stake driven into the weathered bedrock and dated to 70 – 224 cal. AD was recovered at +4.44m OD below 5.55m of alluvium (BH208). Roman ceramic building material was found between* c. *+3m and* c. *+8m OD. Organic remains were very rare. Evidence was found for the development of soils within the top of the Elmore Member. XRF measurements found no evidence of heavy metal concentrations. Human occupation of the floodplain is attested to, not only by cultural material within the Elmore Member but also by XRF measurements for phosphorous that increase up the stratigraphy.*

Archaeological strata was found in the form of dark coloured gritty diamicts but contained no diagnostic ceramics. Thickness was very variable from c. *0.2m to* c. *3m and the strata were absent from the central area of the site. Modern Made Ground was ubiquitous, truncating all the Archaeological strata and also affecting the underlying Elmore Member.*

1. INTRODUCTION

1.1 Project outline

1.1.1 This report discusses the results of a geoarchaeological investigation of 27 geotechnical boreholes drilled by Geotechnical Engineering Ltd at the Gloucester Quayside site in the city of Gloucester, Gloucestershire (henceforth 'the site'). The investigation was carried out by ARCA on behalf of Cotswold Archaeology Ltd at the headquarters of Geotechnical Engineering in Quedgeley, Gloucester, on five separate occasions as phases of the drilling work progressed: 29th September 2017; 19th and 20th October 2017; and on 7th and 9th January 2019. An additional 16 geotechnical boreholes drilled on the site prior to the work are also included in this assessment as are 4 British Geological Survey (BGS) boreholes that lie close to the site. Therefore a total of 47 boreholes form the core of this report. The results of the geoarchaeological borehole survey completed on the former HMP Gloucester site and its environs (Wilkinson 2017a) are also drawn upon and included in the north-south lithostratigraphic cross-sections.

1.1.2 The works outlined in this report conform to a Written Scheme of Investigation (WSI) approved by Andrew Armstrong of Gloucester City Council (Wilkinson 2017b). The WSI is based upon a brief prepared by Andrew Armstrong (2017).

1.2 Structure of the report

1.2.1 The report is arranged as follows: Section 1 provides essential background to the project, i.e. the geographic and geological situation of the site, and the aims of the present work. Section 2 outlines the methodology employed to carry out the fieldwork, subsequent data processing and laboratory examination. The results of the logging of the stratigraphy and laboratory assessments and dating are presented in Section 3, while Section 4 assesses the significance of the results in relation to the aims that have been set. A bibliography and appendices providing details of borehole locations, lithology and XRF data complete the document.

1.3 Location, topography and geology

1.3.1 The Quayside site lies in western Gloucester, to the immediate east of the River Severn (east channel) and is centred on NGR SO 8278 1866 (Figure 1). The site is approximately rectangular

in shape and measures 115m north to south. It is bounded on the east by Barbican Road, on the south by Barrack Square, on the west by the A4301 The Quay, and on the north by Quay Street. The site lies at elevations of between +11m OD and +9.5m OD and has a relatively flat aspect. Beyond Barrack Square to the south of the site is the former HMP Gloucester where geoarchaeological assessment of boreholes has recently been completed (Wilkinson 2017a).

1.3.2 Prior to the work the site was occupied by structures and car parks belonging to Gloucester County Council, although it had previously been used as a gasworks, a foundry, electricity works and as a commercial garage. Previous archaeological fieldwork to the north of the Quayside site suggests the presence of Roman quay(s) running through the site on a north-east to south-east orientation, while proximity to the former castle (south of the site) suggests medieval deposits might outcrop within the study area (Bennetto and Morton 2016; Barber 2016; Brett 2017). It is also possible that early medieval (Anglo-Saxon) strata might exist within the study area (Armstrong 2017, 3).

1.3.3 The British Geological Survey (BGS1975, sheet 234) map the site as lying on limestone and mudstones of the undifferentiated Blue Lias and Charmouth Mudstone Formations, strata that formed between 210 – 183 Ma in the late Triassic to Early Jurassic Epochs. The bedrock lithology is described as dark grey laminated shales with occasional sideritic nodules. A small outcrop of Cheltenham Sand and Gravel lies *c.* 270m to the southeast. The lithology of this unit is fine to medium sands with ooidal limestone stringers and it is believed to have been deposited in the middle of the Devensian cold stage (76,000 – 26,000 ka) by aeolian and solifluction processes. It was derived from the Middle Jurassic Great Oolite and Inferior Oolite Groups on the Cotswold Escarpment. A further distinct gravel unit is also known from the area: the Power House Member[1] and is characterised by well-rounded quartzites and fine to medium sands which are ultimately derived from Triassic strata (Maddy 1997). It aggraded on the palaeo-Severn braid plain during the Late Devensian Glacial (29,000–11,500 ka). Overlying the bedrock in the west of the site is Holocene (11,700 ka to the present day) Tidal Flat Deposits consisting of clays, silts and sands and gravels (BGS 2019a; 2019b). These deposits formed on the floodplain of the Severn as a result of mixed

[1] The Power House Member has recently been renamed Power House Terrace Deposits (River Severn). The former name will be used in this report.

intertidal and alluvial processes. They are known from the former HMP Gloucester site where they contain charcoal and ceramic building material throughout, indicative of periods of subaerial weathering and human action (from the Roman period onwards) on the floodplain (Wilkinson 2017a). All Holocene alluvial and tidal flat deposits in the Severn Valley are cumulatively known as the Elmore Member (Maddy 1999).

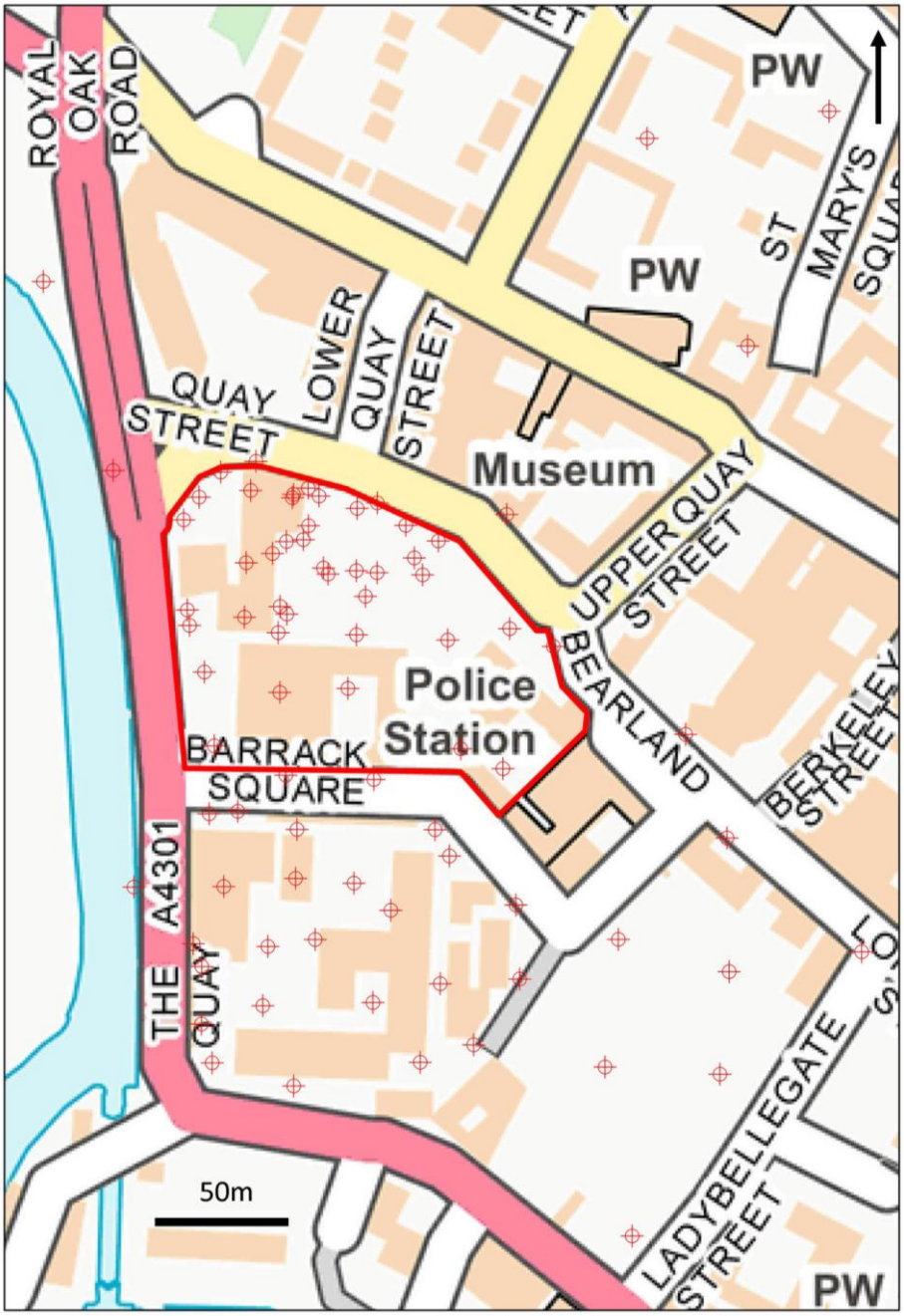

Figure 1. Plan showing the location of the Quayside site (in red outline) and boreholes on the site and in the surrounding area.

1.4 Aims

The aims of the work at the site are similar to those of the investigation of the former HMP Gloucester site (Wilkinson 2017a, 7; 2017b), namely to:

1.4.1 Determine the date, state of preservation, survival and extent of the archaeological and biological remains;

1.4.2 Determine the depositional environments for the Quaternary deposits;

1.4.3 Assess the archaeological and palaeoenvironmental importance of the deposits.

These aims will be addressed by meeting the following objectives (Armstrong 2017, 4):

1.4.4 Describe and characterise the pre-Roman alluvial sequence beneath the site;

1.4.5 Describe and characterise the Roman period waterfront deposits;

1.4.6 Describe and characterise the Saxon and early Norman waterfronts;

1.4.7 Further characterise and understand the sequence of deposits associated with Gloucester Castle;

1.4.8 Identify the point in each borehole where the conditions change from dry/oxidised, to waterlogged/reducing;

1.4.9 Record the depth and location of each element of the sequence;

1.4.10Produce a deposit model of the depositional sequence throughout the site.

2. METHODOLOGY

2.1 Field methodology and core logging

2.1.1 Borehole locations (BH#) were surveyed by Geotechnical Engineering Ltd to the National Grid and Ordnance Datum using a RTK GPS to a minimum accuracy ±0.015m (Figure 2). Each location was CAT scanned for buried services. Prior to drilling an inspection pit 1.2m in depth was excavated to check for the presence of any unmapped services, and for the presence of near surface obstacles and contamination.

2.1.2 Drilling commenced from the base of the inspection pits and continued until either the base of the Quaternary sequence was reached or in accordance with the remit of geotechnical requirements. A Pioneer 2 drilling rig capable of both rotary and percussion drilling was used to retrieve continuous cores of 100mm diameter contained in Perspex liners (for technical and engineering details see Geotechnical Engineering Ltd 2017). Boreholes were cased to ensure the minimum of contamination and the integrity of the borehole. The cores were sealed and labelled on site and transported to Geotechnical Engineering's Quedgeley warehouse for geoarchaeological logging and geotechnical testing.

2.1.3 The sediment retained in the core tubes was carefully hand-cleaned using a sharp scalpel to expose a fresh surface for photography and description. Cores were photographed and the lithology was described using standard geological criteria (Jones *et al.* 1999; Munsell Color 2000; Tucker 2011). The cores from two boreholes were selected for XRF and transported to the ARCA laboratory at the University of Winchester.

2.2 Desk top methodology

2.2.1 Lithological and positional data (19 records) acquired from previous geotechnical work for the Quayside area and a surrounding buffer of 100m have been transcribed into a database of the RockWorks 15 geological utilities program (RockWare 2012) that already exists for the former HMP Gloucester site (Wilkinson 2017a). The data acquired from the logging of the present work has also been added to the data base. The software was then used to plot the lithostratigraphic cross-sections. The location and elevation of the boreholes are recorded in Appendix 1 and lithological data in Appendix 2.

2.2.2 Two-dimensional structural surface elevation models in m OD and structural thickness (isopach) models were generated for the stratigraphic units encountered on the present site and on the neighbouring former HMP Gloucester site. To ensure the maximum possible accuracy of the modelling process an inverse distance algorithm was employed with a cut-off distance of 5% of the project dimensions. That is to say, from each datum point (borehole) the nearest eight points that lie within a radius of *c.* 47m are used. This avoids over generalising the model where data is sparse.

2.3 X-ray fluorescence assessment

2.3.1 Portable X-ray fluorescence (XRF) is frequently used in sediment analysis as a means of elemental characterisation of the deposits and the identification of periods of human activity (e.g., Kylander *et al.* 2011; Coronel *et al.* 2014). A Thermo Scientific Niton XL3 handheld X-ray fluorescence analyser was used to create an elemental profile for BH226 and BH227. The analyser creates an incident X-ray beam using a 2-W Ag-anode tube and detects characteristic X-rays using a 25 mm2 Si drift detector. Four-built in X-ray filters allow for a range of elemental compositions to be determined based on their position in the periodic table ('main', 'high', 'low', 'light'). All analyses were carried out in 'Mining Mode' using an incident X-ray beam or 3mm (Sherriff 2017). Eight elements were selected from a total of 20 elements recorded and are presented in Appendices 3 and 4. Selection was based on the percentage error for each record being less than ten.

2.3.2 XRF analysis was undertaken on the core samples directly beginning at the top of the stratigraphy (sub-sample 1) and continued to the base. A total count time of 150 seconds (60, 30, 30 and 30 seconds on 'main', 'high', 'low' and 'light', respectively) was applied. All XRF data is expressed as parts per million (ppm).

2.4 AMS ^{14}C dating

Radiometric dating was obtained for a single sample of wood derived from a wooden stake recovered from BH208. The sample was submitted to Scottish Universities Environmental Research Centre (SUERC) at Scottish Enterprise Technology Park, Rankine Avenue, Glasgow G75 0QF (see Section 3).

2.5 Palaeoenvironmental assessment

No suitable organic material (peat or organic refuse, for example) was recovered from the borehole cores and as a consequence no palaeoenvironmental sampling was undertaken.

2.6 Archive

The material archive consists of cores from BH226, BH227 and BH225 that will be retained at the University of Winchester until 30th May 2020 and then disposed of *without further notice*. The digital archive consists of photographs of the cores in JPG format and this report in PDF format. These digital archives are stored both on the University of Winchester server and on an external hard drive stored outside the University of Winchester. Copies of these data can be supplied on request.

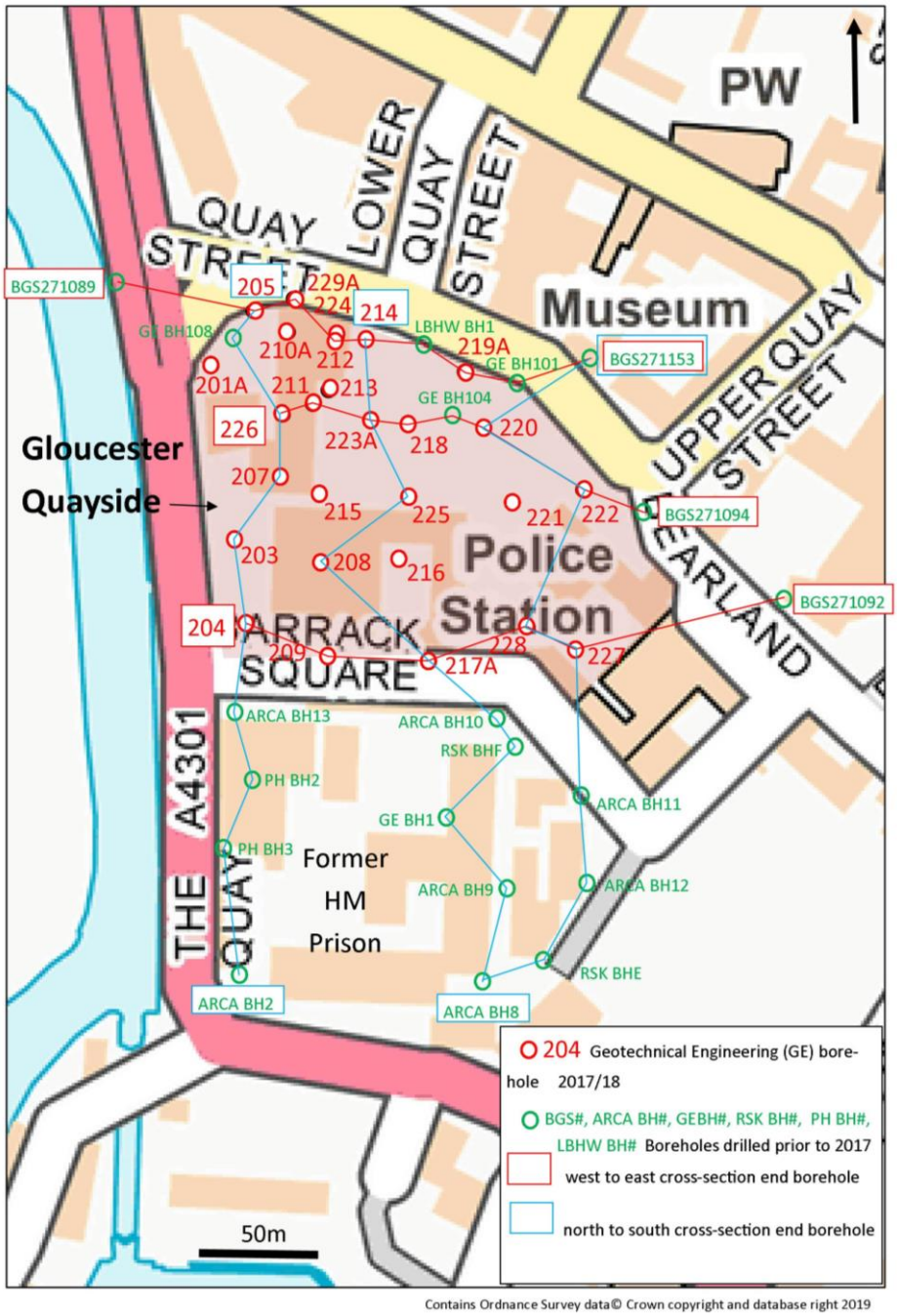

Figure 2. Locations of boreholes drilled on the Quayside site (2017-2019) and lithostratigraphic cross-sections. Boreholes drilled prior to 2017 are shown only where they are included in a cross section.

3. RESULTS: AMS ^{14}C RADIOCARBON DATING

3.3.1 An ash stake recovered from BH208 at +4.44m OD (6.46-6.75m bgl) and measuring 290mm long and 0.50mm wide tapering to a point, was submitted for AMS ^{14}C radiocarbon dating. The results are tabulated below in Table 1.

Sample Location:	**Material dated**	**Lab code**	**δ ^{13}C ‰**	**Conventional radiocarbon age (±1σ)BP**	**2σ calibrated date cal. BC/AD (2 σ: 95.4% probability)**
BH208	Waterlogged Wood : *Fraxinus*	SUERC-85820 (GU50768)	-28.2	1875 ± 30	70-224 cal. AD

Table 1. AMS 14C radiocarbon dating on ash stake from BH208. The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration programme (OxCal v4.3.2; Bronk Ramsey 2017; IntCal13 atmospheric curve; Reimer *et al.* 2013).

3.3.2 The ash stake is dated to 70 – 224 cal. AD in the Roman period.

4. RESULTS: BOREHOLE LITHOLOGY

4.0.1 The sedimentary sequence found in the boreholes is divided into five stratigraphic units. These units are from youngest to oldest:

1. Made Ground (post-dating AD1800 (see Wilkinson 2017a and Section 4.5).
2. Archaeological Strata (Holocene, pre-dating AD1800).
3. Elmore Member (Holocene alluvium).
4. Power House Member (Pleistocene terrace gravels).
5. Blue Lias and Charmouth Mudstone Formation (Lias Group bedrock).

Each unit is discussed in stratigraphic order in the following Sections.

4.1 Lias Group bedrock

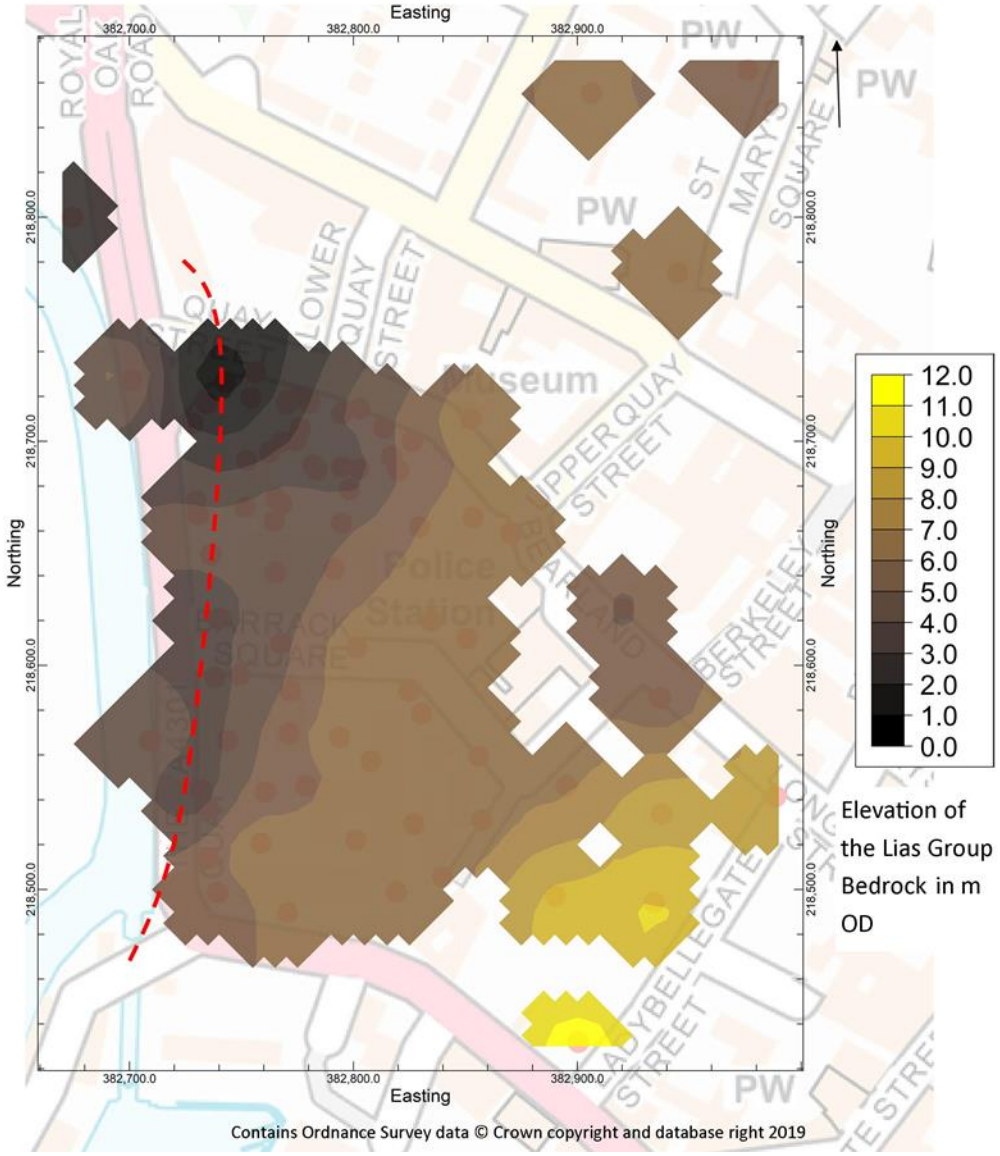

Figure 3. Elevation (m OD) of the Lias Group bedrock. The route of a possible channel is marked in red.

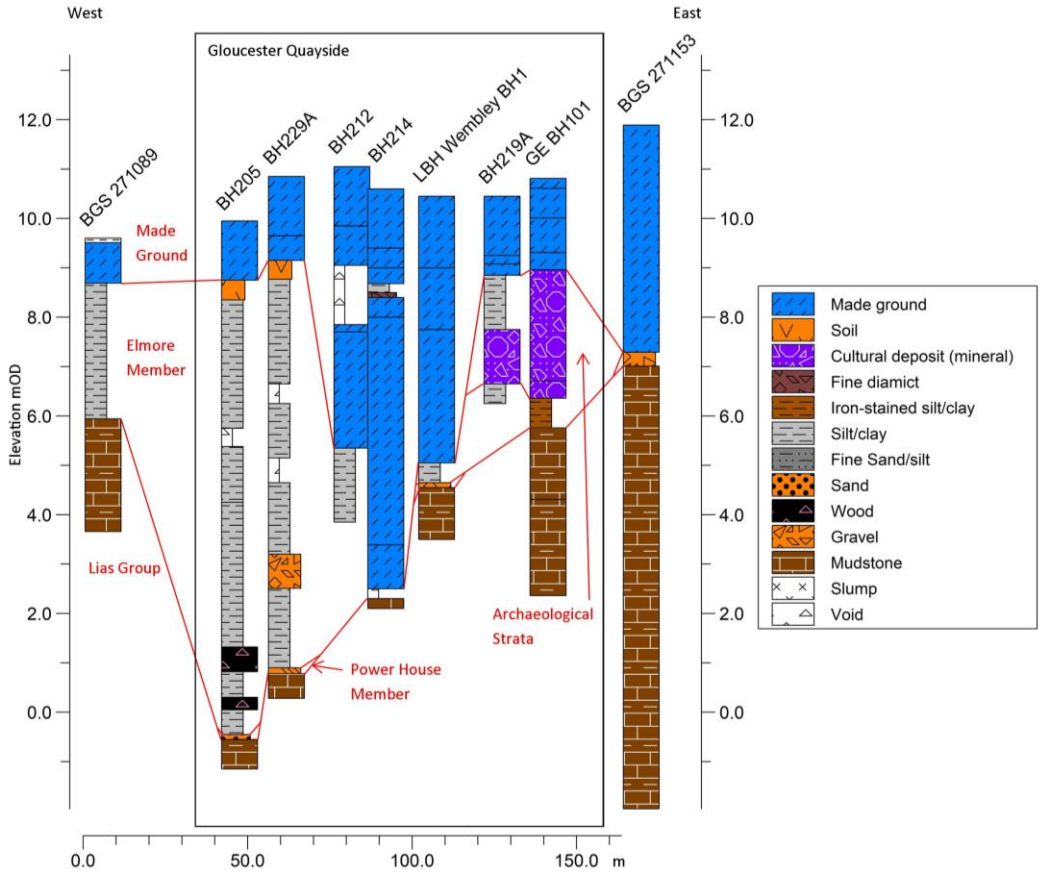

Figure 4. Lithostratigraphic section from west to east across the north of the site. Vertical exaggeration x15. Note deep channel with little gravel and deep penetration by Made Ground (Section 3.3.2).

4.1.1 The Lias Group bedrock is found in 30 boreholes (Figure 3). It lies between -0.55m OD in BH205 (10.50m bgl) in the northwest and +7.50m OD in BH228 3.55m bgl in the southwest of the site. It has a pronounced NNW dip and strike NNE/SSW indicative of an earlier and now filled channel (Figure 3 and Figure 4). The northwest point of this channel immediately south of Quay Street appears to coincide with a postulated late Roman Quay (Wilkinson 2017a, 23). Further southeast of the site, towards Ladybellegate Street, the bedrock rises sharply to *c.* +11m OD which suggests the presence of a high and earlier strath terrace cut by lateral erosion of the bedrock by the ancient River Severn (noted in Wilkinson 2017a, 23).

4.1.2 The lithology of the bedrock is a black or very dark grey (2.5Y 2.5/1 to 2.5Y 3/1) stiff to very stiff laminated and often lustrous mudstone. Fossils are occasionally present. The upper fraction (at the most *c.* 0.6m) can be, but not always, weathered, having

a less stiff texture, homogenous rather than laminated, and an oxidised very dark greyish brown (2.5Y 3/2) colour with olive brown (2.5Y 4/4) mottles. This may be the result of subaerial weathering or oxidation during the aggradation of succeeding deposits.

4.1.3 The bedrock is unconformably overlain by superficial Quaternary deposits.

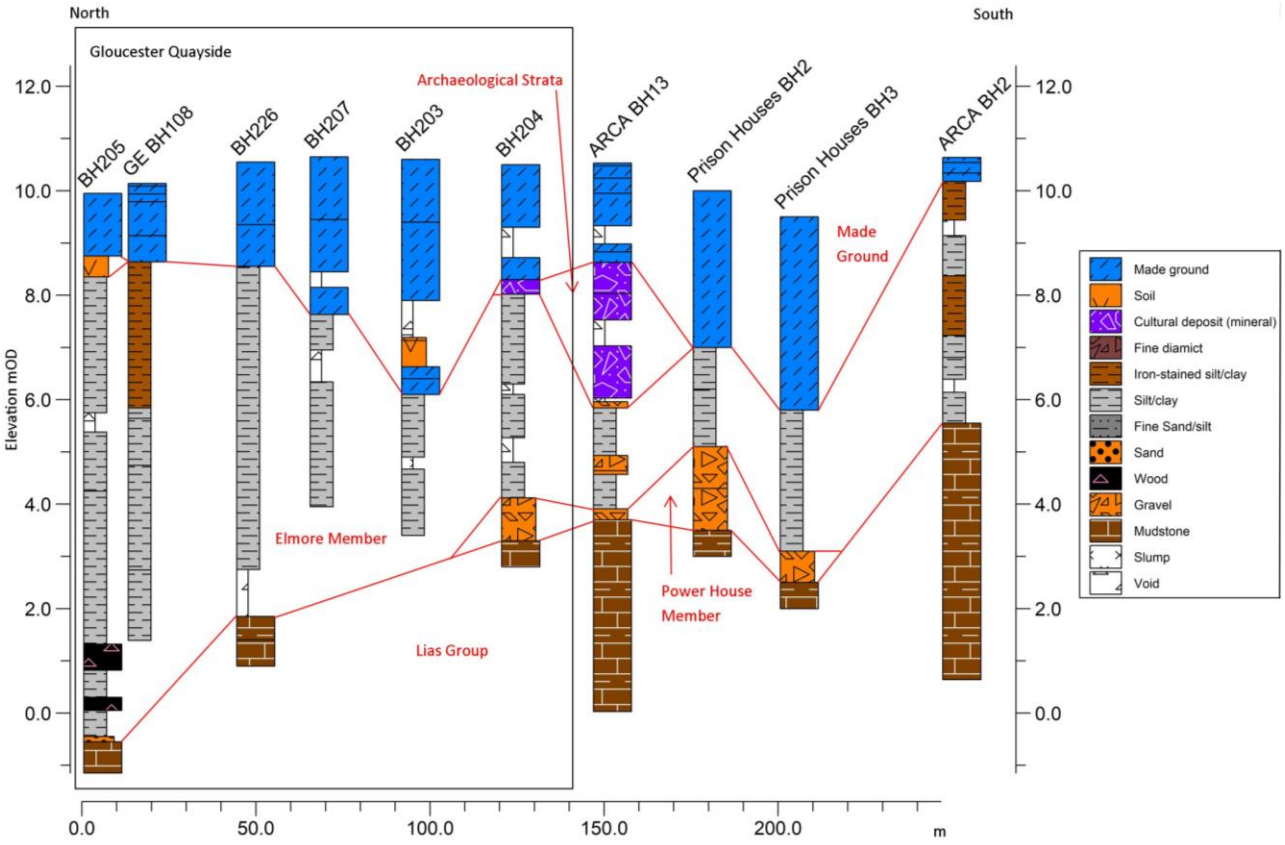

Figure 5. Lithostratigraphic cross-section from north to south in the west of the site. Vertical exaggeration x15. Note the lack of gravels in the channel in the north. Roman ceramic and mixed lithology gravels found in BH204 south to Prison Houses BH3 (Section 4.2.3). Note the rising bedrock bluff at ARCA BH2 (site of the castle) in the south on the former HMP Gloucester site, and the wood timbers in BH205.

4.2 Power House Member

4.2.1 Sands and gravels that are assigned to the Power House Member are found in 13 boreholes. The unit lies between +0.90m OD (9.95m bgl) in BH229A on the northwest boundary

with Quay Street, and +7.48m OD (3.87m bgl) in BH227 in the southeast of the site.

4.2.2 The sub-surface elevation of the Power House Member follows the topography of the bedrock with a general slope NNW (Figure 6). The thickness of the unit generally lies between 0.2 and 0.8m. To the east of the channel the bedrock is depressed in the area just southwest of Bearland and thick (1.28m) upward fining deposits of gravel are found close by in BH227 (Figure 7 and Figure 8). Gravels across the braid plain are expected to vary in thickness filling concavities in the bedrock and forming banks and bars. That being said, gravels in the channel are relatively thin where flow energy was high (Figure 4). Another thick deposit (*c.* 2.5m) is recorded in BH210A where the emplacement of the gravel has reworked the friable top of the mudstone incorporating it within the deposit and artificially augmenting the thickness. In the southeast beyond the site, an unusual thickness is recorded in IFA BH4 where the bedrock itself is high and thick deposits of sand (2.2m) are found to overly it. Rather than the Power House Member this sand is likely to be the Cheltenham Sand and Gravel (Figure 6 and Figure 7).

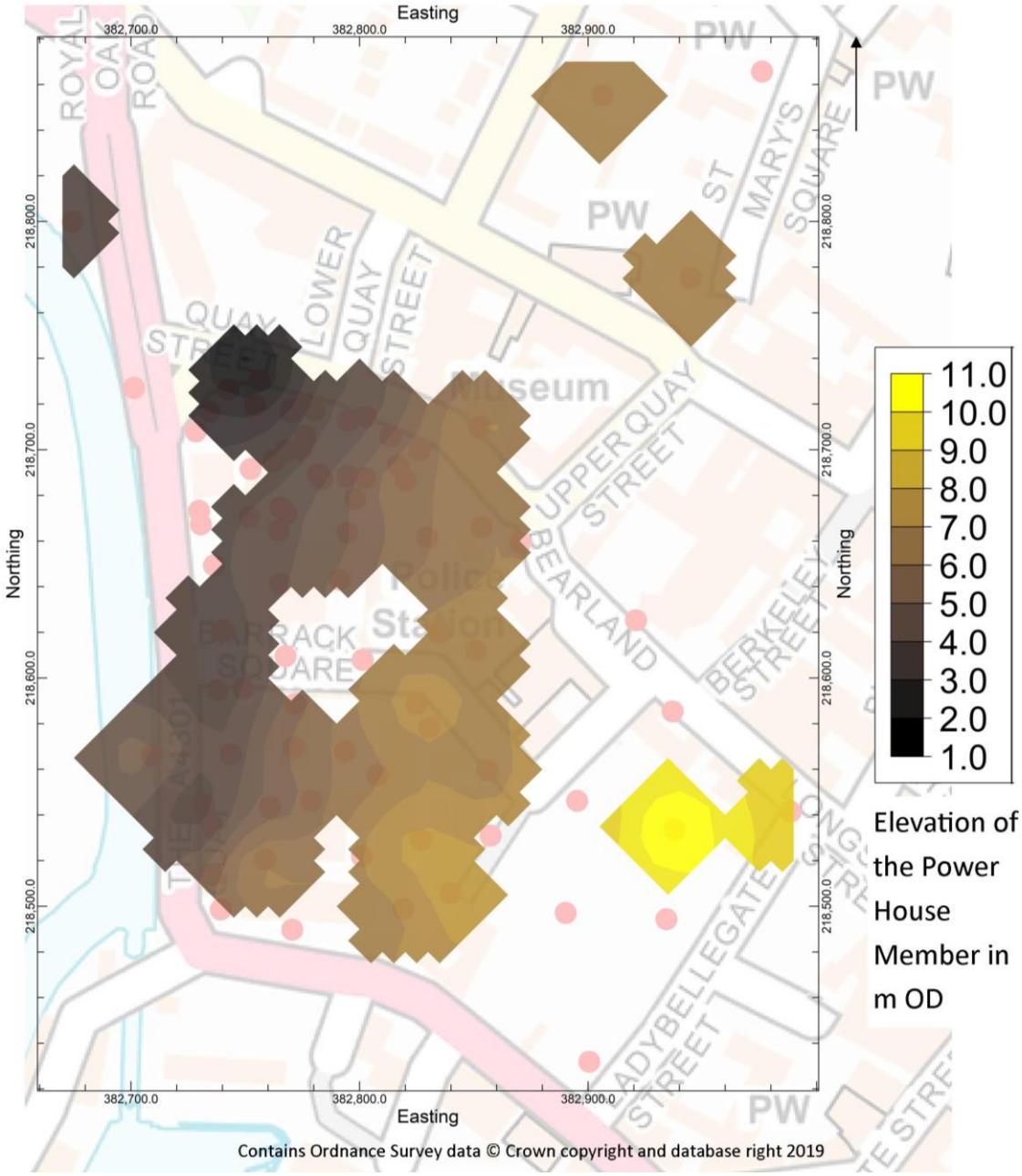

Figure 6. Elevation (m OD) of the Power House Member. Probable Cheltenham Sand and Gravel sub-cropping at *c.* 10m OD in the southeast

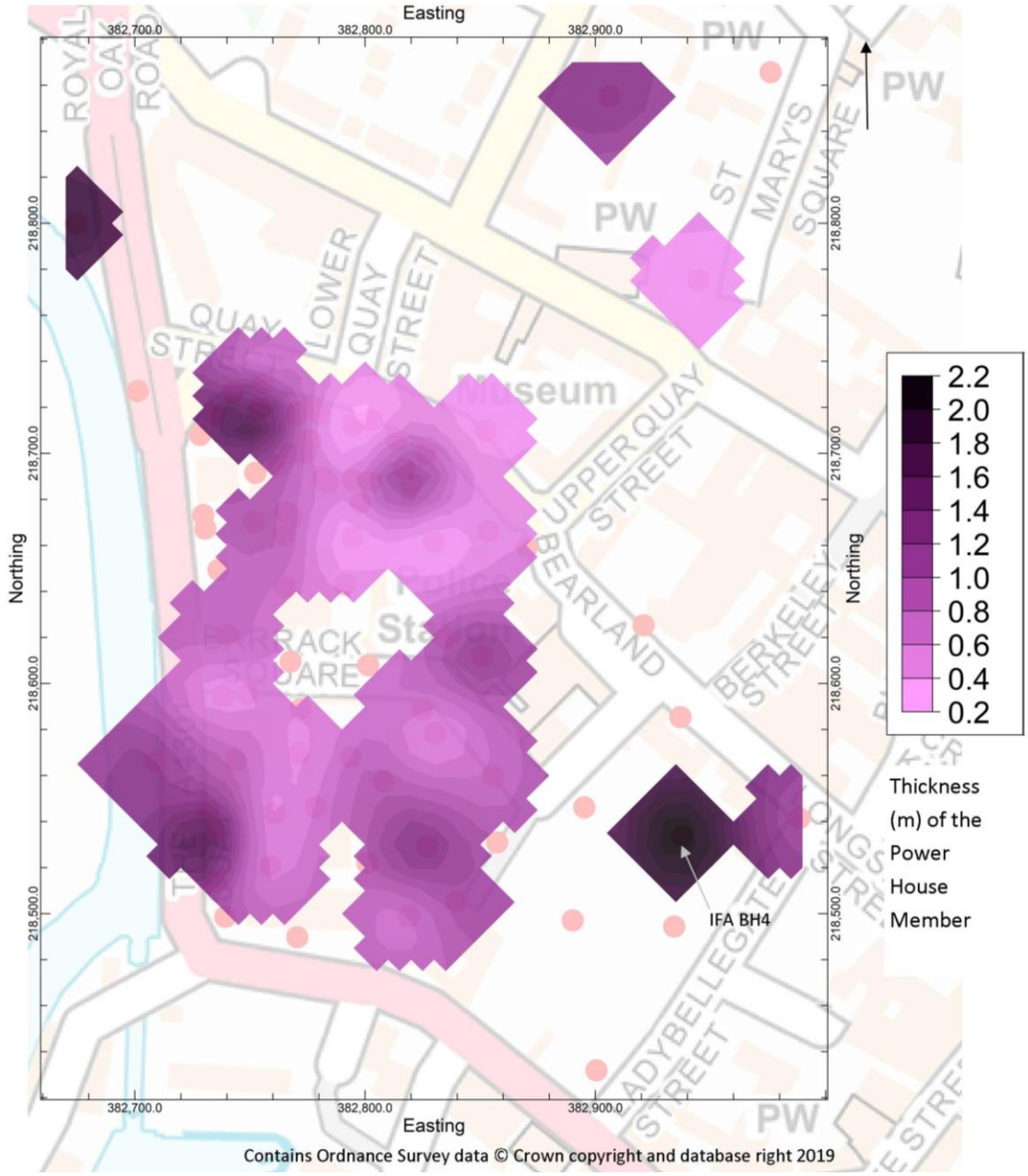

Figure 7. Thickness (m) of the Power House Member. Thick sand deposits probably pertaining to the Cheltenham Sand and Gravel at IFA BH4 in the southeast.

4.2.3 The lithology of the Power House Member is predominantly well rounded quartzites and orthoquartzites from granule to coarse pebble size (2mm – 64mm). They are generally poorly sorted and clast supported (often loose within the core lining) and contain a well-rounded fine to medium sand fraction. Fine pebbles of white vein quartz and rare, well-rounded, oblate fine pebbles of green mudstone are also present. On occasion, ooid grains and

ooidal limestone clasts make up a subordinate fraction derived by erosion from local Cheltenham Sand and Gravel outcrops upstream, as multiple channel threads of the ancient braided River Severn rework the braid plain. On the other hand, Wilkinson (2017a, 23) points out that such material – including Roman ceramics – is associated with a possible reworking of the Power House Member in the Roman period and is seen in ARCA BH13, Prison Houses BH2 and Prison Houses BH3 on the former HMP Gloucester site (Figure 5).[2] Gravels recorded at BH204 *c.* 30m further north also contain ooidal limestone clasts mixed with the Triassic quartzites, and granules of cbm that lend support to the hypothesis of Roman hydraulic activity in the area of The Quay. Two further boreholes have a mixed ooidal limestone/quartzite lithology: BH220 and BH215. In BH215 (located *c.* 20m north of the Roman stake find spot at +4.44m OD in BH208)) clayey gravels of mixed lithology sub-crop at +4.75m OD and include a coarse pebble of Roman cbm and charcoal grains. The mode of formation of this deposit is unclear and may well reflect a direct human influence on the mudflats. The deposit overlies laminated clays of the bedrock.

4.2.4 The gravels of the Power House Member are overlain by fine grained alluvium that pertains to the Holocene Elmore Member.

[2] Recent work at the Barbican site has found Power House gravels to be overlain by thick reworked Cheltenham Sand and Gravel that appears to have no relation to the Roman period and is a manifestation of the Pleistocene braided river.

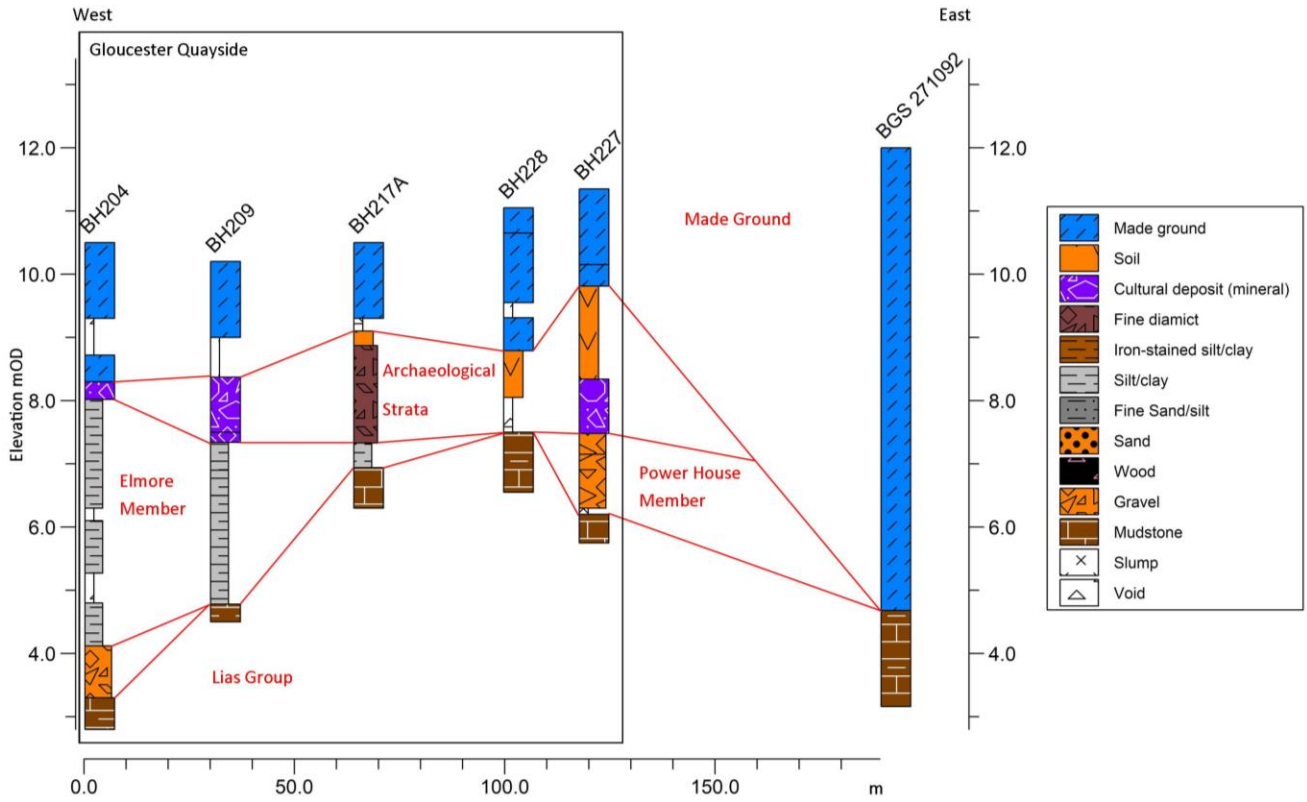

Figure 8. Lithostratigraphic cross-section from west to east across the south of the site. Vertical exaggeration x15. Note thick gravel deposits in BH227 in a bedrock depression southwest of Bearland.

4.3 Elmore Member

4.3.1 The fine grained alluvial unit, the Elmore Member, is recorded in 33 boreholes (

Figure 9 and Figure 10). The unit lies between +4.82m OD (5.83m bgl) in BH215, located west of centre of the site, and +9.15m OD (1.70m bgl) in BH229A on the northwest boundary with Quay Street (Figure 2. Locations of boreholes drilled on the Quayside site (2017-2019) and lithostratigraphic cross-sections.

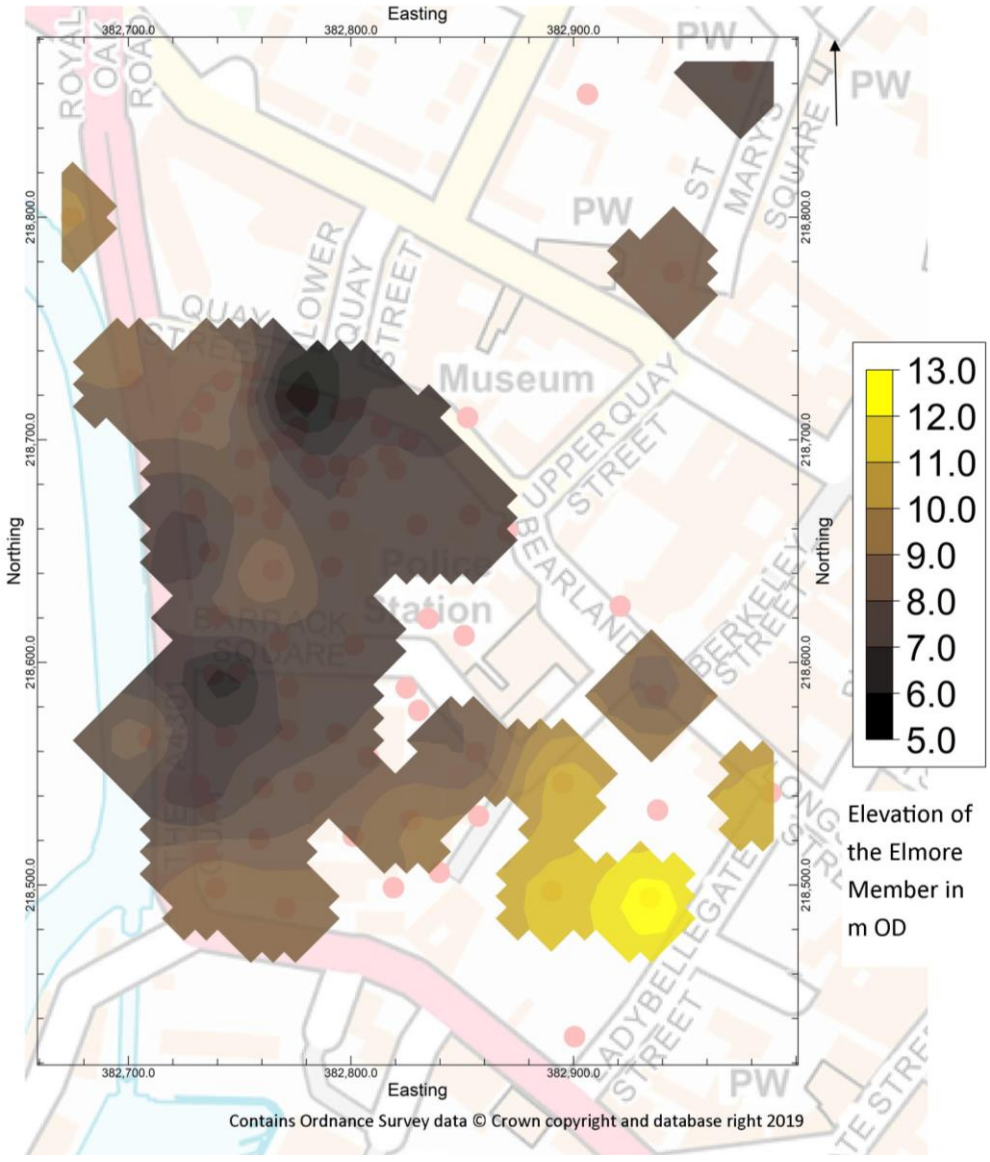

Figure 9. Elevation (m OD) of the Elmore Member.

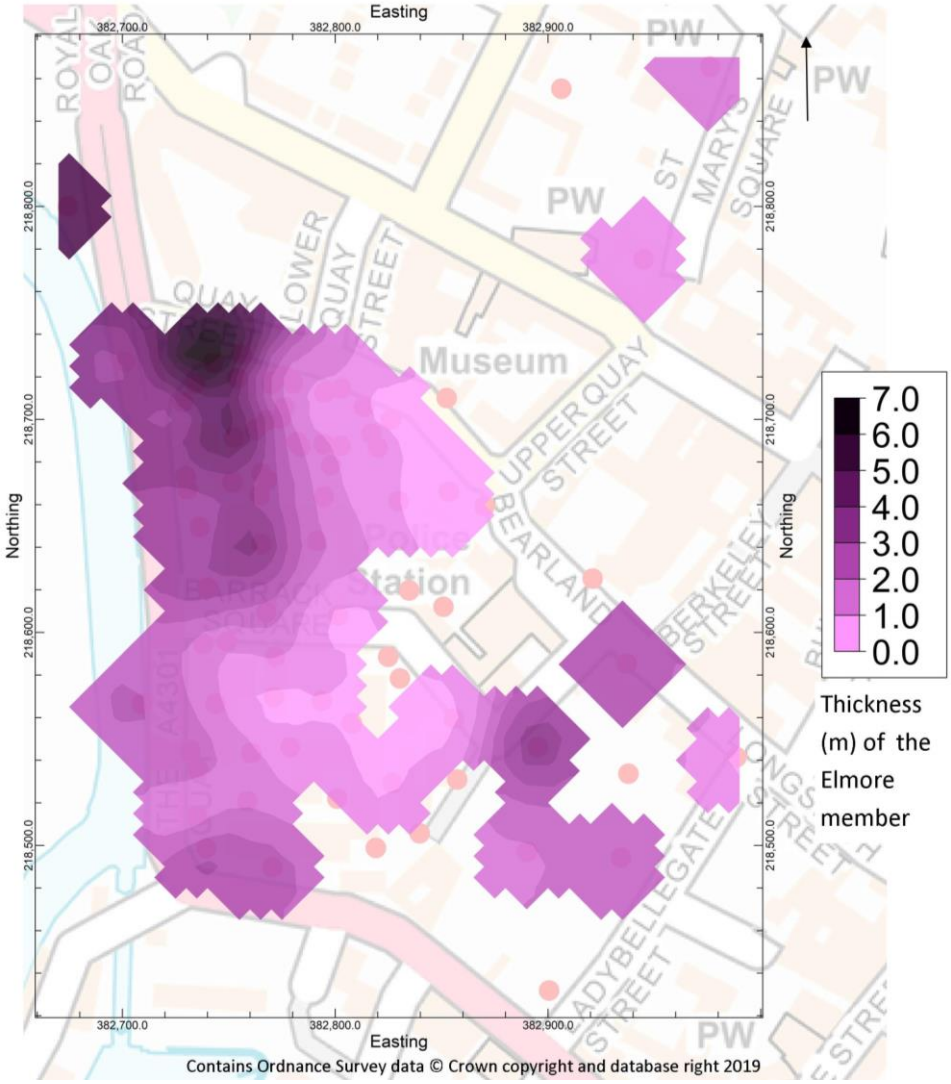

Figure 10. Thickness (m) of the Elmore Member.

4.3.2 The elevation of the Elmore Member has been severely compromised by truncation from Made Ground in the north of the site where thick deposits of it are recorded in BH212, LBHW1 and BH214 (Figure 4), and in the central northern area in BH218 and GE BH104. Aside from the truncation the Elmore Member has a relatively level elevation, on average +7.41m OD varying in the order of plus or minus 1m (
Figure 9). Off-site, in the southeast, deposits are found at high elevation over the elevated bedrock discussed in Section 4.1.1 as a possible terrace.

4.3.3 The thickness of the Elmore Member deposits are highly variable, even when taking into account truncation, and range from 9.20m in BH205 in the northwest and filling the deep NNE-SSW channel, to 0.30m in BH222 in the east (Figure 4 and Figure 11). The deposits are thickest in the west (Figure 5) and thin eastwards across the site as the elevation of the bedrock rises (Figure 11).

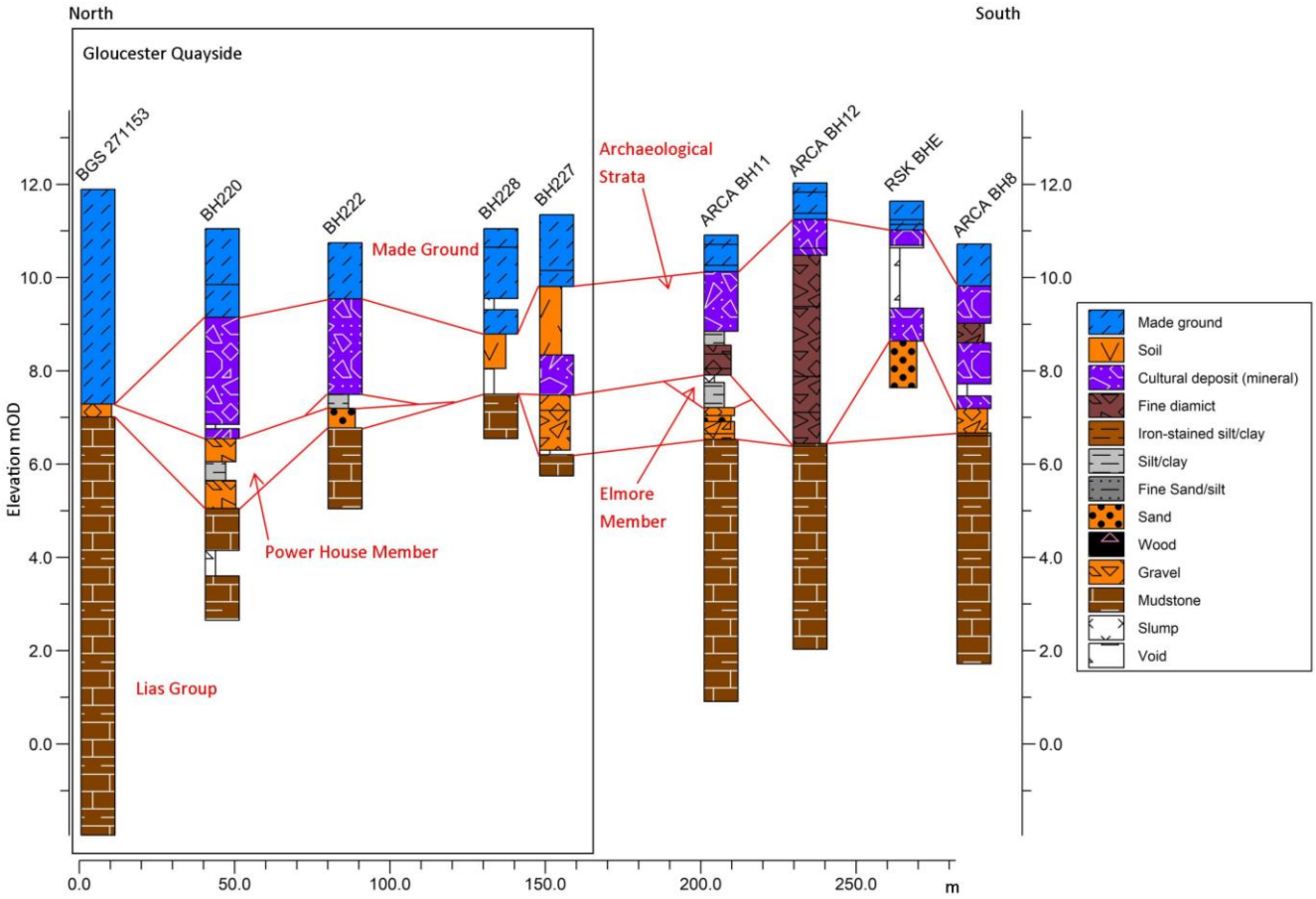

Figure 11. Lithostratigraphic cross-section from north to south in the east of the site. Vertical exaggeration x15. Note the high elevation of the bedrock and the thinned deposits of the Elmore Member. In BH227, for example, Archaeological strata grade from Elmore Member at the base (not shown overlying the gravel and included within the Archaeological strata) to a soil at the top (Section 4.3.6).

4.3.4 The lithology of the Elmore Member is dark brown (7.5YR 3/2), firm, generally massive silt/clay that can show horizontal silt laminae at depth where any disrupting bioturbation is absent. Its characteristic brown colour may be masked by black humic acids as a result of reduction in an anoxic environment. On exposure the sediment rapidly oxidises to a greyish brown (10YR 4/2). The presence of the freshwater molluscs *Anisus*

leucostoma and *Lymnea* sp. are characteristic and whole shells are often preserved. They may be reworked from freshwater habitats on or near the floodplain. Granular to coarse pebble-sized clasts of sub-rounded ooidal limestone are occasionally or even frequently present and the deposit is often somewhat poorly sorted. Sub-angular ochre flint, grey limestone, mortar, bone and cbm form a subordinate clastic fraction. Charcoal grains are ubiquitous but not generally frequent. Cultural artefacts are found at depth and pebble-sized clasts of probably Roman cbm was found at 7.65m bgl (+3.20m OD) in BH229A incorporated within a gravel lens within the NNE-SSW channel. Organic plant remains can be present where the deposit is reduced, however, they are minimal and in the form of rare twigs or other wood fragments, and granular-sized plant fibres. Peat was not found on the site. The fine grained alluvium grades into sandy deposits and thence to gravel.

4.3.5 The predominantly fine grained lithology and the freshwater molluscs indicate low energy deposition of the Elmore Member on the floodplain. The coarse clastic content, charcoal and in particular cbm, is evidence of human activity from the Roman period onwards, probably during dryer periods of time, and notably *Anisus leucostoma* is tolerant of drought. There is no evidence of prehistoric occupation as is found at the Member type-site of Elmore 5km to the southeast.

4.3.6 The uppermost fraction of the Elmore Member may be subject to pedogenesis and the consequent formation of a soil. This will occur as soon as the water table falls sufficiently and for long enough for a soil biota to develop. Six boreholes had evidence of soils (BH203, BH205, BH208, BH217A, BH227, BH228 and BH229A) although only one (BH208) was sufficiently well preserved to show a top soil and a sub-soil, and its contact with the underlying parent clays of the Elmore Member (Figure 12). In BH208 a dated wooden stake (70 – 224 cal. AD) lay *c.* 4m below the base of the soil. As no other dateable artefacts were recovered from the stratigraphy and the thickness of the soil presupposes a lengthy formation, a medieval to post-medieval date for the soil may be proposed. The contiguous borehole south (BH217A) also has a soil but here it overlies a stony diamict that would appear to be an archaeological stratum.

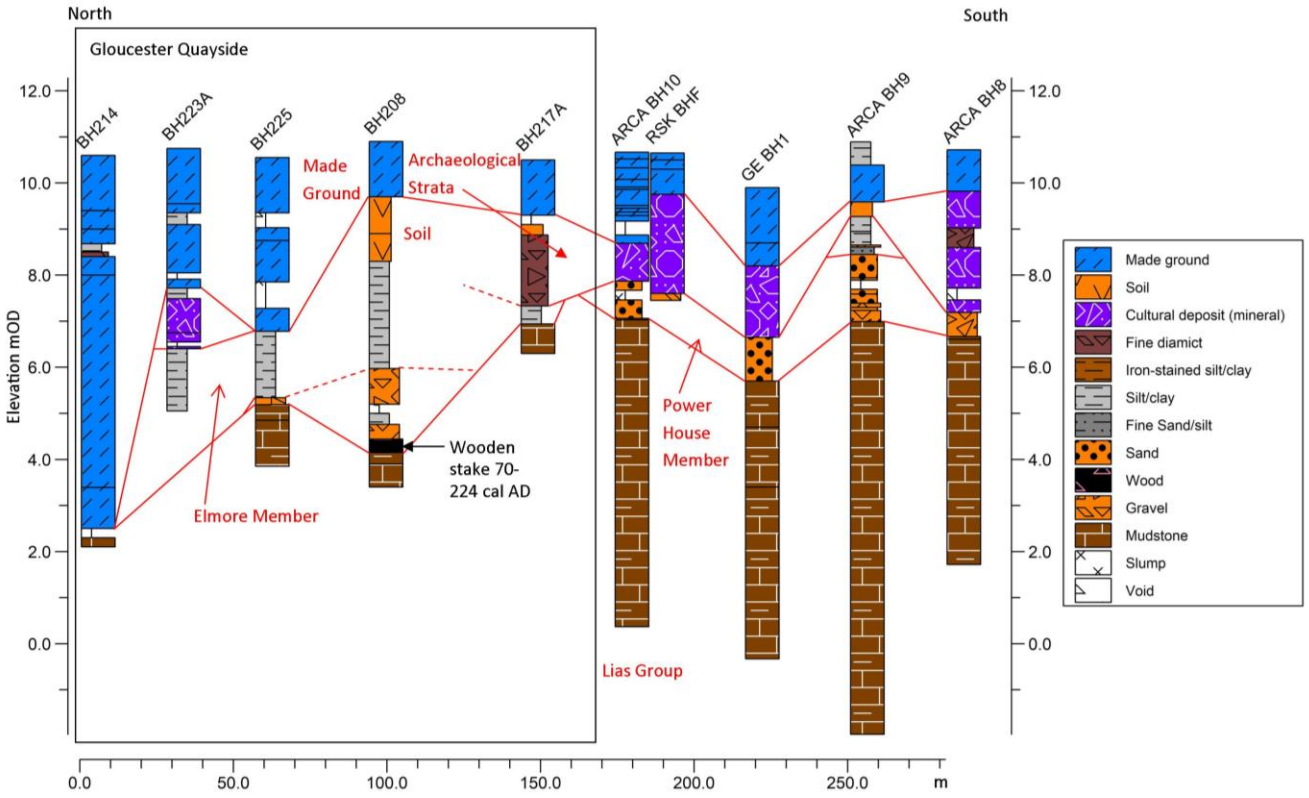

Figure 12. Lithostratigraphic cross-section from north to south in the centre of the site. Vertical exaggeration x15. Note in BH208, a Roman ash wood stake buried by Elmore Member. A soil has developed in the top of the Elmore Member.

4.3.7 Two boreholes recovered evidence of archaeological strata at depth within the Elmore member: two timbers in BH205 in the northwest boundary with Quay Street; and an ash stake in BH208 in the south east of the site (Figure 5 and Figure 12). The two timbers are squared and the upper one lies at +1.32m OD (8.63-9.13m bgl) and the lower at +0.30m OD (9.65-9.90m bgl). They are possibly modern (pers. comm. Keith Wilkinson and Cliff Bateman 2019). The stake (Figure 13), on the other hand, is radiocarbon dated to 70 – 224 cal AD and lay at +4.44m OD (6.46-6.75m bgl). It is 290mm long and 0.50mm wide tapering to a point. It was set vertically into bedrock clays and covered by a coarse ooidal limestone gravel unit through which it was presumably driven. The elevation of the stake provides evidence of the proximity of a Roman surface on the river bank/mudflats.

Figure 13. Ash wood stake dated to 70 – 224 cal AD.

4.3.8 The Elmore member is overlain by archaeological deposits and truncated by Made Ground.

4.4 Archaeological strata

4.4.1 The Archaeological strata found on the site are predominantly mineral in lithology. There was no strata composed predominantly of organic material. In fact, organic material (except for examples of wood discussed above in Section 4.3.7) was very scarce, comprising very rare granular-sized plant fibres, twig and occasional bone. The narrow sample size of the borehole cores (100mm) does not allow any distinction to be made of archaeological features nor permit any chronological subdivision of the unit as the recovery of diagnostic ceramics is inadequate. The Archaeological strata are discussed therefore as a single lithological unit.

4.4.2 Archaeological strata are distinguished from Made Ground following the scheme of Wilkinson (2017a, 27) whereby deposits containing concrete, modern brick and coal are assigned to the Made Ground and date to post-18th century (Victorian period to the present day). Diagnostic pottery was very rare, however, brick (cbm) was ubiquitous and was classified as hand-made and thus pre-18th century or Victorian to modern. This is not an infallible guide as handmade brick continues to be made in the Victorian period. Roman cbm was identified on the basis of its orangish colour and the presence of red grog in the fabric.

4.4.3 Fifteen boreholes recorded Archaeological strata. They sub-cropped between +5.60m OD (5.2m bgl) in BH218 in the centre north and +9.81 (1.54m bgl) in BH227 in the southeast of the site. The Archaeological strata are in all cases truncated

by modern Made Ground as a result the superface of the strata is irregular and generally uninformative. Some inferences about the bed form can be drawn however: first, there is an absence of archaeological strata from the centre of the site (Figure 14); secondly, the thickness varies greatly from as little as 0.28m in BH204 to 3.17m in BH213 (Figure 5); and thirdly, in the area as a whole the strata slopes in a northwesterly direction in compliance with the slope of the bedrock.

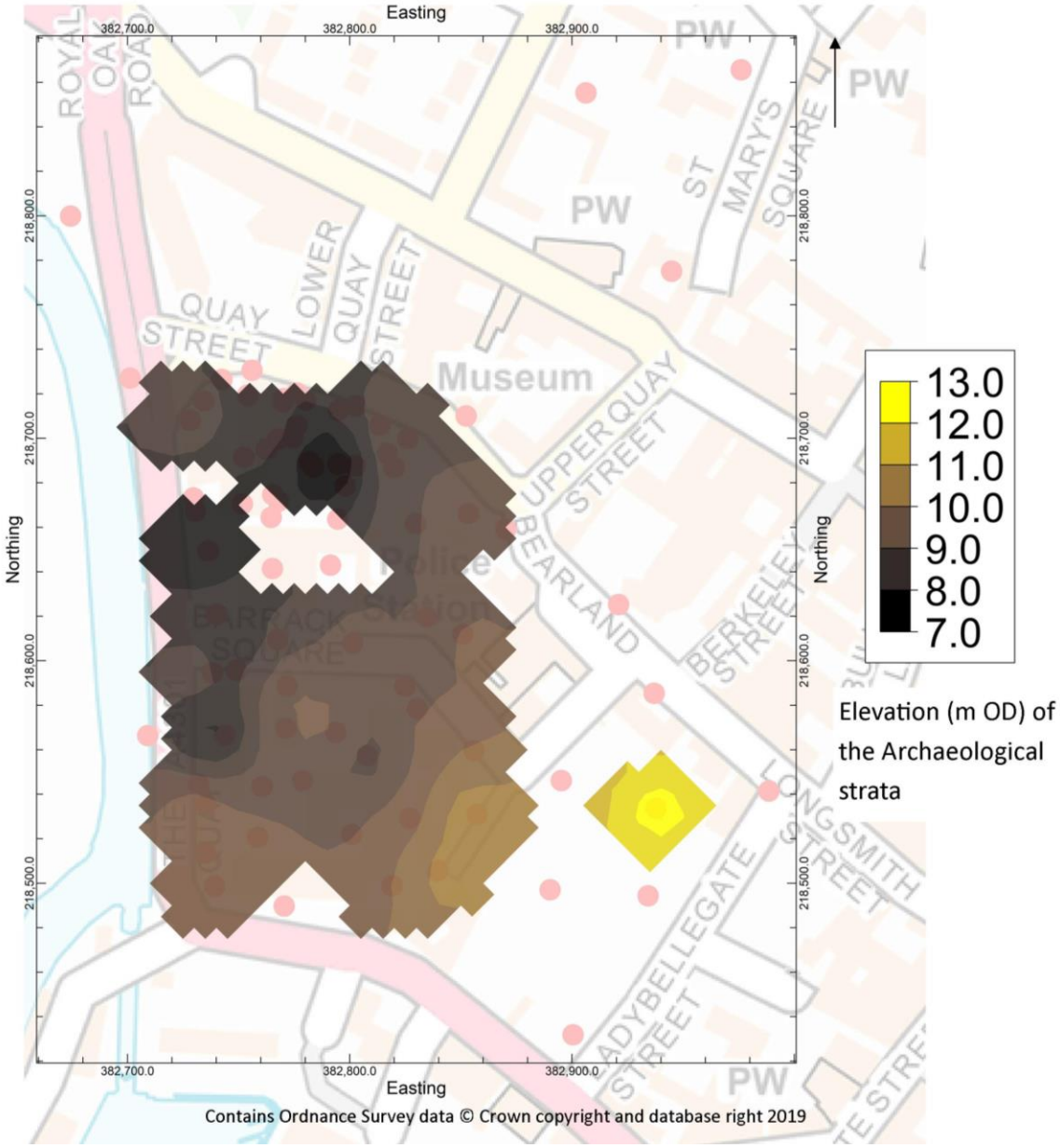

Figure 14. Elevation (m OD) of the Archaeological strata. Note truncation of the strata in the north centre of the site caused by the deep Made Ground.

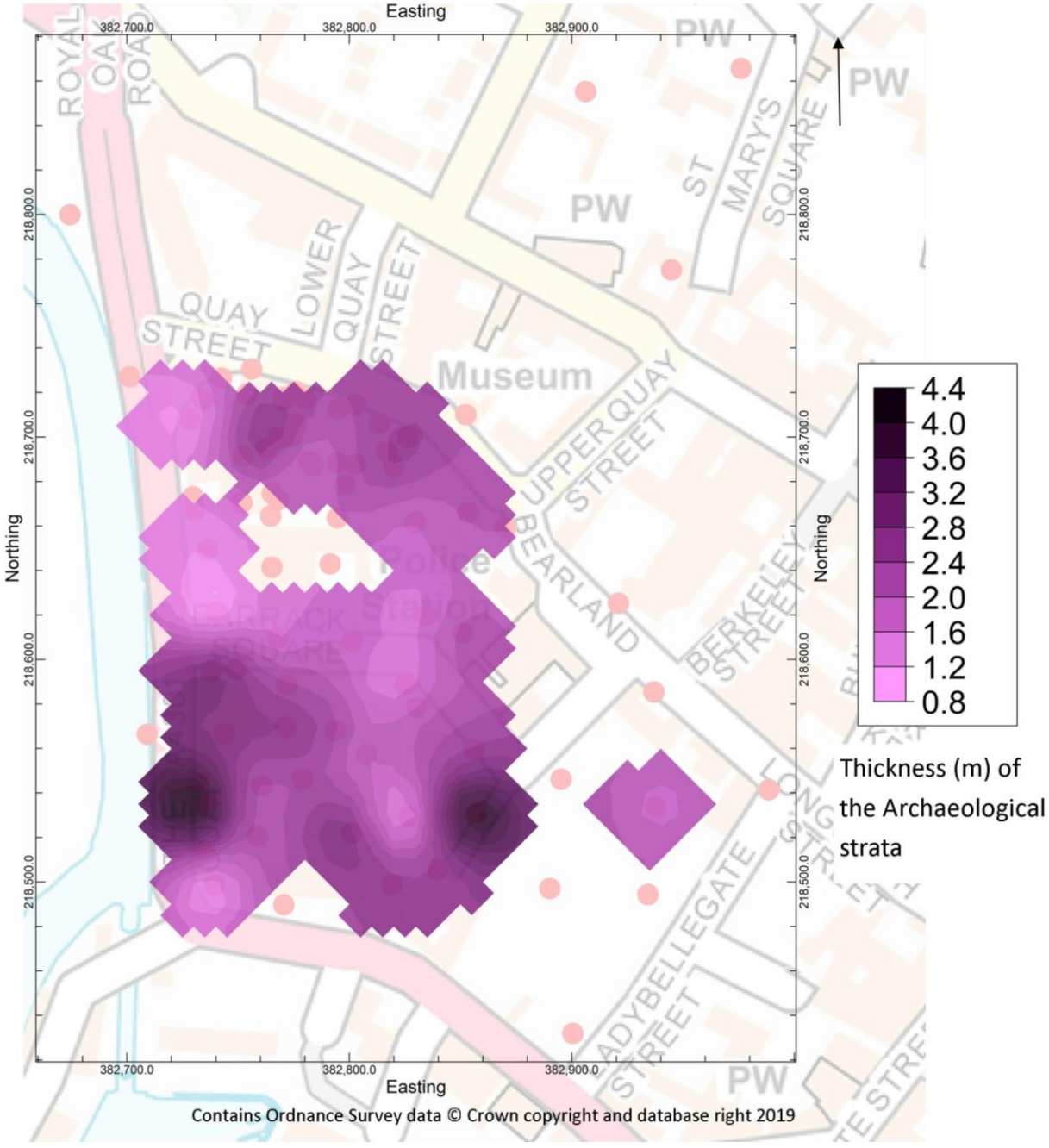

Figure 15. Thickness (m) of the Archaeological strata.

4.4.4 The subface of the Archaeological strata, that is to say, the basal surface, is often a diffuse or gradual boundary in contact with the Elmore Member. The implication being that human action on the floodplain becomes gradually more intense until flood plain processes are no longer operative as the river has moved westwards and/or physical barriers are erected against fluvial deposition.

4.4.5 The lithology of the Archaeological strata is a very dark greyish brown (2.5Y 3/2), firm diamict. The clay matrix is gritty in texture and contains sand- to granular-sized particles of ooidal limestone, mortar, cbm and charcoal. Oxidation mottles are present above *c.* +7m OD, however, the dark colour of the strata often mask this feature. Some ped structure may be present (see Section 4.3.6). The coarser clastic content (fine pebble to cobble sizes: >4mm to >68mm) is composed of varying proportions of ooidal limestone, grey limestone, flint, cbm and occasionally rare clasts of bone (e.g. fine pebble-sized fish vertebra in BH220) and mussel and oyster shell in, for example, BH201A and BH218).

4.4.6 Ceramic building material believed to be Roman were found in: BH215 at +4.25m OD (see Section 4.2.3) and BH229A at +3.20m OD (See Section 4.3.4). A Roman body sherd was recovered in BH227 at +8.24m OD. These finds and elevations can be compared to the stake found at +4.44m OD. The sherd was found in deposits that showed a transition from the Elmore Member to Archaeological strata as discussed above (Section 4.4.4 and Figure 11).

4.4.7 The Archaeological strata are truncated by deposits of Made Ground in all the boreholes.

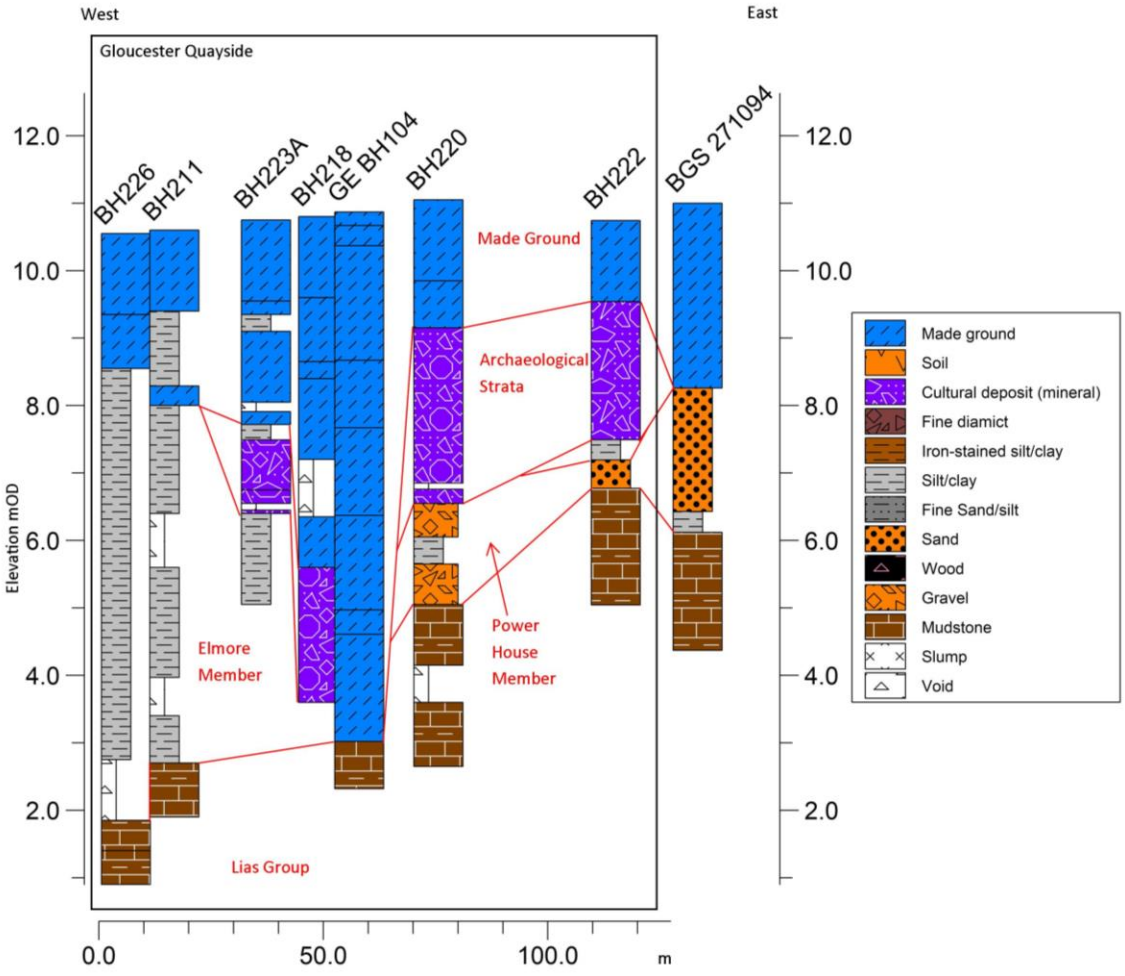

Figure 16. Lithostratigraphic cross-section from west to east in the centre of the site. Vertical exaggeration x15. Note truncation of Archaeological strata by Made Ground; Elmore Member filling channel in the west; and probable Cheltenham Sand and Gravel at high elevation in the far east.

4.5 Made Ground

4.5.1 Deposits classified here as Made Ground outcrop across the site. They are very variable in thickness and range from 8.10m in BH214 on the northern boundary to 1.20m in BH205 on the northwest boundary of the site (Figure 12, Figure 5 and Figure 17). The truncation of underlying deposits has been discussed in Section 4.3.2.

Figure 17. Thickness (m) of the Made Ground deposits.

4.5.2 Made Ground deposits are highly heterogeneous in lithology and very poorly sorted in clast size. Coursed masonry is present, for example, in BH203, BH224 and in BH214 where an extraordinary 4.61m is recorded. Concrete too is present as clasts and structures. Diamicts are the usual lithology with dark coloured clay matrices containing cinder, charcoal, coal, cbm, mortar, slag, slate and ooidal limestone grains and granules. Clasts of exotic angular Pennant sandstone are notable, and are in contrast to the quartzites and ooidal limestone which are derived from local sources. Sand and clay lenses are also found unmixed within the diamicts. A hydrocarbon odour was present in several cores.

5 RESULTS: X-RAY FLUORESCENCE

5.0.1 Concentrations of selected elements (iron Fe, titanium Ti, calcium Ca, potassium K, aluminium Al, phosphorous P, silicon Si and sulphur S) for BH226 and BH227 are discussed below. The raw data is tabulated in Appendix 3 and 4. Because of limitations of the XRF device, highly inconsistent grain size and the irregular nature of the surface of the core material, the XRF data by its nature will be semi-quantitative at best. It is best used to identify chemical trends in similar rock types.

5.1 BH226 (Figure 18) [3]

5.1.1 The finely layered nature of the geological strata, where the laminations are much less than the sampling interval, explains the rapid, unsystematic variations of all element concentrations. The lack of dramatic difference of the XRF response between the Elmore and Lias units results from similarity in mineral compositions of the fine grained alluvium of the Elmore Member and the mudstone of the Lias Group. The Elmore Member, in large part, would be derived by erosion from locally out-cropping Jurassic limestone and calcareous mudstones.

5.1.2 The high calcium (low silicon) peaks near the base of the Elmore Member (between *c.* 7 to 7.4m) suggest a concentration, possibly in fine beds, of detrital calcite grains, derived from the local Lias and middle Jurassic limestones. This may correspond to the gravel noted at 7.2m. The high silicon peak at *c.* 3.3m, indicates an exceptionally quartz rich silty, or sandy, layer in the Elmore Member.

5.1.3 Minor peaks of high sulphur and high calcium may indicate the presence of calcium sulphate as selenite (or gypsum) in the mudstones. Both occur naturally as a product of ground water leeching and precipitation of calcium and sulphur derived from the disseminated pyrites found in the Lias mudstones. As such, selenite crystallisation may be recent or much older.

5.1.4 Figure 19 presents the low phosphorus values in isolation and at a larger scale for better comprehension. In anthropogenic sediments, phosphorous content can be linked to periods of human activity associated with high production of organic matter (Coronel *et al.* 2014). The increase from the middle of the

[3] Because only specific points on the cores were interrogated the point data obtained would more correctly be displayed on a scatter plot, however, a curve has been used for greater visual comprehension.

Elmore Member up the stratigraphy may be seen as evidence of increasing human influence on the floodplain, reflected, too, in occurrences of charcoal and cbm. The unconformable boundary with the Made Ground at 2m bgl is marked by a fall in the values of all the elements.

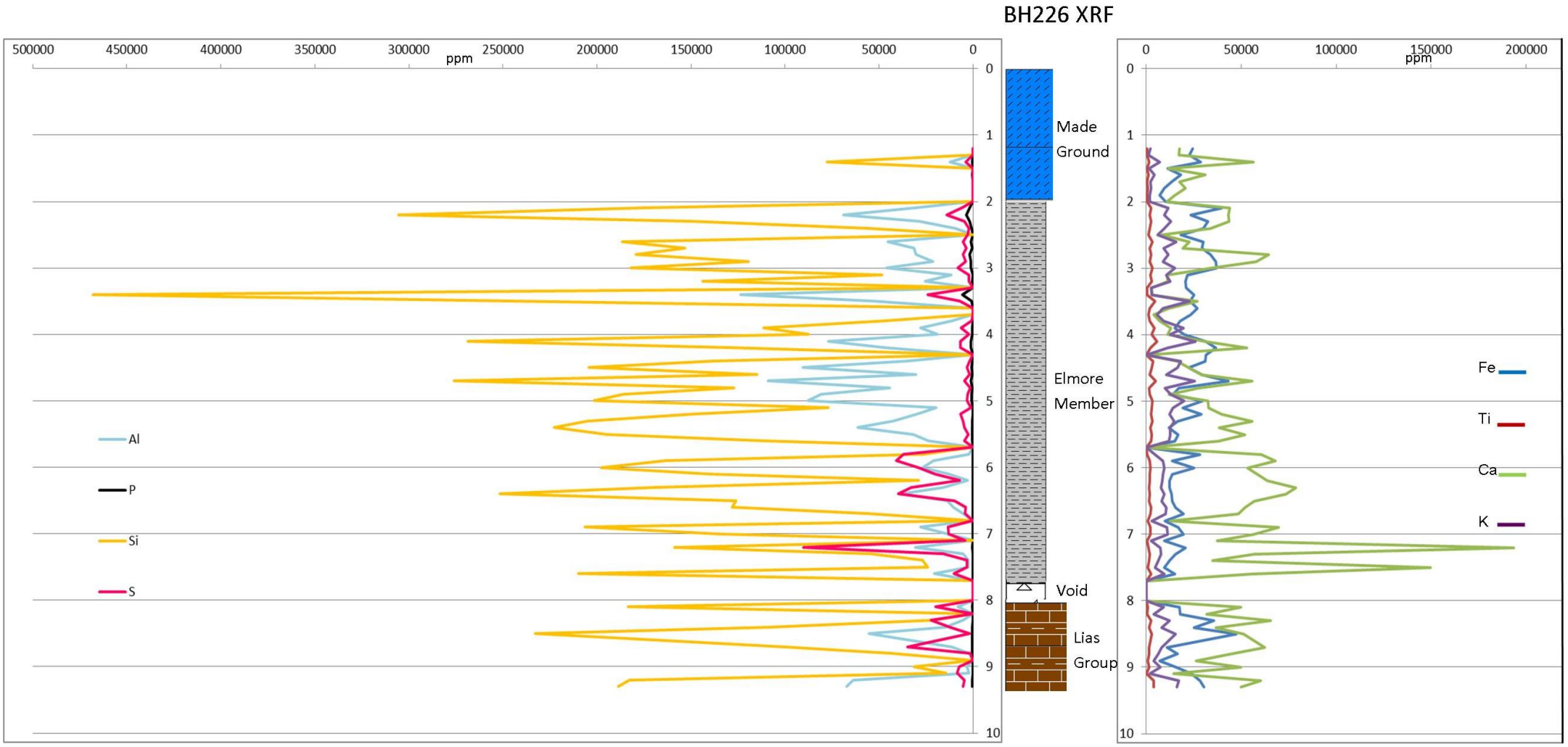

Figure 18. XRF results for BH226 shows the depth variation of concentrations; Al, Si, P and S on the left hand side of the log, and Fe, Ti, Ca, and K on the right. Depth in m.

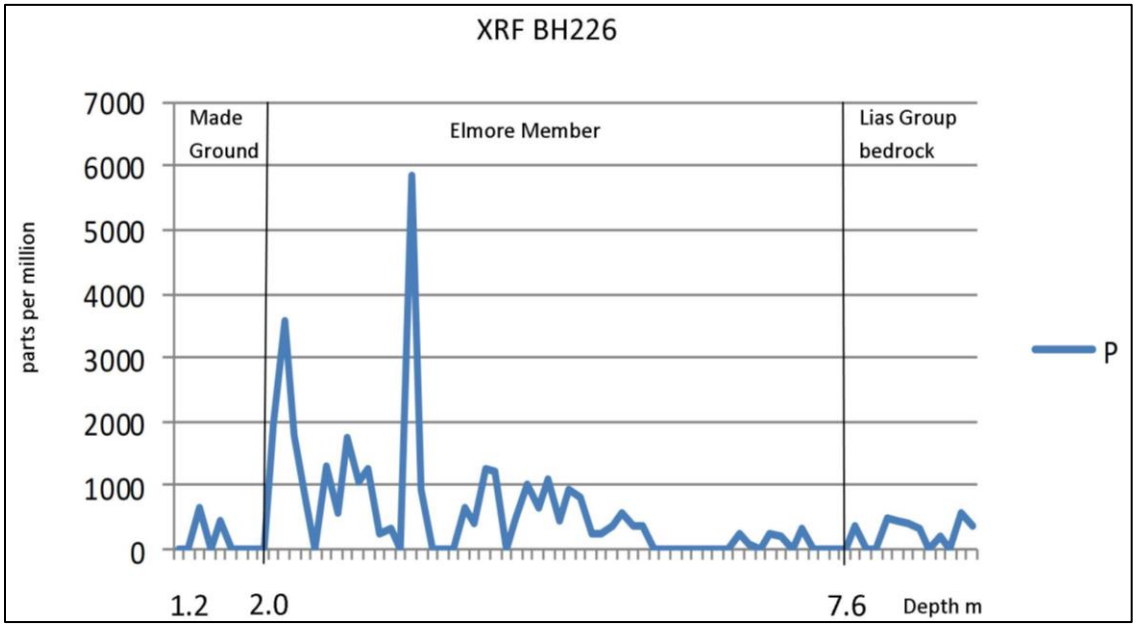

Figure 19. XRF values for phosphorus in BH226.

5.2 BH227 (Figure 20 and Figure 21)

5.2.1 High silicon and low aluminium are generally reflective of silica (silicon dioxide) derived from siliciclastic rock and particularly notable in the Power House Member gravel where silicon has a maximum of *c.* 500,000ppm. The values of the data for the archaeological strata are uniformly low which may reflect the heterogenic nature of the diamict. The soil, on the other hand, records an initial peak in calcium possibly due to calcite, followed by a peak in sulphur which, in association with iron, implies a reducing environment at the base. Phosphorus is also notable throughout and indicative of human action: manuring perhaps. Levels of soil lead where they are recorded (not shown in the figures) are very low, less than half that permitted today in playground soils in the United States (400ppm) (AGTSDR 2017) and below the 840ppm limit in urban areas (above which indicates a state of contamination) (Defra 2012). The significance of this (and the fact that other heavy metals are below the limit of detectability) is that archaeological metallurgical operations were not taking place in this area of the site.

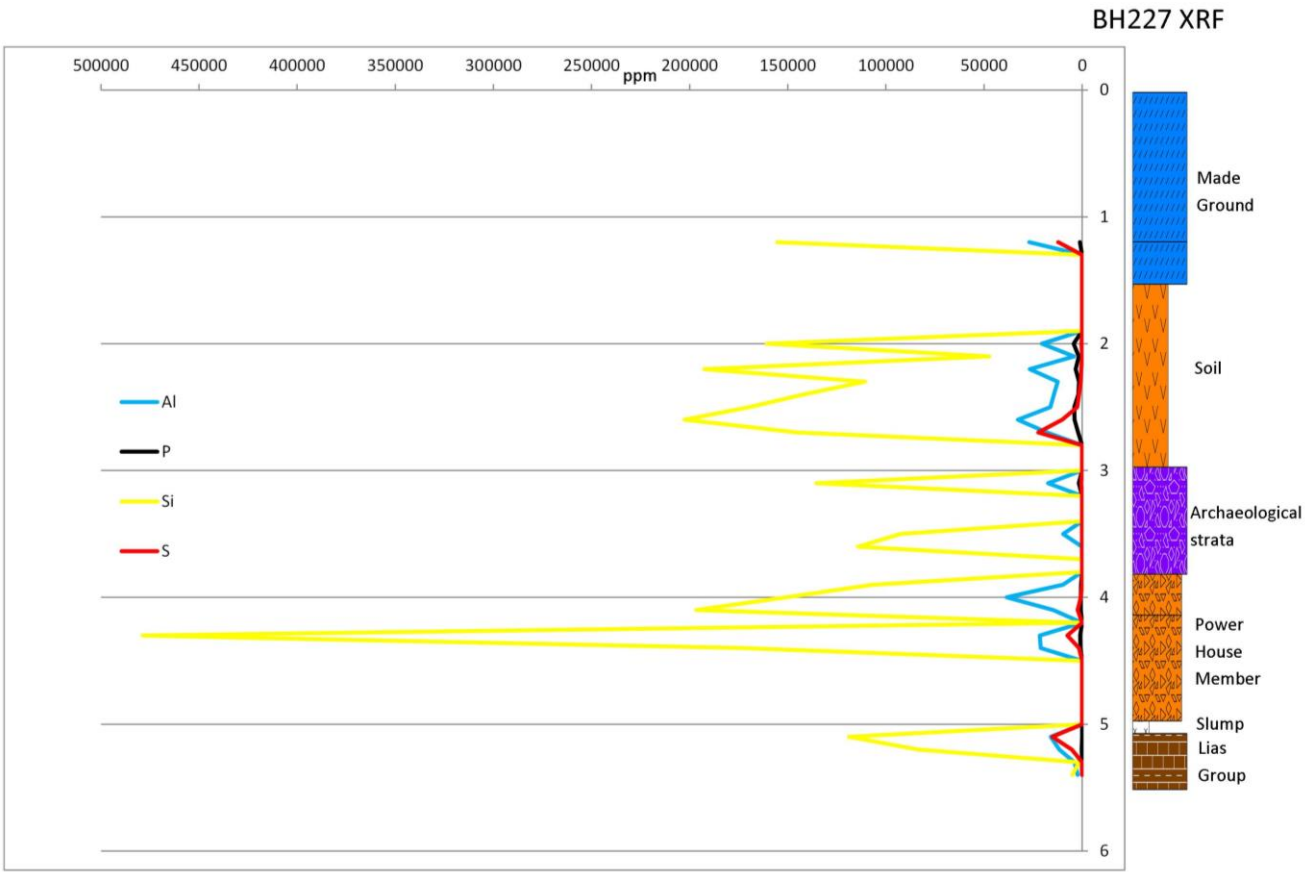

Figure 20. XRF results for BH227 shows the depth variation of concentrations; Al, Si, P and S on the left hand side of the log. Depth in m.

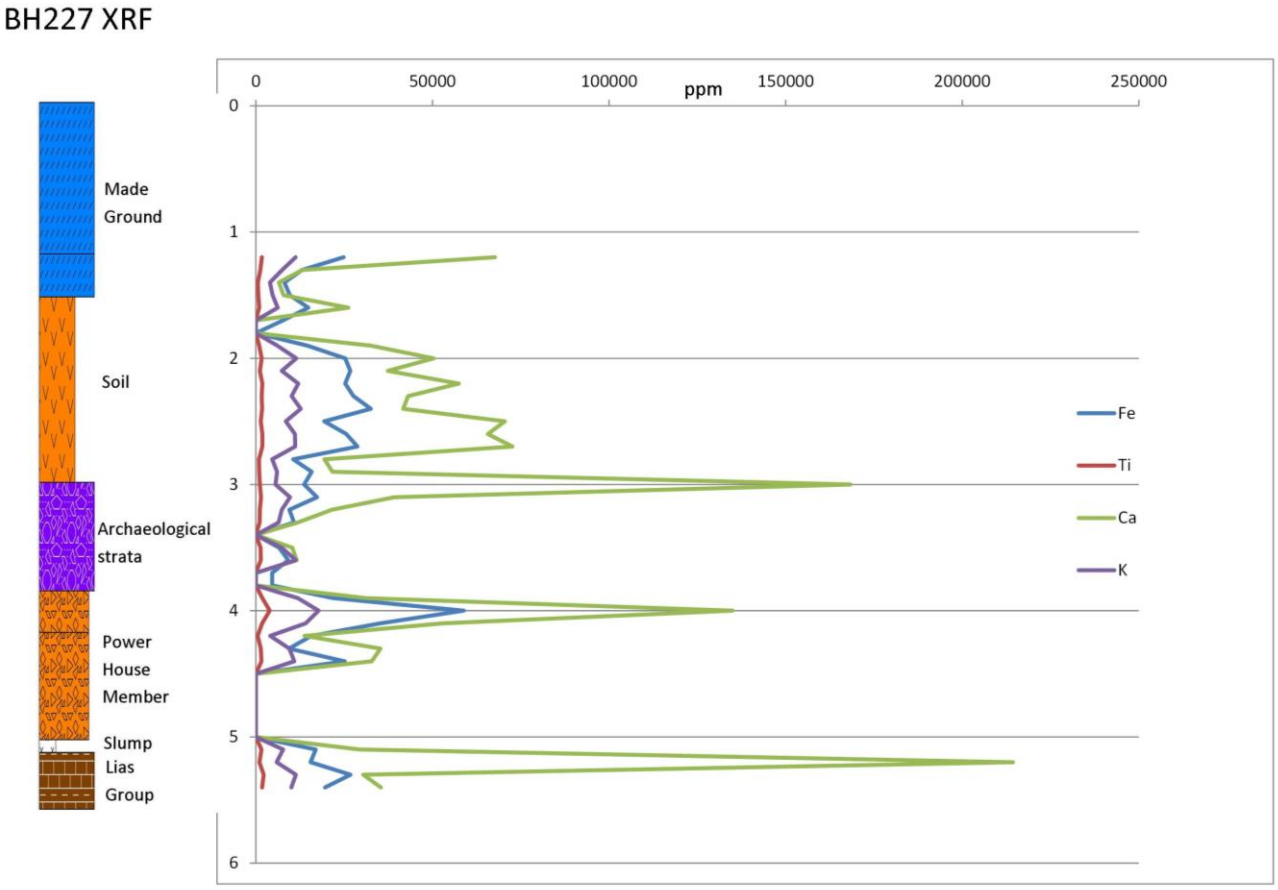

Figure 21. XRF results for BH227 shows the depth variation of concentrations; Fe, Ti, Ca, and K on the right hand side of the log. Depth in m.

6. ASSESSMENT

6.0.1 The sub-sections below review the lithostratigraphic evidence against the relevant aims of Section 1.4.

6.1 Lithostratigraphic sequence

6.1.1 A channel incised in the Lias Group mudstone is identified crossing the site, trending NNE-SSW, and continuing to the south. It attains considerable depth (*c.* 6m) at the junction with Quay Street in the northwest of the site, and in the southwest in the area of the former HMP Gloucester where it may coincide with the Castle Ditch. The incision took place during a

Pleistocene cold stage and probably coincides with the aggradation of sands and gravels of the Power House Member. These are generally thin and range in elevation from +0.90m OD on the northwest boundary with Quay Street, to +7.48m OD in the southeast of the site. Their distribution is uneven and they are not found on the east side of the channel nor in any thickness at its base.

6.1.2 Evidence for reworking of the Power House Member with the inclusion of ooidal limestone from local Cheltenham Sand and Gravel deposits during the Roman period is found in BH204 and supports a more substantial body of data found at the former HMP Gloucester. Outside the site to the southeast, high level deposits of particularly sand found in BGS and geotechnical boreholes are believed to be Cheltenham Sand and Gravel and not Power House sediments.

6.1.3 In the Holocene the River Severn adopts a meandering planform as temperatures rise, vegetation stabilises the regolith, and ground water drainage succeeds the melting of the permafrost. Fine grained alluvium – the Elmore Member – is laid down by flood waters over the gravel bars and abandoned channels of the old braid plain. It attains a maximum of 9.2m in thickness where it fills the channel in the northwest and lies at a maximum elevation of +9.15m OD also in the northwest of the site. These silt/clay deposits are characterised by charcoal and cbm grains and granules with a coarse clastic fraction becoming increasingly evident as human action intensifies, and an archaeological diamict lithology supersedes the fluvial clays. Phosphorus concentrations are seen to rise during the deposition of the Elmore member and also allude to a human influence. Roman occupation of the southwest of the site on the sloping east bank of the channel is demonstrated by the presence of an ash wood stake dating to 70 – 224 cal. AD and driven into the mudstone bedrock. Aggradation on the floodplain continues, possibly at an enhanced rate, and buries the stake under 5.55m of alluvium, in the top 1.40m of which develops a soil. Timbers found in BH205 in the channel are also deeply buried but are likely to be modern.

6.1.4 The probable westward shift of the river channel from the Roman period to the present day is marked by soils developing in the upper fraction of the Elmore Member (particularly BH227 and BH228, the latter containing a Roman sherd at +8.34m OD). Otherwise Archaeological strata are recorded across the site except in the centre where Made Ground penetrates

deposits of the Elmore Member. XRF data show no metal concentrations that may be, for example, attributed to industrial activity in the Archaeological strata. There were no ceramic finds attributable to the Saxon period. Made Ground deposits often truncate both the Archaeological strata and the Elmore Member and cap the Quaternary stratigraphy across the site.

7. CONCLUSIONS

7.1 The following conclusions are drawn:

7.1.1 A NNE-SSW trending channel is incised in the Lias Group bedrock. Its maximum depth is *c.* 6.5m in the northwest of the site.

7.1.2 Power House Member sands and gravels are generally thin and sporadically preserved on the site; they are rarely found in the channel.

7.1.3 Cheltenham Sand and Gravel is tentatively identified off site in the southeast (IFA BH4). The unit also forms part of clastic deposits of mixed lithology, with associated Roman cbm (BH204). They concur with similar deposits found at the former HMP Gloucester site.

7.1.4 Thick deposits (*c.* 9m) of Elmore Member fill the channel and thin eastwards as the bedrock rises. They are severely affected by truncation by Made Ground. There is considerable evidence for soil formation (e.g. BH208) within the top of the Elmore Member, though no evidence of metallurgical contamination.

7.1.5 Phosphorus concentration rises through the Elmore Member possibly as a result of increasing human activity.

7.1.6 Roman activity is manifested by cbm, a ceramic sherd, and a wooden stake dated to 70 – 224 cal AD and located at an elevation of +4.44m OD (BH208).

7.1.7 No evidence was found for possible 1st Century AD river frontage to the east.

7.1.8 No evidence was found for a broadly E-W aligned channel in the approximate location of Quay Street.

7.1.9 Archaeological strata develop in and over the Elmore Member, they are typically dark coloured, oxidised, mineralogenic diamicts with no significant elemental content. Organic strata are absent. Archaeological strata are absent from the centre of the site. Diagnostic ceramics were not found.

7.1.10 Made Ground dated to post-18th century is pervasive and attains depths of *c*. 8m bgl.

8. ACKNOWLEDGEMENTS

8.1 ARCA would like to thank the following for their help during the project: Cliff Bateman of Cotswold Archaeology Ltd; Andrew Armstrong of Gloucester City Council; Peter Wooley of Geotechnical Engineering Ltd and his drilling teams; Dr Eleanor Standley of the University of Oxford; and Dr Robert Standley of Pencarreg Consultants Ltd for help with the XRF data.

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APPENDIX 1: BOREHOLE LOCATIONS

Borehole	Easting	Northing	Elevation m
BH201A	382725	218708	10.20
BH203	382733	218649	10.60
BH204	382737	218621	10.50
BH205	382740	218726	9.95
BH207	382749	218670	10.65
BH208	382762	218641	10.90
BH209	382765	218609	10.20
BH210A	382751	218719	10.80
BH211	382760	218695	10.60
BH212	382767	218716	11.05
BH213	382765	218700	10.75
BH214	382777	218717	10.60
BH215	382762	218664	10.65
BH216	382789	218643	10.75
BH217A	382799	218608	10.50
BH218	382792	218688	10.80
BH219A	382811	218706	10.45
BH220	382818	218687	11.05
BH221	382827	218661	10.65
BH222	382851	218666	10.74
BH223A	382779	218689	10.75
BH224	382768	218718	11.10

BH225	382792	218663	10.55
BH226	382749	218691	10.55
BH227	382849	218612	11.35
BH228	382832	218619	11.05
BH229A	382753	218731	10.85

APPENDIX 2: BOREHOLE LITHOLOGY

Borehole	**Top m**	**Base m**	**Lithology**	**Description**
BH201A	0.00	1.20	Made ground	
BH201A	1.20	1.63	Silt/clay	7.5YR 4/4 Brown, firm silt/clay with rare charcoal grains. Sharp boundary to:
BH201A	1.63	2.18	Cultural deposit (mineral)	10YR 3/2 Very dark greyish brown, firm silt/clay with frequent coarse sand to granular-sized mortar, charcoal, unknown particles. Rare well rounded quartzite pebble and mussel shell. (Some ped structure: possible soil?) Sharp boundary to:
BH201A	2.18	2.70	Silt/clay	7.5YR 4/4 Brown, stiff silt/clay with rare charcoal grains. End of BH.
BH203	0.00	1.20	Made ground	
BH203	1.20	2.70	Made ground	Red brick coursed masonry. (Wall). Sharp boundary to:
BH203	2.70	3.36	Void	Void
BH203	3.36	3.41	Slump	Slump
BH203	3.41	3.47	Soil	2.5Y 3/2 Very dark greyish brown silt/clay with frequent fine to coarse roots (Soil)

BH203	3.47	3.97	Soil	2.5Y 3/2 Very dark greyish brown becoming 2.5/1 Black towards the base, silt/clay with occasional fine to coarse sand-sized mineral grains and occasional plant fibres. Organic mud-like at base. Sharp boundary to:
BH203	3.97	4.20	Made ground	5Y 2.5/1 Black fine diamict of sand to granular-sized angular ?mortar fragments. Red brick cobble at 4m. Mortar cobble at base. Unknown boundary to:
BH203	4.20	4.50	Made ground	5Y 2.5/1 Black fine diamict of sand to granular-sized angular ?mortar fragments. Red brick granular to coarse pebble-sized angular brick clasts. Silt/clay matrix. Gradual boundary to:
BH203	4.50	5.70	Silt/clay	10YR 4/1 Dark grey oxidises to 4/3 Brown firm and homogenous silt/clay with frequent sand-sized black spots. Silty texture. Rare, rounded vein quartz pebbles. Rare grains of black plant matter. (Reduced alluvial unit)
BH203	5.70	5.93	Slump	Slump
BH203	5.93	7.20	Silt/clay	10YR 4/1 Dark grey oxidises to 4/3 Brown firm and homogenous silt/clay with frequent sand-sized black spots. Silty texture. Rare, rounded vein quartz pebbles. Rare grains of black plant matter. Cobble-sized worked timber at 6.01m. (Reduced alluvial unit). Base of BH.
BH204	0.00	1.20	Made ground	
BH204	1.20	1.78	Void	Void.
BH204	1.78	2.20	Made ground	2.5Y 4/2 Dark greyish brown sandy mortar with occasional cobbles of ooidal limestone and pebbles of rounded quartzite. Sharp boundary to:
BH204	2.20	2.48	Cultural deposit (mineral)	7.5YR 3/2 Dark brown, firm silt/clay with occasional grains of fine sand, charcoal and cbm. Occasional granules of ooidal limestone and angular rock fragments. Sharp boundary to:
BH204	2.48	4.20	Silt/clay	7.5YR 4/3 Brown, firm silt/clay with rare charcoal grains. Silt laminae (disrupted) towards the base. (Oxidised alluvial unit: Elmore Member). Gradual boundary to:
BH204	4.20	4.40	Void	Void.

BH204	4.40	5.23	Silt/clay	5Y 3/1 Very dark grey oxidising to 2.5Y 4/4 Olive brown, firm silt/clay with silty partings. Horizontal, poorly developed silt laminae. Rare horizontal pebble-sized tabular wood fragment. Rare, black organic spots. (Alluvium: Elmore Member)
BH204	5.23	5.70	Void	Void.
BH204	5.70	6.38	Silt/clay	5 Y3/1 Very dark grey oxidising to 2.5Y 4/4 Olive brown, firm silt/clay with silty partings. Horizontal, poorly developed silt laminae. Rare horizontal pebble-sized tabular wood fragment. Rare, black organic spots. (Alluvium: Elmore Member)
BH204	6.38	7.20	Gravel	5Y 3/1 Very dark grey, clayey sandy gravel. Very poorly sorted. Angular ooidal limestone, sub-angular to rounded quartzites granules and pebbles. Rare cbm granule? (Basal alluvium) Sharp boundary to:
BH204	7.20	7.70	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH205	0.00	1.20	Made ground	
BH205	1.20	1.60	Soil	10YR 3/2 Very dark greyish brown, firm silt/clay with occasional fine sand-sized mineral grains and rare granules of charcoal, shell, cbm, flint and ooidal limestone. Some granular ped structure. (Possible soil). Sharp boundary to:
BH205	1.60	4.20	Silt/clay	7.5YR 3/3 firm and homogenous silt/clay. Occasional to frequent charcoal grains and granules towards the top. Rare bird bone, rare angular granule of slag. Very rare grains of charcoal from 3m towards base. Rare granule of ooidal limestone. Horizontal and disrupted silt laminae at 3.8m and colour change to 10YR 4/2 Dark greyish brown. Coarse pebble-sized sandstone clast, rare granules of bone and twig towards base. Unknown boundary to:
BH205	4.20	4.57	Void	Void
BH205	4.57	5.70	Silt/clay	Continuation of unit above: horizontal silt laminae 10 YR4/2 Dark greyish brown silt/clay. Unknown boundary to:

BH205	5.70	8.63	Silt/clay	10YR 4/2 Dark greyish brown (reduced colour: 2.5Y 3/1 Very dark grey) silt/clay with horizontal silt laminae. Very fine sandy silt/clay towards base. At 7.47 to 7.84m interbedded poorly sorted sandy gravels with sub-angular to sub-rounded quartzites and fine to medium sands. Sharp boundary to:
BH205	8.63	9.13	Wood	Wood: horizontal and parallel growth rings. Sap wood/bark not present, tightly ringed central heart wood not present. Possibly a horizontally lying beam. Sharp boundary to:
BH205	9.13	9.65	Silt/clay	2.5Y 4/1 Dark grey, firm and homogenous silt/clay, oxidises to 4/2. Unit becomes silty towards base and horizontal laminae are present. Two cobble-sized wood fragments fill core. Sharp boundary to:
BH205	9.65	9.90	Wood	Wood: horizontal and parallel growth rings. Sap wood/bark not present, tightly ringed central heart wood not present. Possibly a horizontally lying beam. Sharp boundary to:
BH205	9.90	10.40	Silt/clay	2.5Y 4/1 Dark grey, firm and homogenous very fine sandy silt/clay, oxidises to 4/2. Frequent granular wood, shell and rock fragments grades into a fine sand.
BH205	10.40	10.50	Sand	Fine to medium sand. (Elmore?)
BH205	10.50	11.10	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH207	0.00	1.20	Made ground	
BH207	1.20	2.20	Made ground	7.5YR 2.5/1 Black, firm silt/clay. Frequent irregular lenses of fine black grains (comminuted charcoal) 50% orange iron oxide and frequent cinder particles. Occasional fine and medium pebble-sized angular pennant sandstone, cinder clasts. Occasional soft calcined granules and charcoal granules. Clay fraction (7.5YR 3/3 Dark brown) increases towards base. Brick granule art base. (Modern Made Ground)
BH207	2.20	2.50	Void	Void.

BH207	2.50	3.02	Made ground	7.5YR 4/3 Brown firm silt/clay. Frequent angular brick clasts from granule to cobble size. Sub-angular ooidal limestone cobble, angular sandstone medium pebble and occasional granules of cinder and slag. (Modern Made ground).
BH207	3.02	3.70	Silt/clay	7.5YR 3/1 Very dark grey to 2.5Y 3/1 Very dark grey soft to firm, homogenous silt/clay. Rare charcoal grains at top. No obvious fabric. (Elmore Member?)
BH207	3.70	4.31	Void	Void.
BH207	4.31	6.70	Silt/clay	Continuation of above: 7.5YR 3/1 Very dark grey to 2.5Y 3/1 Very dark grey soft to firm, homogenous silt/clay. Becoming silty towards base. End of BH.
BH208	0.00	1.20	Made ground	
BH208	1.20	2.00	Soil	10YR 3/1 Very dark grey grading into 3/2 Very dark greyish brown, firm, granular silt/clay. Occasional fine to medium sand-sized mineral grains and frequent grains and granules of shell, charcoal and sub-rounded ooidal limestone evenly distributed throughout. Rare sub-angular ochre flint fine pebble. Generally homogenous unit (Topsoil developed in Elmore member).
BH208	2.00	2.60	Soil	10YR 4/3 brown firm silt/clay without a granular texture. Frequent fine root holes. Occasional fine to medium sand-sized mineral grains and occasional grains and granules of shell, charcoal and sub-rounded ooidal limestone evenly distributed throughout (Subsoil developed in Elmore member).
BH208	2.60	4.93	Silt/clay	7.5yr 4/2 Brown, firm and homogenous silt/clay grades into a reduced silt/clay (5Y 3/1 Very dark grey) with a brownish oxidation on exposure. Rare waterlogged twig. Occasional *Bythnia* sp and *Planorbis* sp. Grades into a 2.5Y 4/1 grey clay. (Elmore Member). Sharp boundary to:
BH208	4.93	5.70	Gravel	5Y 4/1 Grey, firm clayey gravel. Matrix supported. Poorly sorted sandy clay at top. Cobble-sized ooidal limestone clast and finer pebbles. Very clayey and sandy (Cheltenham Sand and Gravel?)

BH208	5.70	5.90	Void	Void.
BH208	5.90	6.14	Silt/clay	Continuation of unit above: fewer clasts; a clay unit.
BH208	6.14	6.46	Gravel	2.5Y 4/1 Grey firm silt/clay matrix to a clast-supported gravel of angular, corroded ooidal limestone coarse pebble and cobble-sized clasts. Gritty surfaces to clasts. Deliberate deposition?
BH208	6.46	6.75	Wood	Shaped, waterlogged wooden stake. Ash. *AMS C14 date*
BH208	6.75	7.00	Mudstone	2.5Y 3/1 Very dark grey stiff silt/clay. (Weathered bedrock). Sharp boundary to:
BH208	7.00	7.50	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH at 7.10m.
BH209	0.00	1.20	Made ground	
BH209	1.20	1.83	Void	Void
BH209	1.83	2.70	Cultural deposit (mineral)	10 YR 3/3 Dark brown, firm diamict. Frequent granular to cobble-sized sub-angular ooidal limestone clast. Cobble of grey limestone. Silt/clay matrix with frequent fine to coarse sand-sized whitish grains of ooids and occasional charcoal. Rare pebble-sized shell fragments. Unknown boundary to:
BH209	2.70	2.86	Cultural deposit (mineral)	Loose, grey , sub-angular limestone cobbles. Sharp boundary to:
BH209	2.86	3.30	Silt/clay	2.5Y 2.5/1 Black oxidising to 2.5 Y 3/1 Very dark grey, firm silt/clay with occasional granular sized whole shell (*Lymnea* sp?). (Alluvium?). Gradual boundary to:
BH209	3.30	3.70	Silt/clay	2.5Y 3/2 Very dark greyish brown mottled 2.5Y 4/4 olive brown, firm sandy silt/clay (sand orangish green). Occasional charcoal grains and ooidal limestone grains and granules. Occasional ooidal limestone sub-angular pebble. (Alluvium?). Diffuse boundary to:

BH209	3.70	5.42	Silt/clay	10 YR 4/2 Dark greyish brown, firm silt/clay with very fine sand or silt laminae (disrupted) appear to become horizontal towards base but not distinct. Homogenous unit. Rare, fine pebble-sized, tabular wood fragment very decayed. (Alluvium). Sharp boundary to:
BH209	5.42	5.70	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). End of BH.
BH210A	0.00	1.20	Made ground	
BH210A	1.20	2.37	Made ground	7.5YR 2.5/1 Black, firm silt/clay. Frequent irregular lenses of fine black grains (comminuted charcoal) 50% orange iron oxide and frequent cinder particles. Occasional soft calcined granules and charcoal granules and coal. Cobbles of red and yellow brick. Baked corroded cbm with purplish vitreous colour. 50mm sheep rib bone. Frequent brick and rock granules and pebble- sized clasts. Grains of transparent glass. (Modern Made Ground).
BH210A	2.37	4.20	Silt/clay	5Y 2.5/1 Black, firm and homogenous silt/clay. Petroleum odour. Heavily oxidised to 7.5YR 4/3 Brown. Unknown boundary to:
BH210A	4.20	7.50	Silt/clay	5Y 2.5/1 Black, firm silt/clay. Petroleum odour. Heavily oxidised to 7.5YR 4/3 Brown. Horizontal and parallel, very fine laminae throughout. Silty texture easily parted. Rare sub-rounded ooidal limestone granule (Elmore member).
BH210A	7.50	10.00	Gravel	7.5YR 4/3 firm gravelly clay. Matrix supported fining upwards. Granular to coarse pebble-sized well rounded quartzites. Clay unit (disrupted bedrock) with occasional gravel clasts towards base. (Power House Member grading into very weathered mudstone).
BH210A	10.00	10.50	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH211	0.00	1.20	Made ground	

BH211	1.20	2.31	Silt/clay	5Y 4/2 Olive grey firm (sticky) and homogenous silt/clay. Completely oxidised. Gritty texture in places (coarse sand-sized mineral grains). Rare angular granule of black crystalline rock. Sharp boundary to:
BH211	2.31	2.60	Made ground	Brick cobble and black bitumen-like unit. Intense petroleum odour. Gradual boundary to:
BH211	2.60	4.20	Silt/clay	7.5YR 4/2 Brown, firm and homogenous silt/clay with rare sub-rounded ooidal limestone granule. Black glistening petroleum products throughout unit. Rare Bithynia sp. (Alluvial deposit). Unknown boundary to:
BH211	4.20	5.00	Void	Void.
BH211	5.00	6.63	Silt/clay	Continuation of unit above: becomes silty with a darker grey (unoxidised) core. Angular over- fired purplish brick cobble at 6m! (*In situ?* Core heavily disturbed by geotechnical investigations).
BH211	6.63	7.20	Void	Void.
BH211	7.20	7.90	Silt/clay	Continuation of unit above: 10mm fine to medium sand bed with petroleum. (Elmore member). Sharp boundary to:
BH211	7.90	8.70	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH212	0.00	1.20	Made ground	
BH212	1.20	2.00	Made ground	2.5Y 3/2 Very dark grey firm silt/clay. Frequent irregular lenses of fine black grains (comminuted charcoal) 50% orange iron oxide and frequent cinder particles. Occasional soft calcined granules and charcoal granules. Frequent granular to cobble sized angular brick clasts. (Modern Made Ground).
BH212	2.00	3.20	Void	Void.
BH212	3.20	3.35	Made ground	Continuation of above unit. Sharp boundary to:

BH212	3.35	5.70	Made ground	5Y 3/1 Very dark grey firm, homogenous silt/clay oxidising to 5Y 4/2 Olive grey throughout core thickness in places. Rare sub-angular ooidal limestone cobble, angular brick, coarse pebble of angular dark grey crystalline rock (sett fragment?). Gritty texture in places with fine sand and cbm grains. (Reworked clay; modern).
BH212	5.70	7.20	Silt/clay	Continuation of above unit: fine sand (ooids) fraction increases, rare well rounded vein quartz fine pebble; rare, fine, bluish grey clay lenses. (Alluvium). End of BH.
BH213	0.00	1.20	Made ground	
BH213	1.20	1.40	Made ground	10YR 7/3Very pale brown concrete. Sharp boundary to:
BH213	1.40	2.14	Void	Void
BH213	2.14	2.43	Made ground	10YR 4/2 Very dark greyish brown diamict with sub-angular rock fragments, angular brick and cobble of masonry brick and mortar. Matrix of fine to medium sandy clay. Sharp boundary to:
BH213	2.43	3.40	Cultural deposit (mineral)	5Y 2.5/1 Black oxidises to 2.5Y 3/2 Very dark greyish brown silt/clay with rare coarse sand-sized plant fibres, occasional to frequent medium pebble-sized sub-rounded white quartz, a cow tooth, well rounded quartzites. (Hydrocarbon odour). Unknown boundary to:
BH213	3.40	3.66	Void	Void
BH213	3.66	5.60	Cultural deposit (mineral)	5Y 2.5/1 Black oxidises to 2.5Y 3/2 Very dark greyish brown silt/clay with rare coarse sand-sized plant fibres, occasional to frequent medium pebble-sized sub-rounded white quartz, well rounded quartzites. Occasional coarse pebble-sized angular brick. Pennant sandstone cobble at base. (Hydrocarbon odour). Base of BH
BH214	0.00	1.20	Made ground	
BH214	1.20	1.60	Made ground	10YR 3/1 Very dark grey diamict with granular to coarse pebble-sized angular brick. Matrix of silt/clay with frequent grains of mortar of ooidal limestone. Sharp boundary to:

BH214	1.60	1.92	Made ground	10YR 3/2 Very dark greyish brown diamict with frequent granular to medium pebble-sized angular brick and mortar. Slit/clay matrix with frequent grains of cbm, ooidal limestone and mortar. Sharp boundary to:
BH214	1.92	2.10	Silt/clay	10YR 4/2 Dark greyish brown silt/clay with very fine disrupted silt laminae (lens in made ground?)
BH214	2.10	2.20	Fine diamict	10YR 4/3 Brown diamict with frequent granular to fine pebble-sized rounded sandstone, iron stained.
BH214	2.20	2.60	Made ground	10YR 4/1 Dark grey, loose gravel of granular to cobble-sized angular to sub-angular brick, quartzite, mortar and ooidal limestone. Cobble of brick and mortar at base. Sharp boundary to:
BH214	2.60	7.21	Made ground	Coursed brick and mortar. Sharp boundary to:
BH214	7.21	8.10	Made ground	Concrete.
BH214	8.10	8.30	Void	Void
BH214	8.30	8.50	Mudstone	2.5YR 2.5/1 Black, stiff, laminated mudstone. End of BH.
BH215	0.00	1.20	Made ground	
BH215	1.20	1.60	Made ground	7.5YR 3/2 Dark brown, firm silt/clay (fine diamict) with frequent granular to medium pebble-sized angular ooidal limestone clasts. Occasional grains and granules of shell, cbm and charcoal. Rare coarse pebble of grey limestone. (Redeposited). Sharp boundary to:
BH215	1.60	2.60	Made ground	10YR 8/1 White friable and broken up concrete/mortar angular pebble-sized rock fragments. Iron tabular pebble-sized strap. Unknown boundary to:
BH215	2.60	5.83	Silt/clay	7.5YR 3/2 Dark brown firm and homogenous silt/clay. Rare sub-rounded fine pebble-sized flints. Rare medium pebble-sized sheep leg bone fragment. Occasional whole coarse sand-sized water snail shells. Rare cbm granules, charcoal grains and plant fragments. Frequent grey reduction areas (7.5YR 4/1 Dark grey). (Unit has oxidised from exposure). (Elmore Member some Cultural deposit?)

BH215	5.83	5.93	Silt/clay	2.5Y 3/3 Dark olive brown firm silt/clay with parallel silt and black (very fine and discontinuous) laminae. Sharp boundary to:
BH215	5.93	6.40	Gravel	10YR 3/3 Dark brown, poorly sorted, sandy gravel with orange iron oxidation stains. Granular to medium pebble-sized clasts of sub-rounded quartzite and white quartz. Finely interbedded with silt/clay. Unknown boundary to:
BH215	6.40	6.80	Cultural deposit (mineral)	10 YR 5/3 Brown, dry, diamict. Broken up and friable except for base. **Coarse pebble of angular Roman cbm**. Cobble of sub-angular grey limestone. Occasional granules and fine pebbles of angular ooidal limestone, grey limestone and rounded quartzite granules. Sandy silt/clay matrix with evidence of laminations particularly well preserved in lowest 100mm (bedrock). Rare charcoal grains and granular plant fragments. (Fluvially reworked archaeological deposit?). Sharp boundary to:
BH215	6.80	7.20	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH216	0.00	1.20	Made ground	Made Ground
BH216	1.20	1.60	Made ground	Crushed coursed brick and mortar. (Modern Made Ground)
BH216	1.60	2.70	Made ground	Old concrete drilled through and fills core. (Modern Made Ground).
BH216	2.70	3.70	Void	Void.
BH216	3.70	4.65	Silt/clay	2.5Y 4/2 Dark greyish brown to oxidised 5Y 4/3 Olive, firm silt/clay. Gritty texture with frequent fine to coarse sand-sized mineral grains and granules of cbm. Rare shell fragments and charcoal grains and granules. Occasional to frequent well rounded ooidal limestone granules and quartzite granules. (Alluvial deposit). Gradual boundary to:
BH216	4.65	5.20	Silt/clay	2.5Y 4/2 Dark greyish brown, firm homogenous silt/clay with rare *Bythnia* sp. (Alluvial deposit).
BH216	5.20	5.60	Void	Void.

BH216	5.60	6.25	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH217A	0.00	1.20	Made ground	
BH217A	1.20	1.40	Void	Void
	1.40	1.63	Soil	10YR 3/2 Very dark greyish brown silt/clay with frequent fine sand and grains of ooidal limestone, charcoal and cbm. Occasional fine pebbles of sub-rounded ooidal limestone and cbm. Fine granular ped structure and fine bioturbation. (Soil). Sharp boundary to:
BH217A	1.63	3.17	Fine diamict	2.5Y 3/1 Very dark grey, fine diamict (greenish shade) with granular to fine pebble-sized sub-angular ooidal limestone clasts. Fine sandy silt/clay matrix with rare grains of charcoal and cbm. Sharp boundary to:
BH217A	3.17	3.56	Silt/clay	2.5Y 4/1 Dark grey oxidises to 10YR 4/2 Dark greyish brown, silt/clay with rare grains of shell and whole, freshwater snail shell and bivalve half. No laminae. Sharp boundary to:
BH217A	3.56	4.20	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). End of BH.
BH218	0.00	1.20	Made ground	
	1.20	2.15	Made ground	10YR 3/2 Very dark greyish brown diamict with fine pebble-sized angular clasts of slate, brick slag and mortar. Sandy clay matrix. (Modern). Sharp boundary to:
BH218	2.15	2.40	Made ground	5Y 5/1 Grey silt/clay with cardboard and brick. (Modern). Sharp boundary to:
	2.40	3.60	Made ground	5Y 5/3 Olive and % Y 5/1 Grey mottled diamict with ooidal limestone granules and thick lens of yellowish grey oxidised, clean clay and lens of dark greyish brown clay with frequent charcoal , brick and mortar granules. (Modern made ground). Unknown boundary to:
BH218	3.60	4.45	Void	Void

BH218	4.45	5.20	Made ground	5Y 5/3 Olive and 5Y 5/1 Grey mottled diamict with ooidal limestone granules and thick lens of yellowish grey oxidised clean clay and lens of dark greyish brown clay with frequent charcoal , brick and mortar granules. (Modern made ground). Sharp boundary to:
BH218	5.20	7.20	Cultural deposit (mineral)	2.5Y 3/2 Very dark greyish brown diamict with a friable texture. Clasts of granular to medium pebble-sized angular brick, mortar and ooidal limestone distributed throughout the unit. Frequent granules of charcoal. Rare oyster shell.
BH219A	0.00	1.20	Made ground	
BH219A	1.20	1.37	Made ground	10YR 3/1 Very dark grey silt/clay with frequent sand-sized grains to fine pebble-sized mortar fragments. Frequent granule to cobble-sized angular brick. Rare plant fibres. Sharp boundary to:
BH219A	1.37	1.60	Made ground	10YR 4/6 Dark yellowish brown friable mortar. Gradual boundary to:
BH219A	1.60	2.70	Silt/clay	2.5Y 2.5/1 Black, stiff silt/clay with occasional coarse sand-sized whole shell (*Succinea* sp?, *Lymnaea* sp?). Frequent charcoal grains and occasional granules of ooidal limestone. Unknown boundary to:
BH219A	2.70	3.80	Cultural deposit (mineral)	2.5Y 3/1 Very dark grey, stiff silt/clay with frequent medium to coarse sand-sized grains of cbm, mortar, flint and charcoal. Rare granular angular mortar fragments. Rare angular cobble of sandstone. Generally a homogenous unit with a greenish tinge. Sharp boundary to:
BH219A	3.80	4.20	Silt/clay	10YR 4/3 Brown, stiff silt/clay. Homogenous with a greenish tinge. End of BH.
BH220	0.00	1.20	Made ground	
BH220	1.20	1.90	Made ground	Coursed red brick and mortar. Frequent black soot (?). Sharp boundary to:

BH220	1.90	4.20	Cultural deposit (mineral)	2.5Y 3/2 Very dark greyish brown, firm silt/clay with frequent grains of charcoal. Rare fine pebble-sized fish vertebra. Occasional coarse sand-sized grains of cbm. Soil-like texture: granular peds but badly disturbed through testing. Clayey texture increases towards base with rare cobble-sized lens of sand, cbm grains and granules and rare ooidal limestone cobble. **Cobble-sized tabular rounded Roman cbm at base**. (Soil to alluvium?)
BH220	4.20	4.29	Void	Void.
BH220	4.29	4.50	Cultural deposit (mineral)	2.5Y 3/2 Very dark greyish brown, firm silt/clay with frequent grains of charcoal. Rare fine pebble-sized fish vertebra. Occasional coarse sand-sized grains of cbm. Soil-like texture: granular peds but badly disturbed through testing. Clayey texture increases towards base with rare cobble-sized lens of sand, cbm grains and granules and rare ooidal limestone cobble. Cobble -sized tabular rounded Roman sherd at base. (Soil to alluvium?)
BH220	4.50	5.00	Gravel	2.5Y 3/3 Dark olive brown with frequent orange iron oxide staining, firm silt/clay with frequent sub-angular to well rounded, granular to medium pebble-sized quartzites, occasional flint clast and rare sub-angular ooidal limestone cobble. (Reworked gravel).
BH220	5.00	5.40	Silt/clay	2.5Y 3/2 Very dark greyish brown frequent mottles of 2.5Y 4/4 Olive brown, stiff silt/clay. Frequent granules of whitish mineral, grainy but friable reducing to powder. (Reworked gravel/top of bedrock?). Unknown boundary to:
BH220	5.40	6.00	Gravel	2.5Y 3/2 Very dark greyish brown mottled 2.5 Y 4/4 Olive brown, stiff silt/clay with occasional angular ooidal limestone cobble and sub-angular medium pebbles of flint and quartzite. (Reworked gravel/ top of bedrock). Gradual boundary to:
BH220	6.00	6.90	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). Unknown boundary to:

BH220	6.90	7.45	Void	Void
BH220	7.45	8.40	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH221	0.00	1.20	Made ground	
BH221	1.20	1.72	Made ground	Coursed red brick and mortar. Sharp boundary to:
BH221	1.72	3.30	Cultural deposit (mineral)	2.5Y 3/2 Very dark greyish brown, firm silt/clay with frequent fine to coarse sand-sized grains of charcoal, mortar, cbm and rock fragments. Occasional sub-angular cobble of ooidal limestone. Gradual boundary to:
BH221	3.30	4.30	Silt/clay	2.5YR 3/1 Very dark grey, firm silt/clay with frequent fine to coarse sand-sized mineral grains. Occasional to frequent granular to medium pebble-sized brick. Rare well rounded fine pebble of quartzite. (Reworked alluvium?)
BH221	4.30	4.38	Gravel	2.5 Y 3/3 Dark olive brown, firm, clayey sandy gravel, poorly sorted. Oxidised dark orangish green colours associated with sand fraction. Clasts of sub-angular to well- rounded quartzite and unknown rock fragments. Frequent medium to coarse sand. (Cheltenham Sand and Gravel/Powerhouse Member?). Sharp boundary to:
BH221	4.38	5.70	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5 Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). Unknown boundary to:
BH221	5.70	6.20	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH222	0.00	1.20	Made ground	
BH222	1.20	3.25	Cultural deposit (mineral)	2.5Y 3/2 Very dark greyish brown, friable to firm silt/clay with frequent fine to coarse sand-sized whitish grains (ooids?) and charcoal grains. Rare cbm grains. Occasional sub-angular medium pebble to cobble-sized ooidal limestone clasts. (Alluvium?) Gradual boundary to:

BH 222	3.25	3.55	Silt/clay	2.5Y 4/2 Dark greyish brown, firm silt/clay with frequent fine to medium sand increasing towards base. Frequent grains and granules of charcoal, cbm, and shell. (Alluvium). Gradual boundary to:
BH 222	3.55	3.97	Sand	10 YR 4/6 Dark yellowish brown fine to medium sand with frequent sub-to well rounded, granular to cobble sized quartzites towards the base. Fining upwards unit. (Power House Member rather than Cheltenham Sand and Gravel?). Sharp boundary to:
BH 222	3.97	5.70	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). End of BH.
BH223A	0.00	1.20	Made ground	
BH223A	1.20	1.40	Made ground	2.5Y 3/1 Very dark grey silt/clay with rare granules of mortar. Sharp boundary to:
BH223A	1.40	1.65	Silt/clay	7.5YR 4/3 Brown silt/clay . Sharp boundary to:
BH223A	1.65	2.70	Made ground	10YR 3/2 Very dark greyish brown silt/clay with frequent granular to pebble-sized ooidal limestone, brick, and mortar. Grains and granules of charcoal. Rare granular-sized freshwater snail Rare sub-angular brick cobble and angular grey limestone cobble. Unknown boundary to:
BH223A	2.70	2.84	Void	Void
BH223A	2.84	3.03	Made ground	10YR 3/2 Very dark greyish brown silt/clay with frequent granular to pebble-sized ooidal limestone, brick, and mortar. Grains and granules of charcoal. Rare granular-sized freshwater snail Rare sub-angular brick cobble and angular grey limestone cobble. Sharp boundary to:
BH223A	3.03	3.26	Silt/clay	7.5YR 4/3 Brown silt/clay. (Hydrocarbon odour). Sharp boundary to:
BH223A	3.26	4.00	Cultural deposit (mineral)	10 YR 3/1 Very dark grey silt/clay with frequent black organic spots and rare medium -sized pebble of ooidal limestone. Colour tends to pinkish grey. Sheep rib bone (100mm). Occasional granular plant fragments.

BH223A	4.00	4.20	Cultural deposit (mineral)	10YR 3/1 Very dark grey silt/clay with occasional fine pebble-sized bone, wood and ooidal limestone clasts. Occasional charcoal granules. Rare medium -sized angular cbm. (Fluvially reworked unit). Unknown boundary to:
BH223A	4.20	4.30	Void	Void.
BH223A	4.30	4.35	Cultural deposit (mineral)	10YR 3/1 Very dark grey silt/clay with occasional fine pebble-sized bone, wood and ooidal limestone clasts. Occasional charcoal granules. Rare medium -sized angular pottery. (Fluvially reworked unit). Sharp boundary to:
BH223A	4.35	5.70	Silt/clay	5Y 4/1 Grey oxidising to 10 YR 4/3 Brown, firm and homogenous silt/clay with frequent charcoal grains evenly distributed throughout. Silt /very fine sand increases towards base. At 5m horizontal, irregular silt and clay laminae. Occasional black organic spots (?Elmore Member). End of BH.
BH224	0.00	1.20	Made ground	
BH224	1.20	1.60	Void	Void.
BH224	1.60	1.80	Made ground	5Y 4/1 Dark grey, firm diamict. Occasional angular brick pebbles and cobble. Cobble of mortar. (Modern Made Ground). Sharp boundary to:
BH224	1.80	2.14	Made ground	10YR 5/6 Yellowish brown sandy silt/clay. Frequent granules and fine pebbles of angular ooidal limestone. (Modern Made ground). Sharp boundary to:
BH224	2.14	2.56	Made ground	5Y 3/1 Very dark grey oxidises to 2.5Y 4/2 Dark greyish brown very fine sandy diamict. Angular fine to medium pebble-sized rock fragments and ooidal limestone. (Modern Made Ground). Sharp boundary to:
BH224	2.56	2.70	Made ground	Cobble of angular red brick. (Modern Made Ground).
BH224	2.70	3.30	Void	Void.
BH224	3.30	3.92	Made ground	Poorly sorted, clast supported gravel of angular brick clasts and coarse sand-sized mortar particles. (Deposit influenced by pressure water drilling).

BH224	3.92	4.20	Made ground	10G-5GY 3/2 Very dark green silt/clay, homogeneous and firm. Cobble of sub-rounded grey limestone. (Modern Made Ground).
BH224	4.20	5.00	Void	Void.
BH224	5.00	5.70	Made ground	Continuation of unit above: rare medium pebble of angular ooidal limestone. (Modern Made Ground).
BH224	5.70	7.20	Void	Void.
BH224	7.20	7.40	Made ground	Continuation of unit above. (Modern Made Ground).
BH224	7.40	8.40	Made ground	Coursed brick and concrete. (Modern Made Ground).
BH224	8.40	8.83	Void	Void.
BH224	8.83	9.90	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH225	0.00	1.20	Made ground	
BH225	1.20	1.52	Void	Void
BH225	1.52	1.80	Made ground	10YR 3/2 Very dark greyish brown diamict with granular to fine pebble-sized brick and mortar fragments. Frequent charcoal grains. Rare fine pebble-sized clay pipe fragment. Rare coarse pebble-sized bone astragalus. Gradual boundary to:
BH225	1.80	2.70	Made ground	2.5Y 2.5/1 silt/clay with frequent fine sand-sized mineral grains and occasional granular to pebble-sized sub-angular ooidal limestone. Occasional granules of cbm and modern wood. Unknown boundary to:
BH225	2.70	3.27	Slump	Slump
BH225	3.27	3.77	Made ground	2.5Y 2.5/1 silt/clay with frequent fine sand-sized mineral grains and occasional granular to pebble-sized sub-angular ooidal limestone. Occasional granules of cbm and modern wood. Unknown boundary to:

BH225	3.77	5.21	Silt/clay	7.5YR 3/2 Dark brown mixed with 4/4 Brown, firm silt/clay. Occasional whole, freshwater snail shell (*Anisus* sp, *Lymnea* sp). Occasional charcoal grains. Rare granular rock fragments. Colour is black (reduced humic conditions) in areas. Rare cobble-sized sub-rounded ooidal limestone clast. Colour grades into 2.5Y 3/1 (oxdises to 10YR 4/2). Horizontal silt laminae and occasional fine sand laminae towards base. Gradual boundary to:
BH225	5.21	5.36	Gravel	Fine sandy gravel finely interbedded with silt/clay.
BH225	5.36	5.70	Mudstone	2.5Y 3/2 Very dark greyish brown mottled 50% 2.5Y 4/4 Olive brown, stiff silt/clay with medium pebble-size whitish, poorly crystalline sub-angular nodules. Lustrous clay with fine sparkle. (Weathered bedrock mudstone). End of BH.
BH225	5.70	6.70	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH226	0.00	1.20	Made ground	
BH226	1.20	2.00	Made ground	2.5Y 2.5/1 Black silt/clay with frequent fine sand-sized mineral grains. Occasional fine to coarse pebbles of angular brick. Gritty texture in places. Frequent angular granules of rock fragments. Occasional ooidal limestone granules and charcoal. (Modern Made Ground). Sharp boundary to:
BH226	2.00	7.80	Silt/clay	2.5Y 3/1 Very dark grey firm silt/clay. Frequent charcoal/humic grains and granules (mottling) throughout. Oxidises to typical brown. Black mottling is intense at 2.7m coalescing to form a black clay; less so deeper and becomes grey and homogenous. Rare organic fibres at 4.2m. Silty towards base. **Medieval? cbm at 7.2m in sandy gravel lens.**
BH226	7.80	8.70	Void	Void.
BH226	8.70	9.15	Mudstone	5Y 2.5/1 Black silt/clay. (Weathered mudstone).
BH226	9.15	9.65	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.

BH227	0.00	1.20	Made ground	
BH227	1.20	1.54	Made ground	10YR 4/6 Dark yellowish brown fine sand mixed with 10YR 3/2 Very dark greyish brown silt/clay. Occasional granules of brick, ooidal limestone and angular grey limestone. (Modern Made Ground). Diffuse boundary to:
BH227	1.54	3.01	Soil	10YR 3/2 Very dark greyish brown, firm and homogeneous silt/clay. Poor granular texture at top. Rare rounded ooidal limestone granules, occasional ooids, sparkly appearance (ultimately derived from bedrock). Rare grains and granules of charcoal and shell. Rare well rounded quartzite. Colour tends to black towards base. Rare Bythnia sp. at base and occasional granules of angular rock fragments (reworked mudstone?). (Possible deeply worked soil developed in alluvium). Sharp boundary to:
BH227	3.01	3.87	Cultural deposit (mineral)	Cobble of angular ooidal limestone at top. 10YR 4/2 Dark greyish brown sandy silt/clay. Rare brick and ooidal limestone granules. **Angular Roman body sherd 40mm.** Rare brick and ooidal limestone granules. (Fluvially reworked? Archaeology developed in Elmore Member). Sharp boundary to:
BH227	3.87	4.20	Gravel	10YR 4/6 Dark yellowish brown well sorted fine to medium sand. Coarsens downwards. Occasional to frequent fine to medium pebbles of well-rounded quartzites and sub-angular ochre flints. Rounded fine pebble of green mudstone. Well-rounded medium pebble of orthoquartzite. (Power House Member?)
BH227	4.20	5.05	Gravel	Continuation of unit above: coarse pebbles of quartzites and sub-rounded ochre flint cobble. Fine pebble of sub-angular ironstone. Fine to medium sand matrix. (Power House Member)
BH227	5.05	5.15	Slump	?Slump (fine gravel and clay from unit above. May be *in situ*)
BH227	5.15	5.60	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH228	0.00	0.40	Made ground	
BH228	0.40	1.50	Made ground	Loose coarse to cobble sized gravel of angular ooidal limestone, brick and grey limestone. (Modern Made Ground).

BH228	1.50	1.74	Slump	Slump.
BH228	1.74	2.26	Made ground	10YR 4/2 Dark greyish brown sandy and clayey gravel. Very poorly sorted and matrix supported. Clasts of angular granules to fine pebbles of ooidal limestone, charcoal and an angular grey limestone cobble. (Modern Made Ground).
BH228	2.26	3.00	Soil	10YR 3/2 Very dark greyish brown, firm and homogeneous silt/clay. Poor granular texture at top. Rare rounded ooidal limestone granules, occasional ooids, sparkly appearance (ultimately derived from bedrock). Rare grains and granules of charcoal and shell. Rare well rounded quartzite. Colour tends to black towards base. (Possible deeply worked soil developed in alluvium).
BH228	3.00	3.55	Void	Void.
BH228	3.55	4.50	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.
BH229A	0.00	1.20	Made ground	
BH229A	1.20	1.70	Made ground	Coursed brick and mortar filling core. (Modern Made Ground).
BH229A	1.70	2.08	Soil	10YR 3/2 Very dark greyish brown silt/clay. Poorly granular at top, darker and more humic with coarse roots. Horizontal oyster shell valve 50mm. Frequent charcoal grains. Cobble of red rick at 2.08m. (Modern soil). Diffuse boundary to:
BH229A	2.08	4.20	Silt/clay	10YR 3/2 Very dark greyish brown silt/clay, not granular and more clayey than above unit. Homogeneous. Occasional sub-rounded fine to medium pebbles of ooidal limestone. Occasional charcoal and shell granules at top. Humic. Oxidises to 7.5YR 4/2 Brown from 2.7-4.2m. Frequent black humic mottles develop.
BH229A	4.20	4.60	Void	Void.
BH229A	4.60	5.70	Silt/clay	Continuation of unit above: Frequent black humic mottles and occasional wood fragments very fine waterlogged twig. (Elmore Member).
BH229A	5.70	6.20	Void	Void.

BH229A	6.20	7.65	Silt/clay	Continuation of unit above: Rare black humic mottles. More silty. Typical 5Y 3/1 Very dark grey core with brown oxidation. (Elmore member).
BH229A	7.65	8.34	Gravel	5Y 3/1 Very dark grey clayey and sandy gravel. Very poorly sorted and matrix supported. **Coarse pebble-sized angular Roman cbm. Well rounded medium pebble of Roman cbm.** Fragment of black bone 30mm (skull?). Rounded, black cobble of fossiliferous limestone. Frequent granules to medium pebbles of well-rounded quartzite and vein quartz. Rare rounded ooidal limestone. (Muddy gravel bed load). Sharp boundary to:
BH229A	8.34	9.95	Silt/clay	5Y 3/1 Very dark grey silt/clay with a silty texture. No humic mottling. Very finely laminated. Rare 50mm fine gravel lens. Rare 10mm fine to medium sand lens. (Fine grained alluvium). Sharp boundary to:
BH229A	9.95	10.07	Gravel	10 YR 3/2 Very dark greyish brown sandy gravel. Sand fine to medium. (Power House Member). Sharp boundary to:
BH229A	10.07	10.57	Mudstone	2.5Y 2.5/1 Black, stiff to very stiff laminated mudstone. (Charmouth Mudstone Formation). End of BH.

APPENDIX 3: XRF DATA BH226

sample m bgl	Fe	Ti	Ca	K	Al	P	Si	S
1.2	24476.7	607.08	17648.1	2103.85	0	0	0	0
1.3	22889.82	452.28	17040.56	1352.15	0	0	0	0
1.4	28703.62	1535.66	56671.66	7145.17	12391.55	667.37	77574.4	4006.88
1.5	11414.13	443.19	11740.97	1531.64	0	0	0	0
1.6	18297.28	1056.01	30974.94	4452.96	0	447.22	0	309.97
1.7	13375.63	555.1	17612.8	2289.29	0	0	0	0
1.8	9466.94	830.22	20623.13	2495.49	0	0	0	0
1.9	7128.87	559.13	15210.66	1767.14	0	0	0	0
2	10094.11	565.02	11035.98	1778.62	0	0	0	0
2.1	39819.49	2425.95	44123.76	11525.59	31269.52	1962.15	176004.6	5956.36
2.2	23382.99	1936.47	43115.72	9472.27	69186.78	3555.53	305544.9	14034.45
2.3	32376.83	2682.18	43699.76	13072.15	28510.49	1775.99	149870.6	4616.42
2.4	30054.13	1976.04	33854.8	9698.36	9377.5	776.12	55746.81	2226.47
2.5	18309.29	1295.04	8140.68	5972.12	0	0	0	3046.92
2.6	30205.84	3352.86	22734.94	15754.13	45202.06	1301.05	186616.8	5418.15
2.7	29457.41	2049.98	19246.71	9344.26	31385.3	573.92	153100.8	3717.34
2.8	33758.05	2487.67	64566.47	11471.72	30581.48	1759.35	179291.5	5425.26
2.9	36719.43	1962.15	58042.69	8741.91	21406.04	1063.98	119383.1	4006.91
3	36871.67	3226.06	34411.86	15120.48	46201.52	1278.28	182107.5	8005.92
3.1	21872.08	2386.45	10847.25	10673.23	11614.32	232.93	48441.26	2281.35
3.2	20611.45	2905.24	11254.75	12667.79	25531.77	327.49	143816.9	2227.34
3.3	20852.14	495.12	3008.5	2706.75	0	0	0	0

3.4	25179.7	526.41	3271.75	3004.66	123482.9	5838.21	468163.7	24282.81
3.5	22973.51	4820.35	27060.01	22891.16	53142.67	935.97	244719.1	7170.69
3.6	27099.66	1842.74	11804.37	8731.75	0	0	0	0
3.7	23628.15	1150.28	3925.79	5784.12	0	0	0	0
3.8	17961.42	1986.14	7057.22	9042	11312.78	0	46949.72	705.48
3.9	15091.22	4356.76	12871.9	19489.61	27942.16	636.7	111362.4	6456.15
4	20003.93	2758.19	11178.51	12531.85	19073.6	411.64	87442.3	2171.13
4.1	31315.98	5705.31	31002.82	25995.83	77036.77	1260.67	268871.6	6684.4
4.2	36824.38	2237.54	52869.58	11182.98	46724.55	1233.57	128516.5	6802.01
4.3	31361.85	0	0	0	0	0	0	0
4.4	30999.01	3664.4	16553.54	18117.14	35135.27	483.63	138294.8	1929.26
4.5	22409.91	2856.96	22340.38	16491.84	90745.24	1008.67	204443.7	3202.53
4.6	29451.11	1991.73	29031.61	10527.15	30427.72	664.69	114886.4	1715.94
4.7	43421.59	4984.59	55885.75	25446.71	109179.6	1097.77	275938.7	4787.93
4.8	17252.24	1646.48	27194.24	9873.32	44313.06	466.87	126955.8	1644.1
4.9	14125.82	1999.9	11840.32	12944.2	80925.45	918.87	185839.7	2989.2
5	29680.56	3405.9	32562.18	19820.61	87731.08	817.67	201649	3144.82
5.1	19375.01	2792.51	32974.63	13910.79	19588.56	243.85	77190.3	1095.84
5.2	28979.86	2540.83	39778.79	12210.12	29857.44	247.71	148454.2	6592.3
5.3	16670.2	3116.43	55658.31	14731.2	42714.11	364.41	205150.7	5453.24
5.4	11999.44	2195.58	38581.3	12627.43	61316.41	573.98	222785	4710.44
5.5	16961.27	2934.38	52065.05	12676.69	31671.86	384.32	194545.8	2503.49
5.6	15172.92	2412.59	37902.41	12121.03	23791.56	373.6	111051	4595.18
5.8	28160.87	538.9	60606.11	4727.94	2078.29	0	26248.83	37048.31
5.9	13636.84	1988	68062.29	8793.87	20989.61	0	163256	40960.91
6	25117.45	2091.92	53219.76	9411.86	26918.19	0	197915.6	29074.13

6.1	13837.29	1757.3	58738.27	8988.3	13072.17	0	140519	20475.04
6.2	12220.6	1836.74	63933.26	8549.1	2958.59	0	29124.92	7180.7
6.3	12189.89	1599.07	78630.48	7817.85	15891.11	0	169143.9	33018.33
6.4	13241.89	2050.45	73476.2	9456.8	37909.35	0	251776.1	39671.15
6.5	13545.77	1698.02	56734.86	8247.6	13658.96	0	126046.4	9783.36
6.6	15620.12	2415.98	51861.24	10618.84	10649.5	266.08	128269.9	4107.23
6.7	19673.24	2260.4	48439.21	10130.18	5446.34	95.82	56211.22	4496.5
6.8	9945.63	719.22	12814.56	2966.22	0	0	0	0
6.9	16715.37	2198.44	69871.38	10787.39	28104.64	244.77	206542.5	13534.96
7	19636.02	2398.96	56453.56	11152.49	13471.25	207.66	134508.1	13025.34
7.1	9418.41	418.68	37435.63	2623.14	0	0	0	4274.29
7.2	20582.78	1260.7	193714.8	7281.51	30772.32	332.33	158875.9	90268.55
7.3	15372.82	1756.59	56736.55	7656.09	5433.76	0	54417.8	15816.88
7.4	12484.49	1661.05	34822.29	6502.73	2698.18	0	26856.73	3261.58
7.5	9593.87	994.81	149739.3	4818.94	2577.68	0	24254.55	3287.12
7.6	14961.01	2565.21	55682.7	9688.9	20525.28	0	209809.1	10119.69
8.1	17471.99	703.54	49729.27	9351.09	8313.31	349.58	183520.6	19897.97
8.2	17956.38	436.34	31748.22	3828.22	0	0	0	0
8.3	35767.81	2425.11	65709.96	12478.42	5302.1	0	21025.3	22569.58
8.4	25195.95	1562.8	36830.77	8064.52	14618.3	509.35	108290.4	12465.58
8.5	47595.76	2826.43	51190.89	15583.42	55454.59	466.9	233042.9	1954.34
8.7	11076.1	1674.04	62584.15	8048.64	11303.03	401.78	99790.7	34878.88
8.8	16540.74	1562.82	44875.06	6319.13	2364.15	335.15	43323.41	1589.95
8.9	7129.21	934.16	26312.08	4003.03	0	0	0	0
9	15908.77	1657.12	50051.69	7540.22	3411.09	187.06	31495.26	7602.24
9.1	23655.45	320.11	14502.61	1728.43	2069.6	0	14403.31	8352.46

9.2	28322.07	4114.57	60182.82	17192.21	63956	552.81	182807	4764.98
9.3	30348.79	3881.48	49805.18	16045.87	67340.32	367.98	188678.6	5336.44

APPENDIX 4: XRF DATA BH227

Sample m bgl	**Fe**	**Ti**	**Ca**	**K**	**Al**	**P**	**Si**	**S**
1.2	24887.48	1728.84	67734.57	11263.52	26891.83	1133.34	155281.7	12162.63
1.3	13116.53	1267.57	13167.27	7446.17	0	0	0	0
1.4	8119.94	607.2	6536.49	4020.91	0	0	0	0
1.5	9642.93	736.29	7883.16	4737.64	0	0	0	0
1.6	14850.69	996.99	26190.28	6195.84	0	0	0	0
1.7	7668.56	0	0	0	0	0	0	0
1.9	14629.58	958.71	32484.85	6055.14	0	0	0	0
2	25272.84	1642.12	50337.55	11448.71	20485.6	4273.36	160712	295.99
2.1	26747.15	1129.33	37388.5	7358.85	4034.29	1718.78	47303.89	0
2.2	25304.13	1871.44	57496.18	12005.87	26645.86	3319.06	192577.5	470.15
2.3	27652.67	1651.78	43159.35	10158.93	12432.55	1611.35	110637.6	685.67
2.4	32579.75	1816.87	41763.34	12710.6	14298.47	1895.79	141922.9	1527.73
2.5	19374.96	1436.67	70470.7	8469.37	16121.94	4021.68	169755.3	2437.79
2.6	25636.86	1844.09	65725.14	11099.2	32695.38	3871.43	202529.9	10143.3
2.7	28794.34	1822.65	72640.19	11122.65	17847.73	2045.48	145144.4	22383.84
2.8	10557	871.88	19428.01	4648.37	0	0	0	0
2.9	15802.79	941.96	21688.35	6012.56	0	0	0	0

3	13666.41	1133.57	168367.1	5610.22	0	0	0	0
3.1	17308.88	1484.14	39217.04	9665.72	17343.36	1726.37	135415.8	465.58
3.2	9483.12	1150.06	21560.83	7320.65	0	0	0	0
3.3	10810.85	1110.93	11895.04	6469.19	0	0	0	0
3.4	0	0	0	0	0	0	0	0
3.5	6605.27	1333.59	10295.77	7344.35	9635.07	0	92621.37	0
3.6	9210.51	1380.18	11577.92	11335.83	0	0	114127.2	0
3.7	4652.3	0	0	0	0	0	0	0
3.8	4614.33	0	0	0	0	0	0	0
3.9	21893.92	1846.4	31294.93	11916.58	9807.94	532.61	106772.5	0
4	58893.91	3949.55	135006.4	17782.71	38439.55	707.86	150653.6	671.26
4.1	35252	1758.54	52781.89	14135.07	14653.6	653.97	196655.5	2243.06
4.2	15783.57	537.97	13803.34	4066.62	0	0	0	0
4.3	9370.09	1385.98	35315.92	9491.67	21540.34	983.25	478789.5	7455.85
4.4	25162.15	1595.49	32857.65	10890.04	21117.28	784.66	172997.7	1598.44
5.1	16959.02	1590.11	29322.76	7720.99	15983.74	0	118881.5	15144.25
5.2	15493.46	1035.09	214375.9	5902.23	11662.01	168.39	83393.55	5197.79
5.3	26823.12	2199.26	30451.28	11305.43	3858.99	0	1454.59	0
5.4	19621.39	1797.74	35395.18	10066.78	2307.65	0	4990.31	0