Cotswold Archaeology

Distribution and Significance of Urban Waterlogged Deposits in Bristol

for

English Heritage

EH Project: 6517
CA Project: 3766
CA Report: 13014

February 2013

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issue	02

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GLOSSARY

ARCA	The geological consultancy arm of the Department of Archaeology at the University of Winchester
BCC	Bristol City Council
BGS	British Geological Survey
CA	Cotswold Archaeology
EH	English Heritage
Facies	'*A body of rock with specified characteristics…defined on the basis of colour, bedding, composition, texture, fossils and sedimentary structures*' (Reading 1986, 4)
HER	Historic Environment Record
MMG	Mercia Mudstone Group
QSF	Quartzitic Sandstone Formation
Quaternary	The present geological period comprising the Pleistocene (2.588 million years [my] before present [BP] to 11.5 thousand [ky] BP) and H olocene (11.5ky BP-present) epochs (International Commission on Stratigraphy 2012a)
UAA	Bristol Urban Archaeological Assessment

EXECUTIVE SUMMARY

EH Project: 6517

An assessment of the distribution and significance of urban waterlogged deposits in Bristol was undertaken by Cotswold Archaeology in 2012 and 2013, in association with Bristol City Council. The project was commissioned by English Heritage as part of the National Heritage Protection Plan. It is one of a number of similar studies assessing urban waterlogged deposits.

The project was designed to analyse the distribution and significance of waterlogged deposits in Bristol. This was approached through the creation of a 3D data model of the geological and archaeological sequence. The project utilised existing data held by ARCA for major archaeological sites in Bristol and also analysed additional data generated from information held at Bristol City Council Historic Environment Record and online British Geological Survey borehole records.

The database generated by the project was manipulated in two different ways, with different levels of associated detail and precision. The first version of the database split the stratigraphy into four broad units (Made Ground, Wentlooge, Avon Formation and Mercia Mudstone). The second version of the database used a more fine-grained selection of strata, including a division of Made Ground into medieval/post-medieval waterlogged and non-waterlogged strata (termed Archaeological Strata 2 and Archaeological Strata 1 respectively). This second version of the database allowed for a larger number of questions to be posed, but was also subject to limitations associated with the variability of the accuracy of the records used to generate the data.

A high concentration of records was generated for the Redcliffe area and therefore it was possible to generate a finer-grained model for this area. This smaller study area includes more concentrated and potentially more reliable information on Archaeological Strata.

Generated models were based on elevation (OD) of the top of deposits and thickness of deposits. To elucidate the models a series of four composite cross sections was generated. These explore the changes in stratigraphic properties. It has been possible to define the units in which waterlogged deposits of archaeological significance occur in both broad terms (i.e. all strata underlying Archaeological Strata 1 and overlying the Mercia Mudstone Group and Avon Formation) and narrow terms (Archaeological Strata 2). It has also proven

possible to model the outcrop elevation and the thickness of these strata across the study area, and to explain the variations by reference to geological and ar chaeological phenomena.

The models have also provided information on former watercourses and the development of floodplain deposits in Bristol. The modelled surface of the Mercia Mudstone Group and the Avon Formation, and the thickness of the Wentlooge formation can be used to infer the possible courses of former river channels, including the possible former course of the Frome.

The project has produced a number of hypotheses and questions that present opportunities for future research. These will feed into the Bristol Urban Archaeological Assessment, which is currently in preparation.

ACKNOWLEDGEMENTS

The Distribution and Significance of Urban Waterlogged Deposits in Bristol was funded by English Heritage and part of the National Heritage Protection Plan. Cotswold Archaeology and Bristol City Council would like to thank English Heritage for their advice and input. Thanks also to Pete Insole, Archaeological Officer for Bristol City Council for refining the mapping of the town walls and the projected line of the medieval river systems, and Matthew Sugden, of the Flood Risk team of Bristol City Council, for information about river levels

The report was produced by Cotswold Archaeology (CA) in association with Bristol City Council. The Project Executive was Neil Holbrook, CA Chief Executive. The project was managed by Gail Stoten, CA Principal Heritage Consultant and Bob Jones, Bristol City Council Senior Archaeological Officer. Day-to-day management was undertaken by Rosey Meara, CA Heritage Consultant. Data collection was undertaken by Diarmuid O'Seaneachain, CA Assistant Heritage Consultant. Dr Keith Wilkinson, ARCA, undertook 3D deposit modelling and the associated description of the geological and archaeological sequence. The report was written by Keith Wilkinson, Bob Jones and Rosey Meara. Illustrations were prepared by Keith Wilkinson and Lorna Gray, CA Illustrator.

1. INTRODUCTION

1.1 This project assesses the distribution and significance of urban waterlogged deposits in Bristol, funded by English Heritage as part of the National Heritage Protection Plan. It is one of a number of similar projects assessing the urban waterlogged resource, including other cities.

1.2 The Project Design for this project (CA 2012) was developed in conjunction with Bob Jones, Bristol City Council Senior Archaeological Officer. It was approved by English Heritage in April 2012.

Background

1.3 Bristol is the largest conurbation in the South-west of England and one of the core cities of the UK. From the period following the Second World War, Bristol experienced a major rebuilding programme that caused the loss or degradation of much of its archaeological resource. Following the appointment in 1968 of a dedicated archaeological officer by Bristol City Council there has been an extensive programme of archaeological fieldwork. One of these fieldwork programmes was devoted to the excavation of the medieval waterfront in Redcliffe, on the south side of the river Avon, from 1980 until 1986. The scope and extent of fieldwork increased further following the introduction of PPG16 in 1990 and the appointment of a City Archaeologist by the Local Planning Authority in 1992.

1.4 Bristol was one of the most important cities in medieval England, originating in the late 10th century on high ground encircled by the Rivers Avon and Frome (Fig. 3). Following its foundation, it rapidly progressed to become one of the leading cities in the kingdom, experiencing particularly rapid growth in the 12th and 13th centuries, when the topography of the city was radically remodelled, involving large-scale, and, for their time, fundamental engineering works. Such works included the diversion of the river Frome, in *c*. 1240, from its original course traditionally thought to run along the south side of the river cliff to a new straight course along Broad Quay and Narrow Quay, meeting the river Avon further downstream. This effectively doubled the port area and from this period, Bristol became a major entrepôt with links to the Mediterranean ports as well as with Ireland and centres in its hinterland. At around the same time, new land was reclaimed to the north and south of the late

Saxon town and the original walled circuit increased to take account of, and establish control over this newly reclaimed area (Fig. 3).

1.5 Much of the area encompassed by the historic core of Bristol – i.e. within or immediately adjacent to the walled areas – lies below the 10m contour and within the floodplains of the rivers Avon and Frome (Fig. 2). Bristol experiences the second highest tidal range in the world – over 13m at Avonmouth at the confluence of the rivers Avon and Severn and around 10m within the historic docks area. Until the completion of the New Cut and the creation of the Floating Harbour in 1809, enabling a static and controllable water level in the docks as far as Cumberland Basin, the historic port had been subject to the exceptional tidal range, with ships often being forced to lie on the mud until floated off by the next high tide.

1.6 The accretion of intertidal/alluvial muds and debris, caused by frequent flooding episodes, has been noted on a number of excavations, especially in the Redcliffe area. Here, repeated efforts to control the effects of the tidal range and to maximise the use of the waterfront for mooring and the loading and unloading of cargo resulted in rapid encroachment on the river Avon by the construction of a series of waterfront revetments and other structures. As a consequence, the river has been constricted by a combination of deliberate dumping and natural deposition. The extent to which this has taken place in other riverside areas is as yet unclear, because of the lack of fieldwork, but it is likely to have done so to some degree.

1.7 More recent fieldwork in the intertidal area/floodplain has also involved the investigation via boreholes of the thick intertidal/alluvial sequences that lie beneath the medieval and post-medieval archaeological stratigraphy. These latter have begun to reveal an interesting pattern of alluvial and intertidal deposition spanning the Late Mesolithic to Middle Ages.

SWARF

1.8 The Archaeology of South-West England: South-West Archaeological Research Framework (SWARF) indicates a need for the development of methodologies and strategies to identify the potential of deeply buried Pleistocene and later deposits, highlighting the need for a better understanding of deep stratigraphy underlying urban developments on floodplains (Webster (ed), 2008, p 275, 15.3.1d). This project advances this aim, by enhancing our understanding of the changing

topography of Bristol and the potential of these deposits for answering questions about pre-urban settlement foci and providing important palaeoenvironmental data.

SHAPE

1.9 The project meets SHAPE Corporate Objective 1A, Ensuring that our research addresses the most important and urgent needs of the historic environment (English Heritage 2008). In particular, the project addresses Activity Type 1: Research, Research Programme A1 – What's out there: Defining, characterising and analysing the historic environment. The project falls under sub-programme Understanding Place: New historic assets discovered from remote sensing surveys (sub-programme number 11111.110), where the urban waterlogged deposits comprise the historic asset and the survey methods include LiDaR and geotechnical surveys. In addition the project meets the aspirations of sub-programme Understanding Place: Assessing historic areas (sub-programme number 11111.150), involving a rapid desk-based assessment of evidence pertaining to waterlogged urban deposits.

NHPP

1.10 As mentioned above, this project was designed in response to a call for project proposals from English Heritage, as part of the National Heritage Protection Plan (NHPP). This project was funded under Measure 3 – Identification of potential; Topic A – identification of heritage assets and their significance; Activity 5 – Identification of wetland/waterlogged sites.

Interfaces

1.11 The ongoing drafting of the Bristol Urban Archaeological Assessment (UAA) is well advanced. The deposit model of the urban waterlogged deposits will form an integral part of the description of the setting of Bristol (included in chapter 2 in the proposed synopsis of the volume) as it will provide information on the former arrangement of river channels within the area. The project has increased our understanding of the waterlogged deposits in Bristol, and also lead to the identification of gaps in the current knowledge of the resource both in terms of geographical areas where data are currently absent and themes that would benefit from future research, detailed in section 7 of this report. These will contribute to the Research Agenda that will form the concluding chapter of the UAA.

1.12 The Bristol City Council *Know Your Place* website went on line in March 2011 and has been widely greeted with enthusiasm both locally and nationally, winning several awards and commendations. It allows interactive access to the monuments of the HER and gives access to a wide range of other historic sources, including early maps, from 1750 onwards, as well as historic views of the city from paintings, drawings and early photographs. The results of this project could form the basis of future interpretative views of the city over time, from the pre-urban environment into historic periods, to be created and imported into the *Know Your Place* website, although the production of detailed reconstruction drawings is beyond the scope of the current project. The database of waterlogged material findspots and GIS contour plots of the deposit models have been provided to Peter Insole, Bristol City Council Senior Archaeological Officer. It may be suitable to upload some of this information onto the *Know Your Place* website in the future, although this is not anticipated in the short term. The findspots are mainly derived from HER data, which may be available on the website in the future. Due to their hypothetical nature and the difficulty of interpreting them outside the context of the report, the data models are not currently suitable for inclusion on the *Know Your Place* website.

Structure of the report

1.13 The remaining sections of the report are structured as follows: Section 2 describes the aims and objectives of the project; Section 3 details the approaches and methodologies by which data were collected, digitised and then manipulated using geological utilities and geographic information systems software; Section 4 describes the distribution and thickness of the outcrop of the main stratigraphic layers that underlie central Bristol, while interpretations are also provided on how and when each unit formed and how it has been post-depositionally transformed; Section 5 discusses the archaeological significance of the waterlogged deposits; Section 6 provides a summary of the project results; and Section 7 presents future research objectives including strategies for future archaeological investigation. Final conclusions are detailed in Section 8.

2. AIMS AND OBJECTIVES

Project aims

2.1 The aims of the project were:

Aim 1: To advance our understanding of the extent and nature of urban waterlogged sequences in Bristol

Aim 2: To capture and present this information in the most useful, intelligible and accessible ways

Aim 3: To facilitate effective development control and future research.

Project Objectives

2.2 The objectives of the project were:

Objective 1: To produce a deposit model of the alluvial and post-alluvial waterlogged sequence by the synthesis of current data (from archaeological interventions and readily available borehole data) (Aim 1).

Objective 2: To map (two-dimensionally) currently recorded findspots of waterlogged material (Aim 1).

Objective 3: To identify layers within the deposit model with potential for waterlogged material of archaeological significance (Aim 1).

Objective 4: To produce illustrations generated from the deposit model of these layers and provide a written description of this resource in a project report (Aims 2 and 3)

Objective 5: To enhance the Bristol HER by providing data on previously unexamined boreholes and by creating a ArcGIS layer of contour data for waterlogged deposits of archaeological significance (Aims 2 and 3).

Objective 6: To contribute to the forthcoming Bristol Urban Archaeological Assessment by providing information on the intertidal/alluvial context of the

city including contour illustrations of the top of the alluvial sequence, and by identifying areas of the city or themes with the greatest potential for future research (Aims 2 and 3).

3. METHODOLOGY

3.1 The project methodology was based upon that given in the Project Design (BCC & CA 2012), formulated during discussions with English Heritage. The project utilised existing data held by ARCA (borehole and other stratigraphic records obtained during geoarchaeological works in the city), supplemented with information derived from records held by Bristol City Council (Historic Environment Record, incorporating the Bristol Urban Archaeological Database, archaeological reports and commercial borehole data), and BGS boreholes available online (free to view). The data were used to model the Quaternary stratigraphy of central Bristol. Once formulated, the models were used as bases for a narrative outlining the stratigraphy of the city (Section 4) and for predicting the distribution of waterlogged deposits that might survive. The approaches by which the data were collected, digitised, manipulated and then used for modelling purposes are described below.

Study area

3.2 The study area can be broadly defined as the area of Bristol City Centre lying within the floodplains of two rivers: the Avon and the Frome (Fig. 1). This area generally lies at or below 10m above Ordnance Datum (aOD), as indicated by LiDaR data (Fig. 2). However, an area to the west of the current Frome channel (St Augustine's Reach/St Augustine's Parade), bounded by St George's Road, Frog Lane and Frogmore Street, was also included within the study area due to the presence of a valley identified as a possible former channel of the Frome during archaeological investigations in the area of Deanery Road. Within the broader study area the areas of the early walled town (and earlier Saxon *burh*), and castle were excluded due to their geological and raised topographical situation (on a bluff of Redcliffe Sandstone at the confluence of the Avon and Frome).

3.3 The discussion text refers to parts of the study area by name, including Canon's Marsh, Redcliffe and Cabot Circus, these are labelled on Fig. 1. For ease of reference, key streets and areas mentioned in the discussion are also labelled on this figure. Street names are visible on the 1:10, 000 base-mapping used for subsequent figures.

Data collection

Introduction

3.4 Data were collected on findspots of waterlogged material and the stratigraphic sequence. The main sources were previously collected records held by ARCA, the Bristol City Council HER, including reports for archaeological excavations and evaluations and boreholes, and online borehole data from the BGS (free to view).

ARCA

3.5 ARCA carried out 13 geoarchaeological borehole investigations within the Bristol study area between 2001 and 2010. These included investigations at Canon's Marsh (Harbourside), Deanery Road (College Street, Lower Lamb Street, Brandon Street and St George's Road area), Broad Quay, Redcliff Wharf, Huller House (Redcliffe), Mitchell Lane (Redcliffe), and Cabot Circus. During these projects dedicated geoarchaeological boreholes were drilled using either Pioneer (or equivalent) geotechnical rigs or man-portable Atlas Cobra/Eijkelkamp vibra corers (Eijkelkamp BV 2012, Geotechnical Engineering Ltd 2012), but reviews of geotechnical information obtained from the sites during design and scoping studies were also made. Lithological descriptions from both types of archive were recorded and wherever possible standardised as formal geological descriptions within a RockWorks database (see below) (Jones *et al*. 1999, Munsell Color 2000, Tucker 2011). Thus 137 stratigraphic records from this source were available for analysis prior to the commencement of the project (Fig. 4).

3.6 A spreadsheet in Excel format was exported from the ARCA RockWorks borehole database and was used as a template when entering stratigraphic data obtained from BCCHER and borehole sources (discussed below), so as to standardise the data with those previously recorded. The data structure is further discussed in the *Data Management* section below.

Bristol City Council HER records of previous archaeological works

3.7 A list of published reports and grey literature on archaeological excavations and evaluation, considered likely to contain relevant data on the geological/archaeological sequence and findspots of archaeological remains, was produced by Bob Jones, Bristol City Council Senior Archaeological Officer. For each investigation a record, or multiple records, were added to the dataset. Sections that showed representative stratigraphic information for each site were selected and stratigraphic sequences at points, or points, were added to the dataset as

appropriate. Where relevant borehole data were included in the reports these were also added to the database, except for those areas already covered by the ARCA dataset. Depths for each layer recorded in section were calculated by measuring off the fixed elevation provided in the report (OD) at the appropriate scale. For selected records, where OD was not available within the report, this was derived from the LiDaR data. Six-figure (2D) co-ordinate points were calculated using ArcGIS, with site plans scanned and geo-referenced where necessary.

Borehole sources

3.8 Selected boreholes held by the BHER were also reviewed and the stratigraphic sequences added to the dataset. Borehole data from the online BGS data (free to view) contained within the study area were reviewed and sequences added to the database. Boreholes for areas already previously covered by ARCA data were not added to the database.

3.9 The project design anticipated a second phases of data collection for areas where few data points were present. Following the completion of the first phase of data collection it was recognised that data were lacking from certain parts of the study area, particularly the northern part around Nelson Street. The BCC Pollution Control Borehole dataset was reviewed and geotechnical contractors were contacted with the aim of identifying additional boreholes for those areas where few data were present. No additional boreholes for the relevant areas were identified on the BCC Pollution Control Borehole dataset. Although positive responses were received from two geotechnical firms these did not identify specific boreholes of potential relevance.

Findspots

3.10 When reviewing the archaeological excavations and evaluations, data on archaeological findspots of waterlogged archaeological remains were also captured. A six-figure co-ordinate location (2D) was recorded for each find along with a description of the find/deposit.

Data management

3.11 The project's stratigraphic data were managed and manipulated using the RockWorks 15 geological utilities software (RockWare Inc 2013). RockWorks 15 was chosen for this purpose as:

a. The borehole data held by ARCA already resided in a RockWorks 15 database (see above);
b. It is the stratigraphic management software in most widespread use (particularly by educational establishments). It is relatively inexpensive ($3000 for a commercial licence) and has been used in many geoarchaeological stratigraphic modelling projects (e.g. Corcoran *et al*. 2011);
c. At the heart of RockWorks 15 is a Microsoft Access database and therefore those organisations that do not possess RockWorks can still add and query data recorded in the software;
d. It can read in data in Excel and Access format, and export data in both those formats, but also as ESRI Shape and AutoDesk .dxf formats.
e. It possesses more flexible modelling algorithms than are available in the Spatial Mapper extension of ArcGIS.

3.12 Nevertheless there are also disadvantages of employing the RockWorks software that are recognised by the project team including:

a. Automation of stratigraphic modelling, especially compared to the TerraStation II software (TerraSciences Inc 2011 used in many British geoarchaeological studies in the last decade (e.g. Bates 2003, Corcoran *et al*. 2011), means that there is little flexibility in what can be modelled;
b. Neither BCC nor CA possessed RockWorks during the project and therefore those organisations could neither manipulate nor model the stratigraphic data;
c. Although BCC will be able to update the stratigraphic database by adding new data within Microsoft Access, they will not be able to revise the models without a RockWorks licence.

Structure of data

3.13 As stated above RockWorks 15 utilises a Microsoft Access engine to store data in a series of related tables each recording a different property of a borehole. Those tables used in the ARCA borehole database were:

a. Location: the Ordnance Survey National Grid Reference (NGR), Ordnance Datum (OD) elevation and total length of the borehole;
b. Lithology: an objective description of each stratum in the borehole according to standard geological criteria (Jones *et al*. 1999, Munsell Color 2000, Tucker

2011), together with outcrop heights below borehole surface (top and bottom);

c. Stratigraphy: an interpretive category grouping lithological strata into formal geological sub-divisions (Table 1).

3.14 Table 1 below details the formal geological units which were utilised within the existing ARCA data. For details on the Hierarchy category refer to the *International Commission on Stratigraphy* (2012b).

Unit	Hierarchy[1]	Description	References
Made Ground	n/a	Strata emplaced by people (deliberately or otherwise) and including archaeological deposits	British Geological Survey 2012
Wentlooge	Formation	Intertidal and alluvial strata accreting in the Lower Severn and tributary valleys during the pre-medieval Holocene	Allen and Rae 1987
Avon	Formation	Fluvial strata emplaced by the River Severn during the Pleistocene (mainly channel gravels)	Campbell *et al.* 1999
Mercia Mudstone	Group	Sands, silts and conglomerates deposited in (mainly) alluvial fan environments in the Triassic (252.2-201.2my BP)	Green 1992, 80-84; British Geological Survey 2012

Table 1. Formal geological units relevant to the central Bristol study area

3.15 In order to maximise the data return in the time available to the project team it was decided that lithological data would not be collected from the records held in the BCC archive. However, the data that were collected were grouped into a larger number of (non-formal) Stratigraphy categories than had previously been employed by ARCA. These categories are detailed in Table 2, below. Other than increasing the speed of data entry, the reason for taking this approach was in order to try and separate archaeological strata from post-medieval/modern Made Ground, waterlogged from non-waterlogged archaeological deposits and different alluvial/intertidal facies. The categories Archaeological Strata 3 and Alluvium 3 were defined at the data modelling stage.

[1] see International Commission on Stratigraphy (2012b).

Unit	Description	Part of Table 1 category
Made Ground	Strata not of archaeological interest, includes deposits where archaeological interest cannot be determined (e.g. boreholes).	Made Ground
Archaeological Strata 1	Medieval/post-medieval deposits without identified organic preservation.	Made Ground
Archaeological Strata 2	Medieval/post-medieval deposits with identified organic preservation (waterlogged).	Made Ground
Proto-urban deposits	Deposits at the top of the Wentlooge Formation, including disturbed ('trampled') alluvium and deposits associated with marsh conditions. Identified in some archaeological works and included in the database where identified.	Wentlooge Formation/Made Ground
Alluvium 1	Wentlooge Formation deposits encountered below made ground.	Wentlooge Formation
Archaeological Strata 3	Strata containing evidence of human activity outcropping below Alluvium 1	Made Ground
Peat	Peat	Wentlooge Formation
Alluvium 2	Wentlooge Formation deposits encountered below Peat	Wentlooge Formation
Alluvium 3	Alluvial sand strata (probably point bar deposits) encountered below Alluvium 1 in ARCA borehole records (mainly in the Redcliffe area)	Wentlooge Formation
Pleistocene gravels	See Avon Formation in Table 1	Avon Formation
Mercia Mudstone	See Mercia Mudstone Group in Table 1	Mercia Mudstone Group

Table 2. Categories used in the classification of BCC stratigraphic data

3.16 For borehole records it was not generally possible to identify archaeological strata and therefore it was necessary to use the generic 'Made Ground' definition. The distinction between Archaeological Strata 1 and Archaeological Strata 2 was not always clear in archaeological/geotechnical reports. However, it was considered important to attempt to identify Archaeological Strata 2 where possible as the identification of these deposits is a key aim of the project. In certain cases the presence of Archaeological Strata 2 was inferred from indicators such as depth, proximity to known waterlogged deposits, the depiction of the deposits in section and the description of the deposits in the report.

3.17 Proto-urban horizons were identified in a small number of locations as a result of consultation with Bob Jones and Peter Insole, and also specified as such in some archaeological reports. Proto-urban horizons are defined as deposits occuring at the top of the Wentlooge Formation and comprise disturbed alluvial deposits ('trampled' deposits). Deposits associated with marsh-type conditions at the top of the alluvial sequence have also been recorded as 'Proto-urban' within archaeological reports. Proto-urban deposits are considered to be broadly of medieval date.

3.18 The Excel speadsheet containing the data derived from the BCCHER and BGS online boreholes was imported into the RockWorks project database containing the ARCA borehole records. This database was copied and the two versions manipulated in different ways. In the first version of the database the stratigraphy data generated from the BCCHER records/online boreholes was synthesised so that they accorded with the more simple ARCA data structure, as defined in Table 1. In the second version of the database the Lithology data held by ARCA were used to assign the stratigraphy categories defined in Table 2 to the ARCA borehole records. The end product was two databases, one using the Stratigraphy categories of Table 1 and the other of Table 2. The advantages and disadvantages of utilising simplified and non-simplified stratigraphic data in the subsequent modelling are discussed in Section 5.

Modelling

3.19 Models were made of the stratigraphic data on the basis of the Stratigraphy categories of the two versions of the database (see above) and using the two-dimensional Structural elevation and Stratigraphic thickness routines of RockWorks 15 (Table 3). Given that the geographic locations of the data points (i.e. boreholes and stratigraphic records) are not evenly spread out across the study area (see Fig 4.), a Kriging algorithm taking account of the nearest 10 neighbours was utilised to generate the models (Fig. 5). A minimum declustering and smoothing setting was also used so that the modelled data took the greatest possible account of the variation in the original data. The surface elevation and thickness resolution of the models that were produced ranges between 0.1m (Archaeological Strata 1 and 2) and 1.0m (Avon Formation and Mercia Mudstone Group).

Modelled dataset	Type	Whole study area	Redcliffe
Made Ground	Stratigraphic thickness	✓	×
Archaeological deposits 1	Structural elevation	✓	×
Archaeological deposits 2	Structural elevation	✓	×
Alluvium 1	Structural elevation	✓	×
Alluvium 3	Structural elevation	×	✓
Peat	Structural elevation	✓	×
Wentlooge Formation	Structural elevation	✓	✓
Wentlooge Formation	Stratigraphic thickness	✓	×
Avon Formation	Structural elevation	✓	✓
Avon Formation	Stratigraphic thickness	✓	×
Mercia Mudstone Group	Structural elevation	✓	×

Table 3. Structural elevation and Stratigraphic thickness models generated for the study area

3.20 Further, higher resolution models were generated for the Redcliffe area following a project meeting held on 19 December 2012 (Table 3). This part of central Bristol has seen a particularly large amount of development since 2000 and as a result there is a greater density of geoarchaeological borehole records for this area than anywhere else. Models for stratigraphic categories that cannot always be discerned in geotechnical records (e.g. Archaeological deposits 1 and 2, and Alluvium 3) and which would be considered unreliable for the study area as a whole can therefore be generated for Redcliffe.

3.21 A series of four composite cross sections was generated for the database utilising the stratigraphic categories of Table 2 and by employing the Striplog function of RockWorks (see Fig. 4 for locations of the cross sections, cross sections reproduced in Figs. 20-23). The purpose of these cross sections was to explore changes in stratigraphic properties along axes perpendicular to the river channels and also to explain variations seen in the Structural elevation and Stratigraphic thickness models.

Output

3.22 The Structural elevation and Stratigraphic thickness models generated in RockWorks were exported as Shape files[2] and then read into ESRI ArcGIS 10.1 and overlaid with topographic (1:10,000 Ordnance Survey) data and stratigraphic record/borehole positions. The resultant maps were exported in Adobe Illustrator format and then manipulated in Adobe Illustrator to generate the illustrations used in this report.

[2] RockWorks 15 converts the modelled data to contours and then turns these into polygons during Shape export.

4. GEOLOGICAL AND ARCHAEOLOGICAL SEQUENCE

4.1 The results of the modelling exercise are discussed below in reverse stratigraphic order, i.e. from bedrock deposits upwards to the recent Made Ground that overlies the medieval/post-medieval, intertidal and alluvial stratigraphy across the whole study area. No attempt is made at this stage to assess the archaeological significance of the strata or whether waterlogged remains of archaeological relevance are likely to occur within them. Rather a description of patterns that are observed is provided in this text, while interpretations are offered in Section 5 below.

4.2 Throughout this report where ^{14}C dates have been given in calendar years (original laboratory data are provided as footnotes), they have been calibrated using the IntCal09 curve (Reimer *et al.* 2009) and OxCAL 4 software (Bronk Ramsay 2009).

Solid geology: Quartzitic Sandstone Formation and Mercia Mudstone Group

4.3 The British Geological Survey map two bedrock units within the study area: Mercia Mudstone Group strata outcrop over the vast majority, but deposits of the Quartzitic Sandstone Formation (QSF) are found in the north-west part, south of the University of Bristol (BGS 2003). The QSF also forms the high ground north of the study area at Clifton (where it was formally known as the Brandon Hill Grit), and where it comprises mudstones, sandstones, conglomerates (mainly of quartzite, thereby giving the unit its name) and occasional fine coal seams (Green 1993, 46). None of the stratigraphic records examined during this project coincide with the QSF outcrop mapped by the BGS (2003), but three geotechnical boreholes in the Lewins Mead area in the northern part of the study area (adjacent to the outcrop) record the presence of QSF beneath the Wentlooge (BGS Boreholes ST57SE271 and ST57SE37) and Avon Formations (ST57SE157) at *c.* 0 to -5m OD. The QSF was deposited in deltaic environments of the Namurian stage of the Upper Carboniferous (326.4-314my BP), but was severely contorted during the Late Carboniferous Variscan Orogeny (Green 1993, 45; BGS 2012).

4.4 The QSF is separated from the overlying Mercia Mudstone Group (MMG) by a major unconformity, in part as a result of folding during the Variscan Orogeny. Thus Late Carboniferous (including the characteristic coal measures that are found south of Bristol) and Permian strata are not found in central Bristol (i.e. deposits from the period 314-251my BP is missing; Green 1993, 48-74, BGS 2012). Deposits of the

Mercia Mudstone Group (MMG) underlie Quaternary strata across most of the central Bristol study area and are examined in this project. The MMG is an agglomeration of a series of geological units that have now become defunct, most significantly the Keuper Marl series that featured on geological maps prior to the 1990s (BGS 2012).

4.5 The sub-division of the MMG outcropps across all of the study area, except for a portion of its north-western margin, is the Redcliffe Sandstone Member (part of the Sidmouth Sandstone Formation; BGS 2012), the type site of which is the cliffs of the River Avon between the Bathurst Basin and Ashton Gate in the Redcliffe area of Bristol (see Fig. 1) (Green 1993, 81). Here – and also in the boreholes examined in the present project where description was of sufficient detail – the Redcliffe Sandstone Member comprises fine-medium, calcareous (although decalcified in the upper few metres) sands of a deep red colour (BGS 2012). In common with other sub-divisions of the MMG, the Redcliffe Sandstone Member formed in terrigenous (largely alluvial fan) environments of the Triassic (251-199.6my BP), a time when Britain was located within the supercontinent of Pangea and at a latitude of 10-20°N (i.e. a similar location to the Sahara desert at the present day) (Hunter and Easterbrook 2004, 96).

4.6 The modelled surface of the MMG is shown on Fig. 6. Green (1993, 81) states that the MMG has a generally flat aspect across the Bristol region, punctuation only by occasional hills of harder sandstones, i.e. strata that have been less heavily impacted by erosion than other facies. Indeed where it outcrops in section (e.g. in the cliffs of the River Avon) the MMG consists of tabular beds, which contrast markedly with the steeply angled bedding of Carboniferous rocks of the area. Thus the variations in elevation of the modelled outcrop of the MMG must reflect sculpting of the stratum by later processes such as fluvial action.

Drift geology: Avon Formation (Pleistocene gravels)

4.7 The BGS (2003) 1:50,000 map shows two superficial geological units outcropping over the lower parts of the study area; 'Tidal Flat Deposits' (discussed further under the Wentlooge Formation below) are located in the Avon and the Frome valleys, while deposits of 'River Terrace deposits 1' are found in the southern part of the Redcliffe area (between Portwall Lane and Redcliffe Way). The latter is BGS terminology for the latest of the Pleistocene fluvial terraces of the Avon valley, and as such forms part of the Avon Formation. In their classification of Quaternary

deposits of South-west England, Campbell *et al*. (1999) do not use BGS terminology for individual terraces of the River Avon and its tributaries, but rather divide the Avon Formation into three members (Table 4). 'River Terrace deposits 1' might be equated with the Bathampton Member or a younger terrace unit that has not been classified by Campbell *et al*. (1999). All of the Avon fluvial terrace deposits are thought to have formed as a result of high seasonal discharge and in periglacial climates of the Middle to Upper Pleistocene (Bates and Wenban-Smith 2006). Interglacial deposits are not known from central Bristol, but occur elsewhere in the Avon valley as palaeosols lying on the top of fluvial terraces (e.g. the Bathampton Palaeosol [Campbell *et al*. 1999]), and as floodplain deposits (e.g. Shirehampton [Bates and Wenban-Smith 2006]). The Avon Formation within central Bristol has neither been the subject of geological nor archaeological study.

Member	Elevation above River Avon	Thickness	Age
Bathampton Member	3-5m	3m	≥ MIS 6 (130ky BP+)
Stidham Member	12m	2m	MIS 8 (301-244ky BP)
Ham Green Member	30m	3-4m	> MIS 8 (>301ky BP)

Table 4. Members of the Avon Formation (data from Cambell *et al*. 1999, 76-77)

4.8 Deposits of the Avon Formation are found underlying strata of the Wentlooge Formation in many of the stratigraphic records examined during the present project, while the modelled surface elevation of the stratum varies between -3 and +8m OD (Fig. 7). Given that the present mean elevation (MHWST)[3] of the river Avon in central Bristol is +6.95m OD (Jones and Watson 1987), these data suggest that two river terraces are likely to be present within the study area: the Bathampton Member in the north-east around Castle Park (+1 to +8m OD) and north-west between St Georges and Deanery Roads (+1 to +5m od), and a younger terrace equivalent of 'River Terrace Deposits 1' elsewhere (0 to -3m OD).

4.9 A plot of the modelled thickness of the Avon Formation across the study area (Fig. 8) is suggestive of few patterns beyond a tendency for thicker deposits (>2.4m) within a band from the central and southern part of Redcliffe, Queen Square and the Canon's Marsh area. This may therefore be the main axis of the Late Pleistocene river Avon, while the thinner (1.8-1.2m) Avon Formation deposits in the northern part of Redcliffe and between Queen Square and Baldwin Street, may suggest a more marginal position. However, the greatest thickness of the Avon Formation is

[3] Mean High Water Spring Tide

associated with the Frome in the northern part of the study area (Nelson Street and Broadmead). Given the proximity of the MMG outcrop in Castle Park to the immediate south, i.e. probably a bluff between the Frome and the Avon in the Pleistocene, the gravel thickness at this point may be the result of a rapid drop in flow energy caused by the rock barrier.

4.10 Assuming that the younger terrace encountered in the boreholes dates to the end of the last glacial period (MIS2, or 25-11.5ky BP) and that following deposition it had a relatively flat aspect, variations in surface elevation (Fig. 7) must therefore be the result of Holocene processes. These were most likely dominated by channel development of the Holocene rivers. The areas with the lowest elevations are found in Redcliffe and to the north-west of Queen Square around Marsh Street and Broad Quay (-3m OD in both cases). The former suggests that the river Avon may have flowed to the south of its present course in the Redcliffe area (Fig. 24) and that the present northerly meander that characterises this part of Bristol was either absent or less pronounced in the earlier Holocene. Indeed a structural elevation model made of the surface of the Avon Formation within Redcliffe (Fig. 9) suggests that the earlier Holocene course of the River Avon may have passed through the area on a course slightly north of Mitchell Lane, while a cross section through Redcliffe (Fig. 22) also suggests the presence of a 4m depression infilled by both Avon Formation gravel and Wentlooge Formation deposits in the central and southern parts of the area. The depression in the Avon Formation in the Marsh Street/Broad Quay area might be indicative of an earlier Holocene confluence between the Avon and Frome. However, a composite cross section though the central part of the study area seems to suggest that the lower fills of the Marsh Street/Broad Quay channel were of the Avon Formation suggesting that the Late Pleistocene Frome also passed through the area (Fig. 21).

Wentlooge Formation

4.11 The Wentlooge Formation comprises intertidal strata of the Severn Estuary (both mineral and organic units) dating from the beginning of the Holocene to the construction of sea defences/formation of natural barriers to salt marsh in the Roman period (Allen and Rae 1987; Rippon 1997, 44; Gardiner *et al*. 2002, 31-2; Holbrook 2006, 117). However, because sea levels were approximately -23m OD in the Bristol Channel at the Pleistocene-Holocene transition [9500 cal. BC (11.5ky BP)] (Heyworth and Kidson 1982), Wentlooge Formation deposits in an onshore location are not found dating before c. 7100 cal. BC (i.e. 9.1ky BP) (Wilkinson *et al*.

2012). They have a maximum thickness of 17m in the Avonmouth area (Wilkinson *et al.* 2012), but Allen and Rae (1987) suggest 5-15m is more typical in other areas immediately adjacent to the Severn, while as discussed below a thickness of 2.5-7.5m is found in central Bristol. The stratotype of the Wentlooge Formation is at Rumney Great Marsh on the western shores of the River Severn and 30 km west of Bristol, while the unit only exists as a surface outcrop in the immediate vicinity of the present Severn channel (Allen and Rae 1987). However, as a buried deposit it extends beneath later alluvium and medieval/post-medieval deposits/recent Made Ground throughout the intertidal portions of tributaries of the river Severn. Thus the Wentlooge Formation is present as a subcrop across the entire study area.

4.12 The Wentlooge Formation of central Bristol has been investigated in several geoarchaeological projects over the last decade and as a result its stratigraphy and chronology is broadly understood. The deposits are discussed below, first in general terms, before a more detailed description of each unit.

4.13 A *terminus post quem* for the onset of intertidal deposition in the area is provided by two AMS ^{14}C dates. The first of *c*. 5200 cal. BC (c. 7.2ky BP)[4] from a palaeosol underlying the Wentlooge Formation at 32-36 Victoria Street in Redcliffe (Wilkinson 2008a), and a second of *c.* 4840-4460 cal. BC (*c.* 5.5ky BP) from an alder tree stump rooted into the alluvium at Canon's Marsh. The earliest Wentlooge deposits are grey laminated silts, clays and occasional sands (categorised as 'Alluvium 2' in this project). These occur across the study area except in Redcliffe where well sorted, laminated and thinly bedded medium sands to gravels are found ('Alluvium 3'). An organic stratum of between 0.2 and 1.5m thickness (collectively termed 'Peat' for the purposes this project) marks the top of the lowest Wentlooge Formation deposits (Alluvium 2), again over most of the study area except Redcliffe, on the inner edge of a meander of the river Avon, where organic strata are not found. Peats only form on the inner edge of a meander where cut off channels are found, and as such any peat in Redcliffe is likely to be very localised. The organic strata have been ^{14}C dated in several locations with the most reliable ages ranging between *c.* 4000-3200 cal. BC (c. 6-5.2ky BP) at Deanery Road[5] in the west of the study area (Wilkinson *et al*. 2002) and *c.* 4300-2600 cal. BC (6.3-4.6ky BP) at Broadmead[6] in

[4] Obtained on unidentified wood charcoal (Beta 245646, 6280±40 BP)
[5] Deanery Road AMS ^{14}C dates on bulk organic samples (Wk 10946, 4594±63 BP and Wk 10947, 5174±61 BP).
[6] Six AMS ^{14}C dates were obtained on bulk organic samples from peats at Broadmead (Beta 229909, 4080±50 BP and Beta 245642, 5430±40 BP are the youngest and oldest respectively.

the east (Wilkinson and Head 2008). As with the peat in a similar stratigraphic position at the stratotype on the west side of the Severn Estuary, the development of the intertidal and freshwater marsh associated with the organic strata indicates a constriction of the estuary and its tributaries during the Neolithic. The constriction was caused by a slow down in the rate of relative sea level rise and is characteristic of all estuaries in southern Britain – albeit that the timing varies (Long *et al*. 2000). The uppermost part of the Wentlooge Formation is relatively uniform across the whole of the projects central Bristol study area and comprises thick beds of (largely structureless) silts and clays (here termed 'Alluvium 1'). The uppermost metre of this unit is heavily iron-stained as a result of fluctuations in the water table, while post-depositional processes are also likely to be responsible for the homogenous nature of the sediments. The 'Alluvium 1' part of the Wentlooge Formation therefore formed after 3200-2600 cal. BC, but prior to reclamation of intertidal areas probably from the period of the earliest settlement of medieval Bristol *c.* AD 1000, perhaps earlier in some places such as south of Baldwin Street and the northern part of Redcliffe where a defended bridgehead is suspected.

4.14 The modelled upper contact of the Wentlooge Formation with the overlying Made Ground varies between +4.6 and +8.2m OD, and variations that appear in the model broadly correlate with present surface elevation (Fig. 10). Therefore as would be expected, higher elevations (i.e. > +7.2m OD) are associated with valley side areas in the St Georges/Deanery Roads area to the west, Lewin's Mead/Nelson Street to the north and the western part of Broadmead in the north-east of the study area. On the other hand, the modelled lowest elevations for the upper contact (<+5.6m OD) correspond to the present Avon channel in its meander around Redcliffe and the eastern part of the Broadmead area (the latter possibly a former course of the Frome). The higher resolution Structural elevation model for the top of the Wentlooge Formation in Redcliffe (Fig. 11) also shows how the lowest elevations (<4m OD) correspond to the channel-side areas, but also suggests that the unit shelves downwards quickly from heights of >+7m OD in the centre of the 'island' to <3m OD adjacent to the channel of the Avon.

4.15 The modelled thickness of the Wentlooge Formation (Fig. 12), however, correlates much less well with the present day topography and is more likely to be indicative of the location of earlier infilled watercourses. Thickness of Wentlooge Formation deposits range between 2.5 and 7.5m. The thinnest deposits (<3m) once again coincide with the valley sides in the St Georges/Deanery Road and Colston

Street/Lewin's Mead area in the west and Fairfax Street in the north (Fig. 13, but also clearly seen in cross section in Fig. 20). However, similar thin Wentlooge Formation strata are also modelled in the southern part of the study area, i.e. to the south of Queen Square, in the southern part of Redcliffe and south-east of St Philip's Bridge. In the first and last of these locations the thin Wentlooge Formation deposits lie across the present channel of the River Avon. On the other hand, the thickest outcrop (>6m) of the Wentlooge Formation is adjacent to the present Avon channel in the Harbourside/Canon's Marsh area in the south-west (Fig. 12), in a northwards projecting strip leading from this area towards Broad Quay and Marsh Street, in the northern part of the study area in the eastern part of Lewin's Mead and in the easternmost part of Broadmead (Fig. 12). It is possible that the thick deposits of the Canon's Marsh to Broad Quay/Marsh Street area might reflect the infilled channel of the pre-medieval River Frome as it came to a confluence with the Avon to the south of the Pero's Bridge area (Fig. 24). Indeed the thick Wentlooge Formation deposits at Lewin's Mead and Broadmead might also be similarly infilled parts of the Frome channel (Fig. 24).

4.16 Having examined the general properties of the Wentlooge Formation as a whole, the two defined sub-components of the unit can now be examined in an attempt to characterise internal stratigraphic variation within the Wentlooge Formation. Before commencing, however, it is worth stressing again that because of inconsistent field recording (especially in geotechnical boreholes) of the subtleties of the Wentlooge Formation, the models of individual sub-strata presented below are considered both less reliable and of a lower resolution than those presented above.

Alluvium 3

4.17 As noted above, records containing Alluvium 3 are only found in the Redcliffe area and where they are likely to have formed on a large point bar (i.e. sands and gravels forming on the inner bend of a meander; Miall 1996, 155-163) as the Avon meander north of Redcliffe became ever more exaggerated. Radiocarbon dating of the base and near base of Alluvium 3 has suggested that the point bar began to form soon after 3400 cal. BC (5.4ky BP) and was still forming at 1450 cal. BC[7], but no chronological information has so far been obtained from the top of the stratum and it is therefore unclear when channel deposition ceased (Wilkinson 2008b, 2009). Nevertheless the early 12th-century deposits that characterise much of Redcliffe and

which lie on top of deposits attributed to Alluvium 1 provide a *terminus ante quem* for Alluvium 3.

4.18 A Structural elevation model suggests that the surface of Alluvium 3 (Fig. 13) slopes downwards from +4m OD in the north-west part of the Redcliffe study area to -2.5m OD in the south-west. The greatest thickness of the stratum (>5m) would appear to be from the northern and southern parts of the area and the thinnest from central and riverside parts of the island. This pattern is further illustrated in a north-south cross section through Redcliffe in which the surface outcrop elevation drops in a southerly direction from +4m OD in Geo VS2 BH2 to +2m OD in Geo ML WSP BH8 (Fig. 22). A west to east cross section both demonstrates the thinness of Alluvium 3 in proximity to the Avon channel on the western side of Redcliffe, but also how surface elevation is -3 to -4m OD compared to +2 to +4m in the interior of the meander (Fig. 21). Nevertheless interpretation cannot be too detailed as only 22 stratigraphic records include Alluvium 3 (cf 219 records for all of Redcliffe), all of which are from the ARCA database. Indeed only four ARCA records (all from the south-western extremity of the Redcliffe study area where Alluvium 3 is either thin or absent) south of the present Avon channel lack Alluvium 3. Furthermore Alluvium 3 outcrops no closer that 2.7m from the ground surface, while in 15 of the records the upper surface of the stratum is >5m below ground surface. In other words Alluvium 3 is likely to be significantly under represented in the records because it has (a.) not been differentiated from other components of the Wentlooge Formation in the geotechnical record, and (b.) outcrops at too great a depth to be encountered in archaeological trenches.

Alluvium 2

4.19 Alluvium 2 is a somewhat artificial sub-division given that the stratum is only recorded when the Peat outcrops and in such situations it is defined as the alluvial/intertidal deposits that underlie the latter (see Fig. 14 for the distribution of records containing Peat and therefore Alluvium 2). Nevertheless where investigated in geoarchaeological boreholes, Alluvium 2 appears rather better bedded (i.e. superior preservation of bedding structures and lamination) than Alluvium 1, has not been subject to the same degree of post-deposition modification than the latter, and contains thin beds (and more frequently, laminae) of organic sediment. Given that Alluvium 2 always underlies the Peat, *terminae ante quem* are provided by dates on

[7] AMS ^{14}C dates on unidentified charcoal from 1-2 Redcliffe Street (Beta 245645, 4720±40 BP) and

the peat (see below), meaning that it must have formed prior to 6000 cal. BC in the Canon's Marsh area (and possibly in the former Frome valley at least as far as Broad Quay – see below), and 4000 cal. BC at higher elevations on the side of the Avon and Frome valleys (e.g. Deanery Road and Broadmead).

Peat

4.20 As has already been discussed, the intra Wentlooge Formation organic stratum in central Bristol is a Middle Holocene phenomenon associated with estuary contraction. Where microbiological analysis has taken place at Deanery Road and Broadmead, the peat has been interpreted as having formed in freshwater alder carr, although at the former site there appears to be some evidence for the ingress of saline waters towards the top of the stratum (Wilkinson *et al*. 2002, Wilkinson and Head 2008). The microbiology of organic strata from the Harbourside site on Canon's Marsh has also been studied and is suggestive of accretion in partially saline environments and on an emergent saltmarsh at 6100-5600 cal. BC[8] (Wilkinson and Tinsley 2005). Thus the central Bristol organic stratum of the Wentlooge Formation formed in a time transgressive manner, initially in the Late Mesolithic in the lower lying valley areas in saltmarsh environments and later during the Neolithic on the valley flanks within freshwater backswamp environments.

4.21 A Structural elevation model for the Peat (Fig. 14) shows that the surface outcrop of the stratum varies between -1 and +5.5m OD. However, the lowest of these values are largely the result of a single data point where organic strata have been recorded at -2.52m OD on the Huller House site in Redcliffe. Further examination of this record demonstrates that the organic strata are present as *Mytilus*-containing interstitial fills within gravels, and may not therefore be comparable to the Peat as found elsewhere in central Bristol. Otherwise the lowest outcropping Peat (0 to +1m OD) comprises 0.2-0.4m-thick organic strata recorded in geotechnical boreholes between Baldwin and King Streets in the central part of the study area (CELx72x098BHA, HER3263BHB, HER3262BH3 and ST57SE127). The next group of records have Peat surface outcrops of +1 to +3m OD, and are found adjacent to the Avon at Canon's Marsh/Harbourside and Deanery Road in the south-western part of the study area, at Broad Quay and on the southern part of Broadmead in the

32-36 Victoria Street (Wk 25623, 3208±31 BP)

[8] AMS 14C dates on bulk organics (Wk 16707, 6694±39 BP and Wk 16708, 7287±42 BP), but there is some indication from comparison of the palynological data with those from the wider region that the 14C chronology is too early and therefore that the samples have been contaminated by petroleum seepage from former gas tanks of the site.

north east. Finally further organic strata are found at elevations of >+3m OD on the sides of the Avon valley in the Canon's Marsh area in the south-west and possibly adjacent to the former Frome channel in the northern part of Broadmead. Given this grouping, the data from previous geoarchaeological studies reviewed above and the composite cross section through the south-western part of the study area (Fig. 20), a possible model to explain this pattern would see the lowest peats in the Baldwin/King Street and Canon's Marsh/Broad Quay and southern Broadmead areas associated with the emergence of saltmarsh during a slow down in relative sea level rise in the later Mesolithic. The higher elevation organic strata on the valley sides on the other hand formed rather later and during the Neolithic, probably in freshwater backswamp environments.

Archaeological Strata 3

4.22 As defined in Table 2, strata ascribed to Archaeological Strata 3 contain evidence of human activity and occur within or below the Wentlooge Formation (i.e. separated from Made Ground by Alluvium 1). Given the medieval *terminus ante quem* for the Wentlooge Formation (see above), Archaeological Strata 3 strata must be of medieval age or earlier. In practice there are only two occurrences of the stratum, both of which are recorded in geoarchaeological boreholes (strata description is too general in geotechnical boreholes to distinguish archaeological levels within the Wentlooge Formation, while archaeological trenches do not penetrate sufficiently deep into the unit to reach such layers). The earliest of the records is from 32-36 Victoria Street in Redcliffe (Geo VS BH1) and has already been mentioned above as providing a *terminus post quem* for the Wentlooge Formation. Here wood charcoal was found associated with a palaeosol at a depth of 9.97m BGL (-2.47m OD) and which was dated to the Late Mesolithic (Wilkinson 2008a). The second occurrence of Archaeological Strata 3 is from the Broadmead Development (Geo BM BH5) where tile fragments were found within the Wentlooge Formation at 7.54m BGL (+1.95m OD) (Wilkinson and Head 2007). Contamination is unlikely given the number of ceramic pieces found and their isolated occurrence within intertidal silts in the centre of a 1m long core, and thus a Romano-British date is likely. Indirect evidence for human activity within the Wentlooge Formation is provided by peaks in microscopic charcoal and enhanced low frequency magnetic susceptibility readings from the Neolithic peat strata at Deanery Road (Wilkinson and Tinsley 2002). These latter data are indicative of burning events in the catchment and therefore possibly of human manipulation of vegetation.

Alluvium 1

4.23 'Alluvium 1' is an artificial construct given that it is defined as Wentlooge Formation deposits overlying Peat, Alluvium 3 or Archaeological Strata 3 (Table 2). In other words where any of the latter strata are present, Alluvium 1 will tend to be thinner and vice versa (e.g. see Fig. 22 for an example in Redcliffe). Furthermore for the same reason initiation of the deposition of Alluvium 1 must have been diachronous, although sedimentation is more likely to have ceased at a broadly similar date. Nevertheless, freshwater organic strata (one component of the 'Peat') and Archaeological Strata 3 are most likely to occur at the floodplain edge. Alluvium 3 is characteristic of point bars at the inner edge of a channel and intertidal organic layers (the other 'Peat' component) are located on upper saltmarsh. Therefore thick deposits of Alluvium 1 are arguably indicative of former channel locations. Fig. 15 demonstrates that the thickest Alluvium 1 sequences (>5m) are found in Canon's Marsh (adjacent to the present Avon), Broad Quay (as discussed above, on the proposed pre-medieval course of the Frome) and the eastern part of Broadmead (again possibly coincident with the channel of a pre-medieval Frome). On the other hand the thinnest sequences (<3.5m) coincide with the Cabot Circus/Deanery Road area on the northern flank of the Avon valley (Fig. 15) and Redcliffe. The latter is located adjacent to the present Avon meander, but as stated above Alluvium 1 deposits sit above thick sequences of point bar sediments (Alluvium 3). Indeed in this location Alluvium 1 can only have begun to form once the Avon had adopted its present course and it must therefore post date 1450 cal. BC (3.45ky BP) (Wilkinson 2009).

Made Ground

4.24 The uppermost unit of the stratigraphic sequence in central Bristol is Made Ground. The British Geological Survey (2012) use this term to describe any deposits that have been deliberately emplaced by people and therefore archaeological strata are included within the definition. Unlike deposits accumulating as a result of the fluvial and intertidal processes previously reviewed, the transporting mechanism of deposited sediments does not follow natural geomorphological/geological laws. The result is that neither the loci nor the thickness of these deposits are predictable using geological principles, but rather a knowledge of the historical development of a study area is a better predictor for the location of Made Ground.

4.25 A plot of the modelled thickness of Made Ground across the study area indicates variation between 5.2 and 1.6m (Fig. 16). However, it should be stressed that the

model is probably less reliable than the Stratigraphic thickness models previously reviewed as some archaeological and rather more geoarchaeological records do not commence from the ground surface, but rather from the base of the Made Ground. It is therefore likely that in some locations the model has underestimated the thickness of Made Ground. Nevertheless this problem is not particular to any one area within the study area, while it does not affect the geotechnical records, and therefore the relative (if not absolute) modelled thickness of the Made Ground is likely to be more or less correct. Somewhat surprisingly the greatest thicknesses of Made Ground (>4m) do not occur in the lowest lying parts of the study area (e.g. Canon's Marsh in the south-west and B road Quay in the centre) but rather on the valley sides (Deanery Road in the south-west), adjacent to the channel of the Redcliffe meander of the Avon and particularly in the eastern part of Broadmead in the north-east. A possible explanation for this pattern is therefore that the thickness of Made Ground reflects the intensity of development in flood-prone areas since the Middle Ages (but particularly in the post-medieval and modern periods). The converse may also be true, in other words that Canon's Marsh has seen low intensity use until the most recent of times. Nevertheless, the thinness of Made Ground deposits in the Broad Quay area are not explained by this hypothesis as in this area activity has been continuous since the medieval period during which time there have been several phases of construction and dem olition. Except for the channel-side areas, the Redcliffe area is also characterised by a thin (<2.4m) Made Ground cover despite a history of development since the Middle Ages. However, in this case it is possible that prior to the Middle Ages the deposition of thick and r elatively solid point bar (Alluvium 3) and floodplain (Alluvium 1) deposits on the inner bend of the meander had raised the area above the level at which major flooding would take place. As a result there was no need to bring in new sediment to raise ground levels.

4.26 As was noted in the Methodology section above, archaeological deposits (here defined as strata of human origin predating AD 1800) are difficult to separate in many stratigraphic records from those deliberately deposited in recent times. In geotechnical borehole logs it is almost never possible to reliably distinguish between the two strata, while in geoarchaeological borehole logs separation relies on the accurate attribution of ceramic inclusions (and the absence of modern indicators such as coal, asbestos, concrete etc) to the medieval/post-medieval or modern periods. Only in stratigraphy recorded in archaeological trenches can archaeological strata be reliably distinguished from modern Made Ground. As was explained in the Methodology, archaeological deposits noted in the stratigraphic records from the

Made Ground were split into two categories: Archaeological Strata 1 are strata pre-dating AD 1800, but which are not waterlogged, while Archaeological Strata 2 are the same, but which contain preserved organic material (discounting bone) or are otherwise noted as archaeological waterlogged deposits.

Proto-urban deposits

4.27 Occurring at the surface of the Wentlooge formation/the base of the made ground, proto-urban layers were identified in a small number of locations, to the south-west of Bristol Bridge, at Queens Square and in the eastern part of Redcliffe. Within Redcliffe these were defined as disturbed ('trampled') alluvial deposits at the top of the Wentlooge Formation, although to the south-west of Bristol Bridge proto-urban deposits associted with marsh-type conditions at the top of the Wentlooge were recorded. The identified proto-urban deposits were not extensive enough to generate any useful surface model or elevation plot. Proto-urban deposits may be present elsewhere in the study area in the lowest deposits recorded as Archaeological Strata 2 on other sites, while organic layers at the surface of the Wentlooge Formation might also be classified as Proto-urban strata.

Archaeological Strata 2 (waterlogged deposits)

4.28 A total of 129 records from across most of the study area contain Archaeological Strata 2 - although it is very unlikely that it is a single continuous stratum (Fig. 17). The identification of Archaeological Strata 2 was dependent on having a sufficient level of information within archaeological reports; it has not been possible to identify Archaeological Strata 2 within boreholes, while there is also some potential for Archaeological Strata 2 to exist within records recorded as Archaeological Strata 1. However, as one of the primary aims of the project was to identify waterlogged archaeological deposits, it was considered important to attempt to identify this layer where possible.

4.29 Despite the limitations of the Archaeological Strata 2 dataset a number of conclusions can be reached from the available data on the basis of its elevation and thickness. The surface of the unit (Fig. 17) varies in elevation between +7.8 and +6.3m OD, with the highest outcrops (> +7.5m OD) coinciding with the Canon's Marsh and Cabot Circus area in the south-west and north-east and the lowest (<+7.0m OD) in the channel-side areas of Redcliffe (particularly around Temple Back) and Broad Quay in the centre of the study area. It is possible that surface elevation in this instance may correlate with age, i.e. where the outcrop of

Archaeological Strata 2 is higher as in the south-west, it is later (i.e. less subject to compression from later deposits). The thickness of the stratum appears to broadly correlate with that of the Made Ground as a whole with >3m occurring in channel-side areas in Redcliffe (between Redcliff Backs and Redcliff Street, immediately south-east of Bristol Bridge and north-east of Temple Back). Slightly thinner (1.5-3.0m) deposits are found on the western side of the Redcliffe meander along Welsh Back, between Lewin's Mead and Colston Street in the north, at Canon's Marsh in the south-west and Broadmead in the north-east. Elsewhere Archaeological Strata 2 is present in thicknesses of <1.5m in the Deanery Road and Canon's Marsh area in the south-west, Broad Quay and Fairfax Street in the centre and in some central parts of Redcliffe in the south-east. The greatest thicknesses therefore unsurprisingly coincide with medieval and post-medieval waterfronts in Redcliffe and to a lesser extent Welsh Back, while lesser thicknesses of waterlogged archaeological deposits are also found in other areas adjacent to the Avon and Frome where medieval occupation took place. Archaeological Strata 2 are only apparently missing (despite the model of Fig. 17 indicating otherwise) from the very centre of Redcliffe and the block in the centre of the study area demarcated by Baldwin, Queen Charlotte, King and Marsh Streets. The absence of Archaeological Strata 2 recorded east of Broad Quay could be taken to suggest that waterfront activity is not present in this last named area. However, the majority of records in this area are associated with boreholes, and it is possible that Archaeological Strata 2 was present but not identified.

Archaeological Strata 1 (not waterlogged)

4.30 Records containing Archaeological Strata 1 occur across the entire study area (241 of the 502 records include the stratum) and at elevations of between +13.5 and +7.5m OD (Fig. 18). As with Archaeological Strata 2, the identification of Archaeological Strata 1 was dependent on sufficient information indicating an archaeological origin in the stratigraphic records. It is generally not possible to identify Archaeological Strata within boreholes.

4.31 The highest outcrop elevations (>+11m OD) are modelled in the Deanery Road area in the south-west and a second area associated with a single (possibly inaccurate) record (ST57SE259) between Tower Hill and Jacob Street. Intermediate outcrop elevations (+11 to +9m OD) of Archaeological Strata 1 are found in the Broadmead area in the north-east and on Canon's Marsh in the south-west, while across the central and south-east part of the study area the stratum outcrops at <+9m OD.

Some relationship exists between outcrop height and proximity to river channels in the central part of the study area as the lowest elevations are modelled in/adjacent to the former Frome channel near Broad Quay and close to the western side of the Redcliffe meander. On the other hand the relationship between the thickness of Archaeological Strata 1 and the proximity of river channels should be less than for the waterlogged deposits of Archaeological Strata 2 (although allowing for the fact that Archaeological Strata 1 may contain unidenfied Archaeological Strata 2). To a certain extent this prediction appears correct and thick (>3m) deposits of the former are found in the Deanery Road area and between Fairfax and Nelson Streets in the north. However, elsewhere thick deposits of Archaeological Strata 1 do occur next to river channels (either current, or hypothetical ancient courses), notably at Canon's Marsh, south of Redcliff Bridge, on Redcliff Backs, east of Temple Backs and in the eastern part of Broadmead. Thus, as Fig. 19 demonstrates the Redcliffe meander is a focus for thick deposits of both Archaeological Strata 1 and 2 (>3m along almost entire course and increasing to >4.5m east of Temple Back), as is the eastern part of Broadmead (>3.5m). The other area with modelled Archaeological Strata 1 and 2 of >4.5m thickness is Deanery Road/Cabot Circus, while Canon's Marsh, Broad Quay and central Redcliffe are modelled as having <2m of Archaeological Strata 1 and 2.

5. ARCHAEOLOGICAL SIGNIFICANCE OF WATERLOGGED DEPOSITS IN BRISTOL

5.1 In theory archaeological waterlogged deposits within the study area could exist in any stratum from the base of Archaeological Stratum 1 (i.e. non-waterlogged archaeological deposits) to the upper contact of the Avon Formation (or where that does not exist at a particular location, the upper contact of the Mercia Mudstone Group) given that preserved waterlogged plant remains have been found in all intervening units. However, waterlogged deposits that are most likely to contain archaeological remains are more likely to occur at the top of this sequence. The text below, therefore, reviews the likelihood of waterlogged archaeological remains being found in the relevant strata and the potential importance of such remains. Table 5 summarises the assessment made of each stratum.

Identification of layers with the greatest potential for waterlogged remains

Wentlooge Formation

5.2 Alluvium 3 is found only in Redcliffe and most likely formed on a point bar that developed on the inner (southern) side of the Redcliffe meander from 3400 cal. BC to at least 1450 cal. BC. Despite the fact that organic lenses have been found in the unit (e.g. at 32-36 Victoria Street; Wilkinson 2009), it is overwhelmingly dominated by bedded sands and silts that are characteristic of deposition in moderately high energy fluvial situations. *In situ* human activity in such environments is unlikely given the water velocity and its likely permanence, although reworked materials might be deposited. It is, however, possible that organic-rich deposits containing indirect evidence of human activity (e.g. pollen and plant macrofossil evidence for human manipulation of local and regional vegetation, sedimentological and microscopic charcoal indications of burning) might exist in infilled chute channels. However, predicting the location of the latter fills is not possible given the depth at which Alluvium 3 is buried by later deposits and the low resolution afforded by the present stratigraphic records. In summary, waterlogged archaeological residues are unlikely in Alluvium 3 and if they were found they would likely be *ex situ*. Indirect waterlogged evidence for human activity in the stratum is likely to be rare, but of potential significance in reconstructing human manipulation of the Prehistoric landscape of the lower Avon and Frome valleys.

5.3 Alluvium 2 is an artificial construct being recorded only beneath Peat outcrops. Given the chronology of the Peat, Alluvium 2 dates from before 4000 cal. BC and is therefore most likely to be an Early Neolithic and Late Mesolithic phenomenon. Bioarchaeological evidence from Deanery Road and Harbourside suggest that Alluvium 2 accumulated in intertidal waters and most likely on mud flats (Wilkinson *et al*. 2002, Wilkinson and Tinsley 2005). Such environments are unlikely to have been intensively exploited by people except during episodes when sedimentation outstripped the rate of sea level rise and when mud flats were emergent (the Mesolithic site of Goldcliff on the western side of the Severn is an example of this phenomenon; Bell *et al*. 2000). Therefore although likely to be rare, waterlogged archaeological remains in Alluvium 2 might be of great significance. However, Alluvium 2 is deeply buried by later sediments (never outcropping closer than 4m to the ground surface), and predicting the location of those parts of the stratum that might contain preserved waterlogged archaeological residues is not possible with the resolution of the stratigraphic record that is presently available. Indeed even was it possible to estimate where such sites might exist, logistical constraints (depth of burial and the high water table) mean that they could not be investigated by trenching. Indirect evidence for human activity (as defined for Alluvium 3 above) is likely to be more commonplace than *in situ* waterlogged artefacts and is found in the thin organic layers that form as mud flats emerge above the level of all except the highest tides (as for example at Harbourside; Wilkinson and Tinsley 2005). Such strata are likely to be present wherever Alluvium 2 is found.

5.4 Peat of inferred Late Mesolithic date is present as a thin outcrop in the Canon's Marsh to Broad Quay area and is thought to have formed in an emergent saltmarsh environment (Wilkinson and Tinsley 2005). Such deposits might have been exploited by Mesolithic hunter gatherers as was discussed for Alluvium 2, but the residues of such activity are likely to be rare, albeit of potentially high importance. While the Peat is a relatively easily detected stratum, albeit only in borehole records as it is deeply buried, the location of archaeological remains within it cannot be predicted (they have not been noted in any of the boreholes that have so far penetrated the unit). Neolithic Peat formed at high elevations on the north bank of the Avon at Deanery Road and is also present in putative backswamps in the Frome valley at Broadmead. Unlike the lower, Mesolithic peat, bioarchaeological data suggest that the Neolithic peat formed in freshwater alder carr (Wilkinson *et al*. 2002, Wilkinson and Head 2008). Human activity in such environments during the Neolithic is attested from localities such as the Somerset Levels (e.g. Coles and Coles 1988)

and East London (Crockett *et al*. 2002), but it would seem that the intention of people in these locations was to cross the marsh by way of trackways rather than to dwell within it. Thus Neolithic waterlogged residues might be present within the Peat, but they are likely to be rare and – given the thickness of the overlying strata – difficult to predict/detect and investigate. Indirect evidence of human activity in both Mesolithic and Neolithic peats is demonstrated by previous investigations at Harbourside, Deanery Road and Broadmead, where preserved microbiological and sedimentological evidence suggests human manipulation of the vegetation and burning (Wilkinson *et al*. 2002, Wilkinson and Tinsley 2005, Wilkinson and Head 2008).

5.5 Alluvium 1 is a primarily mineral stratum that accumulated following the inundation of the Peat or change in the riverine environment around the Redcliffe meander. It seems to have formed in both fluvial (floodplain) and i ntertidal (mudflat) environments since the Neolithic (where overlying the Peat) and,Bronze Age (where it overlies Alluvium 3) or later. Organic lenses have been found within the stratum (for example at Broadmead), while when originally deposited it must have possessed bedding structures. However, subsequent post-depositional processes have homogenised the unit and in many areas, water table fluctuations within its top have caused oxidation of iron minerals. Archaeological evidence within Alluvium 1 has been found (although there is no organic preservation) on the Broadmead site in a single geoarchaeological borehole, but otherwise the only evidence for human activity is indirect from microbiological examination of thin organic layers (Wilkinson and Head 2007). The accumulation of Alluvium 1 sediments predominantly on mud flat environments suggests that *in situ* evidence for human activity within the stratum is likely to be rare as this is not an environment habitually exploited by people. Even where archaeological evidence is present (as at Broadmead), organic preservation cannot be assumed as vertical movements of the water table may have led to the oxidation of such material. Unfortunately the location of archaeological residues cannot easily be predicted, especially given that organic layers indicative of the emergence of mud flats are so rare, but at least the upper part of Alluvium 1 can be investigated using standard archaeological techniques where the overlying Made Ground is thin.

Made Ground

5.6 By definition deposits attributed to Archaeological Strata 2 are both waterlogged and contain organic archaeological materials. As previously discussed Archaeological

Strata 2 dates from the medieval and post-medieval periods, while the thickest outcrops are associated with waterfront areas of the Redcliffe meander. Moderate thicknesses of the stratum are also found in the Cabot Circus area and also associated with the Frome in the Lewin's Mead and Broadmead areas. Thinner Archaeological Strata 2 deposits are found elsewhere within the former medieval city, but the stratum appears to be absent from the centre of Redcliffe. *In situ* preserved biological material that is indicative of past human activity is likely in all locations where Archaeological Strata 2 is present and is of potentially high importance wherever found. Indirect evidence for human action will also be preserved where the stratum is encountered, but is of arguably lesser importance given the difficulties in determining the source of the biological remains and the effects of site formation and modification processes. Proto-urban deposits, associated with trampled alluvial deposits and marsh-type conditions, occur at the surface of the Wentlooge Formation and the base of the Made Ground, and may form an unidentified part of Archaeological Strata 2 in some locations. As with Archaeological Strata 2 the stratum may include *in situ* or indirect evidence for human activity. Given its potential to provide information on the development of medieval Bristol it is of similar importance to Archaeological Strata 2.

Findspots

5.7 In addition to the Archaeological Strata 2 data designed for use in Rockworks, the project also captured findspot data relating to waterlogged material, including data points for the location of former inlets and river walls. These finds comprise material, which by their nature, are associated with Archaeological Strata 2. Analysis of their distribution did not serve to extend the discussion of Archaeological Strata 2, as presented above, as they show only the location of the targeted archaeological works assessed during the project. Where channels have been identified, these are site-specific and adjacent to the existing watercourses, i.e. in areas that would already have been identified as of high potential. While certain sites may be cited as good examples of waterlogged preservation, such as the presence of preserved timbers and leather at St Batholomew's Hospital, these do not, at the level of data captured for the project, allow for wider models to be produced or conclusions reached. However, the identified find spots provide a useful summary of key sites/finds, and may be suitable for integration into the BCCHER. A more detailed discussion of the finds is included in Appendix A.

Summary

5.8 The likelihood and potential significance of waterlogged material is summarised in Table 5 below.

Stratum	Direct archaeological evidence		Indirect archaeological evidence	
	Likelihood	Importance	Likelihood	Importance
Alluvium 3	Low	Low	Low	Moderate
Alluvium 2	Low	High	High	Moderate
Peat	Low	High	High	High
Alluvium 1	Low	Moderate	Moderate	Moderate
Archaeological Strata 2	High	High	High	Moderate

Table 5. Summary assessments of potentially waterlogged strata in central Bristol

6. SUMMARY OF RESULTS

6.1 This section provides a summary of the main results of the project. Due to the limitations of the dataset, these are presented as hypotheses rather than conclusions. Several hypotheses have been developed on the basis of the modelled stratigraphic data. The project has considered deposits containing medieval/post-medieval waterlogged remains as well as underlying strata extending to the solid geology. As a result it has been possible to discuss many different aspects of Bristol's archaeology and Quaternary geology not previously considered using such a broad stratigraphic dataset. The hypotheses presented below fall under three main headings: the thickness and depth of medieval/post-medieval waterlogged archaeological deposits; waterlogged archaeological remains within the Wentlooge Formation; and developing a greater understanding of former water courses. In many cases these hypotheses require or would benefit from testing by further archaeological/geoarchaeological works. Possible future research objectives, leading on from the hypotheses, are given in Section 6.

Thickness and depth of waterlogged archaeological deposits

Hypothesis 1: Archaeological Strata 2 is thickest adjacent to waterfront areas

6.2 The models indicate that waterlogged deposits of Archaeological Strata 2 occur in the greatest thickness in former and present waterfront areas. The greatest thickness of Archaeological Strata 2 coincides with the known medieval/post-medieval waterfront in Redcliffe. It is speculated that these are largely associated with medieval revetments and other waterside structures (Jones and Watson 1987).

Hypothesis 2: The surface of Archaeological Strata 2 is highest in areas of later occupation

6.3 The models suggest that the surface elevation of Archaeological Strata 2 correlates with chronology, i.e. the surface of Archaeological Strata 2 is highest where occupation was late. The highest outcrop is located in the Canon's Marsh area, thought to be the latest of the stratum to accumulate. The lowest are encountered in the channel-side areas of Redcliffe (particularly around Temple Back) and Broad Quay in the centre of the study area, thought to be earlier depositions. This variation in surface elevation may be associated with compression. I.e. areas of later deposition have been subject to less compression.

Hypothesis 3: Archaeological deposits are thinner in areas of later activity

6.4 The areas with the least thick archaeological stratigraphy (e.g. Canon's Marsh, Broad Quay and the central part of Redcliffe), are those where medieval/post-medieval activity has been the least intense (i.e. either activity commences relatively late or structures are utilised for a greater length of time than elsewhere) within the study area.

Hypothesis 4: The thickness of Made Ground corresponds with the thickness of Archaeological Strata

6.5 The thickness of Made Ground as a whole, i.e. all deposits above the Wentlooge Formation, appears to be associated with the intensity of development. The thickness of Archaeological Strata, including Archaeological Strata 2, corresponds with the thickness of Made Ground overall. Therefore thick deposits of Made Ground are also likely to be associated with thick deposits of Archaeological Strata 2.

Hypothesis 5: the model requires refinement in certain key areas

6.6 In several areas of medieval Bristol where people undoubtedly lived and worked, Archaeological Strata 2 appears to only be present in thin/isolated pockets, for example around Broad Quay, Fairfax Street, and in the central parts of Redcliffe. The apparent absence of Archaeological Strata 2 in the area defined by Baldwin, Queen Charlotte, King and Marsh Streets may reflect a lack of archaeological investigation in this area (stratigraphic records are mainly associated with boreholes).

Understanding former water courses

6.7 The hypotheses above suggest that waterlogged archaeological deposits are likely to be thickest adjacent to former water channels. Therefore the location of former waterchannels is a key indicator of waterlogged deposits (Fig. 24).

Hypothesis 6: The surface and thickness of the Avon Formation, and the surface of the Mercia Mudstone Group indicates the location of former river courses

6.8 Variations in the surface of the Mercia Mudstone Group (Fig. 6) reflect sculpting of this stratum by later processes. Surface elevation of the Avon Formation (Fig. 7) is similarly thought to be a result of Holocene processes, most likely dominated by channel development of Holocene rivers. Therefore lower elevations of the MMG/Avon Formation may indicate the presence of now-abandoned channels. Thick deposits of Avon Formation (Fig. 8) may also be used to infer the development

of former channels. Consequently the former channel of the Frome at Broad Quay (Fig. 24) seems to have been active both during the Late Pleistocene (as attested by thick Avon Formation infilling gravels at Broad Quay) and in the pre-medieval Holocene (see below).

Hypothesis 7: The thickness of the Wentlooge Formation can indicate the location of pre-medieval river channels

6.9 The pre-medieval river channels can also be seen in the thickness of the Wentlooge Formation. Thus the confluence of the Frome and the Avon appears to have been to the south of the @Bristol/Pero's Bridge area prior to medieval canalisation, while the Frome channel extended north from this point to Broad Quay/Marsh Street, disappears to the north of the study area (that is to say, cannot be reconstructed on the basis of existing stratigraphic data) and then re-emerges at Broadmead (Fig. 24). There is also a suggestion, in the thickness of the Wentlooge Formation, of a channel extending east from Broad Quay into the centre of the peninsula, north of King Street, the western part of the putative pre-1240 course of the Frome (Figs. 3 and 12). Thick Wentlooge Formation deposits at Lewins Mead and Broadmead may also be associated with the Frome.

6.10 The presence of only thin Wentlooge Formation deposits in areas previously thought to be abandoned channels need to be further explored. For instance, thin Wentlooge Formation deposits are found to the east of Broad Quay and yet this area has been suggested as a possible former course of the Frome (for example, as early as 1480 by William Worcestre, who describes Baldwin Street as '*the street in which 'the river Frome flowed in ancient times*' (Neale (ed), 2000, item 358)). The data as reviewed, which needs further investigation, may be taken to suggest that either the former channel was not east of Broad Quay, or that it occupied such a location for a comparatively short period of time.

Hypothesis 8: Alluvium 3 deposits in Redcliffe provide information on a former meander of the Avon

6.11 The Redcliffe area is underlain by point bar deposits (Alluvium 3) that formed as the Avon meander in this location migrated northwards from a Late Pleistocene location in the southern part of the area. The exaggeration of the meander was still underway in the Middle Bronze Age (c 1450 cal. BC), but it is unclear when it ceased (although certainly before the medieval period). Accretion of bedded sands on the point bar, and later floodplain alluvium in the central part of Redcliffe raised ground levels

above that inundated by regular floods. Subsequent floodplain deposits are relatively thin in central Redcliffe because of the comparative rarity of flooding – in part as a result of the construction of revetments for flood defence.

The pre-medieval Quaternary deposits

6.12 Strata containing remains preserved by waterlogging clearly exist below the medieval archaeological layers, but few archaeological trenches have extended sufficiently deep to penetrate them. The potential importance of archaeological deposits of the Wentlooge Formation is attested in areas closer to the Severn Estuary. In central Bristol, evidence from geoarchaeological boreholes demonstrates that archaeological artefacts (e.g. pottery at Broadmead) and other residues indicative of human activity (e.g. charcoal at 32-36 Victoria Street) do exist within these deposits. Moreover, microbiological investigations of organic strata within the pre-medieval sequence demonstrate human activity in the wider region during the Neolithic period. In other words the Wentlooge Formation deposits that lie below Bristol's medieval layers are of potential archaeological importance and require careful consideration prior to disturbance by development. However, these deposits often occur at substantial depth and are therefore not easily investigated using conventional archaeological techniques.

<u>Hypothesis 9: The location of peat strata of Mesolithic and Neolithic date</u>

6.13 There are two Peat strata, one of Late Mesolithic date that formed on saltmarsh in the Canon's Marsh area and along the reconstructed Frome valley to Broad Quay, and a second of Neolithic date that outcrops at higher elevations in the Deanery Road area in the Avon valley and at Broadmead in the Frome valley, and which formed in fresh water alder carr.

7. FUTURE RESEARCH OBJECTIVES

7.1 Identified research aims fall into four main categories: improved data standards for future research; geographical areas to be targeted for future research; potential for additional information to be generated from existing data; and future model generation. Each of these areas are discussed below, with specific research objectives highlighted.

Improved standards for future research

7.2 The project has produced a number of surface and stratigraphic thickness models for the study area, but these are of variable spatial quality as a result of the irregular distribution of stratigraphic records. In order that future archaeological work carried out in Bristol can be used to enhance the resolution of the models by contributing further high quality stratigraphic data the following recommendations are made:

Recommendation 1: Depth of archaeological investigations

7.3 Intrusive archaeological investigations should penetrate beyond the base of the archaeological stratigraphy and ideally to the pre-Quaternary substrate, while also recording strata in an objective and geologically consistent manner. Where necessary archaeologists should demonstrate and record the outcrop of underlying alluvial and intertidal deposits by drilling through the base of their excavations using either manual or powered augers. The archaeological and pre-archaeological deposits should be classified using the descriptors used in Table 2 and a table included in an excel table submitted to BCC providing the easting, northings and elevation (in m OD) of the stratigraphic record and the depths of the upper and lower contacts of each stratigraphic unit (i.e. Made Ground, Archaeological Strata 1, Archaeological Strata 2, Alluvium 1, Peat etc). A summary of these requirements, suitable for dissemination to archaeological contractors, is included in Appendix B.

Recommendation 2: Analysis of geotechnical boreholes

7.4 An archaeologist with geological competence should study all geotechnical borehole logs relating to any development where archaeological investigation is also a part (ideally they should log the cores alongside the geotechnical engineer). As well as using the logs to interpret the stratigraphy of the site for the purpose of planning the archaeological investigation and interpreting the archaeological record, the archaeologist should also ascribe logged strata to the stratigraphic categories

outlined in Table 2 and then present those data in an appendix to the archaeological report as described in Recommendation 1.

Recommendation 3: Identification of Archaeological Strata 2

7.5 The project has of necessity been limited by the quality of the data sources. The variable nature of archaeological records hinders the consistency of modelling of archaeological strata across the study area. Future recording of Archaeological Strata 2 should be carried out in a uniform and consistent manner, using standardised morphological descriptions and observations by specialists for the presence of anthropogenic indicators (especially artefacts surviving as a result of waterlogged or semi-waterlogged conditions, linked to the survival of palaeoenvironmental data - plant macrofossils, insects, pollen, etc).

Recommendation 4: dating Wentlooge deposits

7.6 While the chronology of the archaeological strata at the top of the Holocene sequence is known because archaeological trenches commonly penetrate such deposits, that of the underlying layers is not. Nevertheless the underlying deposits *are* of archaeological importance, not necessarily because archaeological artefacts or features are likely to be present (see Section 4), but rather because knowledge of the genesis of these alluvial and intertidal deposits can aid archaeological interpretation, particularly with regards to the prehistoric and Roman periods. For example the thickness of the Wentlooge Formation has been used to argue for the location of the pre-medieval Frome river channel, while the microbiology of organic strata at Harbourside, Deanery Road and Broadmead demonstrates the activities of Neolithic/Bronze Age populations in clearing and burning woodland in the wider landscape. However, in order to improve such interpretations it is important that the pre-archaeological units are firstly dated - which given the lack of artefacts within them must be by chronometric means - and secondly explored using microbiological approaches. It is therefore recommended that wherever development penetrates alluvial and intertidal strata (even 'just' by piles), that those strata are AMS ^{14}C dated, genesis determined (alluvial or intertidal by diatom and/or foraminiferal study) and the palynology of organic layers examined.

Geographical areas to be targeted for future research

7.7 The model presented in this report has been reliant on high-quality geoarchaeological records in specific locations (Canon's Marsh/Deanery Road, Redcliffe, Cabot Circus/Broadmead and Broad Quay) supplemented by less reliable

archaeological records and commercial borehole logs with generalised descriptions. There are significant gaps in the current coverage that are likely to limit its precision in certain areas. The greater the data input into the model, the greater the resolution and therefore the greater the precision of any prediction made on its basis. A lack of data is most apparent in three areas: north of the historic city in the Nelson Street/Lewins Meas areas; to the south of the historic core between Baldwin Street/St Stephen's Street and King Street; and to the west of the historic core.

Research objective 1: Investigation of the Nelson Street/Lewins Mead area

7.8 To the north of the historic city in the Nelson Street/Lewins Mead area, major land reclamation took place in the period up to the second half of the 13th century when the outer town wall was constructed on the south bank of the River Frome. Only one excavation has been undertaken in this area in modern times, in 1969, and this work remains unpublished. However, the discovery in Quay Street between the inner and outer town wall circuits, reported in 1848, of a 'canoe, fourteen feet long, and four feet wide, shaped from a single trunk of timber', discovered 'at a considerable depth from the surface' indicates the major potential for the discovery of waterlogged archaeological deposits in this area (BCCHER).

Research objective 2: Investigation to the south of the historic core, between Baldwin Street/St Stephen's Street and King Street

7.9 In the area to the south of the historic core, south of Baldwin Street/St Stephen's Street and north of King Street, there are few reliable indicators of the surface and depth of Archaeological Strata 2, and the thickness of the Wentlooge Formation, while the surface elevation of Alluvium 1 needs further verification. Apart from work at Broad Quay, where detailed archaeological data were obtained, other excavations in this area remain to be published or are not related to descriptions of deeper stratigraphic sequences. This is the area where it has been traditionally assumed, for example by William Worcestre in 1480 (Neale (ed), 2000, op. cit), that the River Frome flowed, prior to its diversion in 1240, creating the well-defined cliff edge between Baldwin Street and St Nicholas Street. The LiDaR data also support this theory (Fig. 2).

Research objective 3: Investigation of the area to the west of the historic core

7.10 In the area to the west of the historic core no modern investigation has occurred. This is the heart of the medieval port and comprises both banks of the river Frome, but is located outside the inner town wall. There is likely to have been considerable

archaeological activity, both in reclaiming land adjacent to the Frome, especially on its eastern side, in preparation for the creation of the town quay, and associated with the functioning of the medieval port.

Potential for additional information to be generated from existing data

7.11 There is potential for additional information to be generated from existing data not accessed by this project. These comprise two main categories: unpublished archaeological works and privately held borehole data.

Research objective 4: Currently unpublished archaeological works

7.12 Accessing the original archives of unpublished archaeological works was beyond the scope of this project. As well as unpublished archaeological work in the Redcliffe area, and south of Baldwin Street, there are also records from the northern part of the study area which could prove to be a valuable addition to the dataset.

Research objective 5: Un-accessed borehole data

7.13 Following the initial phase of data collection geotechnical contractors were contacted for information on addi tional boreholes. Two firms responded positively to the request, but they were not able to confirm if additional boreholes existed for areas lacking other data. Searching the private borehole archives was beyond the scope of this project, however, future research could potentially be targeted in this direction.

Future model generation

7.14 The current dataset is not anticipated as a static, final entity, but rather as a basis for future work.

Research objective 6: Model Generation

7.15 At a point where suitable and sufficient additional data has been generated it is likely to be appropriate to re-generate the models. These future models are likely to refine hypotheses, and may themselves suggest lines for future research.

8. CONCLUSIONS

8.1 The project has generated models of the underlying bedrock and Quaternary strata of central Bristol, presented in terms of surface elevation and thickness. This model has enabled analysis and the formulation of several hypotheses on the development of the central Bristol area, including the development of river channels in the Pleistocene and Holocene.

8.2 The low-lying areas of central Bristol, selected as the study area, hold inherent potential for the preservation of waterlogged archaeological deposits. There is potential for waterlogged prehistoric and Romano-British deposits within strata of the Wentlooge Formation, which occur across the study area. However, such deposits may occur at significant depth, below the limit of normal archaeological investigation. As a result there is insufficient information available to be able to fully determine their potential, although further detail is available in the case of the Peat strata. Peat within the Wentlooge Formation can generally be identified in borehole data where it appears to be of two units, of Mesolithic and Neolithic date respectively. Peat strata may provide indirect evidence of human activity, with potential for localised *in situ* archaeological evidence.

8.3 Waterlogged medieval and post-medieval deposits, categorised as Archaeological Strata 2 also occur across the study area. The modelling of these deposits has been limited by the quality and distribution of archaeological works and boreholes. However, it has been possible to make certain hypotheses, including that they appear to be thickest in channel-side areas, but also that they occur at lower surface elevations in areas of later development.

8.4 There are certain key areas in the city in need of further data/research. These include the north-western part of the study area, north-west of the historic core, and to the south of the historic core around Baldwin Street. In the last area in particular, questions pertaining to a possible former course of the Frome remain.

8.5 In addition to increasing our understanding of the distribution and thickness of waterlogged archaeological deposits, the project has also provided valuable information on the geography of pre-medieval Bristol. Such information could not have been achieved by any other means, thereby serving to demonstrate the value

of deposit modelling in researching (and ultimately, managing) the urban archaeology of England's towns.

8.6 Research aims identified by the project, including the targeting of certain areas and recommendations for data standards, will be fed into the UAA, which is currently in preparation.

7. REFERENCES

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APPENDIX A: DISCUSSION OF FINDSPOTS

In addition to the Archaeological Strata 2 data designed for use in Rockworks, the project also captured data on findspots of waterlogged material, including information on former inlets and river walls. These finds comprise material, which by their nature, are associated with Archaeological Strata 2. A description of this material compliments and elucidates the deposit models generated by this project.

As might be expected, the highest concentration of findspots was adjacent to the extant watercourses including the channel-side areas of Redcliffe. Excavations in Redcliffe have recorded the approximate edge of the medieval/post-medieval southern riverbank of the Avon. Works included those carried out in the waterfront at Redcliffe to the south of Bristol Bridge at 127-129 Redcliff Street in 1982-3 (HER no 344), at 95-97 Redcliff Street (HER no 447, 98-103 Redcliff Street (HER no 3629) and 82-90 Redcliff Street (HER no 342). Additional works have taken place to the north of Bristol Bridge, at Bridge Parade (HER no 3367) and at Finzel's Reach (HER no 24838). These excavations traced the migration of the riverbank in the medieval and post-medieval period through the development of successive riverfront walls, and identified buildings and infrastructure associated with waterfront development, such as slipways. Associated with these deposits are preserved organic remains.

Excavations in Redcliffe have also recorded inlets/channels adjacent to the Avon, including those at Temple Back (HER no 4080) and Finzel's Reach (HER no 24838). In the eastern part of Redcliffe, excavation at Templar House in 2004-5 (HER ref 4164) supported the hypothesis that the floodplain in this area around the southern bank of the River Avon was reclaimed between the 13th and 14th centuries. Deposits interpreted as frequent flood horizons were revealed prior to the end of the 14th century.

To the west of Redcliffe, on the western side of the Avon, excavation to the rear of Nos 1-2 King Street (HER no 3697) uncovered a clearly defined cut into the wetter alluvium in the south-eastern corner of the site, which was interpreted as a possible modification of the medieval northern riverbank of the Avon. The angle of slope of the cut appeared too steep to represent the natural tidal channel itself. Evidence of the northern riverbank of the Avon in the eastern part of the study area is limited. However, an evaluation carried out at Temple Way House HER no 3284) indicated that the natural marsh in this area was reclaimed by a series of dumped deposits in the 17th and early 18th centuries.

At Broad Quay (HER no 407) excavations recorded a small section of the 13th-century town wall and a double-arched structure interpreted as the Watergate. Excavation at the former Olivetti House (now Venturers House), King Street/Marsh Street (Her no 2456) also uncovered evidence for the Marsh wall and demonstrated that it lies a little to the north of its assumed line. The study postulated a new line for the Marsh Wall between Welsh Back and Marsh Street.

The archaeological work carried out at 22-25 Queen Square, and 42-44 Welsh Back, (HER no 3930) demonstrated that that the south-western portion of the Marsh was not occupied at any time before the late 17th century. An evaluation at 42-43 Welsh Back (HER no 3062) also found no direct evidence for land use in the southern part of the Marsh prior to the late 17th century.

In the south-western part of the study area, excavations at the Harbourside (HER no 4087) probably located the position of the riverbank depicted on Rocque's 1742 plan of the area.

To the north of Harbourside, excavations around the west side of College Square (HER no 3772) recorded a large 12th-century fishpond and channel.

In the north-western part of the study area excavations at St Bartholomew's Hospital (HER no 3286), between Leins Mead and Colston Street recorded a probable river inlet or creek leading to the Frome. Waterlogged finds included preserved timbers. Also in the northern part of the study area, excavations at Union Street (HER no 3590) recorded the possible riverbank of the Frome, and waterlogged deposits within pits. To the east, evaluation and excavation at Quakers Friars, Broadmead (HER nos 3849 and 4279) recorded a east/west wall which fronted onto the River Frome.

APPENDIX B: Data format for inclusion in the stratigraphic database:

Future archaeological and geo-archaeological works undertaken within the study area should record information in a format suitable for inclusion in the existing Rockworks database. Works should record stratigraphic records for each borehole/selected sections as relevant. Recorded information should include the six-figure National Grid Reference and elevation (in m OD) of the stratigraphic record and the depths (below the surface level of the stratigraphic sequence described) of the upper and lower contacts of each stratigraphic unit.

This information should be used to populate Excel tables that would be supplied by and must be returned to Bristol City Council comprising a Location table and a Stratigraphy Table suitable for importation into Rockworks. The Location Table would include data on the Bore, File, Easting Northing, Elevation, and Total Depth. The Stratigraphy Table would include the Reference, Depth 1, Depth 2 and Stratigraphy. An explanation of these fields is included below:

Location Table:
Bore: A unique reference number. This may be the unique borehole number, or the HER number with an appropriate suffix where more than one record is added for any HER number. Non alpha-numeric characters should be avoided.
File: The unique reference number as used in the "Bore" field (i.e. a duplicate)
Easting: Six-figure easting co-ordinates
Northing: Six-figure northing co-ordinates
Elevation: The top of the sequence in m OD (Ordnance Datum)
Total Depth: Total depth in metres

Stratigraphy Table:
Reference: The unique reference number as used in the Location Table
Depth 1: Top of the deposit in meters below the surface of the stratigraphic record
Depth 2: Bottom of deposit in meters below the surface of the stratigraphic record
Stratigraphy: The stratigraphic unit, as defined in the table below.

Table: Stratigraphic Units for compatibility with Rockworks

Unit	Description
Made Ground	Strata not of archaeological interest,
Archaeological Strata 1	Medieval/post-medieval deposits without identified organic preservation.
Archaeological Strata 2	Medieval/post-medieval deposits with identified organic preservation (waterlogged).
Proto-urban deposits	Deposits at the top of the Wentlooge Formation, including disturbed ('trampled') alluvium and deposits associated with marsh conditions.
Alluvium 1	Wentlooge Formation deposits encountered below made ground.
Archaeological Strata 3	Strata containing evidence of human activity outcropping below Alluvium 1
Peat	Peat
Alluvium 2	Wentlooge Formation deposits encountered below Peat
Alluvium 3	Alluvial sand strata (probably point bar deposits) encountered below Alluvium 1 in the Redcliffe area.
Pleistocene gravels	Fluvial strata emplaced by the River Severn during the Pleistocene (mainly channel gravels)
Mercia Mudstone	Sands, silts and conglomerates deposited in (mainly) alluvial fan environments in the Triassic (252.2-201.2my BP)

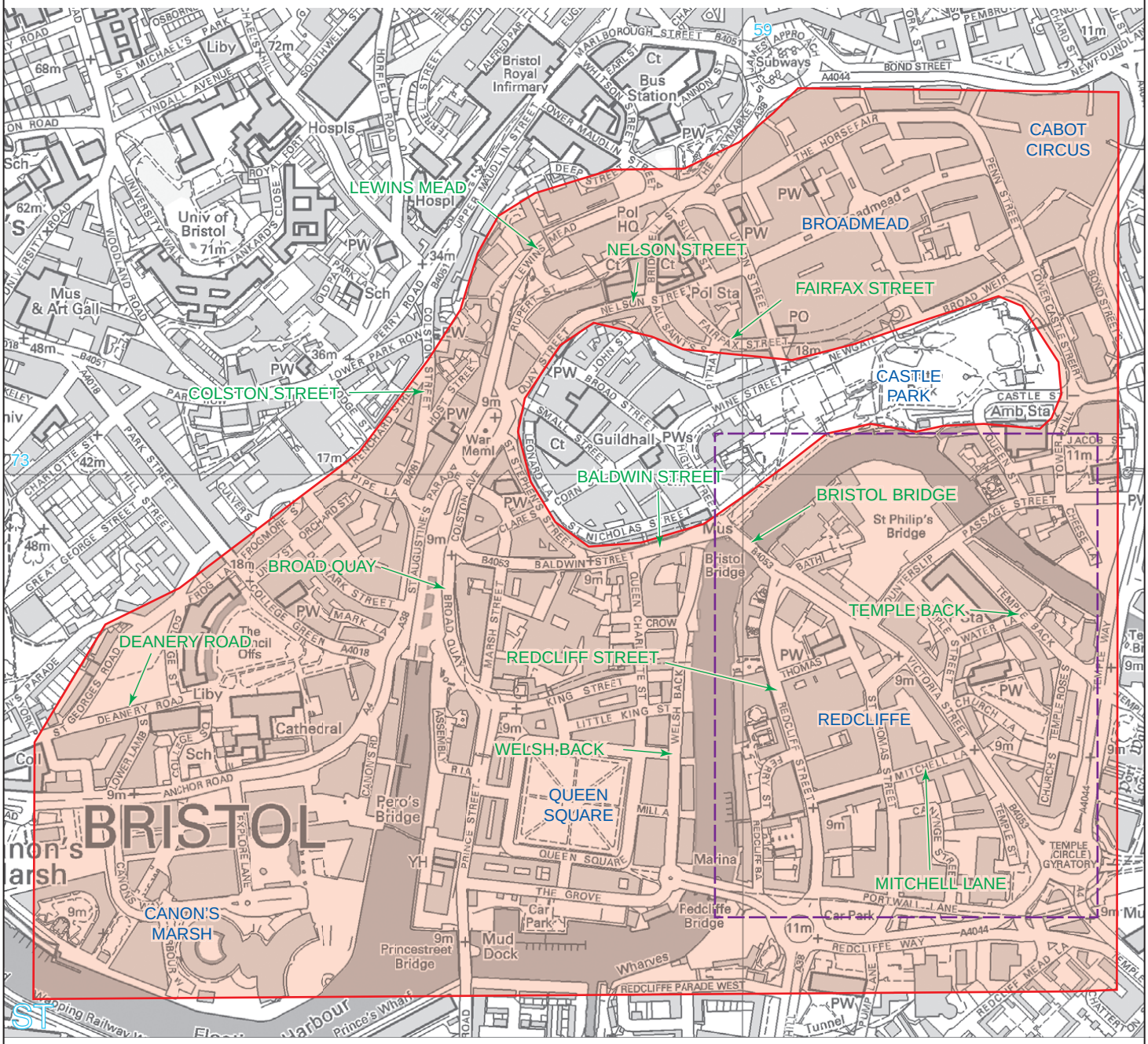
For reference, an example of how to complete these fields is included below

Location data for each borehole or each section point:

Bore	File	Easting	Northing	Elevation (top of sequence in m OD)	Total Depth (meters)
ST57SE141	ST57SE141	358440	172470	9.23	16.2

Stratigraphic data for each borehole or section point

Bore	Depth 1	Depth 2	Stratigraphy
ST57SE141	0	1.9	Made Ground
ST57SE141	1.9	14.1	Alluvium 1
ST57SE141	14.1	15.7	Pleistocene gravels
ST57SE141	15.7	16.2	Mercia Mudstone



N

study area

Redcliffe study area

0 250m

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

The study area

PROJECT NO.	3766	DATE	05-03-2013	FIGURE NO.
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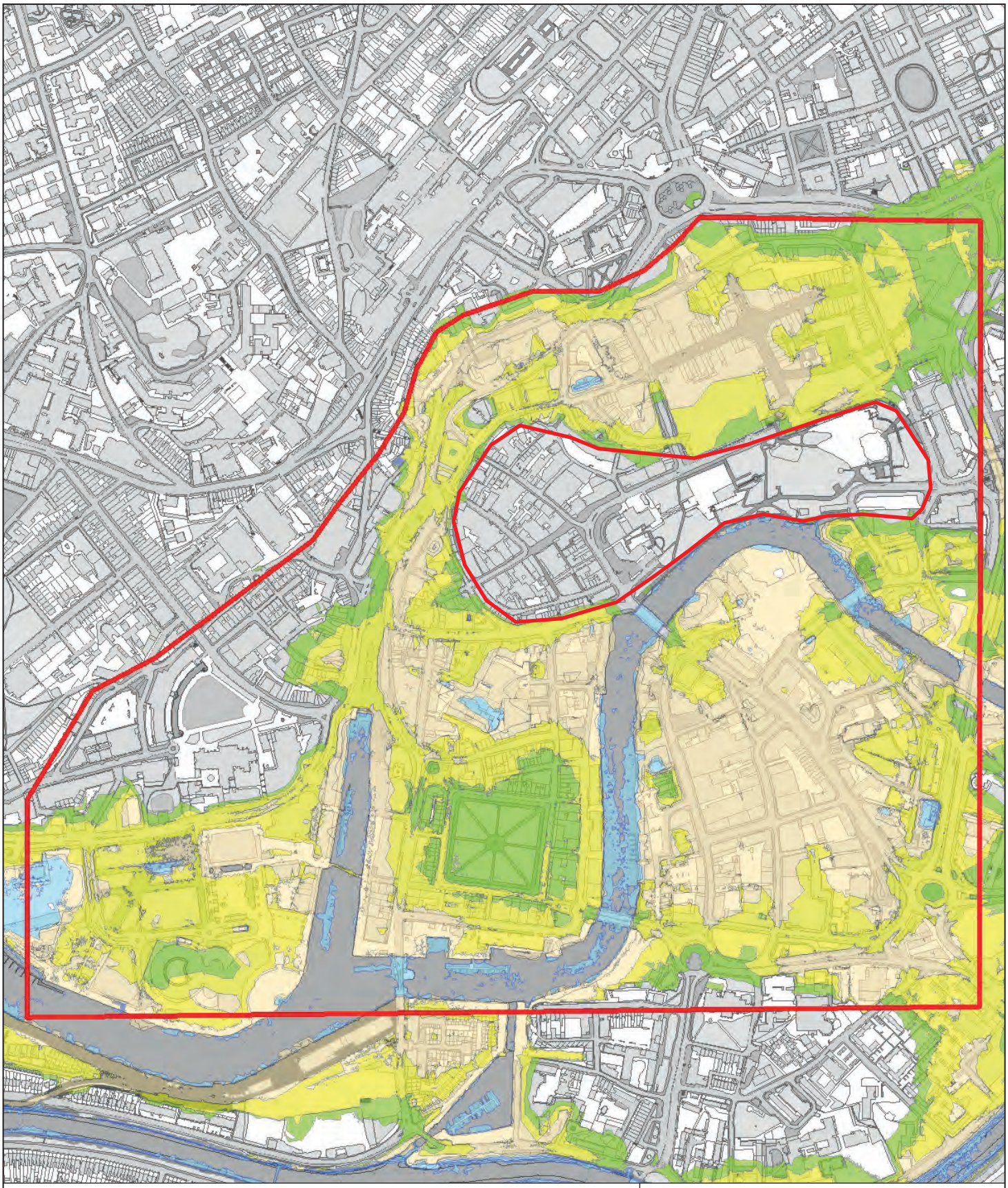

N

HEIGHTS ABOVE SEA LEVEL (m)

- -3 - 6
- 7 - 8
- 9
- 10

study area

0 250m

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

LiDAR data

PROJECT NO.	**3766**	*DATE*	**05-03-2013**	*FIGURE NO.*
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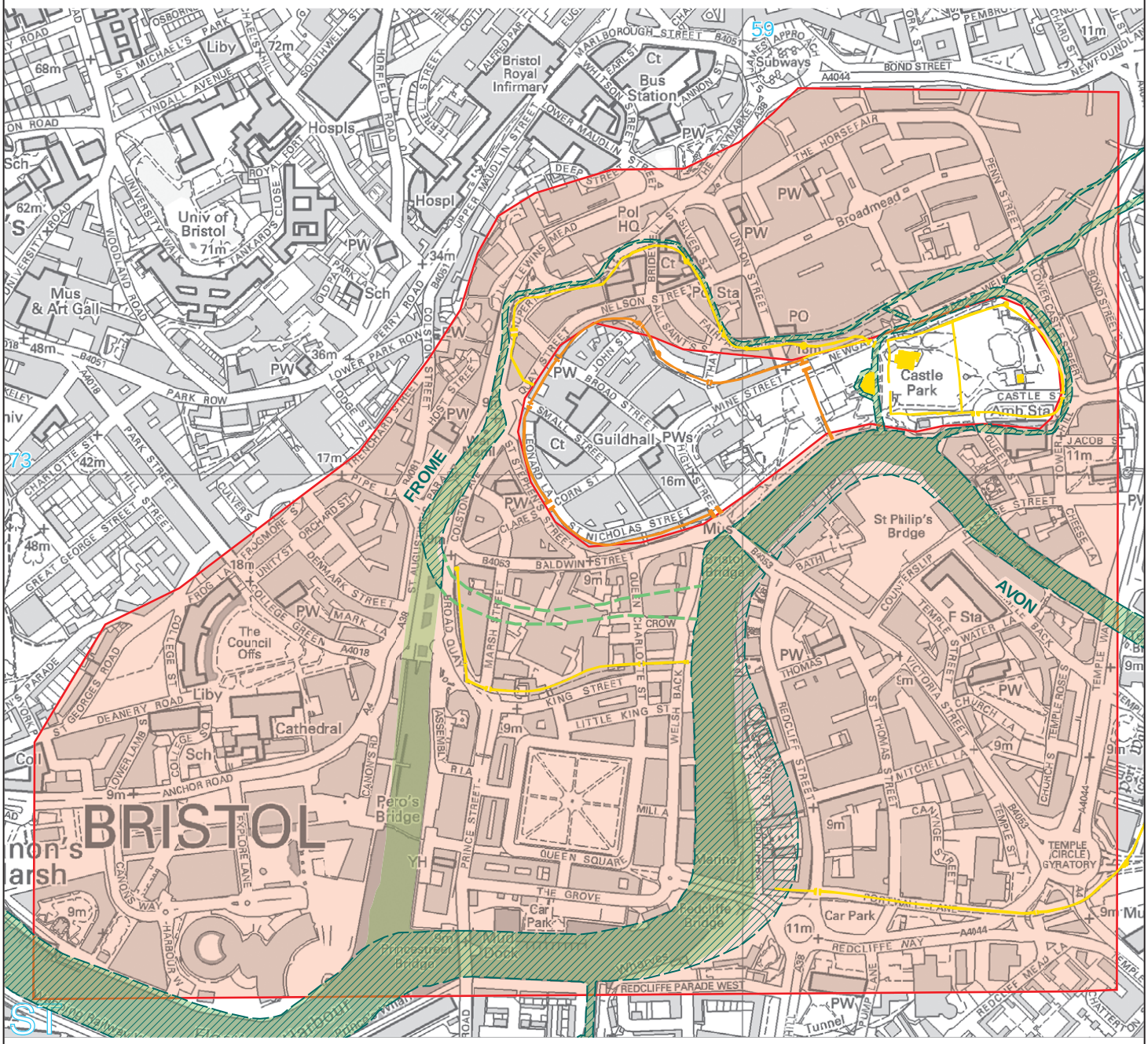

- study area
- Late Saxon defences
- medieval defences
- early medieval/medieval watercourse (pre 1240)
- putative former early medieval/medieval (pre 1240) watercourse
- medieval watercourse (post 1240)

N

0 250m

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PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Medieval defences and watercourses

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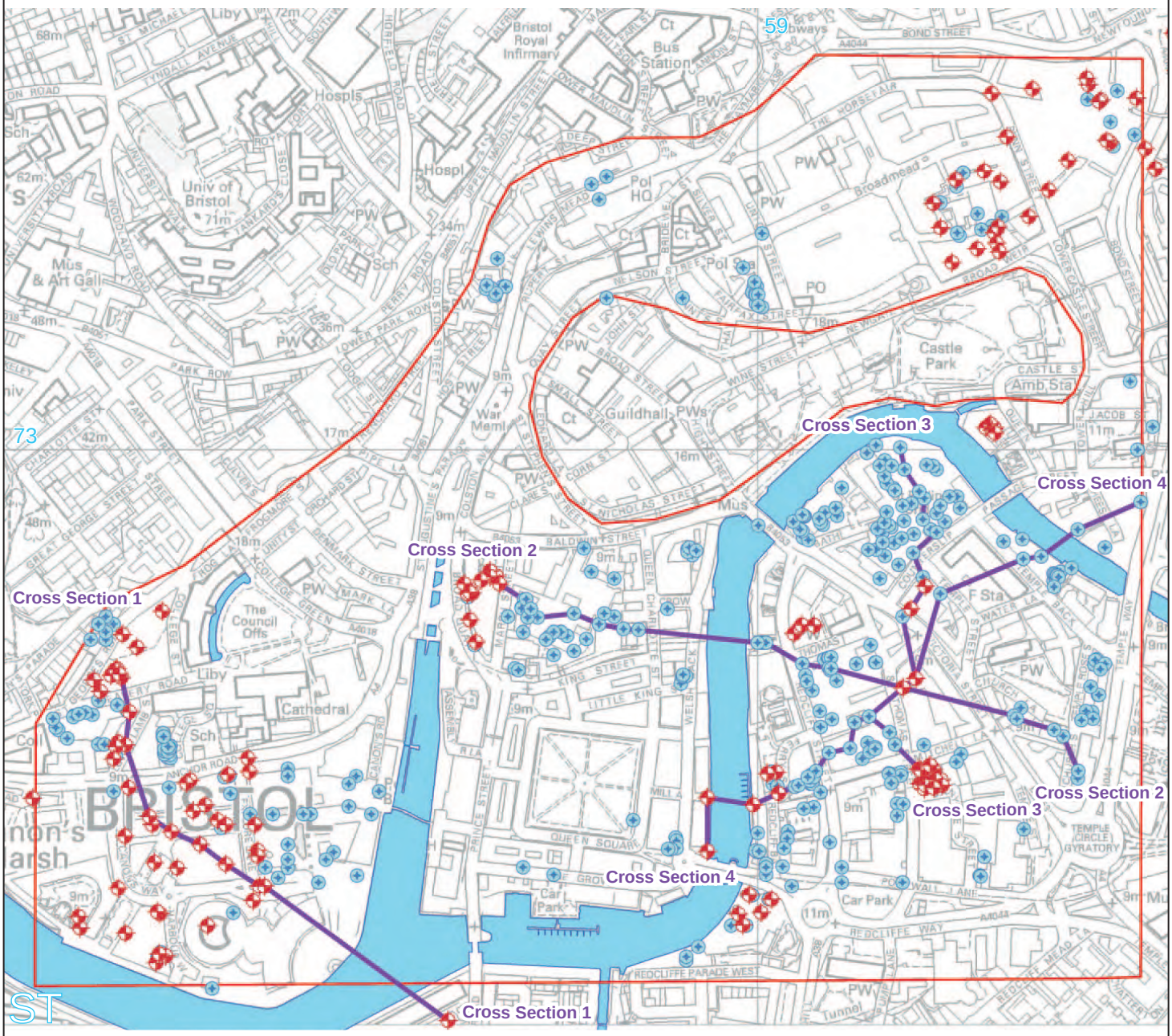

N

ARCA borehole records

BCC stratigraphic records

Cross sections

0 250m

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The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Location of stratigraphic records and cross sections

PROJECT NO.	3766	DATE	05-03-2013	FIGURE NO.
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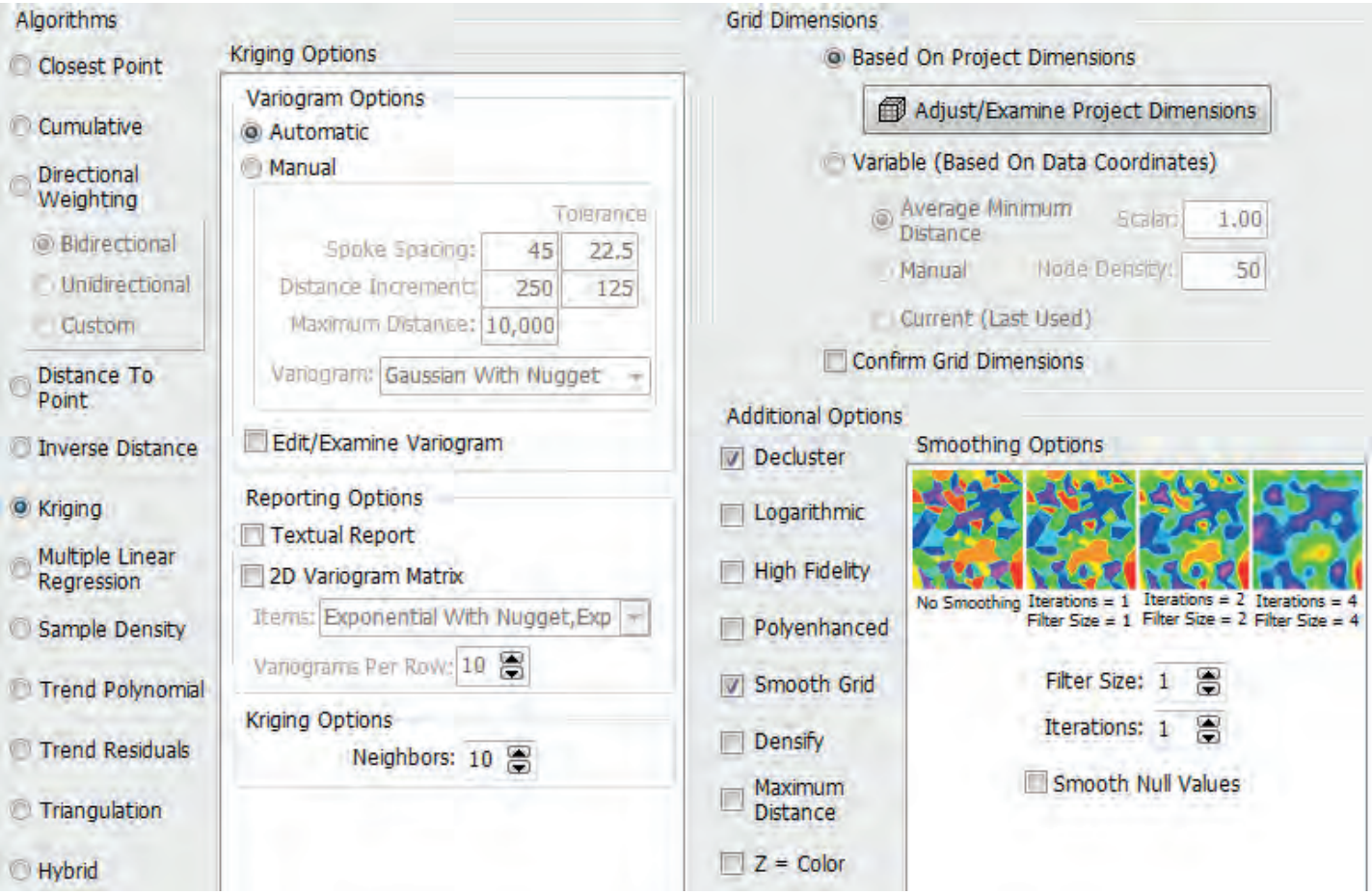

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

RockWorks dialogue box for Structural elevation/ Stratigraphic surface model output showing the selected Kriging algorithm options

PROJECT NO.	3766	DATE	29-01-2013	FIGURE NO.
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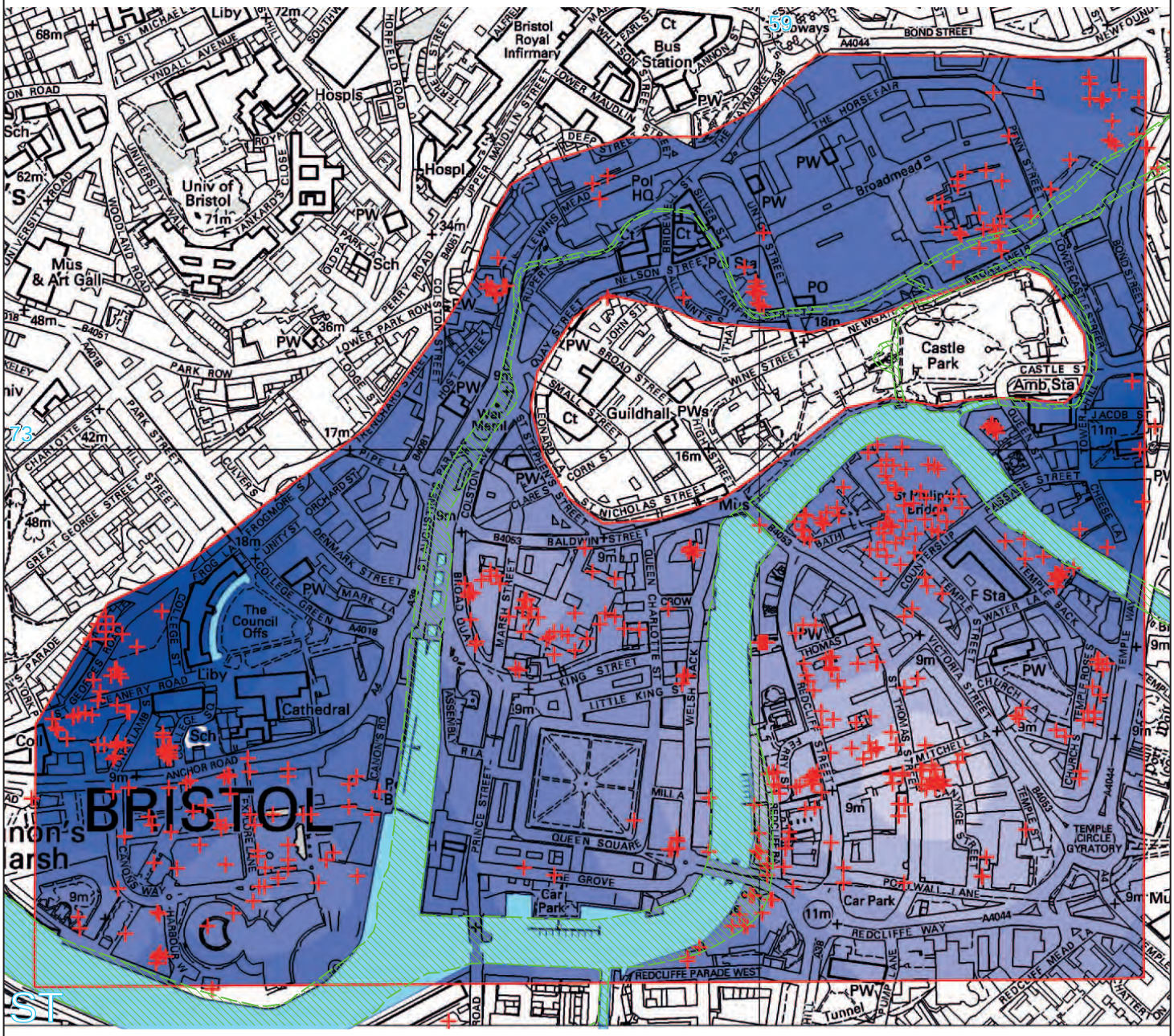

N

Elevation (m OD)

-6	-2	2
-5	-1	3
-4	0	4
-3	1	5

study area

medieval watercourse (post 1240)

Stratigraphic records

0 250m

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surface of the Mercia Mudstone Formation

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
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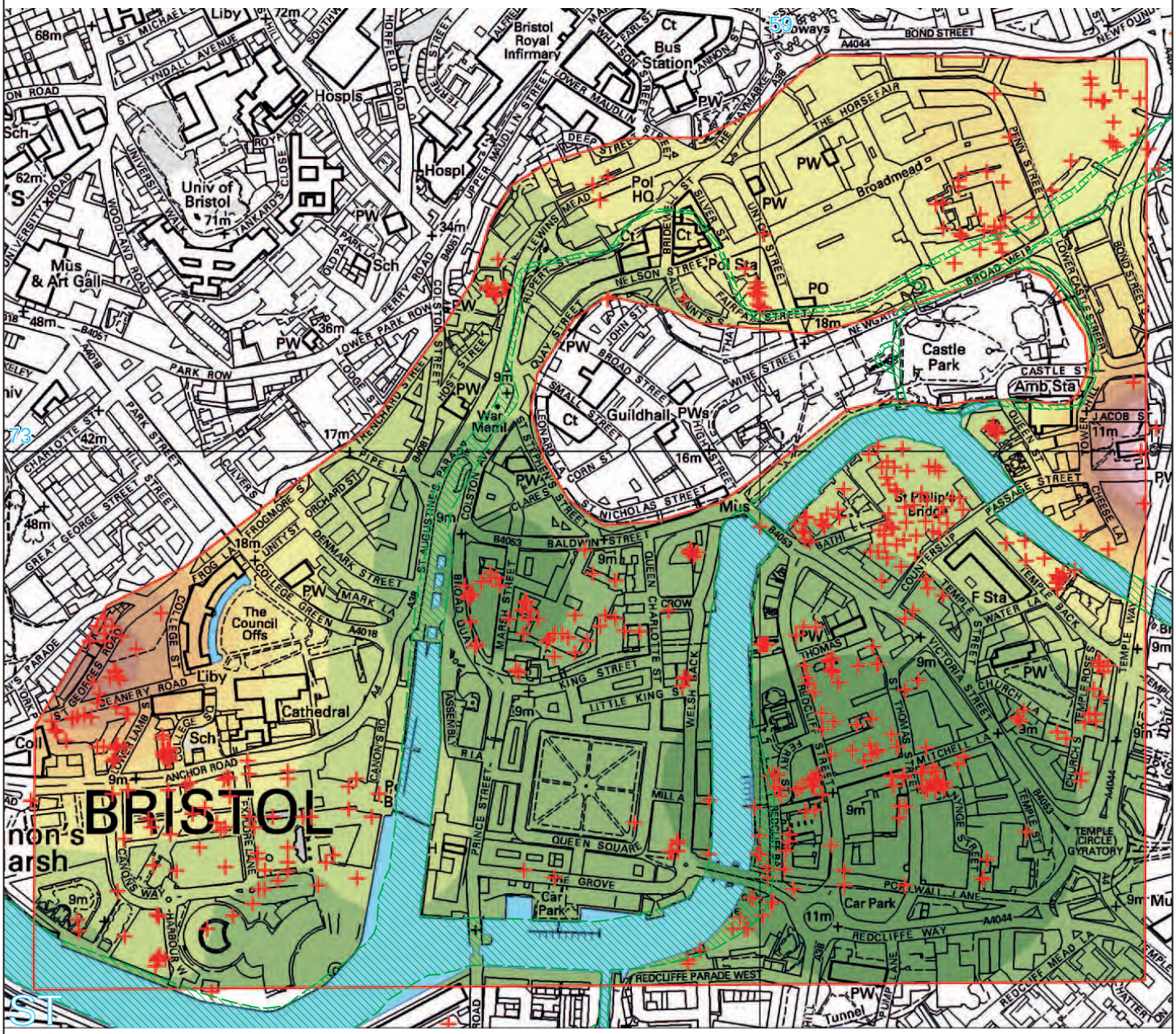

N

Elevation (m OD)

-3	1	5
-2	2	6
-1	3	7
0	4	8

study area

medieval watercourse (post 1240)

Stratigraphic records

0 250m

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PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Surface of the Avon Formation

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
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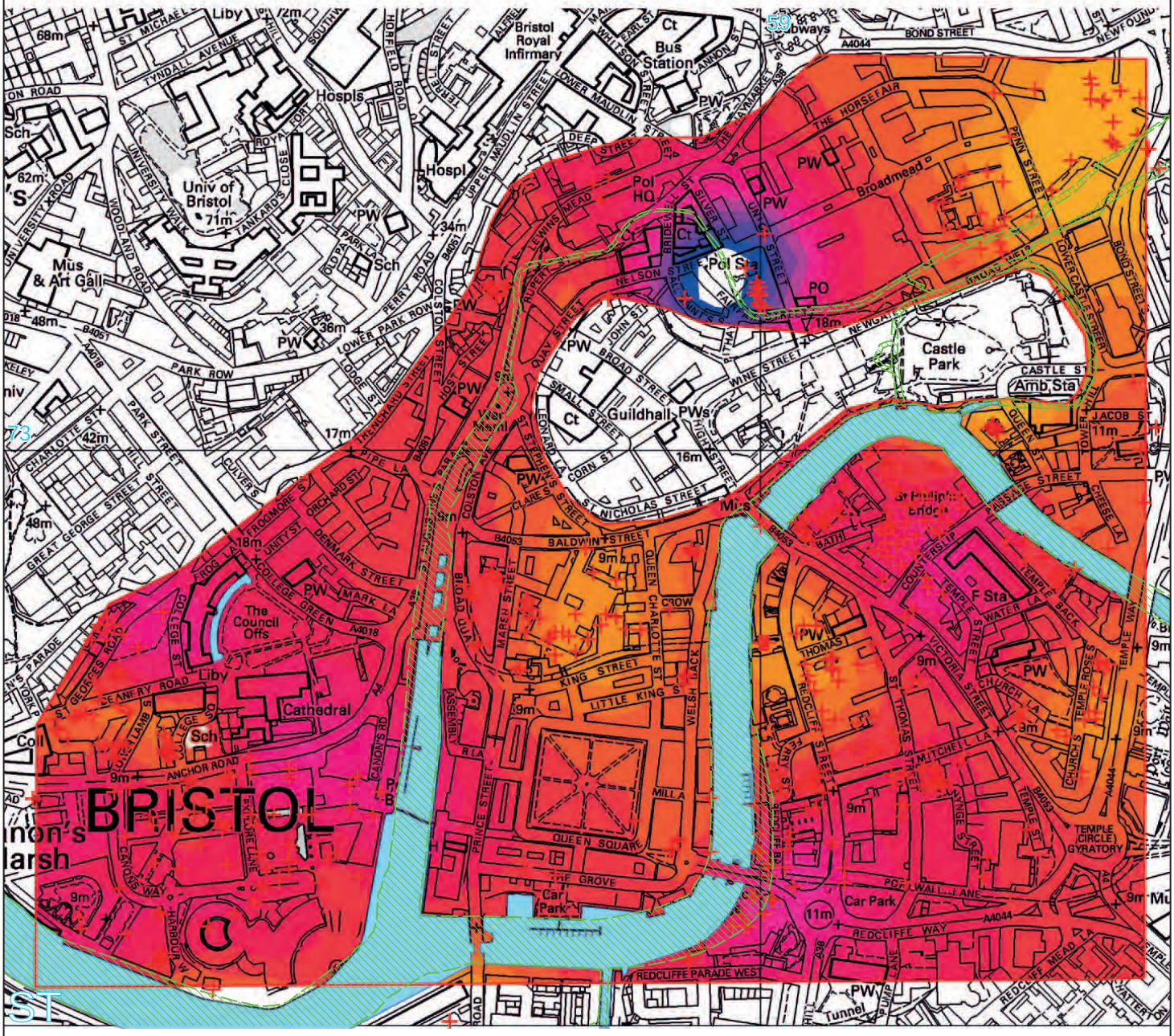

- ▭ study area
- ▨ medieval watercourse (post 1240)
- + Stratigraphic records

Metres

1.2	2	3
1.4	2.2	3.2
1.6	2.4	3.4
1.8	2.6	3.6
	2.8	3.8

N

0 250m

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PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Thickness of the Avon Formation

PROJECT NO.	**3766**	*DATE*	**12-03-2013**
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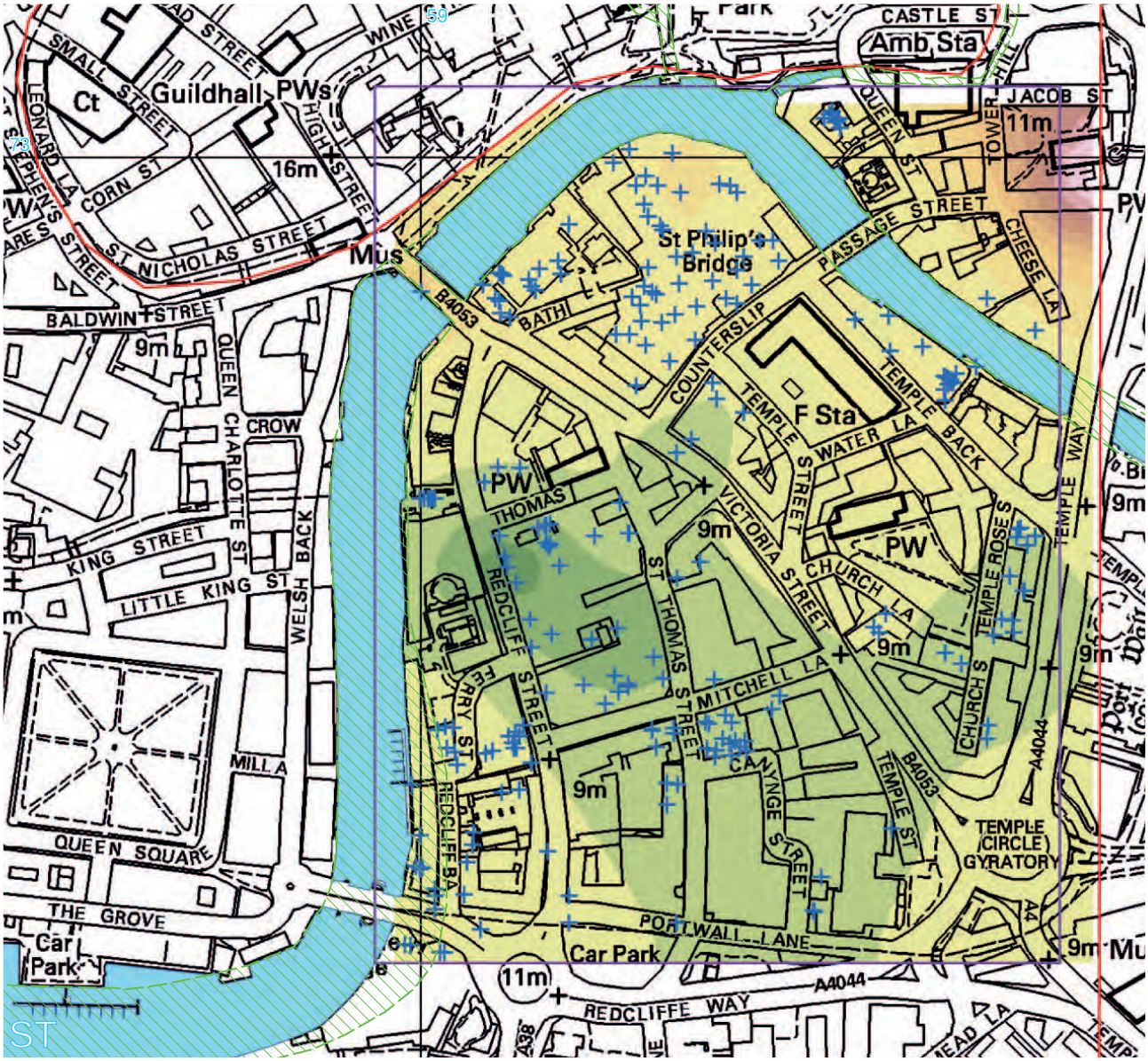
APPROVED BY	**PJM**	*SCALE@A4*	**1:8,000**

FIGURE NO.
8



study area

medieval watercourse (post 1240)

Redcliffe study area

Redcliffe records

Elevation (m OD)

-5	-1	4
-4	0	5
-3	1	6
-2	2	7
	3	8

N

0 250m

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surface of the Avon Formation, Redcliffe area

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
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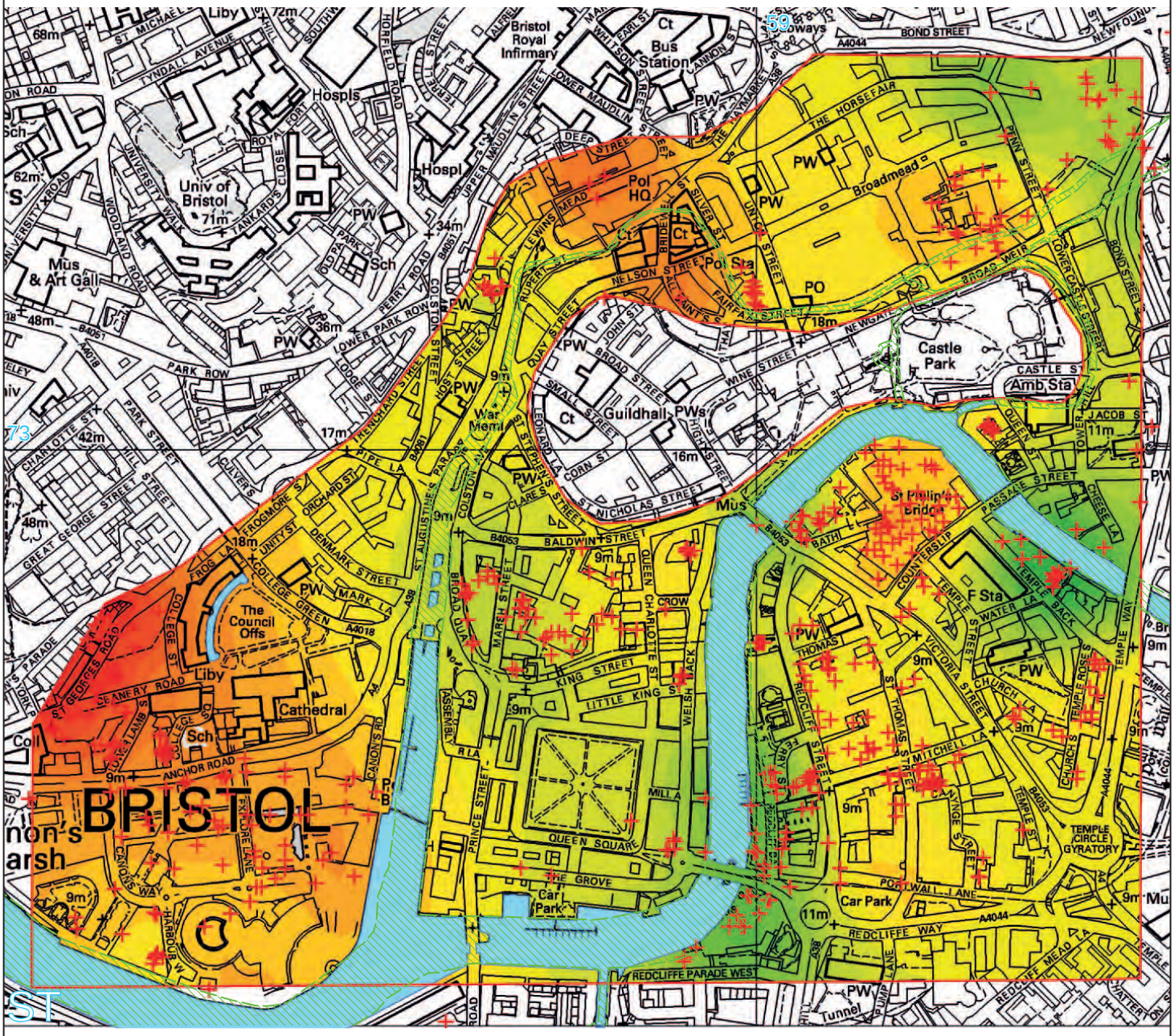

Elevation (m OD)

🟩	4.6	🟩	5.4	🟨	6.4	🟧	7.4
🟩	4.8	🟩	5.6	🟨	6.6	🟧	7.6
🟩	5	🟩	5.8	🟧	6.8	🟥	7.8
🟩	5.2	🟩	6	🟧	7	🟥	8
		🟨	6.2	🟧	7.2	🟥	8.2

☐ study area

▨ medieval watercourse (post 1240)

\+ Stratigraphic records

N

0 250m

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The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surface of the Wentlooge Formation

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	10
APPROVED BY	PJM	SCALE@A4	1:8,000	

N

m OD

3	4.25	5.5	6.75
3.25	4.5	5.75	7
3.5	4.75	6	7.25
3.75	5	6.25	7.5
4	5.25	6.5	7.75

study area

medieval watercourse (post 1240)

Redcliffe study area

+ Redcliffe records

0 250m

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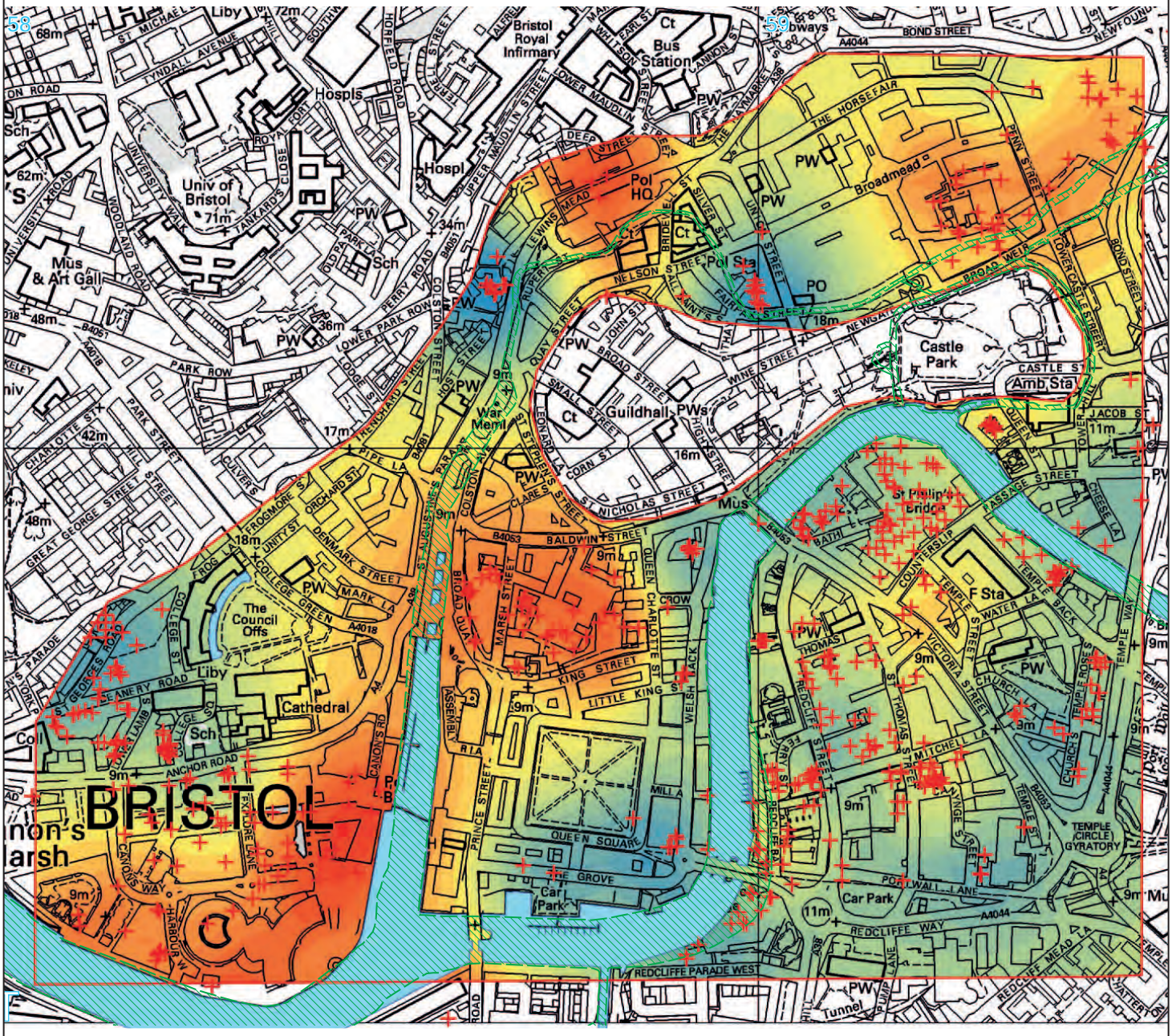
PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surfaces of the Wentlooge Formation, Redcliffe area

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	11
APPROVED BY	PJM	SCALE@A4	1:5000	



Metres

2.5	3.75	5.25	6.75
2.75	4	5.5	7
3	4.25	5.75	7.25
3.25	4.5	6	7.5
3.5	4.75	6.25	
	5	6.5	

study area

medieval watercourse (post 1240)

Stratigraphic records

N

0 250m

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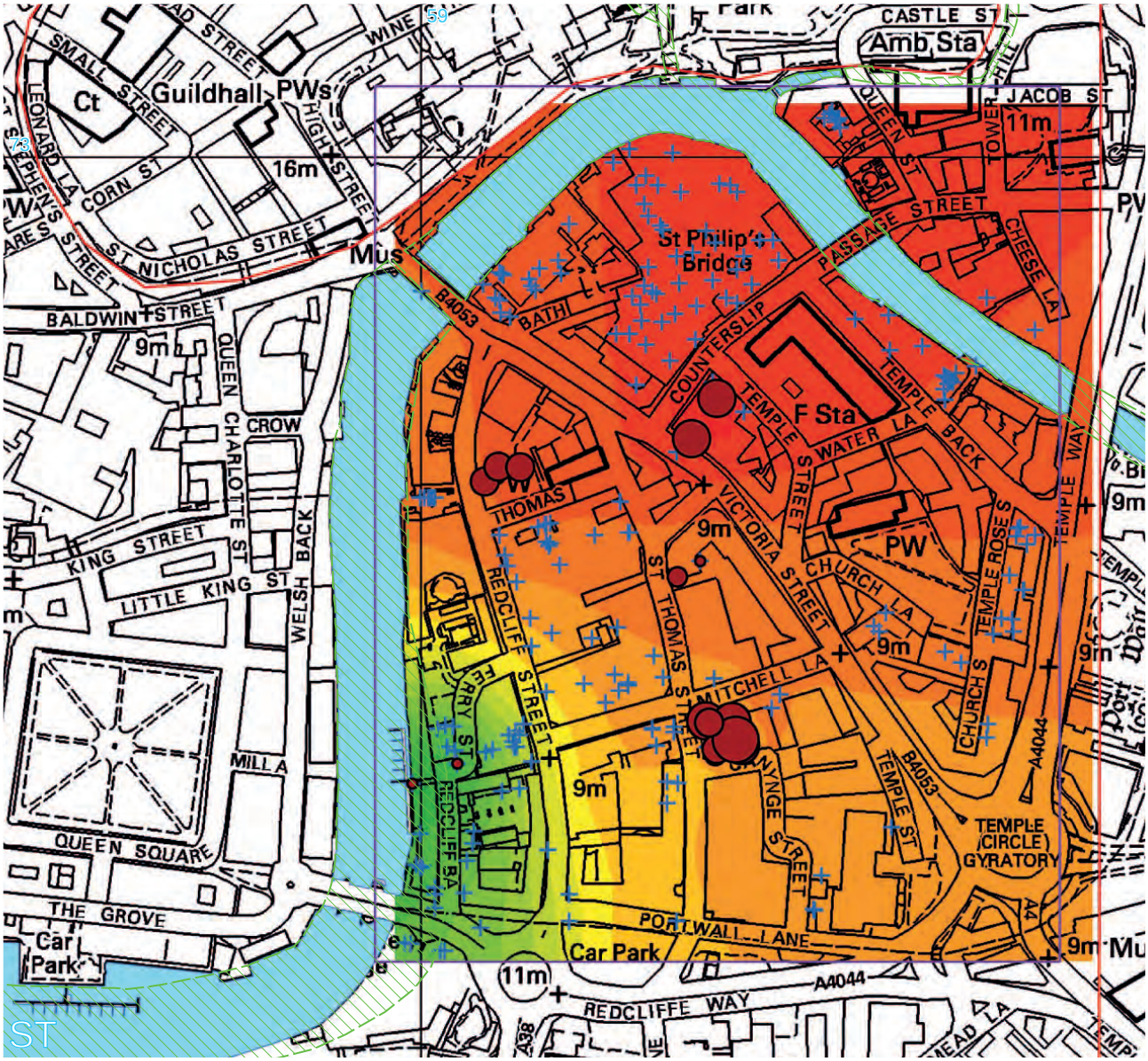
PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Thickness of the Wentlooge Formation

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	12
APPROVED BY	PJM	SCALE@A4	1:8,000	



study area

medieval watercourse (post 1240)

Redcliffe study area

Redcliffe records

Thickness (m)	Elevation (m OD)		
0 - 2	-2.5	-0.5	2
3 - 4	-2	0	2.5
5 - 6	-1.5	0.5	3
7 - 8	-1	1	3.5
9 - 10		1.5	4

N

0 250m

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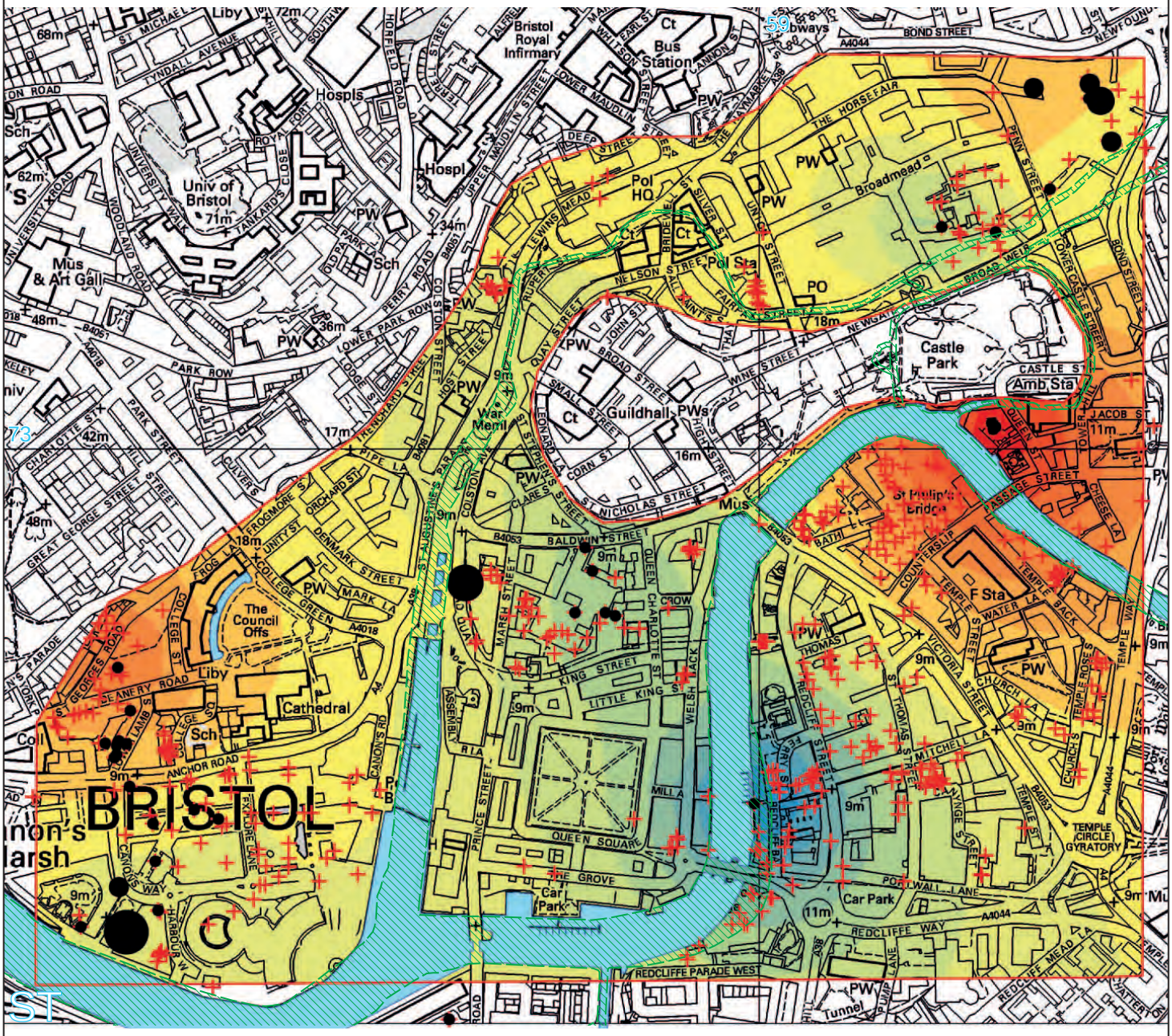
PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surface and thickness of Alluvium 3, Redcliffe area

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	13
APPROVED BY	PJM	SCALE@A4	1:5000	



N

study area

medieval watercourse (post 1240)

+ Stratigraphic records

Thickness (m)	
●	0 - 1
●	2
●	3
●	4
●	5

Elevation (m OD)

-1 | -0.5 | 0 | 0.5 | 1 | 1.5 | 2 | 2.5 | 3 | 3.5 | 4 | 4.5 | 5 | 5.5

0 250m

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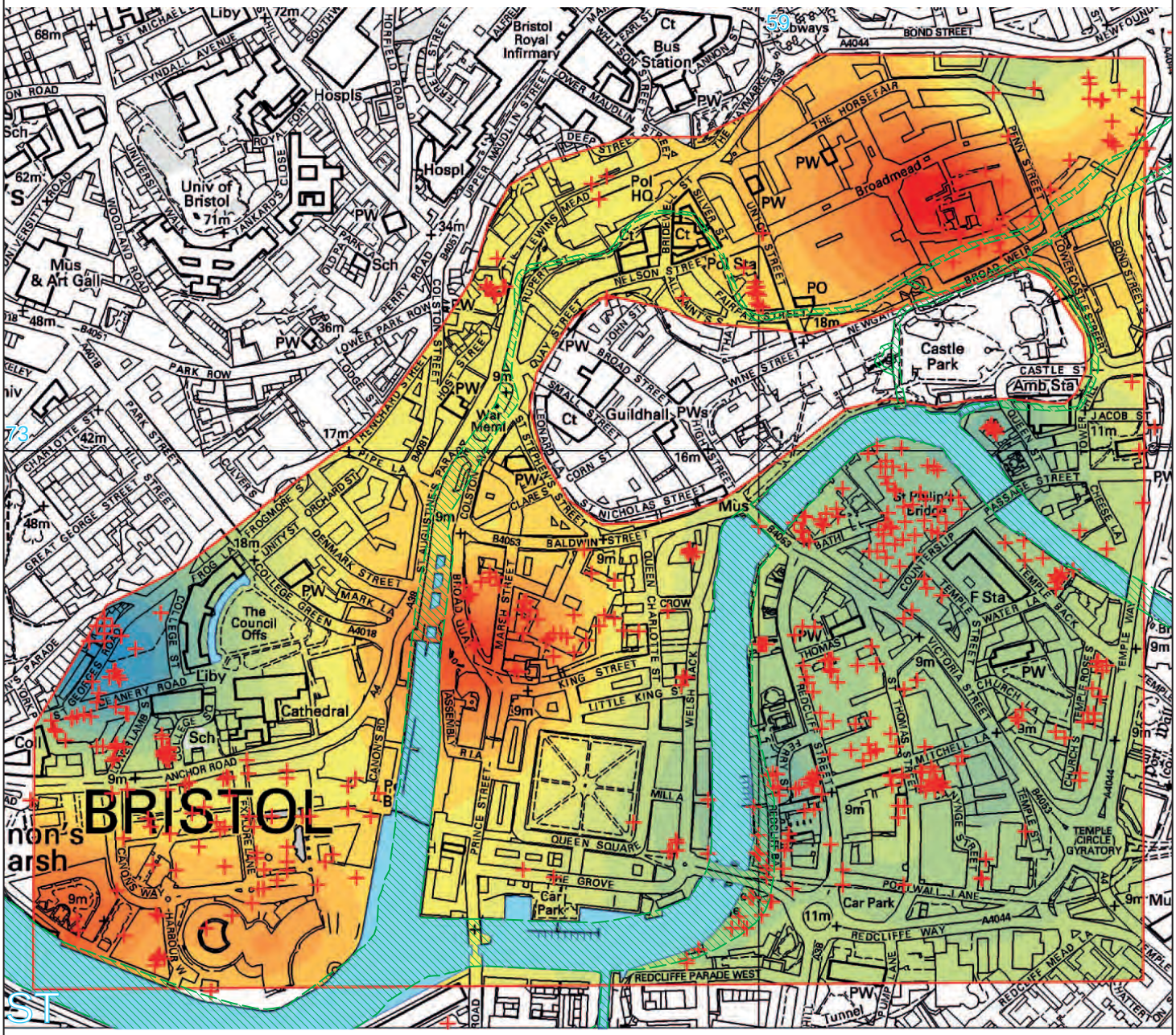
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Surface and thickness of Peat

PROJECT NO.	3766	*DATE*	12-03-2013	*FIGURE NO.*
DRAWN BY	LG	*REVISION*	01	14
APPROVED BY	PJM	*SCALE@A4*	1:8,000	



Metres

2.25	3.5	4.75	6
2.5	3.75	5	6.25
2.75	4	5.25	6.5
3	4.25	5.5	6.75
3.25	4.5	5.75	7

study area

medieval watercourse (post 1240)

Stratigraphic records

N

0 250m

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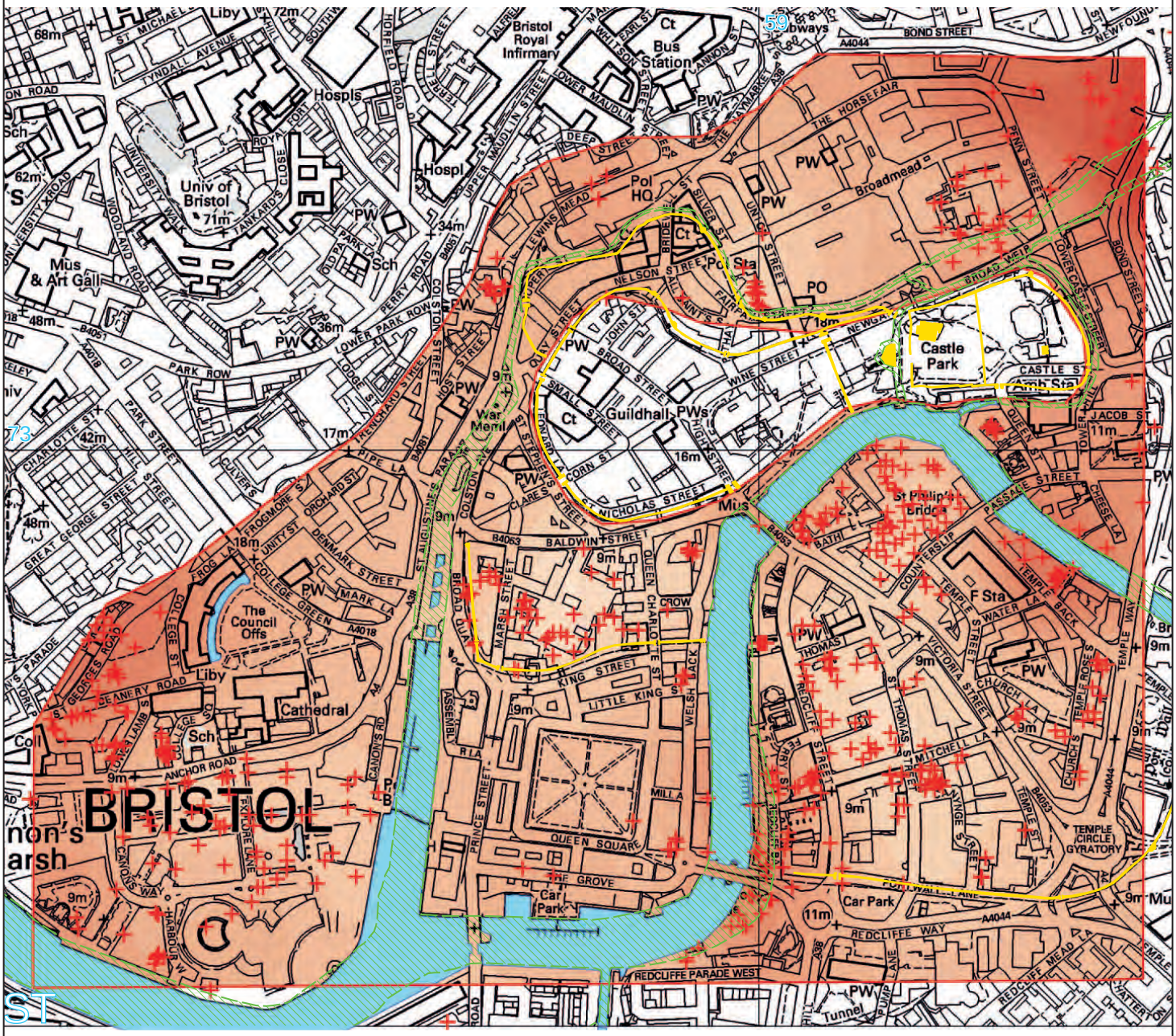
PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Thickness of Alluvium 1

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	15
APPROVED BY	PJM	SCALE@A4	1:8,000	



N

0 250m

Metres

	1.6		2.4		3.4		4.4
	1.8		2.6		3.6		4.6
	2		2.8		3.8		4.8
	2.2		3		4		5
			3.2		4.2		5.2

▭ study area

━ medieval defences

▨ medieval watercourse (post 1240)

+ Stratigraphic records

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

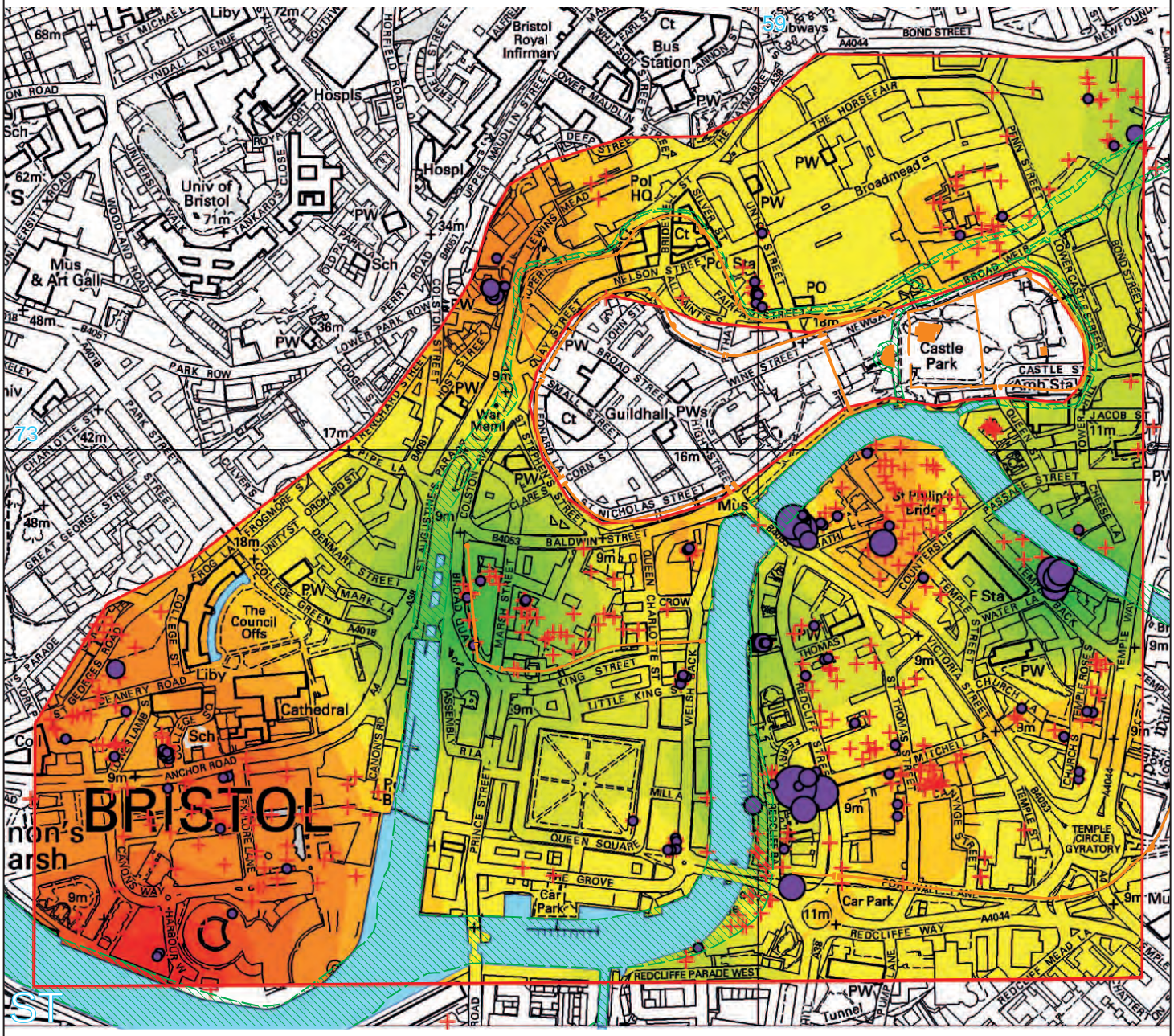
FIGURE TITLE

Thickness of Made Ground

PROJECT NO.	3766	*DATE*	12-03-2013
DRAWN BY	LG	*REVISION*	01
APPROVED BY	PJM	*SCALE@A4*	1:8,000

FIGURE NO.

16



Thickness (m) Elevation (m OD)

●	0.1 - 1.5	🟩	6.3	🟩	6.8
●	1.6 - 3.0	🟩	6.4	🟩	6.9
●	3.1 - 4.5	🟩	6.5	🟨	7
●	4.6 - 6.0	🟩	6.6	🟨	7.1
●	6.1 - 7.5	🟩	6.7	🟧	7.2
				🟧	7.3

🟧	7.4
🟧	7.5
🟥	7.6
🟥	7.7
🟥	7.8

- 🟥 study area
- — medieval defences
- ▨ medieval watercourse (post 1240)
- + Stratigraphic records

N

0 250m

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PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

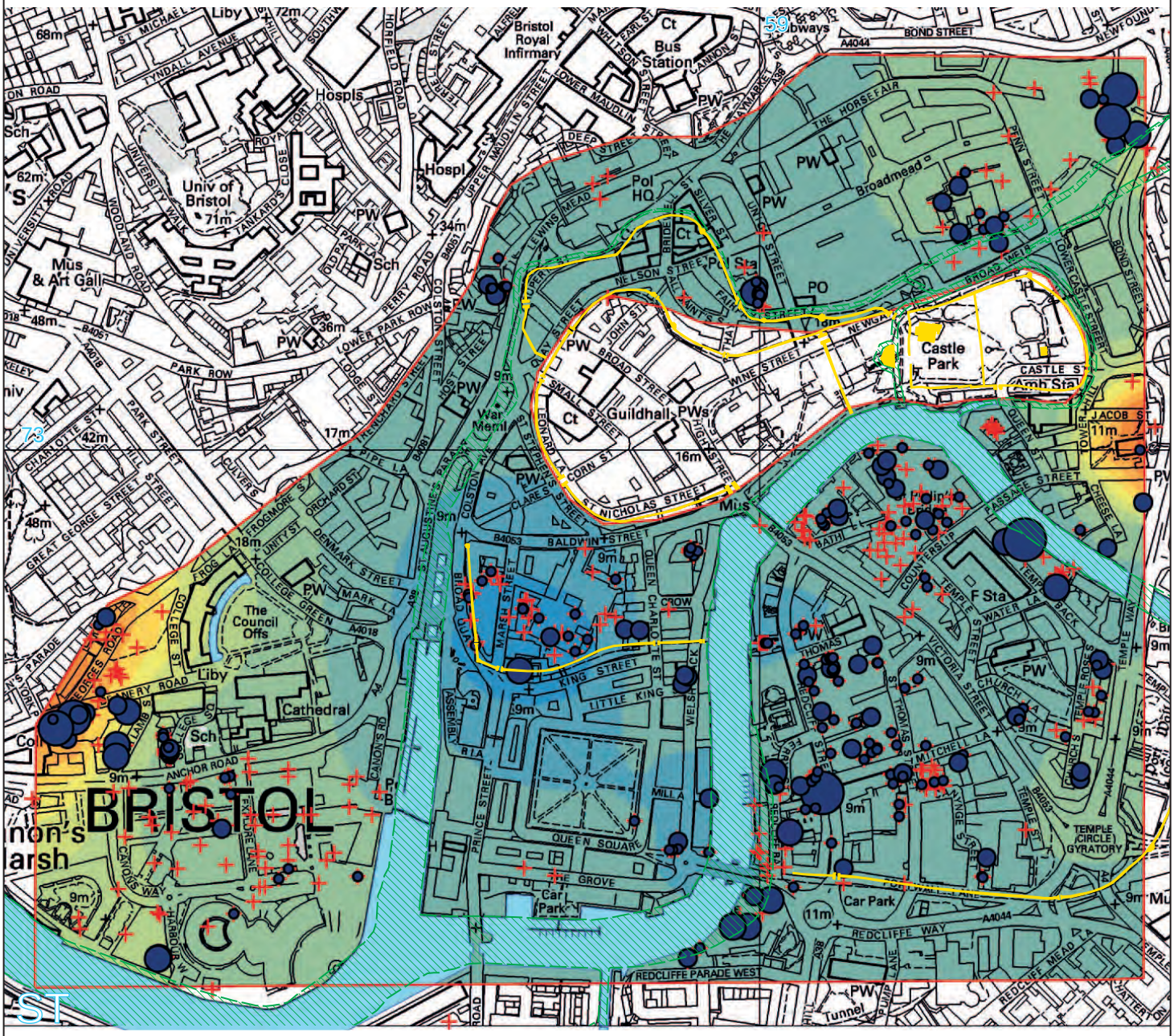
FIGURE TITLE

Surface and thickness of Archaeological Strata 2 (waterlogged deposits)

PROJECT NO.	3766	DATE	12-03-2013
DRAWN BY	LG	REVISION	01
APPROVED BY	PJM	SCALE@A4	1:8,000

FIGURE NO.

17



Thickness (m)

- 0.2 - 1.5
- 1.6 - 3.0
- 3.1 - 4.5
- 4.6 - 6.0
- 6.1 - 7.5

Elevation (m OD)

7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5

- study area
- medieval defences
- medieval watercourse (post 1240)
- Stratigraphic records

N

0 250m

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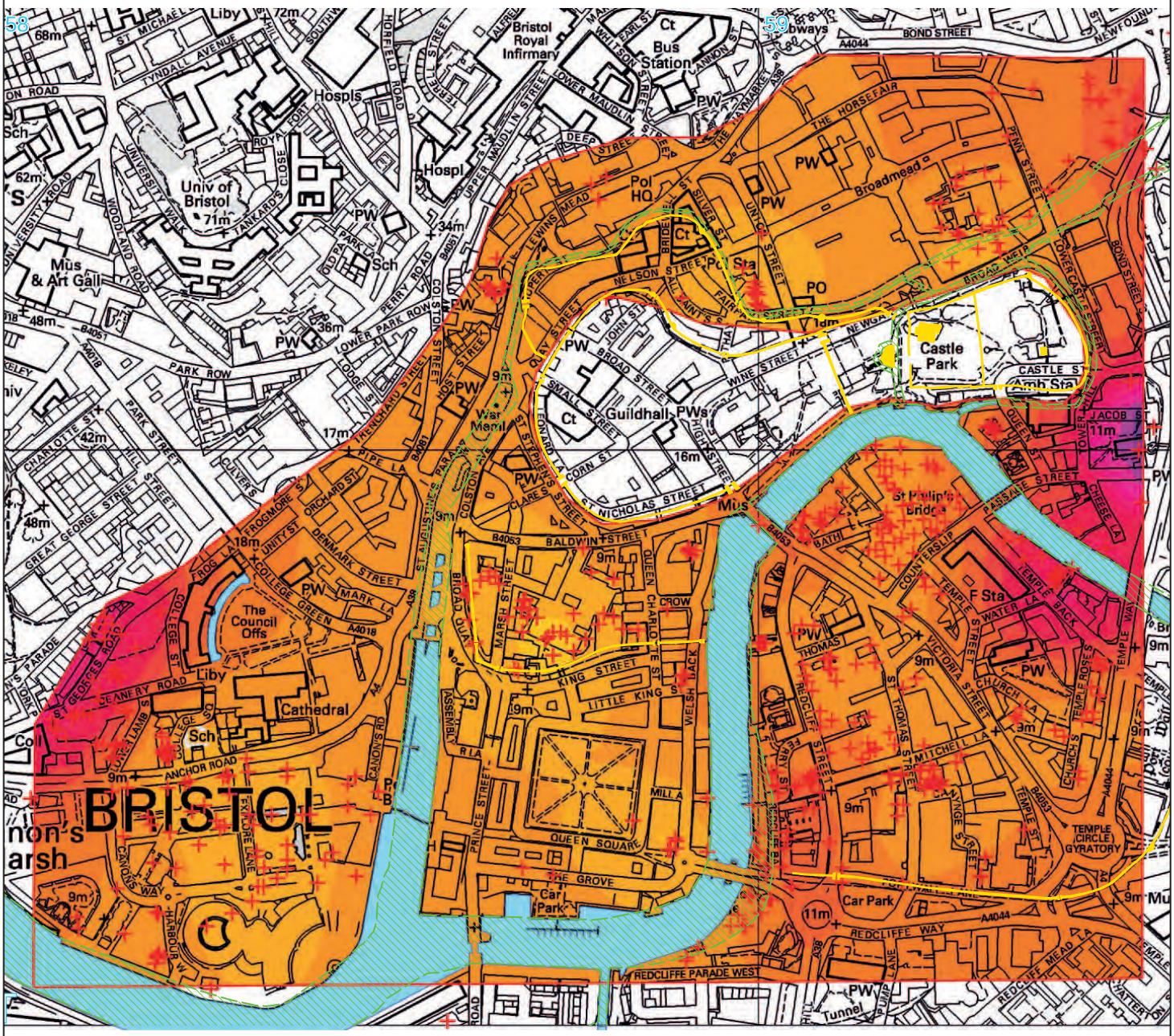
PROJECT TITLE

The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE

Surface and thickness of Archaeological Strata 1 (not waterlogged)

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	18
APPROVED BY	PJM	SCALE@A4	1:8,000	



N

Metres

1.5	3	5	7
2	3.5	5.5	7.5
2.5	4	6	8
	4.5	6.5	8.5

- study area
- medieval defences
- medieval watercourse (post 1240)
- Stratigraphic records

0 250m

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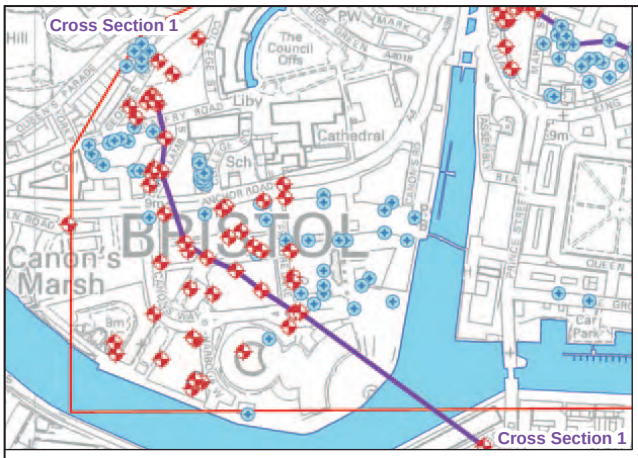
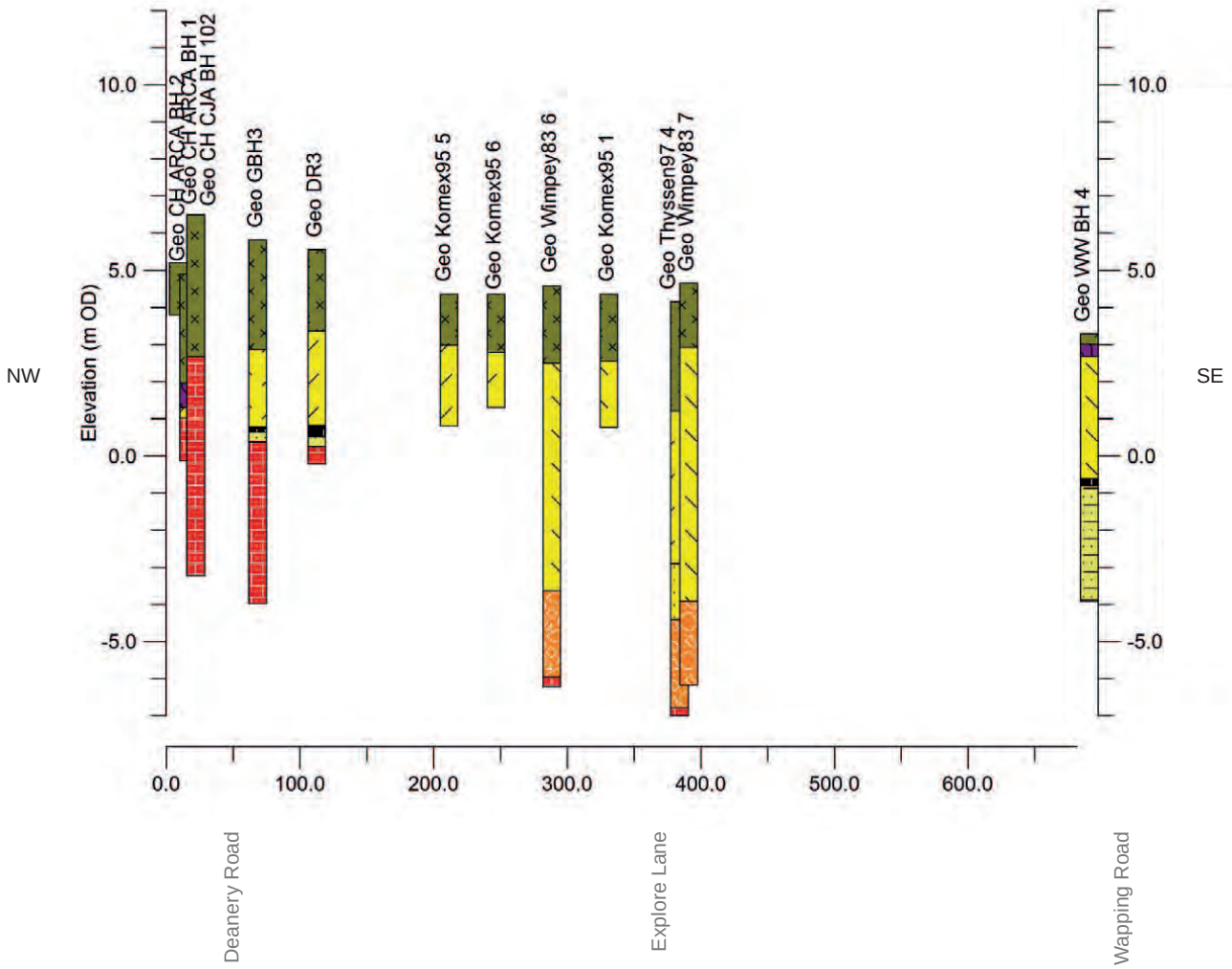
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Thickness of Archaeological Strata 1 and 2

PROJECT NO.	3766	DATE	12-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	19
APPROVED BY	PJM	SCALE@A4	1:8,000	





- Made Ground
- Archaeological Strata 1
- Archaeological Strata 2
- Proto Urban Deposits
- Alluvium 1
- Peat
- Alluvium 3
- Archaeological Strata 3
- Alluvium 2
- Avon Formation
- Mercia Mudstone
- Carboniferous bedrock

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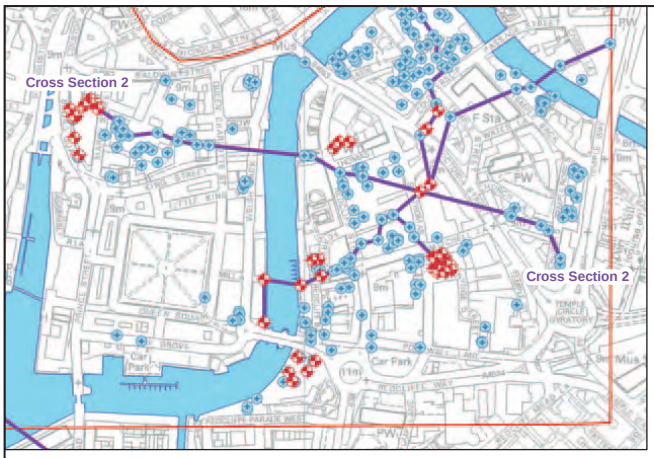
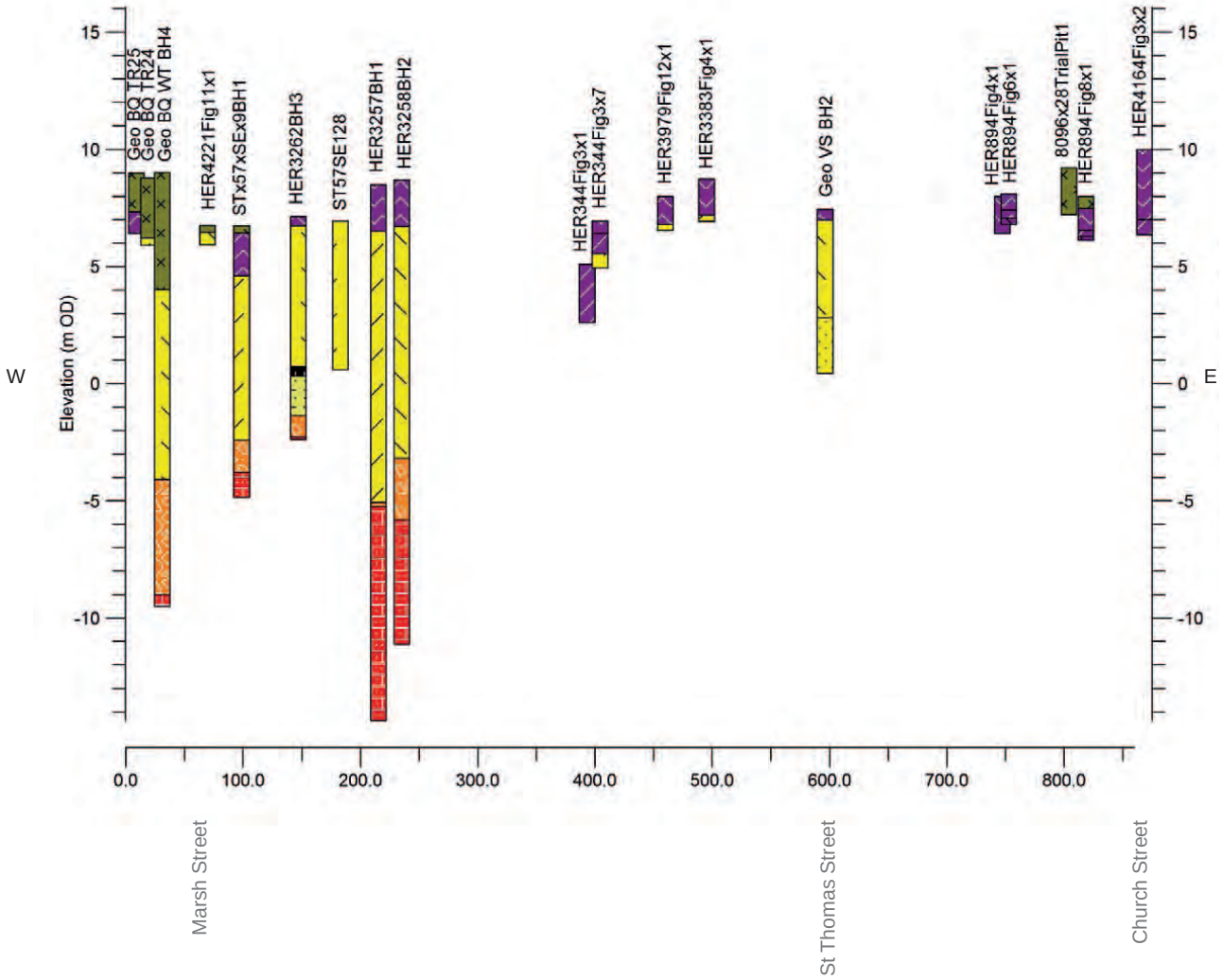
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Cross section 1: Deanery Road and Canon's Marsh

PROJECT NO.	3766	DATE	13-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	20
APPROVED BY	PJM	SCALE@A4	N/A	





- Made Ground
- Archaeological Strata 1
- Archaeological Strata 2
- Proto Urban Deposits
- Alluvium 1
- Peat
- Alluvium 3
- Archaeological Strata 3
- Alluvium 2
- Avon Formation
- Mercia Mudstone
- Carboniferous bedrock

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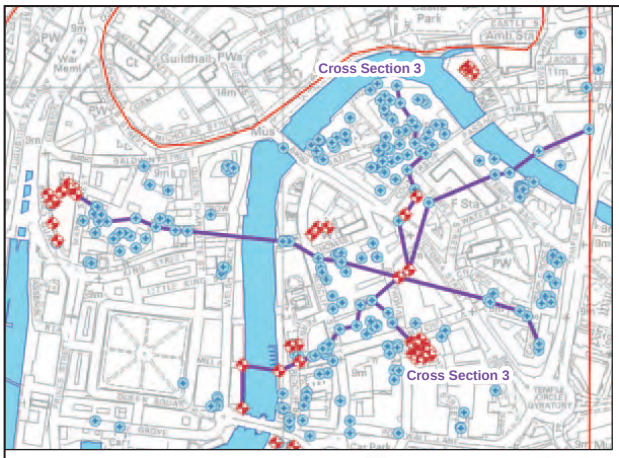
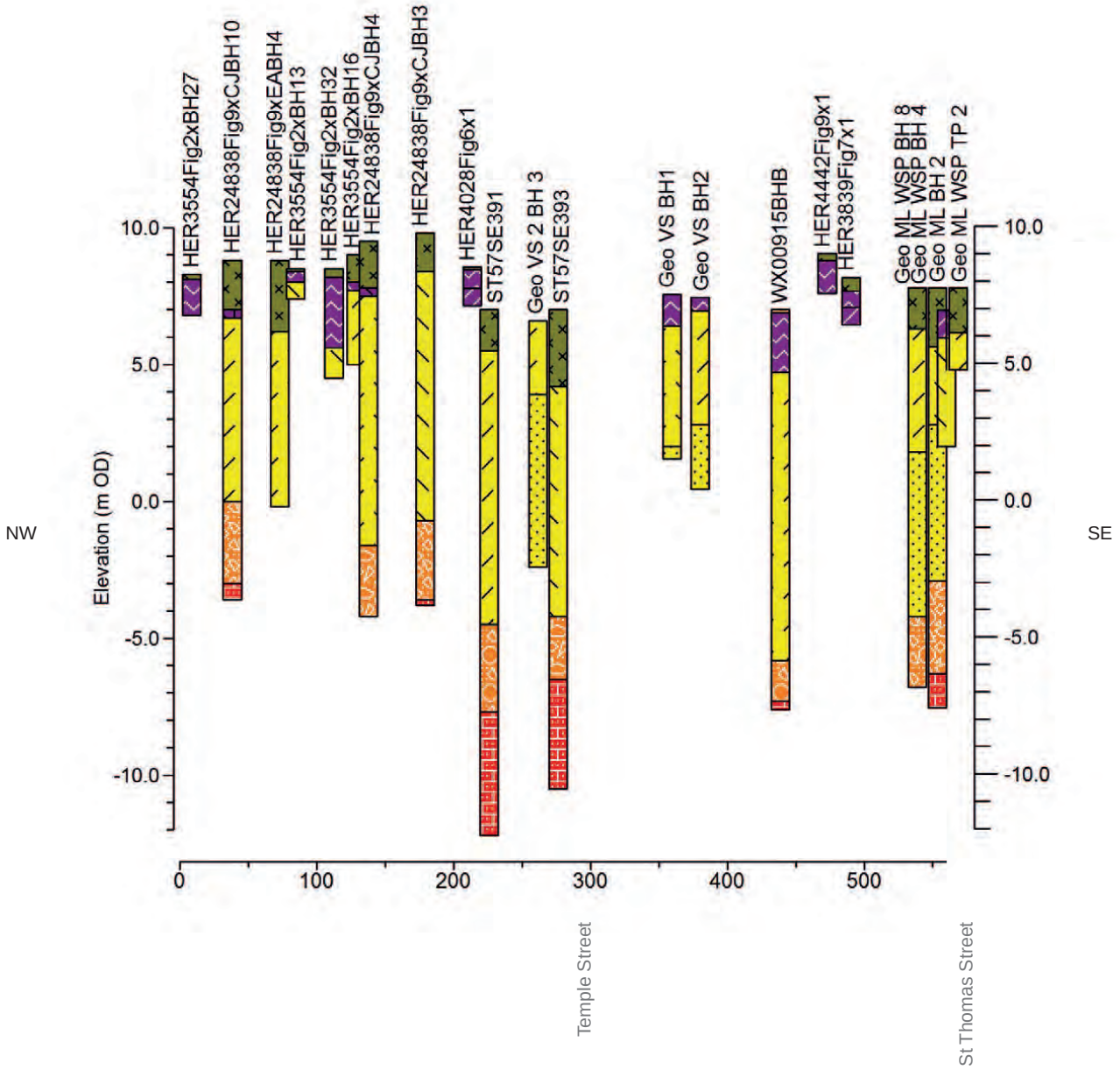
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Cross section 2: Broad Quay to Redcliffe

PROJECT NO.	3766	DATE	13-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	21
APPROVED BY	PJM	SCALE@A4	N/A	





- Made Ground
- Archaeological Strata 1
- Archaeological Strata 2
- Proto Urban Deposits
- Alluvium 1
- Peat
- Alluvium 3
- Archaeological Strata 3
- Alluvium 2
- Avon Formation
- Mercia Mudstone
- Carboniferous bedrock

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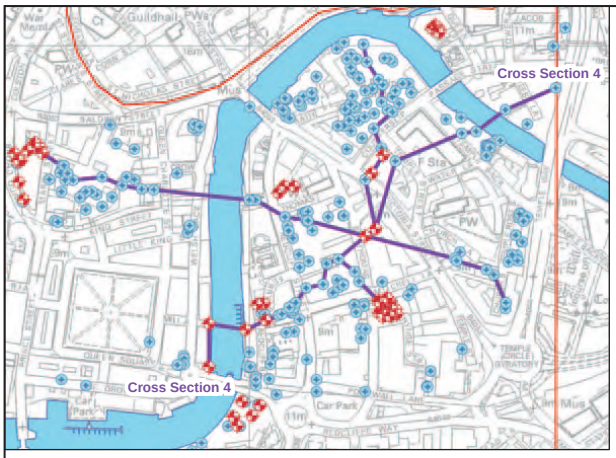
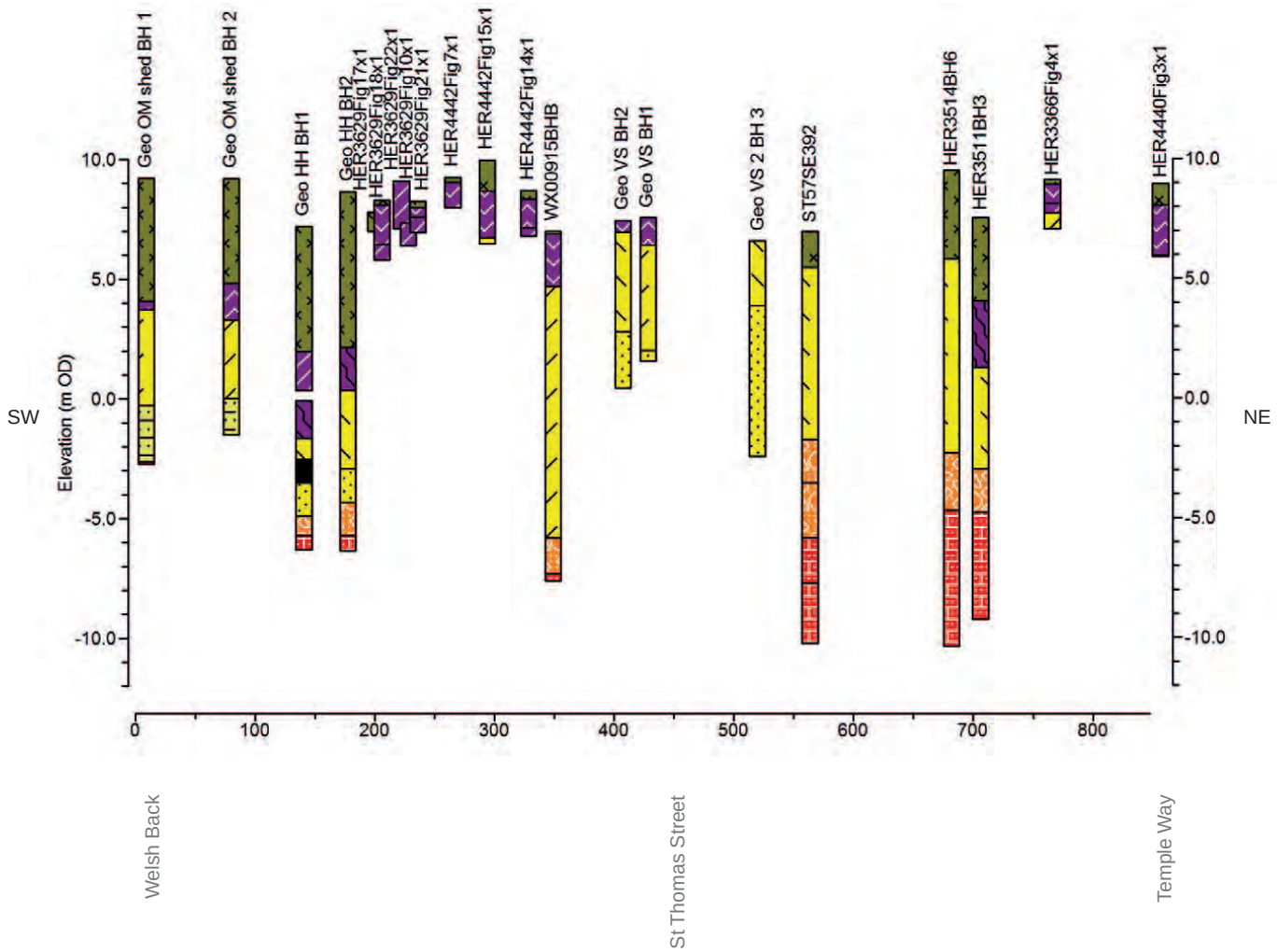
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Cross section 3: Central Redcliffe

PROJECT NO.	3766	DATE	13-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	22
APPROVED BY	PJM	SCALE@A4	N/A	





- Made Ground
- Archaeological Strata 1
- Archaeological Strata 2
- Proto Urban Deposits
- Alluvium 1
- Peat
- Alluvium 3
- Archaeological Strata 3
- Alluvium 2
- Avon Formation
- Mercia Mudstone
- Carboniferous bedrock

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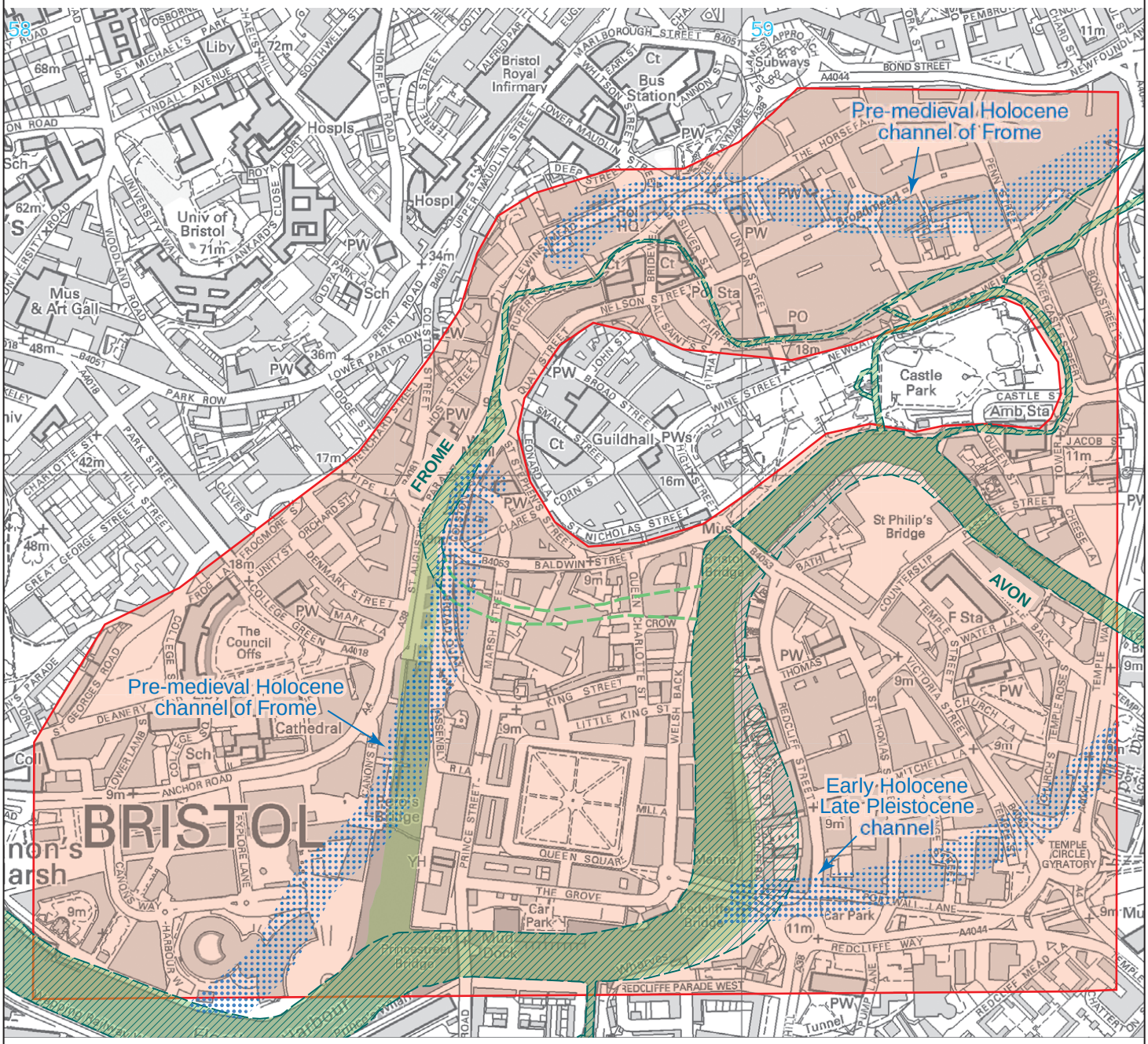
PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Cross section 4: Redcliffe area

PROJECT NO.	3766	DATE	13-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	23
APPROVED BY	PJM	SCALE@A4	N/A	



N

- study area
- putative river channel
- early medieval/medieval watercourse (pre 1240)
- putative former early medieval/medieval (pre 1240) watercourse
- medieval watercourse (post 1240)

0 250m

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PROJECT TITLE
The Distribution and Significance of Urban Waterlogged Deposits in Bristol

FIGURE TITLE
Putative river channels

PROJECT NO.	3766	DATE	13-03-2013	FIGURE NO.
DRAWN BY	LG	REVISION	01	24
APPROVED BY	PJM	SCALE@A4	1:8,000	