Final Report

Assessing the Impact of Trench Arch Drainage Systems on Archaeological Remains in Churchyards

Final Report

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FOREWORD

This reports represents an important step in understanding the impacts of trench arch drainage systems on churchyard archaeology. It was commissioned by Historic England in response to questions about the effects of this drainage method on buried archaeological remains, raised by staff in our regional offices, diocesan and local authority archaeologists.

Trench arch drainage (and other forms of non-mains waste drainage) can be useful methods for remote rural churches wishing to install toilets and kitchen facilities where more conventional waste solutions are not available. This helps with the management and future sustainability of historic churches as continuing places of worship, centres for wider community activities and for visitors wanting to enjoy them as heritage buildings.

The report offers, for the first time, an estimate on the number of these systems installed in churches and their locations. It also summarises the potential risks posed to buried ecclesiastical structures, human remains and other funerary archaeological evidence.

As with any intervention within a historic churchyard, careful consideration is needed as to whether trench arch drainage is appropriate in a particular location.

The report provides a balanced review of the risks and concludes that in certain areas, further research is needed before these risks are understood fully. Until that research has been undertaken, we highlight the following points for those considering trench arch drainage systems:

- Wherever feasible, it is preferable to connect to mains drains if these are available, although making this connection may also have archaeological implications.

- If a trench arch drainage system is proposed, an archaeological assessment of the potential of the churchyard needs to be undertaken at an early stage in developing the project so that the information it reveals can be taken into account in developing the specification.

- The assessment should consider whether archaeological fieldwork, such as evaluation is necessary before permission is granted or works begin.

- Trench arch drains should be located away from archaeologically sensitive areas of the church. Such avoidance is made possible by understanding the archaeological potential of the site.

- It should not be assumed that significant archaeological remains will not be encountered within the top 0.5m, just because this is above current burial depth.

We appreciate that trench arch drainage is considered to offer a low cost / low impact solution for churches without access to mains drainage who are looking to provide greater comfort for their congregation or diversify the range of uses to which their buildings are put. The work in this report, the further research proposed, and the recommendations above seek to ensure that these improvements do not also put at risk important churchyard archaeological remains.

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EXECUTIVE SUMMARY

Trench arch drainage systems are an attractive option for churches wishing to install lavatory and kitchen facilities where suitable mains drainage does not exist. However, the risks these systems pose to buried archaeological remains in churchyards is currently unknown as there has been no archaeological evaluation of their impact. In 2014 English Heritage, as part of the National Heritage Protection Plan (NHPP), commissioned a desk based archaeological study to assess the impact of trench arch drainage systems on archaeological remains in churchyards. Oxford Archaeology submitted a project design for the work in October 2014 and following its approval by English Heritage work on the study was undertaken throughout 2015.

The aim of the project was to assess the risks to buried archaeological remains from the installation of trench arch drainage in order to make recommendations which can help future decision making for faculties and site management. Future guidance will draw on this current project, to meet the overall aim of achieving a balance between conserving heritage and continuing to promote the use of churches by the community in the long term. Employing in-house archaeologists and specialists in human osteology, GIS, heritage management and environmental archaeology, OA worked in consultation with experts in the degradation of archaeological human bone and objects from the Department of Archaeological Sciences, University of Bradford; a specialist in the construction and design of trench arch systems and a diocesan archaeological adviser.

Two surveys, one aimed at the 41 English Church of England diocesan archaeological committees and another aimed at contract archaeologists, were conducted. Primarily, these were to obtain information on the number of trench arch drain installations that have taken place between 2011 and 2015, to record instances of physical impacts on archaeological remains and to assess the frequency with which installations are archaeologically monitored. Seven churches where installations have taken place were selected as case studies and information on usage, management and cleaning and examples of problems/blockages, was obtained. Information obtained from the surveys and case studies, followed up by consultation of designers and installers across England, was employed to explore variation in the design of trench arch systems with reference to soil types and geology. In addition, a literature review of current knowledge on degradation mechanisms of archaeological remains was undertaken and considered in respect of the surveys and case study results.

The main findings of this study are that trench arch installations have taken place at churches all over the country, covering a range of soils, geologies and topographies and sited in archaeologically rich areas. Designs vary in the materials employed and/or dimensions (length, width, depth and gradient) of the trench and some include macerators. All of the installations receive waste water (usually from one lavatory and sometimes a tea/flower point) consisting primarily of sewage, lavatory paper, tea/coffee dregs, flower water waste and biodegradable cleaning products, the latter used on a weekly basis. Information on usage indicates a discrepancy in perceived levels of use and actual use: virtually all of the churches considered usage to be 'low', yet reported patterns suggest this is not always the case with higher levels suggested. In addition, changes in usage patterns following installation are possibly being overlooked. None of the installations were noted by the churches as having associated problems, although one, installed in poor draining soil, possibly had associated damp.

Archaeological monitoring, in the form of watching briefs, has taken place at a number of installations, but has not taken place for all installations recorded in this study. There is generally mixed opinion about whether or not monitoring is required/necessary, reflecting an overall lack of awareness of the potential impacts of trench arch systems on archaeological remains. Archaeologically monitored installations found that the majority resulted in impacts

to buried archaeological remains, most commonly graves and their contents, but also non-burial features, encountered less than 0.5 metres below the modern ground level.

Potential impacts to buried archaeological remains, other than from installation, were explored by literature review in respect of water fluctuation and flow, increases in levels of bio-nutrients and cleaning products. All of these have the potential to accelerate degradation by microbial attack, demineralisation and chemical hydrolysis. However, precise mechanisms and outcomes are not clear on the basis of current knowledge and without scientific testing. Unfortunately, the opportunity to explore these by inspecting the systems following installation was not presented during this study: no archaeological monitoring has taken place following any of the installations considered in this report and there was no opportunity to inspect any of them.

The conclusions of the study are that the impact of trench arch systems on buried archaeological remains seems to be currently under appreciated. Usage patterns of these systems requires greater consideration and greater attention needs to be given to the siting of these systems. Current understanding of impacts needs developing through laboratory tests and monitoring. The production of best practice guidance is recommended.

Assessing the Impact of Trench Arch Drainage Systems on Archaeological Remains in Churchyards

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1 INTRODUCTION, AIMS AND OBJECTIVES

This report describes the results of a desk based archaeological assessment of trench arch drainage systems (TADs) in churchyards. The project was commissioned by English Heritage as part of the National Heritage Protection Programme Measure 2 - Strategic threat and assessment response; Topic C - Natural and environmental threats; Activity 2 – Attritional environmental threats. English Heritage issued a brief (the Brief hereon) and awarded the work to Oxford Archaeology (OA) following the submission of project design (OA 2014).

The main aim of the project was to assess the risks to buried archaeological remains from the installation of TADs in churchyards and to make recommendations which can help decision making for faculties and site management by HE, diocesan advisors and others involved in development and planning.

The Brief set out the following objectives:

1. *To gather information about various different designs of trench arch drainage systems and how they operate*
2. *To collect data on the prevalence of these systems in different dioceses and the reasons for their installation, and produce case study examples, preferably including design drawings and images of installation*
3. *To identify examples of where installation has led to physical impacts to archaeological remains (buried structural fabric within the churchyard; human remains, etc.)*
4. *To summarise current knowledge on degradation of archaeological materials likely to be present in cemeteries (predominantly human remains)*
5. *To provide an assessment of the expected risks from installation and use of trench arch drainage systems (physical, hydrological, biological and chemical) and make recommendations on how to reduce or mitigate these impacts, or, if appropriate, for additional site or laboratory research and analysis to understand the risks in more detail.*

2 BACKGROUND

In 2001, the Gloucester DAC commissioned a document, called Waste Water from Churches (Elemental Solutions 2001), to provide advice to parochial church councils (PCCs) and architects concerned with the installation of kitchens and/or lavatories at churches where mains drainage doesn't exist. The document had arisen as a result of concerns about the cost and archaeological impact of conventional alternatives (for example, septic tanks) to mains drainage and proposed TADs as a potential option.

Today, TADs are generally favoured by churches across England, particularly in rural areas (Elemental Solutions 2001). Unlike conventional alternatives (for example, septic tanks and cess pools) they are generally considered to be cheaper, well suited to the intermittent and variable usage that church facilities typically experience, do not require sludge removal (and therefore access by large vehicles), do not require deep excavations and ostensibly have less archaeological impact (EH 2014; Elemental Solutions 2001). However, the risks these systems pose to buried archaeological remains in churchyards has, until now, not been considered in any detail.

Description of Churchyard Trench Arch Systems

The Trench Arch system of waste water disposal was designed by Elemental Solutions as a result of research, sponsored by the Department of Environment (Elemental Solutions 2001: 9). The TAD is in effect a waste water infiltration system without the usual pre-settlement by septic tank, designed to accept solid lavatory waste directly into the soil within an enclosed trench just below the surface of the churchyard. The system is intended for soils that are relatively free draining and for very low use applications, such as rural churches where the low loading rate allows solids to decompose by a combination of biological, chemical and physical processes before blockage occurs. Intermittent use with long periods of rest helps to maintain aerobic conditions and encourages decomposition. Here, very low use is considered to be a daily average of around 100 litres of waste water a day (N Grant pers comm.).

A simple construction, TADs comprise a conventional soil pipe (usually extending for a number of metres from the church) which discharges waste water into a *c*. half metre deep by one metre wide trench (Fig 1 and Figs 11-17). The trench is either lined with a 600mm diameter pipe, cut in half and laid with the cut edges flush with the ground, or with breeze blocks laid side on and capped with flat paving slabs to create an arch. A 1:20 slope for a length of 3-4 metres where the soil pipe meets the trench (the 'primary zone') allows solids to spread out and wash clear of the inlet pipe where they would otherwise cause blockage. Waste is infiltrated into the soil in the trench (the 'secondary zone') where biological, physical and chemical processes are able to provide high levels of treatment because of low loading and long retention time. As the water is free to drain away, aerobic decomposition can occur at a much faster rate than in a septic tank.

Details of a standard TAD installation are as follows, with reference to Elemental Solutions (2001, Fig 1) and personal communication with N Grant.

1. *The accommodating trench to be dug to a width of 1m, and depth of 400mm. The length of the trench will depend on factors related to individual developments.*
2. *The trench base should have a 1:20 fall for the first 3-4m.*
3. *The end of the trench nearest to the church should have an entry space for a 110mm pipe, to allow waste material to enter the TA system.*
4. *Either a 600mm pipe (cut in half) should be laid down the centre of the length of the trench, or two parallel rows of hollow six inch concrete blocks should be laid down the centre of the trench with a gap of 400mm for the drainage channel between the rows, and gaps (approximately 30mm) between each block. The blocks should not be bonded.*
5. *The blocks should be capped with 600mm x 600mm paving slabs, and the whole structure covered in a layer of suitable geotextile.*
6. *600mm twin wall pipe with inspection chamber should be placed at any change of direction*
7. *The space between the pipe or concrete blocks and trench edge should be filled with a material such as gravel or pebbles.*

8. *The whole trench may then be backfilled with topsoil on top of the TA structure, slightly over-filled to allow for soil settlement.*
9. *Inspection chambers may also be included in the design, to allow the internal part of the drainage system to be observed in the event of a blockage or other problem.*

A TAD has several advantages over other types of drainage system that have traditionally been used to service churches. These are summarised by Elemental Solutions (2001, 9-10) and are repeated here:

1. *They do not require a source of power, as may be required where waste is to be discharged into a water course.*
2. *Sludge (grit and other organic matter that accumulates at the bottom of a septic tank) is not generated, so does not require removal in order to allow the drain to continue working.*
3. *The system is fully aerobic (i.e. the waste matter is fully surrounded by air), so organic matter is broken down quickly and does not smell.*
4. *The drainage chamber, if constructed at/larger than the recommended width of 400mm, is unlikely to become blocked, as incoming solids are dispersed by the accompanying water flow and downward sloping trench base.*
5. *Although they are primarily designed for infrequent usage, the system can cope with occasional bouts of high usage (e.g. during occasional events hosted by the associated church such as weddings, concerts etc).*
6. *In terms of construction, they are fairly simple, requiring little in the way of specialist expertise, and the excavation of a relatively shallow trench for installation. This means that installation of TA systems is also relatively cheap, as well as saving the cost of connecting facilities requiring a drain to the mains drainage.*
7. *Once backfilled and settled, the surface area above the trench arch is suitable for hand lawn mowing and foot traffic.*
8. *The system is also suitable for use where soils have poor percolation value, and drainage of water may sometimes be a problem.*

3 METHODOLOGY

The methodology is based on that which is described in OA's project design (OA 2014). It involved a number of tasks, broadly categorised here as DAC letters and survey; designer and installer consultation; assessment of systems in use; assessment of frequency and damage and degradation review.

3.1 DAC Letters and Survey

A survey and covering letter (Appendix 1) addressed to the DAC and DAC archaeological advisors of the 41 English Church of England dioceses and diocesan-approved architects were designed to obtain information on the number of trench arch drainage systems installed in churchyards in the last 5 years (since April 2011).

The primary aim of the survey was to understand the scale of possible impacts on archaeology from trench arch systems. The questions were diocese specific and were devised to obtain the following information:

- Whether any TADs had been installed between 2011 and 2015; the number installed; where they have been installed;

- What the TADs comprised/how they were constructed;
- Why a TAD was chosen over other options;
- Where TADs are located in relation to the church;
- Whether any are located next to a water course, trees or other vegetation;
- Details of the contractor [this was so that we could contact them directly for additional information if required];
- Whether the installations were archaeologically monitored;
- Whether any archaeological impacts have arisen as a result of installation (and if so what);
- Whether considered to have been successful (if unsuccessful, why);
- Whether there is any on-going monitoring of installations.

Respondents were also asked to attach any relevant photographs and documentation.

It was originally proposed (OA 2014) that a hard paper copy survey would be issued, but this was subsequently revised so that the survey was made available online using LimeSurvey (https://www.limesurvey.org/en/) with hard copies sent to those who requested them (one individual).

The survey and covering letter were emailed to a total of 57 DAC secretaries covering all 41 English Church of England dioceses using a contact list received from Joseph Elders of the Church Buildings Council. The DAC secretaries were asked to provide names and contact details for DAC archaeological advisors (DAA) and diocesan-approved architects so that the survey could be sent to them as well.

A deadline was given in the letter for returning surveys and, as the deadline approached, secretaries were sent a second email. Those who didn't respond to either email were telephoned where it was possible to obtain contact numbers.

Using the contact details forwarded by secretaries and those obtained through internet and other searches the survey was also sent to a total of 27 DAAs representing 31 dioceses (four DAAs covered two dioceses each), and 220 approved diocesan architects. Many of the architects were approved in multiple dioceses and therefore this helped to maximise the return on information.

Survey results were downloaded from LimeSurvey into a Microsoft Excel 2007-2013 spreadsheet. In some cases, the requested survey information had been relayed over the telephone and/or by email and was recorded separately. This information, in addition to any relevant archaeological reports and architect's drawings provided by the respondents, was combined with the survey results (see results, below).

Topography, geology, hydrology and soil type are primary factors to consider in relation to the degradation of below ground archaeology (Haglund and Sorg 1997; Janaway 2008) and the impact trench arch systems may have. In addition, these may influence whether or not systems are installed and are relevant to any observed archaeological impacts. For these reasons, the NGR for each church was linked to OS/UKHO mapping with geology overlain. In addition, National Soil Resources Institute (NSRI) Soilscapes data, developed by Cranfield University and supported by DEFRA (see: http://www.landis.org.uk/soilscapes/), was obtained from Historic England and linked to each church.

By employing the results of the survey seven churches were selected from the dioceses of Gloucester, Oxford, Peterborough, and St. Edmondsbury and Ipswich from which more detailed information could be obtained, as case studies of churches where TADs have been installed. They were selected based on the quality and quantity of information obtained from

the DAC survey and because they represented the widest possible coverage across the country.

For each case study, names and contact details were obtained for associated church wardens, monitoring archaeologist (if any), architects, and builders responsible for installing the TAD. All of these individuals were then contacted by telephone or email, and information collected pertaining to the following:

- *How the trench arch was installed (extent of excavation, materials and design).*
- *Where the trench arch is located in relation to the church.*
- *Other site specific information, such as known buried structures or remains*
- *Information about burial archaeology in the area of the trench arch system (inferred and/or established through an intervention).*
- *Whether the churchyard around the trench arch has been subject to disturbance, e.g. by animals, horticulture, grave digging and, if so, the extent and frequency of disturbance.*
- *Associated archaeological or other reports.*
- *How often the facilities that feed into the trench arch system are cleaned, how they are cleaned, and whether chemicals are used.*
- *Frequency of facility usage, including seasonal changes in usage.*
- *Types of waste disposed of in the facilities.*
- *How the facilities are managed, e.g. whether bins are provided, the facilities are kept locked etc.*
- *Whether blockages or any other problems have occurred and, if so, how often and how the problem was resolved.*
- *Whether the trench arch system has been opened or inspected internally since the installation and, if so, any general comments on below ground conditions and associated archaeological remains.*
- *Whether there would be any opportunities to view below ground conditions during the present study.*

3.2 **Designer and Installer Consultation**

Information on the design and function of TADs (including design drawings and images of installation) was obtained from designers/architects and installers using the information obtained from the more detailed surveys and case studies. Primarily, this involved a contribution from the project's consultant, Nick Grant, a sustainable building consultant, practical engineer and self builder who first introduced TADs.

Information was also obtained from designers/architects and installers from different parts of the country to explore the extent and distribution of design variations. This information was linked to mapping and soils information as described above.

3.3 **Assessment of Systems in Use**

Ranges in extent and patterns of usage were explored by assessing the data obtained for the seven selected case studies. This considered the following variables:

- *Amount of waste water generated (considered in terms of the number of sinks and lavatories served by the TADs)*
- *The full range and frequency of waste products*

- *Patterns in usage*
- *Management and cleaning*
- *The frequency and extent of blockages/ other problems.*

These variables were considered in relation to the context and setting of the church and more specifically the TADs. Here, context and setting refer to knowledge of the burial archaeology, geology, soils, hydrology, topography, any known above- and below-ground structures and buried remains, trees, associated vegetation, animal activity and local excavations (e.g. grave digging).

3.4 **Archaeological Contractor Survey**

A simple survey (Appendix 1), aimed at contract archaeologists, was designed to obtain information on the frequency with which archaeological schemes of work are required in relation to the installation of trench arch systems (in the last five years) and to record instances of physical impacts on archaeological remains from installation. The survey was also aimed to explore whether archaeological schemes are routinely required by dioceses when TADs are installed.

The survey was designed using LimeSurvey (https://www.limesurvey.org/en/) with the option for hard copies to be sent to those who requested them (no requests). As with the DAC survey, the original plan had been to send out hard copies, but this was no longer considered to be as effective.

A tweet, with a link to a web page about the project, hosted by OA (see: http://oxfordarchaeology.com/news/384-assessing-the-impact-of-trench-arch-drainage-systems-on-archaeological-remains-in-churchyards) was sent out inviting contractors to take part in the survey. In addition, an email with the same link was sent to over 70 archaeological practices listed on the Chartered Institute for Archaeologists' (CifA) website. Efforts were made to include as many companies with less than 10 staff, because it is the small practices that are more likely to undertake archaeological schemes relating to TADs. A deadline was given in the email for returning surveys and, as the deadline approached, a reminder email was sent out.

The survey requested the following information:

- *Company and contact details [for the purposes of chasing up any details only].*
- *Number of trench arch schemes worked on, including details of each church (name, location, etc.).*
- *Type of investigations carried out (e.g. watching brief, evaluation or other).*
- *Depth and extent of archaeology encountered.*
- *Basic description of observed impacts and/or any other observations about the scheme.*

Recipients were also asked to attach any plans, photographs and/or provide any relevant references.

Survey results were downloaded from LimeSurvey into Microsoft Excel 2007-2013. This information was supplemented by data obtained from grey literature reports (obtained via ADS/other internet sources and/or sent by contractors) and by telephone/email conversations with contractors.

3.5 **Degradation review**

A brief, high level review of current knowledge on degradation mechanisms of archaeological materials from graveyards (mainly human remains) was prepared by experts in the

degradation of human bone and materials from the Department of Archaeological Sciences, University of Bradford, in order to place the findings of the present study in context. The review was compiled from site reports, research articles, books and published guidelines spanning the fields of archaeological science, forensic science, soil geochemistry and conservation science.

4 RESULTS

4.1 DAC Survey

The results of the DAC survey are presented here and are based on the survey responses (available digitally), supplemented by telephone calls and emails (see above). The dataset is described first, followed by a description of the information obtained in relation to each survey question.

The dataset

A total of 73 completed surveys were returned and of these 12 were from DAC secretaries, three were from DAAs, 12 were from architects and 46 were from anonymous respondents. Many of the returns were incomplete, or provided little in the way of detailed information and therefore supplementary information was collected from a total of 13 DAC secretaries, seven DAAs, 21 architects and one county archaeologist via emails and telephone calls (Appendix 4).

Obtained information related to churches from 38 of the 41 dioceses. Attempts to obtain information for three of the dioceses (Chichester, Manchester, and Southwell and Nottingham) were unsuccessful and therefore these were excluded from the study.

Although the survey was solely targeted at churches in the dioceses of the Church of England, one of the architects offered information on a Catholic church - St Mary's Cricklade, Wiltshire - and has been included here in the interests of maximising data. For the purposes of the present study this church has been included under the Diocese of Bristol even though it really comes under the Catholic Diocese of Clifton.

Number and distribution of installations (survey question 1)

Of the 38 dioceses, 34 had had TADs installed in the last five years at a total of 84 churches covering most parts of the country. Although the survey did not request information for proposed TADs, information was volunteered with regard to 11 churches (at three dioceses) which have TADs proposed for installation in 2016. In order to maximise information for this study, these have been included increasing the dataset to 95 churches from 38 dioceses.

Four dioceses had not had any TADs installed. In addition, although TADs were said to be present in the dioceses of Canterbury, Leicester and Norwich, no further details were provided.

The number and distribution of TADs is summarised in Table 1, Figs 2-3. The number of installations was highest in the South of the country (in particular, Gloucester, Bath and Wells and St Edmundsbury and Ipswich) where as many as 11 were reported for one diocese (Gloucester). However, this is probably a reflection of the level of information obtained rather than a true indication of geographical distribution.

Table 1 TADs installations by diocese as indicated by the DAC survey

TADs Present (diocese abbreviation; n)	TADs Not Present	Data Not Available
• Bath and Wells (BW; 9) • Blackburn (B; 3) • Bristol (BR; Y) • Canterbury (Y) • Carlisle (CA; 5) • Chelmsford (CH; 1) • Chester (Y) • Coventry (CO; 2) • Derby (DE; 6) • Durham (DU; 5) • Ely (EL; 1) • Exeter (EX; 4) • Gloucester (GL; 11) • Guildford (GU; 1) • Hereford (H; 3) • Leicester (Y) • Lichfield (L; 1) • Lincoln (LI; 3) • Liverpool (LV; Y) • Newcastle (N; 2) • Norwich (Y) • Oxford (O; 4) • Peterborough (PE; 5) • Portsmouth (PO; 1) • Rochester (R; 1) • Salisbury (SA; 3) • Sheffield (SH; 2) • St. Albans (STA; 3) • St. Edmondsbury and Ipswich (SEI; 9) • Truro (T; 1) • West Yorkshire and the Dales (WY; 4) • Winchester (WI; Y) • Worcester (WO; 1) • York (Y; 4)	• Birmingham • London • Sodor and Man • Southwark	• Chichester • Manchester • Southwell and Nottingham

Note: Abbreviations given for dioceses where TADs have been installed (see Fig. 2). Where "Y" is indicated instead of a number, the presence of TADS was identified in the DAC survey but specific examples were not referenced.

Most of the churches with TADs installations were on loamy soils (81.1%; 77/95 churches), with smaller numbers on clayey (13.7%; 13/95) and sandy (6.3%; 6/95 churches) soils (Fig 4). In addition, most of the soils were free draining (65.3%; 62/95 churches) or had slightly impeded drainage (28.4%; 27/95 churches) (Fig 5). Fewer TADs had been installed in soils that were naturally wet (5.3%; 5/95 churches) or had impeded drainage (16.8%; 16/95 churches) (Fig 5).

Reasons for TADs installations (survey question 5)

Reasons for TADs installations were given for a total of 86 churches and these fell into eight different categories (Fig 6) with multiple reasons often given for the same installation. The most common reason was that mains drainage was either not available, or that mains drainage was situated too far away from the church (26/86, 30.2%). Other drainage options having more severe archaeological impacts (17/86, 19.8%), and the church not wishing to or being unable to install a septic tank (16/86, 18.6%), were also common reasons. Other decision influencing factors were: the requirement for a system to cope with infrequent usage; not wanting, or not being able to install a composting lavatory; the lower cost of a trench arch versus the higher cost of connecting to mains drainage; and TADs being considered to be more environmentally friendly than other options.

Trench arch installations proposed but not installed (survey question 1a)

Only three cases were noted where trench arch systems were proposed but not installed. Of these, one was in the diocese of Durham, where a TAD was considered to be unsuitable because of the presence of heavy clay soils. Another was in the diocese of Newcastle, where a planning application was withdrawn for unknown reasons and a second application for an alternative drainage system resubmitted. The third case, in the diocese of Rochester, was turned down because of the potential impact of a TAD on archaeological deposits and the risk of unpleasant smells, coupled with the fact that mains drainage was available. In all three of these cases, the precise church name and location was not given.

What the TADs comprised and how constructed (survey question 4)

Many of the descriptions received on the survey returns in relation to composition and construction lacked detail. Where these could be determined they were all broadly similar in design and installation to the standard type described by Elemental Solutions (2001; see Section 2 above). More detail on the design and construction of TADs was obtained by follow-up emails/telephone calls with architects and installers and is described in the relevant section below.

Location of TADs and proximity to water courses, trees and other vegetation (survey questions 6, 7, 8)

Locational information was returned for a total of 52 churches. Trench arch drainage systems were most commonly located on the north side of the church (21/52, 40.4%: Fig 7). Almost a third of trench arches were located on the west side of the church (16/52, 30.8%), almost a quarter on the south side (12/52, 23.1%), and only three on the east side (5.8%). These locations all, presumably, have been determined by the location of the lavatory within the church.

Information on the distance of TADs from the church was provided for 18 churches. Of these, 11 were located less than 10m away (61.1%; Fig 8). The remaining seven were located more than 10m away (38.9%).

None of the survey responses reported that TADs had been installed next to existing water courses.

Over half the responses indicated that trench arch systems were located next to trees or other vegetation (not including grass/turf: Fig 9). Of these, over a quarter were located next to trees (15/53, 28.3%). Almost half of the sites with this information available were not located near to any vegetation.

Although not relating to a particular question on the survey, additional information on the location of TADs was volunteered in some cases. First, it was frequently noted that TADs were deliberately installed where existing paths were located, in order to minimise the perceived risk of disturbing existing graves. In addition, locations were also heavily

influenced by the proposed location of new facilities within the existing church structure, and the frequency/density of observable burials and grave stones at the current ground level.

Archaeological monitoring and impacts (survey questions 10, 11 and 14)

A total of 15 dioceses said that trench arch installations had been monitored in relation to 25 churches. A further six dioceses (nine churches) said that they hadn't. Neither a yes or a no was indicated by 11 dioceses for 61 churches, although subsequent telephone conversations with DAAs and DAC secretaries suggested that six of these churches had had no monitoring.

A total of 15 dioceses answered the survey questions relating to whether they were aware of any archaeological impacts as a result of installation (including excavation to install and subsequently; question 11, Appendix 1). Of the 15, one said that they were aware of impacts in relation to an installation at one church and this involved burials. The other 14 dioceses said that they were not aware of any impacts, but this question was perhaps confusing, with one respondent stating:

'Q 11 is ambiguous. In each case we were aware of the potential for archaeological impact, but no deposits were encountered. None of the installations had any archaeological implications as the path could be selected which minimized the risk of such, especially under church paths for example'

The comments section provided in relation to question 11 (on impacts) included the following from the one diocese with an observed impact:

'The arch was set above the burial layer'

This was in addition to the following comments from dioceses who responded 'no' to observed impacts:

'Church lavatories and sink facilities are rarely used. The Environment Agency does not require a license due to low water use. Church cleaners are the most likely cause of regular use of detergents, perhaps once a week. Generally speaking, they use eco products'

'The tea making facility use is limited and the Church has been encouraged to use biodegradable washing up liquid'

'We are not aware of any issues with these or, indeed, older installations. We are unsure how to determine this without specific investigation'

No survey returns said that they knew of any on-going monitoring of TADs that had been installed between 2011 and 2015. As a result of telephone conversations, two churches offered to open the inspection chambers on their installed TADs and take photographs, but later said they did not have the time available. It has therefore not been possible to view the interior of any long standing TADs, or associated archaeological deposits, during the present study.

Other relevant monitoring and impact information

Some of the survey responses obtained on the telephone and by email returned general comments (usually in the comments section for question 3) relating to monitoring and impact (see Appendix 4). One response, from an architect, commented that TADs are only installed where they are:

'….technically viable (i.e. where use will be very low; where there has been a successful soil percolation test, according to the calculations set; and where there is suitable, flattish, land without burials)'

They then went on to say:

'…there is still a triple lock on such drains - building control, the Environment Agency and the DAC all have to approve. Building control will not agree where ANY other form of drainage is viable. The Environment Agency will not agree where any watercourse might

possibly be affected (I don't remember their limit but I think it was hundreds of meters). The DAC will not agree where any burial or archaeological deposit might be affected.'

As a result, they considered TADs to be

'.. correspondingly rare'

Stating concern that archaeological impact is not

'….properly assessed by the DACs and their archaeological advisors/members is, in my experience, misplaced. Another example: I am about to design a WC in a medieval church. I haven't suggested a trench arch, because the churchyard will be dense with burials, other possible archaeological deposits AND because building control will not allow a trench arch where there is any possible sewer connection (which here there is, albeit at a good distance and across a road, which will be expensive). Even the drain excavation in a churchyard path will need archaeological oversight.'

While another DAC said they strongly encourage the use of TADs in churchyards, they said that obtaining approval from local authorities was difficult, the authorities being unsure about

'…what to approve because these systems have no moving parts.'

Conversely, according to another architect building control is relaxed/confident about TADs, and in some cases no planning permission is required at all. However, another had to get both Environment Agency and local authority building regulation approval which imposed certain conditions, for example, the TAD has to be low usage; access is restricted and the TAD is managed at busy times. In addition, the use of hazardous chemicals/heavy duty cleaner is prohibited and only single ply lavatory paper is allowed.

Another architect commented on avoidance of impacts thus:

'…aiming to route the trenches through areas 'apparently free of graves'. Clearly there is still a risk of exposing shallow, unmarked remains [sic] Building Control appear to be both relaxed and confident about these installations, though their response in some cases has been to say 'no application required'.'

One DAC secretary wrote:

'As most of our 400+ churches are in rural locations, TA [trench arch] *remains the most cost effective way of providing a WC for a church. The Diocesan Archaeology Advisor attends all DAC meetings and will usually make a site visit to assess the likely impact of the scheme and make recommendations accordingly.'*

In addition, an architect considered that, to the best of their knowledge, they've installed systems

'…without any significant disturbance to articulated skeletons'

They considered TAD to be a success because of this and elaborated with comments about usage and construction:

'Overall the systems work very well in my opinion. The amount of material which is discharged into them is very small and we often have to recommend that churches flush the lavatory two or three times a week just to keep the system active and stop it drying out. As an adaptation of the suggested layout in the Gloucester DSE paper we have added an external interceptor chamber close to where the system leaves the church and also just before the start of the trench arch itself. This is so that we have got access to the system if we need to let the ground rest. An earlier system we put in nearly 7 years ago seems to be functioning fantastically well with no signs of any settlement of the ground where it was installed. There

is also no difference in the colour of the grass which still seems to be growing as abundantly as neighbouring areas. We have also installed a combination of a trench arch and a pumped system (with macerator). It would be interesting to know whether the system works better with a 'liquid feed' for the worms rather than solid. I've been doing a lot of work with the Environment Agency getting them to be comfortable with these systems in the district in which I am working.'

Further comments reflect general perceptions of TADs in relation to impacts. One builder considered burials not to be an issue because they '….tend to dissipate' and some reflected the view that burials won't be encountered under existing paths:

'*… many churchyards have been shown in recent years to have archaeological deposits within the first 400mm from the [ground]surface level [……] this system appears to have extensive shallow excavation requirements. However, if situated beneath existing pathways it (trench arch) may be preferable to traditional methods. However, there is an obvious potential conflict here with existing service runs.'*

Others (architects and church wardens) were of the opinion that archaeological monitoring wasn't necessary because the only impact would be to post-medieval burials.

One architect considers TADs to be:

'….a brilliant solution to the provision of WCs in our rural churches.'

And went on to say:

' So long as the ground drains reasonably effectively, there really should be nothing that can go wrong. I specifically avoid installing inspection hatches as they should not be necessary and I am keen to avoid possible sources of unpleasant smells. Similarly, I have not installed any form of vent into the chambers. The process of flushing and introducing oxygenated water with each flush should be more than adequate. The process of decomposition is surely no different to normal burials, excepting that the deposits are replenished. The rate of solid deposits is unlikely to be more than 5 a month. I do make sure that the WCs concerned do not utilise any toxic non- degradable cleaning products or bleaches, or flush any inappropriate materials.'

Were installations considered to have been successful? (survey question 12)

Of the 95 systems that had been installed at the time of this study, almost all were considered to have been successful. Only one church (St Mary's, Woolpit, see Appendix 3) described possible problems in relation to a TAD installation, but despite this couldn't say they thought it was a failure (their investigation of the problems had not been concluded at the time). This is discussed in Section 4.3 below.

Supplementary information (Appendix 4) provides some further information on problems associated with installations and is perhaps relevant here :

'All our [this architect firm's] trench arch systems [not all in churchyards] have been installed following the guidance available on the Gloucester DAC website. Apart from the normal locations on the drains leading to the trench arch we have not used inspection chambers. The only occasion we had to inspect a trench arch itself was one installed at a country house to provide facilities for visitors. Here, a blockage occurred when paper towels were flushed down the lavatory on a regular basis. We were able to access the drain by lifting some of the slabs over the trench arch. We discovered that the paper towels had dropped into

the trench arch and had slowly built up to eventually block the end of the drain pipe. This was easily removed and a hand dryer was installed and the use of paper towel, discontinued.'

In addition, another architect commented that they did not know of any problems but doubted there were any, because the TAD doesn't take solid waste :

'There is a trench arch for the kitchen waste water and a 300mm inspection chamber just before the outlet to the arch, which is more for rodding the pipe work and outlet than inspecting the arch detail itself. I would be very surprised to find any problems with it because it does not take solid waste. We can check it next time on site but from recent visits to the church no signs of the arch were visible from above.'

4.2 **Information on trench arch systems – designer and installer consultation**

Consultation with installers and architects has identified seven variations on the basic TADs design, described in section 2.1. These have been called TAD Type 1 – 7 and their geographical distribution plotted (Fig 10). They are described as follows.

- ***TAD Type 1:*** *The basic TA form is retained, but the width and depth of the excavated trench, as well as the gradient of the trench base may differ from the recommendations.*
- ***TAD Type 2:*** *The basic TA form is retained, but a double drainage chamber is constructed (i.e. three parallel rows of hollow concrete blocks capped by two rows of paving slabs).*
- ***TAD Type 3:*** *The basic TA form is retained, but the arch is constructed from brick.*
- ***TAD Type 4:*** *The basic TA form is retained, but built to different dimensions. The parallel rows of concrete blocks line the long sides of the trench. No space is left either side of the blocks for the inclusion of gravel.*
- ***TAD Type 5:*** *The basic TA form is retained, but the concrete blocks are anchored down with rebar.*
- ***TAD Type 6:*** *The basic TA form is retained, but a pumped system with macerator is included.*
- ***TAD Type 7:*** *A plastic half pipe is laid the full length of the trench to create a void instead of the concrete TA structure. The pipe may be perforated, may be covered with geotextile, and the sides/top of the trench backfilled with gravel, stone or topsoil.*

Examples of TAD Type 1 were observed at several churches located within the dioceses of Derby, Ely, Gloucester, Oxford, Peterborough, Salisbury, St. Albans, St. Edmundsbury and Ipswich, and Winchester (Figs 11-17c), and are the most common form of TAD observed in this study. The excavated trench widths vary from 400mm-1000mm, and trench depth from 400mm – 1150mm. In addition, trench base gradients vary slightly from the recommended type, depending on the overall length of the excavated trench.

One example of TAD Type 2 was observed in the Diocese of Coventry, at All Saints church in Sherbourne (Fig 17). The excavated trench was 1600mm wide, but only 400mm in depth. However, all other aspects of the construction follow the Elemental Solutions methodology.

A TAD Type 3 was observed in the Diocese of Guildford, at St. Mary and All Saint's church, Dunsfold. The system was constructed from brick, measured 40m in length, and was situated within a 500mm deep trench. It was not possible to clarify what type of brick was used from the given description.

The TAD Type 4 was observed in the diocese of St. Edmundsbury and Ipswich, at St. Mary's in Woolpit (see case study 7, Appendix 3) The excavated trench measured 8m long and 450mm wide and was constructed to produce a 250mm deep drainage chamber. The trench was lined with concrete blocks and then capped with paving slabs. The gradient of the downward slope was 1:50 for 5m, rising up for the remaining 3m.[i]

A TAD Type 5 was observed in the Diocese of Gloucester, at St. Katherine's, Wormington (see case study 2, Appendix 3). The excavated trench measured 12m long and the arch was constructed from concrete blocks anchored down with rebar and capped with paving slabs.[ii]

One example of a TAD Type 6 was observed, at St Lawrence's Church, Thornton Curtis. In this case, a pumped system with a macerator was included at an unknown point in the drainage system so that only "liquid feed" was introduced into the TAD. All other aspects of the installation follow the Elemental Solutions methodology/design.

The TAD Type 7 was the second most common type observed in this study. It was observed in the dioceses of Coventry, Peterborough and Portsmouth. Excavated trench dimensions were similar to the Elemental Solutions type. The pipes utilised in these drains are typically 600mm wide, and split in half lengthways. Plastic pipes were used in the majority of cases, although a stainless steel pipe was utilised at St. Leonard's at Glapthorne in Diocese of Peterborough. The only church where the pipe was noted to have been perforated was St. Peter's in Bishop Waltham, diocese of Portsmouth. The pipe at St. Peter's, Bishop Waltham was also covered with geotextile.

The distribution of the different types of TADs in relation to soils shows no pattern (Table 2)

Table 2 Distribution of TAD types in relation to soils

TAD type	**Soils**	**Number of churches**
1	Free draining/loamy	15
	Slightly impeded/loamy	3
	Slightly impeded/clay	4
	Slightly impeded/clay	1
2	Free draining/loamy	1
3	Impeded drainage/loamy	1
4	Free draining/sandy	1
5	Free draining/loamy	1
6	Slightly impeded drainage/loamy	1
7	Free draining/loamy	1
	Slightly impeded drainage/loamy	1
	Impeded drainage/loamy	1

4.3 **Detailed Assessment of Systems in Use from Case Studies**

This section describes information obtained from seven selected case study churches on the extent and usage patterns of facilities served by TADs (summarised in Tables 3-4 and detailed in Appendix 3). First, it considers setting and context followed by information on the different usage variables set out under 'methodology' (Section 3). The churches are listed in Table 3.

Table 3: Case study summary

Diocese	Church Name	Location	Map Code
Gloucester	St. Katherine's	Wormington	GL9
Gloucester	All Saint's	Newland	GL10
Oxford	St. Mary's	Kirtlington	O4
Peterborough	St. Mary and St. John	Brington	PE1
Peterborough	St. Peter and St. Paul	Scaldwell	PE3
St. Edmundsbury and Ipswich	St. Mary's	Shotley	SEI1
St. Edmundsbury and Ipswich	St. Mary's	Woolpit	SEI8

Table 4: Summary of assessment of systems in use from case studies

Name of church	**Diocese**	**Number of water services**	**Range of waste products**	**Frequency of waste products***	**Patterns in usage**	**Management and cleaning**	**Frequency and extent of blockages/other problems**
All Saints', Newland	Gloucester	2 lavatories; 2 bathroom sinks; 2 kitchen sinks	Sewage; waste paper; lavatory paper; tea and coffee leaves/granules	Sporadic	Church services twice a month; community events** 4-10 times/yr; No evening groups ; very occasional large school groups; approx. 14,000 visitors to church/year	Lavatories open all week for general public; Cleaning of lavatories – once/week; kitchen after each occasional use. Only eco-friendly cleaners and detergents used.	No blockages/other problems
St Katherine's, Wormington	Gloucester	1 lavatory and small sink	Waste water; sewage; lavatory paper.	Infrequent	Church services 3 times/month; occasional lunchtime functions; WI meetings (occasional, not held on a regular basis)	Lavatory kept locked when not in use (but parishoners know where to find a key) Cleaned infrequently (once a week) with eco-friendly detergent.	No blockages/other problems
St Mary's, Kirtlington	Oxford	1 lavatory and sink (may link a second sink in near future)	Sewage, waste water and lavatory paper.	Sporadic	Church services 3 times/week; pilates classes 1/week; meetings approx. 1/week; approx. 11 baptisms, weddings and/or funerals/year;	Lavatory unlocked at all times – known to be used frequently as a public lavatory. Notice in lavatory asking that nappies/sanitary items	No blockages/other problems

Name of church	Diocese	Number of water services	Range of waste products	Frequency of waste products*	Patterns in usage	Management and cleaning	Frequency and extent of blockages/other problems
					two summer concerts; large Christmas service and carol concert (100+ attending)	aren't put down the lavatory with bin provided. Cleaned once a week.	
St Mary and St John's, Brington	Peterborough	Lavatory and sink	Waste water, lavatory paper, sewage	Infrequent	Church services once/week; 2 Summer concerts; a Christmas service and Fayre; c. 20 weddings/funerals.	Lavatory open for public use at all times. Notice in lavatory asking that nappies/sanitary items aren't put down the lavatory with bin provided. Cleaned once a week using eco-friendly products	No blockages/other problems
St Peter and St Paul's, Scaldwell	Peterborough	One lavatory and sink; one kitchen sink	Waste water, lavatory paper, sewage	Regularly	3 days/week (services and mother and toddler group); occasional weddings/funerals; one large Christmas event (Christmas Eve)	Lavatory open for use all the time, but thought that use is limited outside scheduled services. Notice in lavatory asking that nappies/sanitary items aren't put down the lavatory. Infrequent cleaning (once a week) using eco-friendly sink/lavatory cleaner (Tesco/Waitrose)	No blockages/other problems
St Mary's, Shotley	St Edmundsbury and Ipswich	1 lavatory and sink; one tea	Sewage, waste water and lavatory	Infrequent	Services once/week; weddings (3-4/year)	Infrequent cleaning (once a week) using	No blockages/other problems

Name of church	Diocese	Number of water services	Range of waste products	Frequency of waste products*	Patterns in usage	Management and cleaning	Frequency and extent of blockages/other problems
		point	paper		and funerals (5+/year)	eco-friendly products (Ecover). Restricted access to factilities – only unlocked for services. No notices have been put up.	
St Mary's, Woolpit	St Edmundsbury and Ipswich	Lavatory and sink; sink for flower arranging	Sewage, lavatory paper and waste water.	Low usage	Services once/week; occasional weddings and funerals	A bin is provided for waste products that shouldn't be flushed down the lavatory. Cleaned infrequently	No reported blockages. Damp on north side of the church in the vicinity of the TAD. No plans to address this at present, but anticipate needing a second drain run.

*Frequency as perceived by the survey respondent; ** Fayres, concerts, etc.

Setting and context

The churches all have associated burial activity dating back to at least the 11th or 12th century with the exception of St Mary's, Woolpit which dates at least to the mid 15th century. Archaeological investigation has established that at least two of the churches – St Mary Shotley and All Saints, Newland - are sited in the vicinity of earlier archaeological features, including evidence of pre-medieval land-use and Bronze Age features. In addition, St Mary, Shotley, includes Commonwealth war graves dating to the First World War.

According to NSRI Soilscapes data all of the churches are sited on free draining soils, with the exception of St Mary's Woolpit, which is located on soils with impeded drainage. In addition, soils are acidic loamy (All Saints, Newland; St Katherine, Wormigton and St Mary, Shotley); acid, loamy and clayey (St Mary and St John, Brington); acidic and sandy (St Mary's, Woolpit) and loamy (St Mary, Kirtlington). Trees/shrubs are located in the vicinity of all of the churchyards. None are thought to have been disturbed by digging by animals or for horticulture, but it is not clear whether there are ongoing excavations for burial and if so, how extensive these are.

Amount of waste water generated

In general, the TADs installed at all seven churches served a small number of facilities requiring a relatively limited amount of drainage. Six of the churches had TADs to serve one lavatory and an associated sink each and one had a TAD to serve two lavatories and two associated sinks.

Full range and frequency of waste products

The range of waste products comprised sewage, waste water, cleaning products, lavatory paper and tea/coffee dregs. When specified, all of the cleaning products were eco-friendly. All of the lavatories and sinks were considered to be used infrequently, although patterns of usage (see below) indicated that this was variable.

Patterns in usage

All of the churches considered usage to be 'low' or 'infrequent'. This is with the exception of St Peter and St Paul's, Scaldwell, where facilities were said to be used 'regularly'. Church services were held as little as twice a month at one church (All Saints', Newland) to as much as three times a week at another (St Mary's, Kirtlington). In addition, two churches (St Mary's Kirtlington and St Peter and St Paul, Scaldwell) hosted regular (weekly) group meetings (pilates/mother and toddler groups). Use for weddings/funerals/baptisms was very variable. Other patterns in usage included large Christmas events, Summer concerts and visits from large school groups. One church (All Saints', Newland) had counted 14,000 visitors in one year.

Overall, these patterns reflect sporadic use throughout the year with occasional high use at certain times, in particular Christmas. They suggest that overall usage of TADs could be higher than the 'low' usage that they were designed to service in some cases.

Management and cleaning

All churches used ecologically friendly cleaning products for lavatories and sinks. The regularity with which cleaning was undertaken was, generally, as required for kitchen sinks and infrequently or once a week for lavatories and sinks. Five churches kept their lavatories unlocked at all times for public use (with one stating it was known to be used 'frequently' as a public lavatory and another stating that use was thought to be 'limited' outside scheduled services). Several of these churches had put up signs to remind users not to place nappies/sanitary items in the lavatories and had provided bins. Two churches kept their lavatories locked when the church was not in use, but one of these stated that the parishoners knew where to find a key.

Frequency and extent of blockages / other problems

Six of the churches stated that they were not aware of any blockages/other problems. One church (St Mary's Woolpit, St Edmundsbury and Ipswich diocese; see case study 7, Appendix 3) described the ground being excessively damp on the north side of the church in the vicinity of the TAD. The church has anticipated that a second drain may need to be dug to deal with the problem, although this was not considered to be a priority for church funds and there are no current plans for further drainage works. Although the precise reason for the ground becoming damp is unclear, it is possible it is related to the design of the installed trench arch and the fact that the soil has impeded drainage.

4.4 Contract Archaeologist Survey

This section presents the results of the survey sent to contract archaeologists. A description of the data obtained is presented first. This is followed by information obtained on the number of schemes worked on; type of investigations carried out; depth and extent of archaeological remains encountered and observed impacts.

The dataset

A total of 9 survey responses were received from eight archaeological units and one self-employed archaeologist. It should be noted that many of the survey responses were incomplete and therefore the information received was supplemented by data collected from reports, attached with the survey returns and from follow-up emails and/or telephone calls to archaeological contractors and county archaeological advisors (from the local government Historic Environment Records office). One response, covering four churches (all in Exeter, diocese), was not viable, as the churches described within the response did not actually have any TADs.

Number of schemes of work

A total of 10 TAD schemes were described as having been worked on by the nine archaeological contractors over the last five years (Table 5). All of the schemes were subject to archaeological watching briefs and they all encountered archaeological remains with the exception of one (Christ Church, Cricklade, Swindon) which found none.

Table 5: Trench arch schemes worked on by contract archaeologists in the last 5 years

Diocese	Church Name	Location	Map Code
Bristol	Christ Church	Cricklade Street, Swindon, Wiltshire	BR1
Bristol	St Andrew's	Tadpole Lane, Blunsdon, Wiltshire	BR2
Bristol	All Saints Church	Church Place, Lydiard Millicent, Wiltshire	BR3
Bristol	St. Mary's	High Street, Cricklade, Wiltshire	BR4
Lincoln	Holy Trinity	Alford Road, Bilsby, Lincolnshire	-
Salisbury	St Katherine's and St. Peter's	Winterbourne Bassett, Wiltshire	SA4
Sheffield	St John the Baptist	Church Road, Wadworth, South Yorkshire	SH1
Winchester	St Mary's	11 Manor Close, Abbotts Ann, Hampshire	WI2

York	St Cuthbert	Church Hill, Crayke, North Yorkshire	Y2
York	Church of St. Hilda	Tofts Lane, Danby, North Yorkshire	Y5

Archaeological remains encountered

The archaeological remains encountered comprised graves, disarticulated bone, non burial related pits and ditches, made ground and residual finds (Fig 18).

As far as could be established from the surveys and accompanying information, a total of 28 medieval or post-medieval graves were encountered at four of the 10 churches. All 28 were plain earth cut graves and they contained one discrete skeleton each (all human remains were fully skeletonised). There numbered between four and 12 graves/skeletons at each of the four churches.

Evidence for coffins disturbed by TADs was reported for two of the churches (St Katherine's and St Peter's, Salisbury, Wiltshire and Church of St Hilda, Danby, Yorkshire). These survived as traces of wood and coffin furniture, including iron nails, iron and coffin handles.

Disarticulated bone was encountered at seven churches, although it was unconfirmed whether that from St. Mary's, Winchester, was human or non-human animal (it has been counted as human here).

Non-grave related pits and ditches were observed at two churches (St Mary's, Cricklade, Wiltshire and St Katherine's and St Peter's, Salisbury, Wiltshire) and comprised an undated linear pit or ditch with associated burning and vitrified fill, and a possible early medieval refuse pit containing 11th – 12th century pottery. These features were dated either stratigraphically, or by associated finds.

Residual finds were found at five churches and were predominantly post-medieval in date, with the exception of Romano-British pottery fragments from St Mary's, Cricklade, Wiltshire. Other residual finds included ceramic floor and roof tile fragments, brick fragments, iron nails, two coins (one dating to the medieval and the other to the post-medieval period) and non-human animal bone.

Depth and extent of archaeology encountered

Excavations ranged from 0.3m to 1m in depth with archaeological remains being encountered from as little as 0.2m below ground level (Table 6). Disarticulated human bone, residual finds and made ground were commonly encountered within 0.3m of the current ground surface (Table 6). The tops of grave cuts, grave structures, pits/ditches and building rubble were encountered from approximately 0.5m below the current ground surface. Articulated human skeletal remains and stone grave structures were encountered less than 0.6m below the current ground surface. As far as could be determined, the full extents of graves and other features (pits/ditches) were not encountered within the excavations.

Table 6: Archaeological feature depths

Feature	**Depth Encountered Below Ground Level**
Articulated human skeletal remains	0.57m
Disarticulated human skeletal remains	0.2m
Grave Cuts	0.46m
Ditch/Pit	0.5m
Made Ground	0.25m
Building Rubble	0.4m
Residual Finds	0.3m

Observed archaeological impacts

All of the graves that were encountered at the four churches were excavated and recorded archaeologically. At three of these churches, articulated skeletal remains were lifted by the archaeologist and returned to the PCC or appropriate church authority for reinternment. The watching brief methods statement for the scheme at St. Peter's and St. Katherine's church in the diocese of Salisbury stated that, should burials be encountered, the drainage system would be re-designed and the burials would be left in situ where possible (Cotswold Archaeological Trust, 2012, 4). However, it was unclear whether this was actually achieved.

No specific notes were made in any report regarding the fate of excavated coffin fittings. It is anticipated that these were either retained or discarded according to the specific finds policies and requirements of the relevant curators.

At all seven churches where disarticulated bone was encountered, this was collected up and then reinterred, either within the excavated TAD pipe trench or elsewhere on the same site. Of the two cases where pits/ditches were excavated and recorded, one was retained in situ. It is assumed that the other was removed prior to the TAD installation. At three of the churches where residual finds were recovered, these were retained and deposited in the local museum. At the remaining three schemes, it was deemed that residual finds were not worth retaining, so a discard policy was implemented.

4.5 Review of Current Knowledge on degradation mechanisms of archaeological materials from graveyards

This section is taken directly from a review of current knowledge on degradation mechanisms of archaeological materials from graveyards by Hannah Koon, University of Bradford. It provides a general overview of the factors that are known to contribute to the degradation of buried remains and associated materials and focuses on human remains and other organic materials which may be preserved in the burial environment.

Degradation of buried human remains and associated artefacts

Once human remains are placed in a burial environment they immediately become susceptible to a range of degrading agents. In order for preservation to take place the organisms that promote decomposition must be inhibited by environmental factors (Janaway 1996; Forbes 2008; Hopkins 2008). In the case of human remains there are several interrelated agents acting on a body, such as internal and external bacteria, fungi, insects and carnivores, which cause decomposition (Bass 1997). Over time an equilibrium / buffering relationship can be achieved between the remains and their immediate environment (High *et al*. 2015; Nielsen-Marsh 2000). However subsequent external changes, in this instance the installation of a drainage system, will likely alter the burial environment and as a consequence may cause accelerated degradation.

Processes of bone degradation in the burial environment

The majority of burials will be represented by the hard tissues only; the soft tissue will be lost and the only organic material to survive is that protected within the bones and teeth by mineral. Bone is essentially composed of two components; an organic matrix (principally a protein called collagen) which is embedded with small (predominately) plate-like minerals of

poorly crystalline bioapatite. It has been argued that both components are in part mutually dependent upon each other for the long-term preservation of bone. The presence of mineral stabilises the collagen fibres, whilst the presence of this protein slows the rate of mineral alteration. The diagenetic processes (chemical processes of bone degradation) that act upon bone are intimately linked to the burial environment. In a large scale study of diagenesis, three pathways were identified, leading either to the preferential alteration of bone mineral, preferential loss of collagen or conditions under which these two components are destroyed as a composite (Collins *et al*. 2002; Smith *et al*. 2007). Outlined below are the main pathways by which bone can be degraded in the burial environment; for in depth reviews on the subject of bone diagenesis see Hedges (2002) and Collins *et al*. (2002).

The loss of bone mineral can occur relatively rapidly as the bioapatite is both poorly crystalline and has a high surface area (Weiner and Price 1986). Apatite mineralogy suggests that apatite is stable at around neutral pH (Hedges and Millard 1995), but the mineral is increasingly susceptible to dissolution at pH's lower than this (at higher pH, the phosphate dissolves but alternative calcium minerals such as Ca(OH)2 are precipitated). Therefore in environments in which the pH is sufficiently low to promote dissolution and the burial environment favours removal of the dissolved phosphate (i.e. in free draining soils), it is predicted that the bone will rapidly lose its mineral component. In a dynamic environment, where the water table is fluctuating through the archaeological layer, a buffered zone between the skeletal remains and the surrounding soil water would have to constantly be re-established, leading to more and more dissolution of bone mineral (High *et al*. 2015; Cronyn 1990; Cronyn 2001). Subsequent accelerated alteration in collagen may be a consequence of the partial removal of the mineral. It has been speculated that loss of apatite decreases the stablization of the collagen fibrils (Covington *et al*. 2006).

Collagen is believed to be protected from biodegradation by close association with the mineral phase (i.e. Nielsen-Marsh *et al*. 2000), and will therefore decay by chemical hydrolysis if the mineral is present (Collins *et al*., 1995). If the mineral is removed however (see above) collagen will be exposed to rapid hydrolysis by enzymes known collectively as collagenases, which are secreted by microbes (Child 1995). In other words, if bone is in an environment where the mineral is not altered, the only way in which the collagen can degrade is via the relatively slow (time and temperature dependent) process of chemical hydrolysis of the peptide bonds. If the bone is in an environment what will cause dissolution of the mineral the exposed collagen will be rapidly degraded by microbial attack.

Much bone is subjected to microbial attack by both fungi and bacteria (for an overview of the types of microbial alteration see Hackett (1981) and Jans *et al*. (2004)). This attack can occur within a few years (Yoshino *et al*. 1991) or even months post-mortem (Bell *et al*. 1996, although the sample in question was recovered from a predator scat). The microbes demineralize the bone, which leads to the destruction of histological features (Garland 1987; Jackes *et al*. 2001) and an increase in porosity (Jans *et al.* 2004), which in turn can accelerate degradation of the collagen (Nielsen-Marsh and Hedges 1999).

Fungi appear to mine bone for phosphate, tending to burrow in from the external surface and cut across bone ultrastructure. In this way they can be differentiated from bone destruction of bacterial origin which respects bone ultrastructure and follows the anatomy of the bone (Jans *et al*. 2002). Using the analogy of dental caries, it has been speculated that this form of attack is principally associated with conditions under which biodegradation of excess organic matter (e.g. for soft-tissues and body fluids) leads to local anoxia, fermentation and the production of organic acids (e.g. putrefaction) (Collins *et al*. 2002). Adventitious removal of the mineral exposes the collagen which then is itself biodegraded. The bacterial and fungal alteration collectively termed 'focal destruction' can be observed histologically from thin sections of bone. A histological index has been developed to assess the extent of microbial alteration to bone (Hedges *et al*. 1995). Using this index it has been shown that bones tend to have either mild or extensive alteration (Hedges *et al*. 1995; Millard 2001). This suggests that unless

microbial attack is inhibited in some way (e.g. by anoxic, acidic conditions) complete destruction will eventually occur.

Degradation of other organic materials

In addition to skeletal remains other associated organic material such as hair, nails, soft tissue, wood and textiles may be preserved in the burial environment. The extent to which these organic materials and associated evidence survive within depositional environments is governed by a number of factors (Dent *et al*. 2004; Forbes 2008). Initially burial mode (i.e. type of coffin construction, presence of textiles, coffin packing, metals fixtures) and burial type (i.e. soil, brick-lined grave, vault, crypt) will have an impact, particularly with post-medieval remains (Garland and Janaway 1989). Soil conditions subsequently have an impact on survival – most notably pH which is influenced by local geological conditions and redox which is affected by water-table, soil compaction and soil particle size distribution. Specific conditions are known to be conducive to the formation of adipocere (Fiedler *et al*. 2004; Hau *et al*. 2014), which in itself can help in understanding the nature of the body, funerary practice and the historic depositional environment. It has long been shown that the condition and survivability of archaeological organics are influenced by the stability of the depositional environment. In experimental taphonomic studies, the disturbance of graves has been shown to affect organic materials through increased aeration, elevated temperatures and increased rates of microbial decomposition (Adlam and Simmons 2007; Carter and Tibbett 2008; Hopkins *et al.* 2000; Stokes *et al*. 2009; Carter *et al*. 2008). At a superficial level varied soil conditions are known to affect the outward appearance of human remains through staining, (independent of the presence or absence of a coffin and of coffin type) which is ascribed to factors within the soil – suggesting that water flow is particularly important here (Beyerolsen and Risnes 1993).

Degradation mechanisms in relation to TADs

In summary, the degradation of buried human remains and associated organic materials is complex and multi-layered, being governed by a number of processes, which in themselves are influenced by extrinsic (for example, presence or absence of a coffin) and intrinsic (for example, age and build of the deceased) variables. The processes may be summarised as demineralisation, chemical hydrolysis and microbial attack by bacteria and fungi. TAD installations, may, potentially, accelerate these processes by primarily introducing fluctuating water levels, water flow and altering the soil pH. This is discussed in more detail below.

5 DISCUSSION

5.1 Introduction

This desk based study has employed questionnaires to assess the distribution and extent of TADs in churchyards across England and their patterns of usage. It has also explored impacts on archaeological remains, both in terms of actual impacts recorded through archaeological monitoring and potential impacts reviewed from current knowledge on degradation.

5.2 Robustness of the findings of this study

Before discussing the results of this study, it is important to consider some limitations. First, information obtained from the DAC survey varied greatly depending on the diocese and respondent, this being reflective of numerous factors, such as differences in how information was recalled, whether from memory or by searching information management systems, differences in information systems (paper or digital files, etc.), the amount of time spent on looking up/recalling examples and different levels of involvement with installations (e.g.

secretary/DAA/architect). For example, information was collected for a total of six churches in the Diocese of York, however a phone conversation with the DAC secretary indicated that at least 30 installations have actually taken place. Further, others referred to a lack of resources to undertake the enormous task of tracking down examples by searching reports/records, most often non-digital. To quote one DAA:

'It would be possible work out a full list of churches through the diocesan records, but I am told these have been archived. All applications for major drainage works are automatically covered by a clause which states that an archaeological watching brief should be carried out in accordance with a written brief. So any archaeological work done during these years should have been described in a "grey literature" report and submitted to the Norfolk Historic Environment Service. Such reports will have been filed under HER record numbers and I do not think there would be any way of searching under the term "Trench Arch".'

In addition, there is also the possibility that not all questions in the survey were understood. For example, at least one respondent said that question 11 was ambiguous (see 'Results' above).

These factors – misunderstanding the questions and variation in recalling information – will have biased the information on extent, distribution, types and usage of TADs to some degree. That said, the information was obtained from a large number of individuals, including DAC secretaries, DAAs and architects, from the vast majority of dioceses. Thus, the survey results represent a good coverage and, despite the aforementioned biases, are considered to be relatively robust in terms of addressing the aims of this study.

Regarding the archaeological contractor survey, most information was obtained from reports, rather than directly from survey responses. Reporting was very variable in terms of detail and terminology employed, with some information being ambiguous. For example, it was not always clear what archaeological remains were found in relation to TAD installations when excavations relating to other installations/developments were also involved. In addition, TADs appear to be referred to as 'soakaways' in some instances. These discrepancies are not considered to have had significant effect on the data reported here, however.

Lastly, literature review has shown that current knowledge of degradation in churchyard settings is somewhat limited for assessing the impact of TADs on archaeology. Most of the observations reported here (in particular those presented in the discussion on impacts, below) are based on patterns/outcomes observed in various non-graveyard contexts, including agricultural settings, and require testing via experimentation and monitoring of TADs which have been installed.

5.3 **TAD installations: extent, design, usage, monitoring and impact**

According to the DAC surveys a total of 95 TADs were installed across England between 2011 and 2015 and were primarily at churches in rural locations in loamy, free draining or slightly impeded draining soils. The number of installations probably under-estimates the *actual* figure, possibly quite significantly considering the issues associated with recalling information (see above). It would therefore seem that TADs are being installed in high numbers across the country.

Contrary to the standard design described by Elemental Solutions (2001), installations were found to be considerably varied in terms of materials (brick/concrete/plastic pipe) used and extent (depth, length, width and gradient). They are therefore less of a known entity in this respect than has perhaps been previously considered. Further, usage patterns would suggest

that, certainly in some cases, they may not be serving the 'low' level use they are designed for. For example, in addition to high usage at key points in the year (for example, Christmas), some lavatories are left unlocked for public use and some churches hold weekly classes/toddler sessions. In addition, the fact that one church recalled 14,000 visitors in one year but described usage as 'low/infrequent' suggests that levels of use are perhaps being overlooked at the planning stages of installations, or that changes in use following installation are not being considered.

Both the DAC and archaeologist surveys reflect mixed perceptions about impacts to archaeological remains from TAD installations. In terms of the planning process, TADs appear to fall into a 'grey area', being treated differently by different local authorities and/or dioceses. Thus, some churches are required to obtain planning permission for installation while others aren't. This means that archaeological monitoring does not always take place when the systems are installed, reflecting mixed opinion about their perceived risk to archaeological remains and a lack of awareness of the potential impacts. General opinions are that impact is non-existent/minimised because TADs require shallow excavation and that siting them under existing paths will avoid archaeological remains. The standard TAD design requires excavation to approximately 400mm, which is shallow in relation to other types of drain installation (for example, septic tanks). However, the findings of the archaeologists' survey show that excavations were up to one metre deep in some places. Further, undisturbed archaeological remains were encountered in excavations from less than 0.5 metres. These results suggest that the relative shallowness of TADs in comparison to other types of installation is irrelevant here, because even at these relatively shallow depths there is excavation into the archaeological horizon and disturbance to features. Thus, the consideration that TADs require shallow excavations is misleading in the context of archaeological impact.

5.4 **Potential Impacts of TADs installations to buried archaeology in churchyards**

This discussion considers the potential impacts of TADs on buried archaeological remains in churchyards. It has primarily been taken from text prepared by Hannah Koon and colleagues, of the University of Bradford, with information included, where relevant, from the surveys and designer/engineer consultation. It will focus specifically on those factors that are likely to change as a direct result of the installation of TADs, and potential ways in which this might impact nearby archaeological remains, burials in particular.

The present study was unsuccessful in identifying an opportunity to inspect a TAD that has been installed to observe what impact it may have on archaeological remains. In addition, there were no reports returned in the surveys from archaeology practices or DACs of observed impacts, other than those relating to installations themselves.

Human remains and associated archaeological deposits as an important resource

Any discussion on the potential impact of TADs on archaeology is not complete without considering the significance of the archaeological resource, in particular, human remains. Recent work has focused on research practice and sampling strategies for enhancing our understanding of burial grounds and human remains as a resource, highlighting the research potential of such assemblages and the measures needed to maximise information recovery (APABE 2013; APABE 2015; Powers *et al*. 2013; Wilson *et al*. 2013). Increasing emphasis on holistic approaches to understanding our past are in usage as evidenced by the concepts of Archaeothanatology (Duday *et al*. 2009) and the Index of Care (Tilley and Cameron 2014) in the study of archaeological burials. Both concepts place increasing importance on contextualising evidence at an individual level. This importance draws upon often quite ephemeral evidence – including botanical and other environmental evidence - to understand

care, compassion and funerary practice evident at excavation. This type of evidence will only survive under specific environmental conditions and will be affected by adverse changes to the stability of the depositional environment. Parallels can be drawn from our understanding of the survival of palaeoenvironmental evidence (Jones 2011) recovered from organic deposits in urban settings that have been described as 'irreplaceable [palaeoecological] archives at risk' (Kenward and Hall 2008) due to threats from development and changes to groundwater. Another relevant example of the dramatic impacts to organic remains when the burial environment is altered can be seen in recent findings from Star Carr. At this important archaeological site recent changes in the water table have led to accelerated degradation of faunal material (Milner *et al.* 2011).

Organic molecules such as DNA, osteocalcin and collagen are able to survive within bone for thousands of years and have been used to provide information on topics as diverse as migration patterns, diet, genetics, sex, age and aging. Bone collagen, for example, has been utilized for radiocarbon dating (van Klinken and Hedges 1998), stable isotope paleodietary analysis (Ambrose 1993; Makarewicz and Sealy 2015; Schoeninger *et al.* 1983) and amino acid racemization dating (AAR) (Csapó *et al*. 1994). Assemblages where soft tissues, such as hair, nail, muscle and brain matter survive in addition to skeletal remains, offer research opportunities through survival of additional biomolecular evidence. These have most frequently been recovered from post-Medieval assemblages, where the potential for soft tissue remains is highest (Wilson *et al.* 2013). Keratotics such as hair and nail offer scope for genetic studies (Bengtsson *et al.* 2012) and high-resolution diachronic isotopic data resulting from the incremental growth of these tissues (Thompson *et al*. 2014); similarly, brain matter has seen extensive study (O'Connor *et al.* 2011). There is an ever-greater potential of DNA studies, based on the reduced cost and increased speed of next generation sequencing methods. Yet, the susceptibility of degraded material and difficulty of decontaminating archaeological human remains has previously been shown to be a limiting factor for genetic studies (Gilbert *et al.* 2005; Pilli *et al*. 2013; Sosa *et al.* 2013).

In terms of artefactual material, post-medieval burial grounds will have a range of metalwork, ranging from construction fittings such as nails and closures, to important documentary sources such as depositums (with epigraphic data), to decorative fittings such as coffin grips and grip plates; end plates, escutcheons and upholstery pins. These have conventionally been made from a range of materials, including, iron, lead and copper alloy and have included a range of surface finishes, such as various white metal finishes, and paint (Litten 1992). Each provides insight into funerary custom, design and technology of manufacturing. Organics (both from the coffin – wood, textile coverings and fittings such as mattresses and pillows; and the body – skin, hair and shrouds/clothing) may survive in their entirety due to localised conditions dependent on coffin and grave construction and otherwise be evidenced in association with corroding metalwork (Janaway 1989; 1996; 1998).

Installation of TADs

A particular concern with the use of this drainage system is the 'selling point' that as a low-tech solution and low-cost alternative it can be readily installed 'in-house, without great expertise'. This downplays the fact that most rural churches are surrounded by archaeological deposits. These include churchyard construction/phasing evidence as well as the burials themselves. The installation process, as described above (Section 2), would in itself be highly destructive to archaeological deposits within burial grounds. Whilst the church surveys suggest that in most cases care was taken to place the TADs in areas away from graves it should be noted that grave markers cannot be relied upon as accurate evidence for locating historic burials, since historic burials may often lack visible grave markers, or these may have been repositioned (Dalan *et al*. 2010).

Prior to installation, guidance (Elemental Solutions 2008) advises that the suitability of TADs be considered with reference to the soils, topography and usage requirements. The majority of TAD installations considered in this report have been made in free draining or relatively free draining soils and to varying depths and designs and are therefore taking on board these

considerations. However, the extent to which usage is being considered is unclear, the survey results indicating that this could be higher/more intense than the 'low' level usage they are designed for. This is especially the case for those churches where the lavatory is always open to the public. In addition, sudden, moderate or high level use (for example, Christmas and Summer concerts, seen here) is certainly a factor and its impact will depend on the dissipation of water from the trench into the soil, with the worst case scenario being flooding in soils that are not free draining. The scale of the impact of sudden increased use will depend on the baseline conditions. For example, in a relatively dry, relatively nutrient poor, relatively neutral to alkaline environment a massive sudden influx of waste would have greater impact on the localised soil chemistry and flora compared with more aerobic and more acidic baseline conditions. It would be perhaps useful to establish the threshold of the different environments to establish at what point increased usage becomes an issue.

The survey results indicate that a number of TADs are being installed less than 10 metres away from churches and on all sides, although more often on the north or west side. Archaeologically speaking, these locations are especially rich and are where church structures, including crypts, and dense burial activity, including ancient burials, are more likely to be encountered than locations greater than 10 metres from the church. In addition, burials are likely to be of higher status and include more elaborate graves (for example, grave structures) on the south side of the church next to the porch. None of the TADs described in the present study encountered such burial structures or church structures, but they are clearly an important consideration.

A particular concern is brick lined vaults (generally 18th and 19th century) which, being high status may have been inserted through earlier burial deposits adjacent to the church. Depending on their construction, these may have the tendency to form water retaining voids. While this can happen naturally, through water penetration, both from above through the soil profile and laterally due to a raised water table, the introduction of a TAD might exacerbate this. Furthermore, salt-laden outflow that has penetrated these voids may have an adverse effect on above-ground monuments and the church fabric, where excess moisture may wick upwards as rising damp and fluctuating conditions may induce surface spalling of masonry, depending on the quality of building materials.

Water fluctuation

Site conditions will determine factors such as drainage, with a combination of soil type and position affecting water flow. Water will flow down gentle gradients and, therefore, a particular concern with many historic burial grounds is the use of brick-lined graves, which may inadvertently become flooded as subsurface water follows the path of least resistance.

Of particular concern is the inevitable water fluctuation, which will likely bring about cycles of wetting and drying to the adjacent burials. As stated above this is a key factor that can accelerate degradation of bone as well as of associated organic remains. Indeed, through burial and lab-based experiments, it has been shown that bones under 'stagnant' conditions have been far less altered than those under 'dynamic' conditions (High *et al*, 2015; Williams 2008). In addition, bone contained in a dynamic burial environment that is already damaged (for example archaeological material) is likely at far greater risk than modern analogues. Further concern is that this is not purely mechanical; the impact of water flow at a localised level can be demonstrated from literature on flood events, where microbial community responses to water environment impacts have been shown to fluctuate (Lillie *et al*. 2012).

While the impact of water fluctuation on archaeological, or more specifically, human remains is recognised, a more detailed understanding of the scale of the issue in the context of TADs installations is much harder to grasp with present knowledge. While the amount of waste water entering a TAD is regularly described as 'low' it is presently very difficult to pin down what volume this equates to and how much this might be on an annual basis. A TAD design recently prepared by N Grant included the following estimate:

'Loading information has not been provided but has been said to be 'low'.

Peak usage on a busy day has been estimated as:

WC flushes (6 litres x 25)	*150*
Wash basin	*30*
Cleaning	*10*
Miscellaneous	*20*
Total	*210 litres/day*

These figures are generous and could be reduced with efficiency measures such as a hand basin spray tap and 4 litre WC but 210 litres will be assumed for design purposes. Since average use will be much lower than this we can comfortably design for half this peak load as a daily average i.e. say ***100 litres/day****'*

In addition, according to the *Waste Water from Churches* document:

> *'A church is very unlikely to use as much water. Using informed guess work we might make an approximation to the most water that will be used in a day from a rural church. (Note that this is an imaginary example and should not be assumed to reflect this situation at your church. The real sum should be made by those with real knowledge of the church and take into account the likelihood of use over the next 20+ years!)*
>
> *Changing flowers 6 litres*
>
> *Cups of tea 12 litres*
>
> *Washing paintbrushes for kids club 5 litres*
>
> *Lavatory use (6 litres x 20) 120 litres*
>
> *Cleaning 10 litres*
>
> *Miscellaneous 20 litres*
>
> *Total 173 litres/day*
>
> *Therefore, using conservative estimates (which in this case means overestimating water use) a church on a busy day may use 173 litres which is approximately what a statistically average person uses in a day at home….there may be occasional fund raisers and concerts where much more water is used – say 500 litres'*
>
> (Elemental Solutions 2008, 6)

Thus, the above two sources suggest that between 100 and 210 litres of waste water might be generated on a peak day increasing to 500 litres at maximum usage. The DAC survey results from the present study have provided usage information, but it is very limited in terms of how it might be quantified to estimate annual amounts of waste water generated. Between one and two peak usage days a week might be assumed, in addition to approximately eight additional peak usage days for large gatherings (for example, concerts, fund raisers, Christmas and Easter). Off peak days could be assumed to average at approximately 10 litres/day. This would calculate as approximately 16,930 – 28,370 litres a year, depending on whether 100 or 210 litres is assumed for peak usage and assuming two peak usage days a week.

Whether water fluctuation from a TAD will significantly increase the normal average amount of water which trickles down to burials from annual rainfall will be highly dependent on several site specific factors, in particular local rainfall patterns, the soil type and the topography of the churchyard. There are, however, the following observations worth noting in this context:

1. Downward water penetration is well modelled for agricultural crops etc. and civil engineering purposes, but a churchyard is a much more complicated deposit.

2. Throughout most of year surface temperatures in the UK are not sufficient to produce massive surface evaporation (although green plant transpiration is a significant factor). Generally speaking, unless conditions result in waterlogging (high input/poor loss) then most soils will drain out.
3. The ability to retain water will depend on the soil texture (particle size) and organic content. Sandy, low organic deposits will be more free-draining than for instance clays. Most of the installations described in the present study are in free draining or slightly impeded draining soils.
4. Topography of the churchyard is another critical factor and needs to be understood in term of the general water shedding of the site in its immediate topographic context. For instance, a church sited on small hill with a sandy loamy soil, over permeable solid geology will shed water that is introduced (by both natural and anthropogenic means)

Whether or not TAD installations cause a significant increase in the amount of water in burial environments cannot therefore be answered with current knowledge. Further, should this be the case, it is not known whether this would accelerate degradation because, for example, there are no known studies of graveyards with increased rainfall and percolation. As mentioned above, soils and topography would be important extrinsic factors, as well as numerous intrinsic (e.g. the age and body mass of the deceased) variables.

One such extrinsic variable – trees/vegetation – was a common factor in the setting of the TADs considered in this study, but again their influence on water fluctuation and skeletal degradation is a neglected area in the archaeological literature. On the one hand, root growth within the vicinity of a TAD could be restricted by the low soil oxygen supply and mechanical impedance due to soil compaction (Gilman *et al.* 1987), so would have limited influence on de-watering. On the other hand, however, the roots of a well-established tree would dewater the immediate area of the root mass and would promote periodic aerobic conditions and expose remains to biological decay agents (Dent *et al*. 2004). This would be influenced by a number of factors, the most critical of which are the type of tree/vegetation, season, evaporation/transpiration rates, drainage characteristics of soil profile, depth and fluctuations of the water table.

Other impacts that roots have on the preservation of burials are known from observations of animal remains buried close to trees. In these contexts the remains rapidly become enveloped in rootlets, the acids from which cause dissolution and characteristic tunnelling/etching on the bone (R Nicholson, pers comm.)

It is perhaps relevant to mention here the observed effects of tree de-watering on human remains buried in heavy clay in First World War mass graves in Fromelles, Northern France (Barker *et al*. 2014). Here, the three graves which were closest to Pheasant Wood showed greater degradation of bone tissue, loss of bone integrity and bone collagen compared the three graves further away from the wood (ibid.). Thus, this example could suggest that the siting of TADs in close proximity to trees/vegetation may be detrimental to human remains buried within or near the installation.

Increased bio-nutrients

Given that the pipework of TADs is designed to discharge into the underlying soil, it is necessary to look at the characteristics of grave soils. Studies have shown that the highest total concentration of phosphorus is observed in the A horizons of the anthropogenic burial horizons and undisturbed cemetery soils (Majgier *et al.* 2014). Similarly, increased microbial loading of cemetery soils has been linked to organic and inorganic contaminants (Calkosinski *et al*. 2015; Jonker and Olivier 2012; Spongberg and Becks 2000a; Spongberg and Becks 2000b), which are affected by environmental conditions (Amuno 2013; Amuno and Amuno

2014; Zychowski and Bryndal 2015). Additional leachate therefore has the potential to increase nutrients, microbial load and thus contribute to biodeterioration of the archaeological resource, as well as mobilising elements that are concentrated in grave soils (Fiedler *et al.* 2012; Zychowski 2012).

While sewage microflora are well studied (for example, http://aem.asm.org/content/79/9/2906.full) knowledge of its impact on different archaeological remains is limited. Regarding wood, hair/wool textiles and bone, and subject to experimental validation, it is suggested that:

1) Wood will only survive for significant timescales if the conditions are anaerobic, the introduction of sewage is unlikely to break down the wood and will in all likelihood further drive the deposit towards anaerobic conditions

2) Hair/wool textiles require keratin decomposers - keratinolytic microorganisms have been isolated from sewage sludge and can also be derived from soils worked by burrowing animals.

3) Bone again will only survive for significant timescales if the conditions are anaerobic

Increased microbial/fungal attack on human remains or other artefacts as a result of the presence of sewage may occur if there is a change in the microflora and pH to support microbial activity. However, equally, sewage might swamp the deposits, the faecal microflora out-competing everything else. This application is so specific in terms of the microfloras and the environment that there are currently no relevant baseline data to be conclusive here. With this in mind, further advice was sought from researchers studying human decomposition using donated corpses at the Forensic Anthropology Center, University of Tenessee, (http://fac.utk.edu/default.html). Whilst their research to-date has focused on surface decomposition and associated soil microbes, as opposed to burials, they were able to provide some insightful comments that could be pertinent to this review. They speculate that the micro-organisms that are degrading bodies in the churchyard soils would be similar, but not the same as those that would break down raw sewage from a lavatory (which could find its way into the burial ground via the new drainage system). Whilst both environments are conducive to high levels of nitrogen, they have noted little evidence for ammonification and denitrification in grave soils, compared to a well-functioning septic drainfield soil. Based on these observations it is speculated that using a graveyard as a septic drainfield would change the decomposition dynamics by introducing a lot more nitrogen to an already nitrogen rich environment. As a consequence of too much nitrogen, body decomposition could become carbon limited and actually slow down decomposition.

While these comments are inconclusive they are useful nonetheless; based on small experiments, burying in a compost heap does not increase bone diagenesis (the reverse in fact), but the effect of smaller inputs of nitrogen and ammonia via occasional sewage is likely to be very different (R Nicholson, pers comm.).

Some of the TADs identified in this study had installed macerators to break down solids before they enter the system and this presents another variable to consider in relation to sewage and archaeological degradation. Macerator injection into the soil could influence microbiological communities, but the relationship is complicated. Firstly, there is a pre-introduction microbial community, whose abundance and activity will depend of the availability of nutrients, hydrology and soil pH. The introduction of effluent into this soil ecosystem will affect it in a number of ways, but principally by introducing a mass of effluent-specific bacteria, but also modifying the hydration and pH. If the effluent is sufficiently concentrated it is likely that conditions will sufficiently change to favour the effluent-derived bacteria rather than the resident soil microflora. However, churchyard soil floras are in themselves probably specialised and understudied, so that while the result of the introduction of bovine slurry onto pasture is well understood and therefore capable of predictive modelling, it is unlikely that sufficient solid base data exists for it to be possible to be specific about macerator output into graveyards.

Cleaning Products

The inclusion of detergents and other cleaning products as part of routine use and cleaning practice will affect the pH of the leachate. Extremes of pH are destructive to bone, teeth and other organics, affecting the appearance of dental calculus and bone cortex and limiting surface detail such as evidence of disease, trauma and modification (Amadasi *et al.* 2015). Highly acidic conditions will dissolve dental enamel and bone mineral. Highly alkaline conditions are extremely aggressive to DNA and protein survival, leaving bone and teeth friable and destroying keratotics such as hair, nail and surviving skin and fibrous connective tissue, such as ligaments. There is currently no information available on what the cut-off might be for pH levels to have no detrimental impact on the preservation of human remains or other archaeological remains.

According to MSDS data sheets (https://www.msdsonline.com/msds-search), the pH of various cleaning products ranges from 1-2 for lavatory bowl cleaner to 12.5 for bleach:

Clorox bleach	12.5
Hand dishwashing liquid	9-9.2
Antibacterial hand soap	9.9.2
Ammonia	7.9
Coffee grounds	c. 5
Eco-friendly detergent	9.5
Lavatory bowl cleaner	1-2

Information on how much a cleaning product changes the pH of, say, a flush worth of lavatory water is negligible and it is currently not known to what extent products would need to be diluted to no longer have an impact on archaeological remains. Common sense would suggest that the risk would be negligible, considering the effects of dilution, but this would require testing through experimental research. Once carried into a TAD by water the extent to which active ingredients in cleaning products would be carried down through the soil profile, whether they would be subject to alteration/change through microbial action and what their impact might be on soil flora and fauna, are questions which cannot be answered here and would require input from a soil chemist and perhaps a specialist in environmental pollutants.

Recommendations for Further Work

The present study has identified considerable gaps in knowledge which have prevented satisfactory evaluation of the impact of TADs on archaeology. Yet, the different installations, inconsistency in monitoring and misconceptions regarding disturbance to archaeology (especially burials) clearly show that information is badly needed.

Paucity of controlled experiments or monitoring of the impact of new drainage systems in churchyards.

It would be extremely valuable to test this desk-based assessment by examining effective in-situ monitoring data of the soil conditions at sites that have employed TADs. Groundwater risk attributes examined for green burial sites in the UK do not provide the needed scale or resolution to examine the effect of TADs within the burial ground itself (Kim *et al.* 2008).

Our current knowledge of degradation processes come from three main areas 1) direct observations of excavated remains (be they forensic or archaeological); 2) burial experiments (where human or animal remains are placed in different burial environments and changes are monitored) or 3) lab based experiments (where different aspects of the burial environment are reproduced under laboratory conditions and monitored). Evidence from 1) is largely anecdotal and site specific. The advantage of the latter two approaches is in the existence of a documented taphonomic history of the specimens under study so that consequently a number

of factors can be accounted for when determining the state of preservation (Nicholson, 1996,1999; Stokes *et al.* 2013; Turner-Walker *et al*, 2008). Within the burial environment itself different factors can be controlled and monitored over the course of the burial, which is not possible with an archaeological deposit. Currently there is a paucity of controlled burial experiments that have looked at the impact of raw sewage (and associated increased microbial activity) in close proximity to buried remains, or the potential impact of cleaning products and other waste products such as tea and coffee grounds (particularly with regard to changes in the pH and redox of the local environment). Both of these issues in addition to the close monitoring of water fluctuation would need to be investigated further in relation to the installation of TADs in churchyards. In addition, this work should be supported by more detailed monitoring of usage patterns, which would help to determine more precise and useful estimates of the amount of waste water generated.

To summarise, particular areas that this study has suggested would be useful to explore are:

1. Options for looking inside a TAD which has been installed and in use. This might be by looking down inspection chambers (where they have been installed) and/or by limited excavation. Funds permitting, one of the case study churches (St Mary's, Woolpit, St Edmundsbury and Ipswich diocese) has mentioned that they need to dig up their TAD (see DAC survey results above and case studies in Apppendix 3) and re-install it, so this might present an opportunity for investigation.
2. Monitoring a selection of TADs to assess soil conditions and obtain more accurate and detailed information of the usage patterns of the facilities that they serve, the amount of waste water generated and characteristics of waste products.
3. Monitoring burials in locations where there is high rainfall versus locations where there is little rainfall to explore differences in water fluctuation.
4. Practicalities and funds permitting, monitoring pH, redox potential, microbial activity and saturation levels in soils directly beneath a TAD.
5. Laboratory tests to explore the effects of different cleaning products – diluted and undiluted - on human bone, wood and textiles.
6. Design and execution of a laboratory experiment to explore the impact of sewage on human bone, wood and textiles.

Ideally, these areas would be explored by an expanded team of soil chemists and other scientists with specialisms in sewage and environmental pollutants, in addition to the specialists already involved.

5.5 **Recommendations for Mitigating Risk**

Recommendations for mitigating risk are presently limited until further work, in particular field observations and controlled experiments, has established a more detailed understanding of the impacts associated with TAD installations. However, work could be done to raise awareness of TADs and the potential risks they pose to archaeology. This might be in the form of a guidance note and/or by posting a version of this report online. The majority of individuals who responded to the surveys and/or answered our telephone calls said they are keen to learn more about the findings of the study and one diocese has asked to publish an article about the project in a journal. The guidance could recommend some basic management strategies as follows:

1. In an early stage in the development of a TADs proposal, basic research should be undertaken to explore the potential for archaeology. This not only includes the potential for burials, associated objects and/or church structures, but other archaeology which is not necessarily directly associated with burial environments. In particular, the archaeological landscape and context can be complex for churchyards

which represent a later phase of activity of an earlier site, or are part of a larger site structure.

2. The proposed installation should also take into account any national or key local designations such as Sites of Special Scientific Interest, Scheduled Monuments or Areas of Archaeological Interest (or local equivalents).
3. Pre-determination/pre-construction evaluation to determine the likely impacts prior to deciding on the most suitable location for a TAD installation should be considered.
4. TADs should be sited in in areas which are likely to be well away from archaeologically rich areas. They should also not be sited close to established trees.
5. Installations should keep to a ca. 40cm depth, as this would help to reduce (but not eliminate) the possibility of encountering archaeology.
6. Any articulated burial encountered during an installation should be archaeologically excavated and studied.
7. Detailed appraisal of usage patterns should be undertaken in consultation with an engineer/architect. This should also consider the potential for levels and patterns of use to increase/chance following installation.
8. Do a percolation test (such as that described by Elemental Solutions 2001, 7) to explore whether the soil is suitable
9. Keep lavatory facilities locked when the church isn't in use.
10. Include electric hand dryers rather than paper towels to prevent the risk of blockage from the latter.
11. Use spray taps and low flush lavatories to reduce the amount of water entering the drain, but increasing water flow (for example, by second or third flushes) should be considered when washing cleaning products away, until further work has established what effect these may have on archaeological remains.
12. Avoid the use of any toxic non- degradable cleaning products or bleaches; use notices to deter users from flushing any inappropriate materials into the system and use single ply paper.
13. Record keeping of installations by dioceses is improved, in digital format, as this will assist monitoring.

6 CONCLUSIONS

Trench arch drain installations in churchyards are popular and have been installed across England in high numbers in the last five years. They are designed for 'low' usage facilities, yet this might under-play *actual* usage, in particular sudden intense usage at peak times and changes in usage patterns following installation. This means that the impact of these systems on buried archaeological remains, which primarily comprise medieval and post-medieval burials, might be under-appreciated. Impacts include increased nutrient loading, water fluctuation and de-wetting and potential alteration to the soil pH from products which, under certain conditions, can all accelerate degradation. In addition, despite the relatively shallow excavations required to install TADs, disturbance to archaeological remains (in particular, burials) is frequent, because in a churchyard context deposits tend to survive at a relatively high level, considering the effect of hundreds of years of burial activity, especially in locations close to the church and on the sides of the church that were popular for burial (for example, near the porch) in the past. More precise details on how TADs might affect archaeological degradation and how this might be mitigated cannot be addressed based on current archaeological knowledge. This requires specific experiments and monitoring of these systems, as well as consultation with a wider group of experts (for example, soil scientists)

than have contributed to the present study. In the meantime, the production of best practice guidance, using the sparse knowledge we currently have, would be worthwhile to reduce the risks to buried archaeological remains.

In summary, the following points are worth stressing here:

1. The siting of TADs is critically important. The survey results suggest that a number have been installed less than 10 metres away from churches, usually on the north or west side. Archaeologically speaking, these locations are especially rich and are where church structures, including crypts, and dense burial activity, including ancient burials, are more likely to be encountered than locations greater than 10 metres from the church. In addition, burials are likely to be of higher status and include more elaborate graves (for example, grave structures) on the south side of the church next to the porch.
2. It is important to undertake research to identify the potential for other archaeology besides burials and/or church remains and, if necessary, undertake predetermination/pre-construction evaluation when deciding the most suitable location for a TAD installation. TADs proposals should accord with any national designations, where they apply.
3. Church use varies and may change. For example, churches are being increasingly used for social activities, such as toddler groups, so current estimates of waste water and the use of TADs may need to be reviewed.
4. The diagenetic processes (chemical processes of bone degradation) that act upon bone are intimately linked to the burial environment, which will vary from one site to the next. For example, in a relatively dry, relatively nutrient poor, relatively neutral to alkaline environment a massive sudden influx of waste would have greater impact on the localised soil chemistry and flora compared with more aerobic and more acidic baseline conditions. In general, it can be said that fluctuations in the water table, and specifically periods of wetting and drying and freeze/thaw, are detrimental to the survival of skeletal remains.
5. Whether or not TAD installations cause a significant increase in water or other conditions in burial environments cannot be answered with current knowledge. Every site will present a unique burial environment, but further studies should allow general types of burial environment to be grouped and the effects of increased water, nutrients and chemicals on these can be investigated in the future, in part by monitoring deposits surrounding a selection of existing TADs.

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The project was managed by Louise Loe with assistance from Klara Spandl. Advice was provided by Julian Munby and Rebecca Nicholson. Lauren McIntyre assembled the results of the questionnaires, consulted with designers and installers and followed up information on the telephone. The report was compiled by Louise Loe and Lauren McIntyre and GIS was by Gary Jones.

[i] This is the description of the drain as given by the builder responsible for construction. This description differs substantially from the architect's plan, which follows the standard TADs design (see plan in case study, Appendix X). Furthermore, the church warden commented that this drain has been problematic, and has caused damp/moisture problems in the immediate locale (see case study, Appendix 3). She stated that the drain probably needs by be dug out and potentially mended/unblocked/changed, but the church currently does not have the funds to undertake this and it is not deemed to be high on the list of priorities for expenditure.

[ii] This is the description of the drain as given by the builder who said he would provide plans, but has since not been in touch or responded to phone calls/emails. This description differs substantially from the architect's description of the TAD: '*A 600mm plastic land drain pipe was cut in half lengthways and laid in the bottom of a shallow trench, with the inflow pipe installed at one end. The land drain pipe was covered in geotextile to stop rooting. The pipe was then backfilled with soil. The trench was 12m long' (Architect couldn't remember width/depth of trench).*

Appendix 1: DAC Covering Letter Questionnaire

DAC TRENCH ARCH DRAINAGE SURVEY

Oxford Archaeology South

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Osney Mead
Oxford OX2 0ES

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e: oasouth@oxfordarchaeology.com
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Diocesan Archaeological Committee
Secretary

08.07.15

Dear Sir/Madam,

Help needed for Historic England commissioned survey on trench arch drains in churchyards

Oxford Archaeology has been commissioned by Historic England to undertake research on the number and extent of trench arch drain installations in churchyards, looking at their effectiveness and identifying any impacts they may have on buried archaeology. Your help in making this work practical, accurate and well informed would be greatly appreciated. Please could you complete our simple questionnaire by following this link :

http://surveys.oxfordarchaeology.com/index.php/survey/index/sid/592121/newtest/Y/lang/en

It should not take more than 30 minutes of your time. However, if it is too time consuming, please could you focus on questions one and two and give us the details of the architect(s) involved so that we might contact them.

We are inviting all Diocesan Advisory Committee secretaries and archaeological advisers in England to share their knowledge. Where DAC Secretaries are willing to pass on this invitation we would welcome input from architects and surveyors who undertake quinquennial inspections in the diocese also. So, if you are able to forward this letter to those on your diocesan list, that would be a huge help. We are also asking contract archaeologists about how often they are involved in providing archaeological recording alongside trench arch installations.

In addition to obtaining information on the number of systems that have been installed in the last four years, the survey also seeks to determine why they were installed in preference to other systems, whether installation was accompanied by an archaeological presence/survey (and if so by whom) and how successful the systems are considered to be. The results will be used to inform a second round of more detailed surveys in selected dioceses.

Oxford Archaeology is working with specialists in the degradation of archaeological material from the University of Bradford, an expert in sewerage system engineering/ drainage works and Julian Munby, diocesan archaeological adviser for Oxfordshire, to compile the results of the study into a report, with case studies and recommendations for Historic England. The report will inform Historic England's future advice on faculty applications and assist others involved in decisions made under the Ecclesiastical Exemption and secular planning system. We hope it will also have a practical impact on national archaeological monitoring and guidance, with the overall aim of achieving a balance between conserving heritage and continuing to promote the use of churches by the community in the long term. We will, of course, make the report available to dioceses later this year.

Please can you complete the questionnaire by 03 August 2015 ? If you do not want to take part in this study, please let me know (louise.loe@oxfordarch.co.uk) and I will make no further attempts to contact you, otherwise we will send a reminder in a few weeks.

If you would like further information about the project please get in touch – contact details below. We would also be very happy to send you a hard copy of the questionnaire, should you prefer to complete it that way.

Thank you for your time.

Yours sincerely,

Dr Louise Loe

If you would like to speak to someone about the project, please contact either:

Louise Loe

Head of Heritage Burial Services, Oxford Archaeology

Louise.loe@oxfordarch.co.uk

Tel: 01865 980741

Or

Helen Webb

Project Officer, Oxford Archaeology

h.webb@oxfordarch.co.uk

Tel: 01865 980871

Section A: Page 1 of 4

A1. Name of diocese

A2. 1. Were any trench arch drainage systems installed in your diocese in 2011, 2012, 2013, 2014 and/or 2015?

Yes ☐

No ☐

Don't know ☐

A3. 1a. Have any trench arch systems been proposed but not installed in your diocese? If so, why were they not installed? (Please give church and parish where possible)

A4. 1b. Please can you refer us to someone who might know? For example, this might be the archaeological adviser and/or the diocesan architect.

Section B: Page 2 of 4

B1. 2. How many trench arch drainage systems were installed in your diocese in 2011, 2012, 2013, 2014 and/or 2015?

B2. 3. Please can you list the churches where they have been installed? Please note that from this point onwards the churches listed here will be numbered Church 1, Church 2 etc., so please take note of the order you have listed them in here, and stick to this numbering system.

Church:

Parish:

Year:

B3. **3a. Comments (e.g. add any further churches here)**

B4. **4. Briefly, what did the trench arch comprise and how was it constructed?**

Description:

Church 1

Church 2

Church 3

Church 4

Church 5

Church 6

B5. **4a. If you are able to attach any photographs and/or plans and/or drawings to accompany your description it would be greatly appreciated. Please label the files with the church names first, followed by the parish name. Alternatively, please send (post or email) them to us.**

B6. **5. Why was a trench arch chosen over other options (for example, connecting to the main sewers; composting toilets; septic tank, etc.)?**
Reason:

Church 1

Church 2

Church 3

Church 4

Church 5

Church 6

B7. **6. Where are they located in relation to the church (for example, approximately, 10 metres from the north/south/east/west side of the church)?**

	North side <10m	North side >10m	South side <10m	South side >10m	East side <10m	East side >10m	West side <10m	West side >10m	Other
Church 1	☐	☐	☐	☐	☐	☐	☐	☐	☐
Church 2	☐	☐	☐	☐	☐	☐	☐	☐	☐
Church 3	☐	☐	☐	☐	☐	☐	☐	☐	☐
Church 4	☐	☐	☐	☐	☐	☐	☐	☐	☐
Church 5	☐	☐	☐	☐	☐	☐	☐	☐	☐

B8. **6a. If you selected 'other', please provide details for each church, as applicable.**

B9. **7. Are any of the trench arch drains located next to a water course?**

	Yes	Uncertain	No
Church 1	☐	☐	☐
Church 2	☐	☐	☐
Church 3	☐	☐	☐
Church 4	☐	☐	☐
Church 5	☐	☐	☐
Church 6	☐	☐	☐

B10. **8. Are any of the trench arch drains next to trees or other vegetation?**

	No	Yes - trees	Yes - vegetation	Yes - both
Church 1	☐	☐	☐	☐
Church 2	☐	☐	☐	☐
Church 3	☐	☐	☐	☐
Church 4	☐	☐	☐	☐
Church 5	☐	☐	☐	☐
Church 6	☐	☐	☐	☐

Section C: Page 3 of 4

C1. **9. Please list the companies who undertook the installations**

Company details:

Church 1	
Church 2	
Church 3	

Church 4

Church 5

Church 6

C2. **10. Were any of the installations archaeologically monitored? If yes, please note the name of the archaeological monitor.**

Yes/No:

Church 1

Church 2

Church 3

Church 4

Church 5

Church 6

Archaeological monitor:

Church 1

Church 2

Church 3

Church 4

Church 5

Church 6

C3. **10a. Please give any further relevant details, for example, relevant available reports**

C4. **11. Are you aware of any archaeological impacts that have arisen as a result of installation? For example, in addition to excavation, this might be due to influxes of water, the introduction of detergents, etc.**

	Yes	Uncertain	No
Church 1	☐	☐	☐

	Yes	Uncertain	No
Church 2	☐	☐	☐
Church 3	☐	☐	☐
Church 4	☐	☐	☐
Church 5	☐	☐	☐
Church 6	☐	☐	☐

C5. **11a. If you answered 'yes' to the above, please outline below what you believe the impact was on. Note: if you answered 'no' to any of the above, please leave the fields blank, as appropriate.**

	Burials	Structures	Other	Combination	Not sure
Church 1	☐	☐	☐	☐	☐
Church 2	☐	☐	☐	☐	☐
Church 3	☐	☐	☐	☐	☐
Church 4	☐	☐	☐	☐	☐
Church 5	☐	☐	☐	☐	☐
Church 6	☐	☐	☐	☐	☐

C6. **Comments**

C7. **12. Are the trench arch systems that were installed in 2011, 2012, 2013, 2014 and/or 2015 considered to be successful?**

	Yes	Uncertain	No
Church 1	☐	☐	☐
Church 2	☐	☐	☐
Church 3	☐	☐	☐
Church 4	☐	☐	☐

	Yes	Uncertain	No
Church 5	☐	☐	☐
Church 6	☐	☐	☐

C8. **13. If you selected 'no' above, why do you think the systems were unsuccessful? Please complete for each church as appropriate.**

Reason:

Church 1	
Church 2	
Church 3	
Church 4	
Church 5	
Church 6	

C9. **14. Do you know of any on-going archaeological monitoring of trench arch drains that were installed in 2011, 2012, 2013, 2014 and/or 2015?**

Yes/No/Don't Know:

Church 1	
Church 2	
Church 3	
Church 4	
Church 5	
Church 6	

If yes, please provide details:

Church 1	
Church 2	
Church 3	
Church 4	
Church 5	
Church 6	

Section D: Page 4 of 4

It would be helpful, although not obligatory, if you could provide us with your name and some basic contact details. Thanks.

D1. Your name

D2. Your email address

D3. Your phone number

Thank you very much for taking the time to complete this survey. Your help is greatly appreciated.

Contact details:

Louise Loe, Oxford Archaeology

Tel. 01865 980741

Louise.loe@oxfordarch.co.uk

OR

Helen Webb, Oxford Archaeology

Tel. 01865 980871

Helen.webb@oxfordarch.co.uk

Appendix 2: Archaeologist Survey Questionnaire

CONTRACT ARCHAEOLOGIST TRENCH ARCH DRAINAGE SURVEY

Section A: Contact details

It would be helpful if you could provide us with your name, position, company and some basic contact details. Thanks.

A1. Your name

A2. Your position

A3. Company

A4. Contact details

Section B: Churchyard trench arch schemes

B1. How many churchyard trench arch schemes has your company worked on in the last 5 years ?

If your company hasn't worked on any such schemes, please state 'none'

B2. For each scheme please: 1. Give the church name, parish, full address & postcode/grid reference and type of investigations carried out (whether a watching brief, evaluation or other) 2. Describe the depth and extent of archaeology encountered (if no archaeology was encountered, please state 'none') 3. Provide a basic description of any observed damage (including observed extent) and/or any other observations about the scheme. Where available, attach any plans, photographs and/or provide relevant references. Please see box at bottom of page for uploading files.

Scheme 1:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 2:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 3:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 4:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 5:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 6:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 7:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 8:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 9:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent

Description of damage / other observations

References

Further comments

Scheme 10:

Church name

Parish

Full address & postcode/grid reference

Type of investigations carried out

Depth and extent	
Description of damage / other observations	
References	
Further comments	

B3. Where available, please attach reports, plans and photographs here mentioning in title for which scheme these are and in comment what the document represents.

Thank you very much for taking the time to complete this survey. Your help is greatly appreciated.

Contact details:

Louise Loe, Oxford Archaeology

Tel. 01865 980741

Louise.loe@oxfordarchaeology.com

OR

Helen Webb, Oxford Archaeology

Tel. 01865 980871

Helen.webb@oxfordarchaeology.com

Appendix 3: Case Studies

CASE STUDY 1: ALL SAINTS, NEWLAND, DIOCESE OF GLOUCESTER (MAP REFERENCE GL10, FIGURES A3.1 –A3.3)

Background Information

The church of All Saints has a likely foundation date of AD 1216. The earliest architectural features of the current church date back to the 14th century.

Taken from Stuttard, A. 2015 *The Cathedral of the Forest*. Available at: http://www.allsaintsnewland.btik.com/News:

"*The Church of All Saints at Newland, traditionally and affectionately known as the 'Cathedral of the Forest', was begun in the early 1200s. King John appointed Robert of Wakering as first Rector in 1216. The original, probably rather small, building was expanded during the next two hundred years to the size and shape of the present church. A major restoration in the 1860s widened the chancel arch and slightly raised the roof of the nave. The village of Newland did not exist before the clearing was made in the Forest and the church built."*

Soils, Environment and Geology

The soils at All Saints, Newland are free draining, slightly acidic and loamy in texture. Landcover is characterised as arable and grassland. The local habitat is characterised as neutral and acid pastures and deciduous woodlands; acid communities such as bracken and gorse in the uplands. The local geology is sandstone.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

   Splitlath Ltd

2. **How was the trench arch system installed?**

   The TAD was dug between the headstones to minimise impact on graves (Figure A3.2). Architects drawings stipulate the trench should be 14m long, 400mm wide and 450mm deep. However, the archaeological report notes that the trench was actually 11.8m long, 800mm wide and 600mm-650mm deep. The trench had a solid base (worked over with pitchfork to loosen up because quite clayey). The ground that was excavated had a natural slope, so the trench was kept at a consant depth, following the slope. The TAD had blockwork side walls, covered with 24 inch precast concrete slab covers. Gaps were left between these blocks. No geotextiles were used. Pea gravel was put down trench sides.

3. **Where is the trench arch system installed in relation to the church?**

   North side of the church, off the north wall of the tower. Less than 10m away from the church walls.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   Yes, graves on all sides, including graves with visible markers/headstones. Development tried to put

the TA trench in a location where there was least/no interference with graves observable from the surface.

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc.), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   Yes, graves on all sides. However, archaeological monitoring of this development did not encounter any graves, evidence of the top of any grave cuts, or any other archaeological deposits/features.

   Some evidence was found pertaining to 19th century building work. Whilst digging the trench for the TAD, lots of old building rubble, lime and so on was observed at the south end of the trench, thought to relate to works carried out in 1861.

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

   There were quite a number of trees and shrubs in the area of the TAD.

7. **Are there any associated archaeological reports available for this site/area?**

   Yes – Church and Site Archaeology monitored the site during the full period of time that the development was taking place. See the report reference below.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   The TAD services two facilities – two lavatories, each with their own sink, and a kitchen which has two sinks (Figure A3.3). These are cleaned infrequently: the lavatories are cleaned once a week, and the kitchen is cleaned whenever it is used so this varies in frequency. Only eco-friendly cleaners and detergents are used.

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   Services are held in the church twice a month. Other events such as concerts, fairs and Christmas events are held between four and ten times a year. In addition, there are around four weddings, funerals and baptisms a year. There are no regular evening groups/classes using the church, but very occasionally there are large groups of school children, brought in for classes. The lavatories are open for walkers/general public. The counter on the door has calculated an average of 14,000 visitors to the church per year (including services).

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    Lavatories: sewage, waste water and lavatory paper.
    Kitchen: waste water, eco-friendly detergent, tea and coffee dregs from washing up.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    The lavatories are kept open all the time. There is a bin provided for rubbish, but no sign telling

people not to dispose of items such as sanitary waste or nappies in the lavatory.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No

Archaeological Report Reference

Church and Site Archaeological Services, 2015 Archaeological Watching Brief at All Saints Church, Newland, Gloucestershire, GL16 8NL. Report no. 441/2012/11/WB/01.

CASE STUDY 2: ST. KATHERINE, WORMINGTON, DIOCESE OF GLOUCESTER (MAP REFERENCE GL9, FIGURES A3.4-A3.6)

Background information

The church of St. Katharine's, Wormington was constructed in AD 1475.

Taken from Lockie, R 2012. *Places of Worship Database: Gloucestershire Places of Worship*. Available at: http://churchdb.gukutils.org.uk/GLS554.php

"*This Place of Worship was founded in 1475. Kelly's Directory of 1923 describes St Catherine's Church as "a building of stone in the Anglo-Norman or Transitional style, consisting of chancel, nave of two bays, aisles and a small embattled tower of wood on the western gable containing one bell". On the south chancel wall there is a curious brass with figures of a woman and child in bed, erected in memory of Ann, eldest daughter of Richard Daston, and wife of John Savage, who died June 17th 1605. There are also several mural tablets to the Gist family. The parish registers begin in 1615. The return for the Religious Census of 1851 (HO 129/343/2/2/2) recorded an average attendance of 25 to morning service, and 30 in the afternoon, with 10 Sunday Scholars to both morning and afternoon classes. It was completed by J.R.F. Billingsley, the Rector, who recorded his address as "Wormington Rectory, Evesham".*

Note: St Katherine (or St Catherine)'s Church is recorded on the British Listed Buildings website with Dumbleton parish, as also are Great and Little Washbourne. It certainly deserves its Grade II Listed status, set as it is in a strategic position against the backdrop of the village green. According to their account, it was built (or rebuilt) in 1475 by the Abbot of Hailes, probably on the site of an earlier 12th century church.

Above the altar at the east end of the south aisle is a stone Saxon crucifix, which has been dated to the 9th century. It was found in the grounds of Wormington Grange, and it is thought originally to have belonged to Winchcombe Abbey prior to the Dissolution.

The entry for Wormington in The National Gazetteer of Great Britain and Ireland (1868), when S.G. Gist, Esq. of Wormington Grange, was lord of the manor, records the church as dedicated to the Holy Trinity or St Catherine, but most sources agree on "St Catherine", or as it is recorded as one of the Winchcombe Team of Parishes *and on our photograph, St. Katherine."*

Soils, Environment and Geology

The soils at St. Katherine's, Wormington are free draining, slightly acidic and loamy in texture. Landcover is characterised as arable with grassland at higher altitude. The local habitat is characterised as herb-rich chalk and limestone pastures, with lime-rich deciduous woodlands. The local geology is mudstone bedrock with superficial gravel, sand, silt and clay.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

   Highgate Construction

2. **How was the trench arch system installed?**

   Architect response: A 600mm plastic land drain pipe was cut in half lengthways and laid in the bottom of a shallow trench, with the inflow pipe installed at one end. The land drain pipe was covered in geotextile to stop rooting. The pipe was then backfilled with soil. The trench was 12m long (architect couldn't remember width/depth of trench). The drain was installed along the line of

the church path, to minimise the likelihood that burials would be encountered.

Builder response: TADS constructed from concrete blocks, anchored down with rebar and capped with paving slabs. An inflow pipe entered the TADS at one end.

3. Where is the trench arch system installed in relation to the church?

West side of the church, less than 10m away. The system was installed under an existing path and a grassed area (Figure A3.5). The bathroom is located on the south side of the church, and a soil pipe runs from the lavatory/sink along the south side of the church (under the new path) to the trench arch which is located to the west.

4. Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?

Archaeological monitoring was conducted on the site in 2010 as part of this installation. This anticipated possible burials and/or monuments dating to, or after the medieval period, potential archaeological evidence for the building and development of the church and churchyard, and also evidence for pre-medieval land use.

5. Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers

The trench arch drain was dug in this location/to the given depth because it was anticipated it would fall above the level of any buried archaeology/remains. See report for all trench locations.

Four manually excavated "mole pits" located to the south and west of the church (and dug to a depth of 0.6m), yielded fragments of disarticulated human bone, and the limestone foundation layers of the Chancel.

Trench 1 measured 10.7m in length, 0.4m in width and was dug up to 0.55m in depth. Small fragments of disarticulated human bone, and two residual sherds of Romano-British pottery were found.

Trench 2 measured 8.5m in length, 1.2m in width and approximately 0.7m in depth. Four undated human burials were discovered at the base of this trench. None of these grave cuts were fully exposed and continued beyond the limit of excavation. The size of these grave cuts indicated that they were all likely to belong to adult or adolescent individuals. Excavation of these cuts was not conducted, as they were only discovered at the maximum required depth of excavation for the development: all four graves were therefore preserved in situ. Although the burials remain undated they pre-date the laying out of the current path which appears to be depicted on the Ordnance Survey map of 1891. The soil layer immediately overlying the graves contained sherds of Romano-British, early and late medieval, and early post-medieval pottery.

6. Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?

Graves lie within the immediate vicinity of the church. Standing headstones are located on the north and east sides of the church. However, the discovery of four unmarked graves during this development suggests that there is potential for other, unmarked, graves elsewhere on the site.

7. Are there any associated archaeological reports available for this site/area?

Yes, by Benchmark Archaeology – report in case study file. This report, documenting archaeological monitoring of the 2010 trench arch drain installation, states that this watching brief is the only archaeological intervention/monitoring recorded for this site.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   Once a week (infrequent), with eco friendly cleaner.

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   Sporadic. There are three services a month, occasional lunchtime functions and Women's Institute meetings.

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    The TAD serves a lavatory and a small sink (Figure A3.6), so the main types of waste are waste water, sewage, and lavatory paper.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    The lavatory is kept locked when the church is not in use. However, the key is left in the church, so members of the public, who know where the key is kept, are free to use the lavatory facilities.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No

Archaeological Report Reference

Benchmark Archaeology 2010 St. Katherine's Church, Wormington, Gloucestershire, WR12 7NL. (NGR: SP 0388 3642). A Programme of Archaeological Building Recording and Watching Brief 2010. Unpublished report for St. Katherine's Parish Church Council.

CASE STUDY 3: ST. MARY, KIRTLINGTON, DIOCESE OF OXFORD (MAP REFERENCE O4, FIGURE A3.7)

Background information

The earliest known record of the parish of Kirtlington is a record in the Domesday Book from 1086 A. D. The oldest architectural features of the current church date to the 12th century.

Taken from Akeman Benefice. 2016. *History at Kirtlington*. Available at: http://www.akemanbenefice.org.uk/st-mary-the-virgin-kirtlington/history/

"*St. Mary's church is both modern and ancient, for it dates back over a thousand years. A meeting was held there by King Edward the Martyr in 977, and the Saxon priest is named in Domesday Book, but almost nothing survives from this period. The tower arches are early Norman, the nave thirteenth century, though the south side was rebuilt in the fourteenth: clerestory and south porch were added a century later, as was the wall-painting of St. George and St. Christopher. Altar and pulpit are Jacobean. In the eighteenth century the Dashwood family turned the lady chapel into a family chapel and pulled down the tower (in response to the neurotic fears of the dowager Lady Dashwood): it was rebuilt in Norman style in 1853. The chancel, restored by the Dashwoods, is fine Victorian work by Sir Gilbert Scott: the mediaeval south window, priest's door, double aumbry and double piscina were discovered during rebuilding. The stained glass is Victorian. Re-ordering begun in 2009 has replaced poor quality Victorian pews and tiles in the nave with handsome chairs and York paving (with underfloor heating); the Victorian font was moved, and modern plumbing, including a lavatory, introduced*."

Soils, Environment and Geology

The soils at St. Mary's, Kirtlington are free draining and loamy in texture. Landcover is characterised as arable with grassland at higher altitude. The local habitat is characterised as herb-rich chalk and limestone pastures, with lime-rich deciduous woodlands. The local geology is Kellaways clay.

Questionnaire Responses

1. Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)

Architects: Acanthus Clews Architects
Builder: Edgar Taylor

2. How was the trench arch system installed?

The 4m north-south oriented section of the trench was located towards the north of the church building at the west end. Here, the trench was widened for a manhole and turned to run east-west for 6m. It then turned to run north-south again for 0.8m, where it was widened for another manhole. Finally, the trench continued to the west of the main entrance to the church. The trench was approximately 0.3m wide where the sewage pipe was laid, 1m wide where the arch sewage management was constructed. The service pipe section started at 0.6m below ground level, dropping to 0.8m at the lowest point. The trench arch section of the trench started at 0.9m below ground level and decreased at a 1:20 gradient for the first 5m, to a depth of 1.15m. The remainder of the trench continued at a depth of 1.15m. Breeze blocks were laid along the length of the trench to construct the TAD, up to three courses high. Concrete slabs were laid across the top of these. Aggregate was placed down the sides and a layer of terram was laid over the top.

3. **Where is the trench arch system installed in relation to the church?**

   West side of the church, approximately 4m away.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   No known archaeological deposits prior to development, except for the potential for human burials in the vicinity of the church building.

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   Yes. A total of 36 probable late medieval skeletons, one post-medieval skeleton, and fittings from three post-medieval coffins were recovered during archaeological monitoring of this development from 39 earth cut graves. A high proportion of the burial population (48.6%) were sub adults.

   The coffin fittings represent a range of coffin types. One appeared to be relatively basic, because it lacked ornate grips, grip plates and upholstery studs. The other two sets of fittings were highly decorated and were of an unknown/uncatalogued design typology; they therefore make an important contribution to archaeological knowledge of Georgian/Victorian funerary regalia.

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

   Graves (see above). All human remains encountered during this development were removed and reburied in the same trench that had been dug for the purposes of the development and as close to their original burial location as possible. Burials from along the line of the trench arch drain were largely deposited on top of the drain cap. These remains are therefore unlikely to be affected by waste products flowing through the trench arch drainage system, but are now located much closer to current ground surface level than their original burial location.

7. **Are there any associated archaeological reports available for this site/area?**

   Yes, Oxford Archaeology South, report # 8551.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   Once a week (infrequent).

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   The church is used frequently, and the trench arch drain serves one lavatory and a hand basin. A further sink may be linked to the trench arch drain in the near future.

   Services are up to 3 times a week. There are pilates classes and various other meetings (approximately 1 a week) at various times of year. Weddings, baptisms and funerals number approximately 11 a year (combined). There are usually 2 concerts in the summer, and also a large Christmas service/carol concert that usually has 100+ people in attendance. Furthermore, the church and lavatory are left unlocked at all times. The majority of villagers are aware that the lavatory is

available as a “public loo” and people are known to use it frequently outside normal church open hours.

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    Waste water, lavatory paper, and sewage only

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    Although the facilities are left open to the public all of the time, a large notice is up asking people not to flush sanitary items, nappies and suchlike down the lavatory. A large bin is also provided.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No

Archaeological Report Reference

Oxford Archaeology 2008 St. Mary the Virgin, Kirtlington. Archaeological Watching Brief Report. Report number 8551. Unpublished report for Acanthus Clews.

CASE STUDY 4: ST. MARY AND ST. JOHN, BRINGTON, DIOCESE OF PETERBOROUGH (MAP REFERENCE PE1, FIGURE A3.8)

Background information

The earliest record of a church at Brington is in the Domesday Book in AD 1086. The current stone church dates is 12th century in date, although it is possible that an earlier wooden church existed on or in the vicinity of this location.

Taken from Kimbell, R. 2016. *St. Mary the Virgin w. St. John, Great Brington, Northamptonshire*. http://www.greatbringtonparishchurch.co.uk/

"*Great Brington is recorded in the Domesday book and it is likely that a wooden church originally stood on this site before it was burned down in the 13th Century. The current church dating from between 1220 and 1280 follows the pattern of the Early English Decorated and Perpendicular styles.*

The present church stands on the site of an earlier Saxon church. The first record of a priest at Brington is in the Domesday Book in 1086.

[The Tower]…is the earliest part of the Church and was built around 1200 A.D. It was one of the old chain of beacon towers and now houses the bells and the clock. The clock is dated 1820 and was made by John Corby of Castle Ashby. There are six bells which were re-cast in 1745 by Rudhall of Gloucester and re-hung on a metal frame in the 1800's. Charles 1st's dinner bell which is also known as the "priest's bell" was brought here from Holdenby House and also hangs here.

On the outside wall to the East is the effigy on an unknown priest and dates from the 1300's. The South Porch was restored by Edward Blore in 1832. The glass doors and screen were installed in 1998. These were designed by Maurice Watson and decorated by Richard Barnard.

Developments of the original church have taken place over the centuries particularly when Sir Edward Grey and his grandson Sir Thomas 1st Marquess of Dorset (Lords of the Manor of Nobottle and Brington) integrated the tower with the church building."

Soils, Environment and Geology

The soils at St. Mary's and St. John's, Brington, are slightly acid loamy and clayey with impeded drainage. Landcover is characterised as arable with grassland. The local habitat is characterised as having a wide range of pasture and woodland types. The local geology is mudstone bedrock with superficial glaciofluvial deposits comprising sand and gravel.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

   JW Turner Ltd.

2. **How was the trench arch system installed?**

   Concrete beam sides and a block roof leaving a void in the centre and an earth floor.

3. **Where is the trench arch system installed in relation to the church?**

Builder response: West side of the church.

Church warden response: north side of the church, approximately 5 yards from the north wall, running east-west.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   Yes. The earliest recorded burial on the site dates to 1625, but there are known to be earlier, unrecorded burials dating back to at least the medieval period.

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   Yes, graves and bones disturbed during installation of the trench arch. No archaeologist was present so all disturbed remains were gathered up and reinterred in the side of the TA trench. A small service was held at the time of reburial.

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

   No

7. **Are there any associated archaeological reports available for this site/area?**

   No archaeological monitoring or consultation was undertaken in regards to this development.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   Infrequently, once a week. Eco-friendly cleaning products are used.

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   Church services are held once a week. The church also hosts approximately two annual summer concerts, a Christmas service, an annual bazaar and up to around 20 weddings/funerals (combined) every year.

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    The TA drain serves a lavatory and hand basin. Normal waste water, sewage and lavatory paper are disposed of there. Nothing else.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    The lavatory is kept open at all times for the public to use. There is a sign asking that patrons do not flush nappies, sanitary waste and suchlike down the lavatory. There is a bin provided.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No, both the church warden and Reverend emphatically stated that it functions perfectly.

CASE STUDY 5: ST. PETER AND ST. PAUL, SCALDWELL, DIOCESE OF PETERBOROUGH (MAP REFERENCE PE3, FIGURE A3.9)

Background information

The earliest architectural features of the church date to the 12th century.

Taken from The Corpus of Romaneque Sculpture in Britain and Ireland. 2016. *St. Peter, Scaldwell, Northamptonshire*. Available at: http://www.crsbi.ac.uk/site/1267/

"The church has an aisled nave with a clerestorey on the S side only, chancel and W tower. The nave arcades are of two bays and date from c.1300. The N aisle has been widened and extended W ward alongside the tower, probably in the 19thc. The N aisle doorway has been blocked; the S is 19th c. and protected by a porch. The chancel has chapels to N and S, the N chapel two bays long with an arcade of c.1300; the S of a single bay which now houses the organ. The W tower is of three unbuttressed storeys; the lower storeys 12thc. with plain round-headed lancets in the S and W walls, the top storey bell-openings all with replaced heads and probably 13thc. A parapet has been added, perhaps in the 18thc. The church was extensively restored by William Slater and Gillet in 1863, and further repairs were carried out by E. A. Roberts and P. J. Panter of Wellingborough in 1961-66. Romanesque features described here are the plain tower arch and the font.

The first mention of the church is in 1224, when the advowson was in the hands of the abbot of Bury, and the abbey retained the advowson for the remainder of the middle ages.

At the W end of the nave, S of the tower arch. The font stands on an extremely tall modern double step, which raises it to an unusually high level. The bowl is chalice-shaped with a roll around the angle of the rim and another, thinner roll just below. The lower rim projects and the edge has angle rolls at top and bottom. The upper rim has lock damage, and the basin is lined with lead. The bowl stands on a five-shafted pier with panels between the shafts, some carved with relief quatrefoils in circles. This pier must be 14thc., but the bowl dates from the 12th c."

Taken from Crotty, P. 2012. *Scaldwell, a Brief History.* Available at: http://www.scaldwell.org/history.html

"*The name Scaldwell is derived from the Danish Scald. Meaning shallow and the Saxon Weile. Meaning spring, and the village is first mentioned in the Domesday Book, although there is archaeological evidence in the form of Roman pottery kilns and a hoard of 6thcentury loom weights to show earlier occupation.*

The Parish church of St Peter and Paul has a 12th Century tower, with the main structure belonging to the late 13th century with 15th and 19th century additions."

Soils, Environment and Geology

The soils at St. Peter and St. Paul's, Scaldwell, are loamy with impeded drainage. Landcover is characterised as arable and grassland with some woodland. The local habitat is characterised as seasonally wet pastures and woodland. The local geology is Northampton sand formation: ironstone and ooidal bedrock with superficial glaciofluvial deposits comprising sand and gravel.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

Martyn Taylor Ltd.

2. **How was the trench arch system installed?**

   The excavated trench measured 300mm deep and 800mm wide. The length of the trench is unknown. A 600mm double walled pipe was cut in half and installed down the length of the trench. An unknown base material was laid in the bottom of the first 3m of the trench to stop soil erosion. The trench was then backfilled.

   Two siting holes with covers are still visible on the site and mark the location of the drain.

3. **Where is the trench arch system installed in relation to the church?**

   At the north side of the church, at the west end.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   Unknown.

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   Unknown.

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

   No

7. **Are there any associated archaeological reports available for this site/area?**

   No

   The builder stated that no archaeological monitoring took place, that nothing archaeological was found, and that this was likely because of the shallow depth of the trench combined with the fact that "burials tend to dissipate".

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   The drain is for a kitchen and a lavatory, which is cleaned once a week (infrequent), with water and either Tesco or Waitrose eco-friendly sink/lavatory cleaner.

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   The church is used regularly (approximately 3 days a week) for services and a mother and toddler group. There are also occasional events, e.g. weddings/funerals, and a large event every year on Christmas Eve. The church is open every day and the facilities are therefore available for anyone to use at any time. It is thought that outside the scheduled services there are very few visitors.

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    Regular kitchen waste – washing up water and so on, sewage, lavatory paper.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    The lavatory and kitchen are not locked, but there are signs placed up stating that people using the facilities should not flush nappies or sanitary items down the lavatory.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No, the system has worked perfectly.

CASE STUDY 6: ST. MARY, SHOTLEY, DIOCESE OF EDMUNDSBURY AND IPSWICH (MAP REFERENCE SEI1, FIGURE A3.10-A3.11)

Background information

The earliest record of a church at Shotley is in the Domesday Book in AD 1086. The nave of the current church building is the earliest architectural feature, dating to the 13th century.

Taken from PastScape. Historic England. 2015. *Church of St. Mary.* Available at: http://www.pastscape.org.uk/hob.aspx?hob_id=1578074&sort=2&rational=m&recordsperpage=10&maplat=51.97803010&maplong=1.25610160&mapisa=1000&mapist=pc&mapilo=1.2561&mapila=51.9780&mapiloe=e&mapilan=n&mapios=TM235361&mapigrn=236118&mapigre=623592&mapipc=IP9%201ES

A PastScape search of the Shotley area immediately around the church highlights archaeological sites comprising a moat (date unclear), cropmarks – several ring ditches/trackway/field systems/enclosures, Bronze Age spearhead fragment, Romano-British coins and a brooch (findspots) and a WW1 anti-aircraft battery.

Taken from OneSuffolk. 2016. *St. Mary's church, Shotley.* Available at: http://shotley.onesuffolk.net/services-2/local-churches/st-marys-church-shotley/

"The church is positioned on high ground overlooking Shotley Marshes. It is located at the end of an unclassified road north of the B1456 between Chelmondiston and Shotley, Outside the church, the large churchyard descends steeply towards the Orwell estuary, and there are simply hundreds of military graves, mainly Royal Navy, but also some for Dutch sailors who were killed near here. It is the last resting place to many generations of seaman, including from HMS Gypsy, which struck a mine in the Orwell and sank. There are two entries for the hamlet of Shotley (Scoteleia) and an adjacent settlement of Kirkton (Cherchetuna) listed in the Domesday Book of 1086."

Taken from Commonwealth War Graves Commission. 2016. *Cemetery Details, Shotley (St. Mary) Churchyard*. Available at: http://www.cwgc.org/find-a-cemetery/cemetery/44229/Shotley%20(St.%20Mary)%20Churchyard

"There are 201 Commonwealth burials of the 1914-1918 war at St. Marys, 8 of which are unidentified, and there are 34 of the 1939-1945 war, 2 of which are unidentified Royal Navy seamen and 2 of which are Merchant Navy seamen from the S.S. Skagerak. There are also 13 German Foreign National burials of the 1914-18 war, 1 of which is unidentified."

Soils, Environment and Geology

The soils at St. Mary's, Shotley, are free draining, slightly acidic and loamy. Landcover is characterised as arable and grassland. The local habitat is characterised as neutral and acid pastures and deciduous woodlands; acid communities such as bracken and gorse in the uplands. The local geology is Red Crag formation sand bedrock.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

   Architect: Nicolas Jacobs

   Builder: Norman & Gardiner Ltd

2. **How was the trench arch system installed?**

   The TAD was based on the Elemental Solutions' concept. A trench 900mm wide and 900mm deep was cut, falling at 1:20 for the first 6m and then 1: 500 until final metre, which rose at 1:5. The trench was hand dug. The end of the trench was protected from surcharge by fitting dibutyl rubber across the cut face, held in place by paviors. Six inch hollow concrete blocks were placed 400mm apart and with a 30mm gap between the end, down the middle of the trench. The surface of the trench was raked to avoid compaction. 600mm x 60mm close-butted concrete paviours were placed over these blocks down the entire length of the trench. These were covered with geotextile, and 20mm clean stone chips were laid down in the gap on either side of the arch. The whole trench was backfilled with topsoil and the paving slabs for the path reinstated. The bottom of the discharge pipe terminated at 10mm above the trench base.

   (Note: the system was installed at a lower depth than would normally be expected, because of the internal floor level of the church. As required by Building Control, percolation tests were carried out prior to the installation, involving the digging of 3 holes in the location of the proposed trench arch and monitoring the speed with which water drained from the holes. The hole locations were as shown on the plan.)

   Contractors were responsible for informing the County Archaeologist about development timings approximately 2 weeks prior to the excavations taking place, and also for liaising with them regarding archaeological monitoring/recording etc. In this case the architect could not find any correspondence in their file relating to the County archaeologist so assumed that no significant findings were made.

3. **Where is the trench arch system installed in relation to the church?**

   West side of the church. The trench arch was located below the existing footpath as it was felt this would be the least likely place to disturb archaeological remains, as the footpath had been there for many years. There were some burials either side of the footpath that were not disturbed during the construction.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   Unknown

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   Known and unmarked graves are located within the vicinity of the church – Royal Navy/Dutch sailors' graves. There are also 201 recorded Commonwealth burials dating to the first world war. It is unclear exactly where these burials are located.

   Recorded grave monument details are available online at: http://www.gravestonephotos.com/public/cemetery.php?cemetery=873

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

No

7. **Are there any associated archaeological reports available for this site/area?**

   No

   As part of the Faculty procedure proposals are put before the panel at the Diocesan Advisory Committee, (in this case at St Edmundsbury & Ipswich Diocese) who have an archaeologist on the panel providing advice for schemes such as this. The archaeologist that would have been consulted is Bob Carr, and he is often the architects/builders' first point of contact when considering excavations within churchyards.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   Infrequent – the TAD only serves one lavatory and a "tea point" (Figure A3.11). A volunteer cleaner comes around "as needed". She only uses eco-friendly cleaning products (from Sainsburys – Ecover?).

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   Yes, occasionally opened up if there is a wedding or a funeral. Weddings are approximately three to four times a year, funerals more frequent but the number per year does vary. Generally, the facilities are only used when the church has services (i.e. once a week, approximately four times a month).

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    Only sewage and lavatory paper.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

    Access is restricted. The door to the bathroom is kept locked at all times and only unlocked when there is a service (once a week, = approximately 4 times a month, plus occasional wedding/funerals). No signs or anything are put up.

12. **Have any blockages occurred? If so, how frequently? How were these cleared?**

    No

13. **Have any other problems been encountered?**

    No

CASE STUDY 7: ST. MARY'S, WOOLPIT, DIOCESE OF EDMUNDSBURY AND IPSWICH (MAP REFERENCE SEI8, FIGURES A3.12-A3.13)

Background information

The first records pertaining to the existence of Woolpit as a settlement date to AD1005, where the "Wlfpet" was given to the Shrine of St. Edmund a year after the Battle of Thetford. Woolpit is also mentioned in the Domesday Book in 1086.

The current church building at St. Mary's dates back to at least the mid-15th century, with the porch being built at some time between 1430 and 1455.

Taken from TailorMade. 2016. *St. Mary's Church*. Available at: http://woolpit.org/st_marys_church/

"*The steeple of St Mary's dominates the skyline from whatever direction you approach. Our church has evolved over the centuries from its Norman origins like many other churches in Suffolk, but it is special because of its magnificent double hammer beam roof, angel carvings, fourteenth century porch and carved pew-ends, which make it one of the finest village churches in East Anglia. Over the centuries its porch has stood proudly over the south door, built in the fourteenth century from donations.*"

Soils, Environment and Geology

The soils at St. Mary's, Woolpit, are free draining, slightly acidic and sandy. Landcover is characterised as arable. The local habitat is characterised as acid dry pastures; acid deciduous and coniferous woodland, with potential for lowland heath. The local geology is Crag Group sand bedrock.

Questionnaire Responses

1. **Details of the manufacturers/installers of any trench arch systems installed (in the last 3 years?)**

   Valiant builders

2. **How was the trench arch system installed?**

   Builder: Hand dug trench, dug by the contracter. A shallow trench was dug to a width of 450mm and a length of 8m for a 250mm deep underground chamber. This was lined with blocks and capped with slabs. The gradient of the downward slope was 1: 50 for 5m, with the last 3m of the trench rising up again. The trench was dug under the modern tarmac path.

   (Note: this description by the builder doesn't match that provided by the architects (Figure A3.13). The trench should have been 1m wide and 400mm deep, with 150mm wide hollow concrete blocks (400mm space between), capped with heavy duty concrete paving slabs. This structure should have been covered by a geotextile membrane and should have had gravel/stones down the side of the trench, lining the drain and the remainder of the trench backfilled with topsoil.)

3. **Where is the trench arch system installed in relation to the church?**

   The builder stated that the drain was on the north side, 6m away from the church wall, under the modern tarmac path.

   The architect stated that the drain was located under a path, running with the ground away from the north wall of the church, in an area which appeared to be free from burials, and indeed proved to be so. The water main was brought in from the front (south) of the church in an equally shallow hand

dug trench.

4. **Site specific information – any known burial structures/buried remains? Where are these in relation to the trench arch system?**

   No obvious remains and the trench arch was shallower than the depth at which the diocesan archaeologist expected to find remains in situ.

5. **Is there any burial archaeology in the area of the system? This information may have been established via archaeological intervention, or inferred based on knowledge of burial practice relative to church chronology/history and location of the church in question. Any dates of burials, known rites (coffined etc), burial depth horizon c.f. present ground level, cultural separation of burials e.g. adults/children, location of any nearby above ground grave markers**

   The builder who installed the drain stated that the project was monitored by an archaeologist (one from the council), but he couldn't remember a name. He also said that no archaeology was observed.

   The architect stated that no archaeology was known before the excavation and none unearthed during.

6. **Is the churchyard within the vicinity of the system subject to disturbance from animals, horticultural excavation, graves, or anything else? How might this influence the impact of trench arch drains on archaeology?**

   No

7. **Are there any associated archaeological reports available for this site/area?**

   Monitored by Suffolk County Council – a watching brief was undertaken but no artefacts were discovered, and "no significant report" produced (according to architect).

   James Rolse at Suffolk County Council could not find any records or planning enquiries for this particular drain installation.

8. **How are the church facilities cleaned? How often? - infrequent (0-10 times a week), moderately frequent (10-20 times a week) or frequent (>20 times a week). What are the facilities cleaned with? What chemicals are used?**

   The builder stated that the trench arch drain on the north side was built to service a lavatory, hand basin, and a second sink, to be used for the church floral arrangements. All of these were deemed to have low usage.

9. **Do the facilities have sporadic/frequent use e.g. during festivals, fetes, other community events? Is usage more/less at specific times of year, e.g. Christmas?**

   N/A

10. **What different types of waste are disposed of in the facilities? e.g. sewage, waste paper, sanitary waste, kitchen waste etc.**

    Sewage, lavatory paper, waste water – lavatory/hand basin/floristry sink.

11. **How are the facilities managed? E.g. are notices put up, and requirements e.g. certain things NOT disposed of in the system? Are alternative disposal systems e.g. bins provided? Does this influence the quantity/range of waste disposed of into the facilities?**

No need for a notice. A bin is provided.

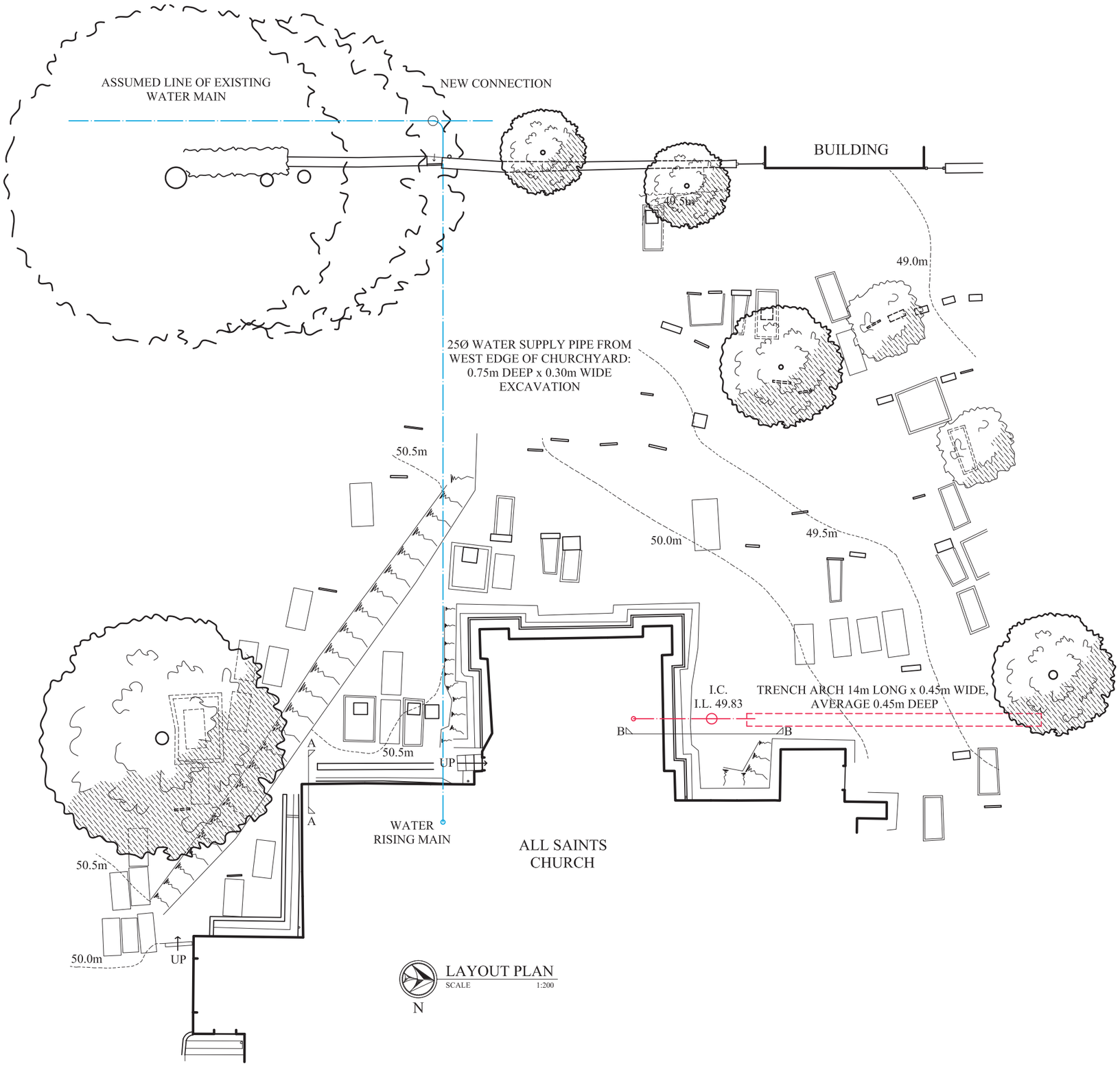
12. Have any blockages occurred? If so, how frequently? How were these cleared?

No

13. Have any other problems been encountered?

Although no blockages have been reported, the church warden did report damp problems on the north side of the church in the vicinity of the trench arch. It is anticipated that a second drain will have to be dug in the future to deal with this. However, this is not considered to be a priority for church funds and there are currently no plans scheduled for these works.

Figure A3.1: All Saints church, Newland, Gloucestershire (Google Earth, 2015, 51°46’56.03”N, 2°38’57.71”W, elevation 122m. <http://www.google.com/earth/index.html> [Viewed 25 February 2016].



NOTES:

1. ALL DIMENSIONS MUST BE CHECKED ON SITE AND NOT SCALED FROM THIS DRAWING

REV.	DATE	REVISIONS
-	-	-

John Falconer Associates
101 Promenade
Cheltenham, Glos, GL50 1NW
Tel: 01242 582362
Fax: 01242 222855

CLIENT
THE P.C.C. OF NEWLAND WITH REDBROOK

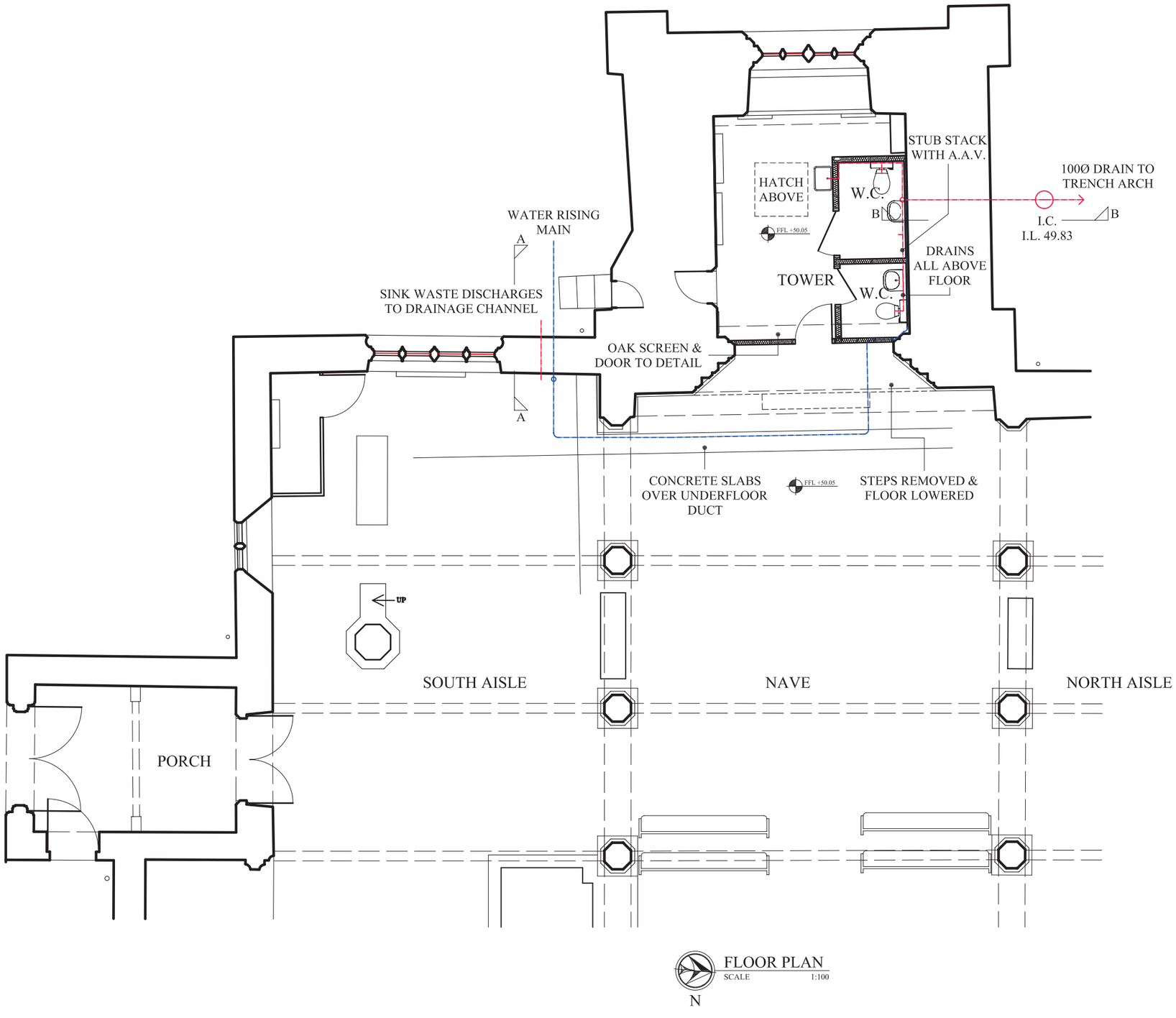
JOB TITLE
ALL SAINTS CHURCH,
NEWLAND, GLOS.

DRAWING TITLE
WORKING DRAWING
LAYOUT PLAN &
UNDERGROUND SERVICES

SCALE 1:200 @ A3
DATE 22.11.12
DRAWN BY JR

DRAWING NO. 1111 - P1 - 01
REV. -

Figure A3.2: All Saints church, Newland, TAD location



NOTES:

1. ALL DIMENSIONS MUST BE CHECKED ON SITE AND NOT SCALED FROM THIS DRAWING.

REV.	DATE	REVISIONS
-	-	-

John Falconer Associates
101 Promenade
Cheltenham, Glos, GL50 1NW
Tel: 01242 582362
Fax: 01242 222855

CLIENT

THE P.C.C. OF NEWLAND
WITH REDBROOK

JOB TITLE

ALL SAINTS CHURCH,

NEWLAND, GLOS.

DRAWING TITLE

WORKING DRAWING

PROPOSED FLOOR PLANS

SCALE		
1:100 @ A3		
DATE	22.11.12	DRAWN BY JR

DRAWING NO.	REV.
1111 - P1 - 02	-

Figure A3.3: All Saints church, Newland, TADs Floor Plan (John Falconer and Associates, 2012)

Figure A3.4: St. Katherine's church, Wormington, Gloucestershire (Google Earth, 2015, 52°01'33.72"N, 1°56'40.34"W, elevation 54m. <http://www.google.com/earth/index.html> [Viewed 25 February 2016].

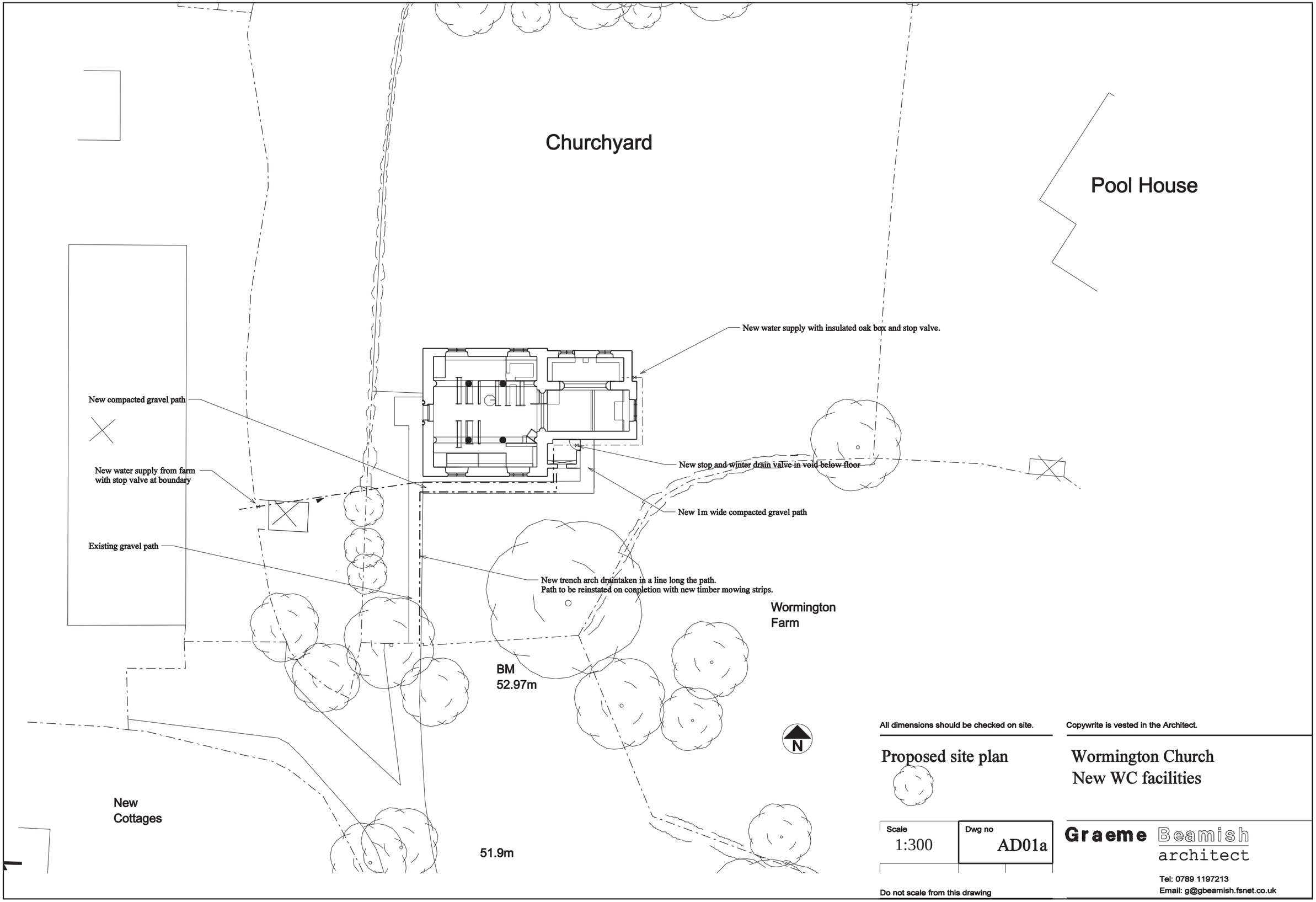


Figure A3.5: St. Katherine's, Wormington. Proposed Site Plan

New sink with drain to exit in to back of existing rainwater pipe.

New sink unit by client
with instantaniuos heater below

Door to be redecorated and five lever dead lock supplied and indicator bolt colour to match existing. Note frame to be sealed against wall.

Hot water for sink to be provided by instantanious heater.

Existing floor to be sanded and sealed with Danish oiled

New plaster board and stud bulhead formed to support sink

New hatch, floor board screwed to ply panel on removable joists
On steel angle (galvanised) rawl bolted to wall.

Water supply

Soil pipe to trench arch

New light fitting to light path also on PIR and timer
to match existing

Floor plan

Header tank raised to ceiling and boxed in.
with overflow connect to WC overflow.

Extract to chimney

Extract to chimney

Heater on frostat

Brush down wall only

Bulkhead fitting with

Mirror

Hatch to be sealed with
compriband and fixed shut

Brickwork to be brushed down only
and limewashed

baby changin table

Sections of proposed disabled toilet

All dimensions should be checked on site.

Copywrite is vested in the Architect.

Plan Elevation Proposed

Wormington Church
New WC facilities

Scale 1:75

Dwg no AD02a

Do not scale from this drawing

Graeme Beamish architect
Tel: 0789 1197213
Email: g@gbeamish.fsnet.co.uk

...\CAD\c99 disable toilet .dgn 29/04/2010 22:23:39

Figure A3.6: St. Katherine's, Wormington. Proposed Facilities

Figure A3.7: St. Mary’s church, Kirtlington, Oxfordshire (Google Earth, 2015, 51°52’18.91”N, 1°16’28.43”W, elevation 104m. <http://www.google.com/earth/index.html> [Viewed 26 February 2016].

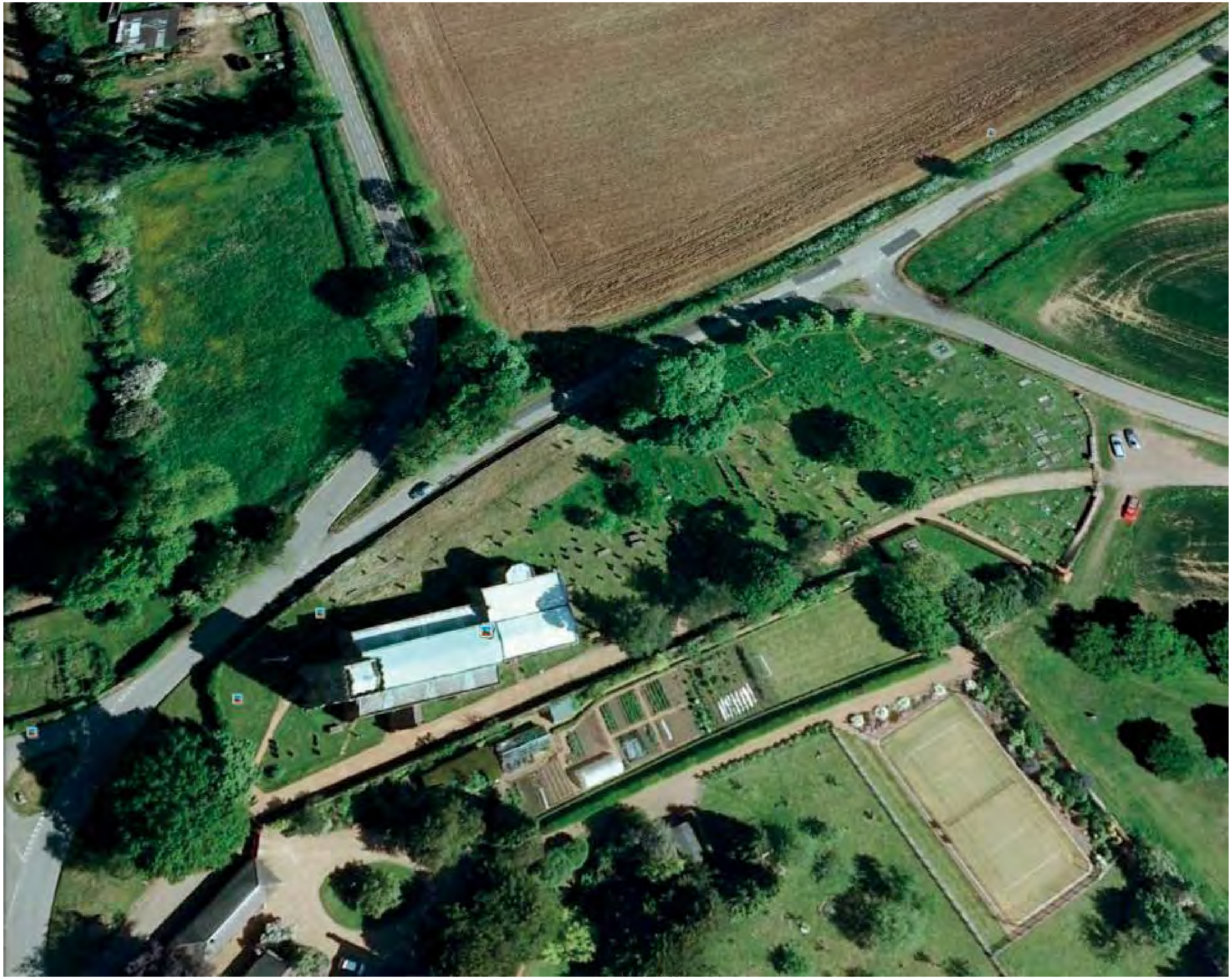
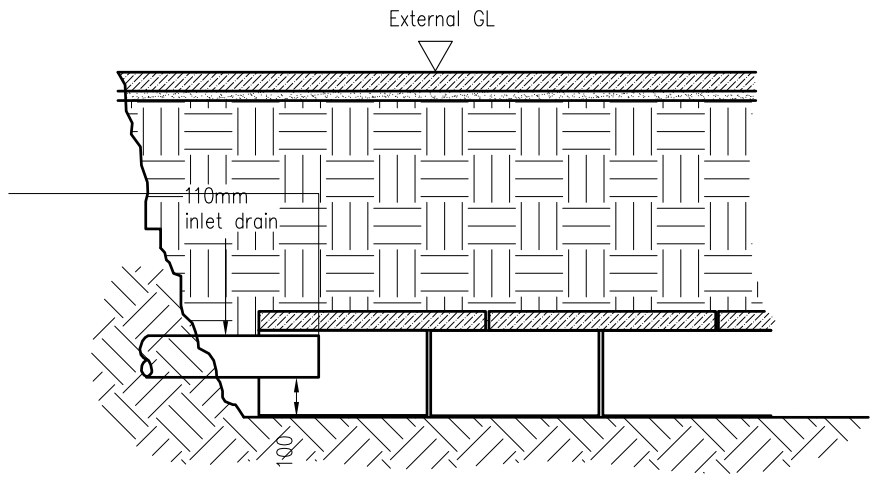


Figure A3.8: St. Mary and St. John's church, Brington, Northamptonshire (Google Earth, 2015, 52°16'52.79"N, 1°01'22.26"W, elevation 134m. <http://www.google.com/earth/index.html> [Viewed 26 February 2016].

Figure A3.9: St. Peter and St. Paul's church, Scaldwell, Northamptonshire (Google Earth, 2015, 52°20'45.04"N, 0°52'23.72"W, elevation 120m. <http://www.google.com/earth/index.html> [Viewed 26 February 2016].

Figure A3.10: St. Mary's, Shotley, Suffolk (Google Earth, 2015, 51°58'39.46"N, 1°15'21.31"E, elevation 18m. <http://www.google.com/earth/index.html> [Viewed 26 February 2016].

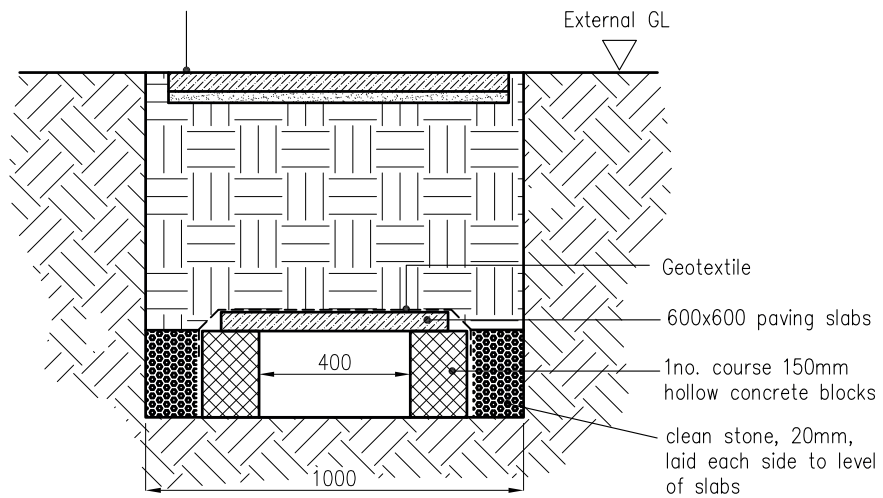
BLOCK PLAN



Trench base @ 1:20 fall for first 4–6m,
then 1:500 fall to one metre from end,
last metre 1:5 rise.
Do not smear or compact base

TRENCH ARCH
SECTION DD - 1:20

backfill with topsoil, compacting in layers and relay 600x900mm paving slabs on bedding



TRENCH ARCH
SECTION EE - 1:20

Nicholas Jacob Architects
89 Berners Street
Ipswich
Suffolk
IP1 3LN
Tel: 01473 221150
Fax: 01473 255550
Nicholas.Jacob@NJArchitects.co.uk

Client PCC OF ST MARYS CHURCH SHOTLEY
Job PROPOSED NEW WC & TEA POINT
Title BLOCK PLAN & DRAINAGE DETAILS
Drawn MAI
Checked
Date Sept. 2010
Scale 1:200 & 1:20

0847/04

Do Not Scale. Check all dimensions on site and report discrepancies.

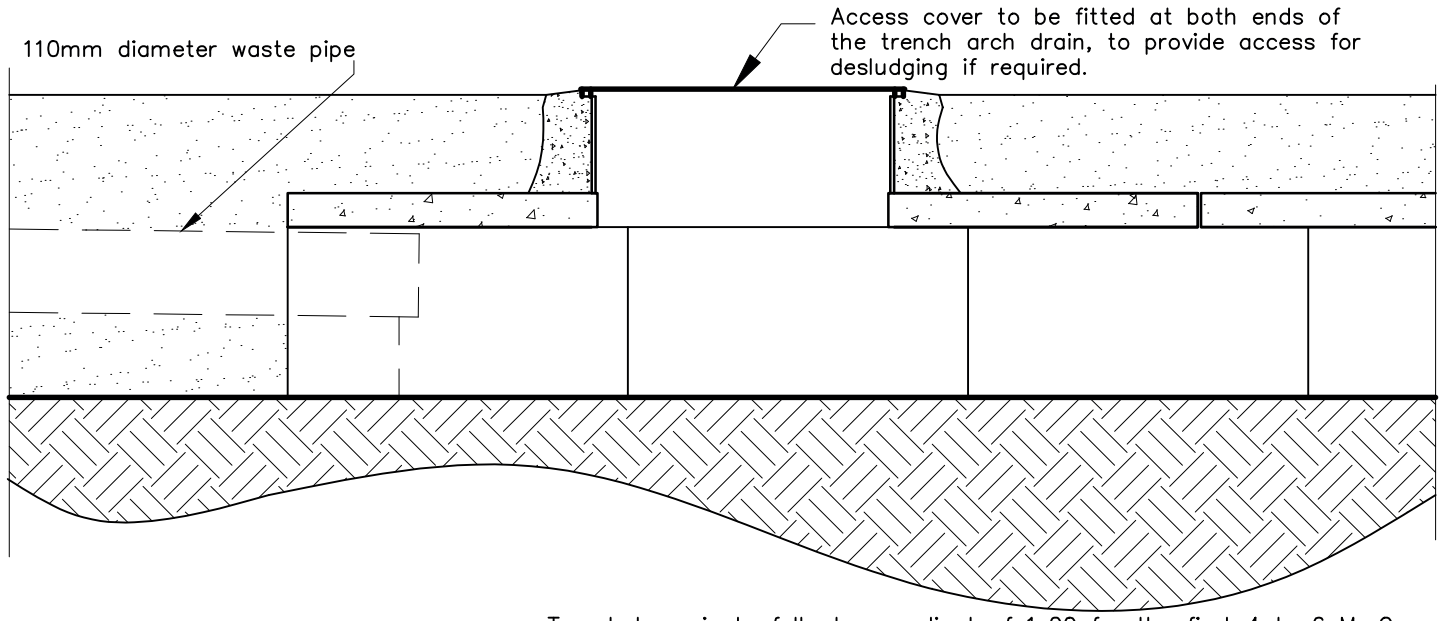
100

Figure A3.11: Block Plan and Drainage Details, St. Mary's church, Shotley

Figure A3.12: St. Mary’s, Woolpit, Suffolk (Google Earth, 2015, 52°13’30.33”N, 0°53’22.29”E, elevation 63m. <http://www.google.com/earth/index.html> [Viewed 26 February 2016].

NOTE .

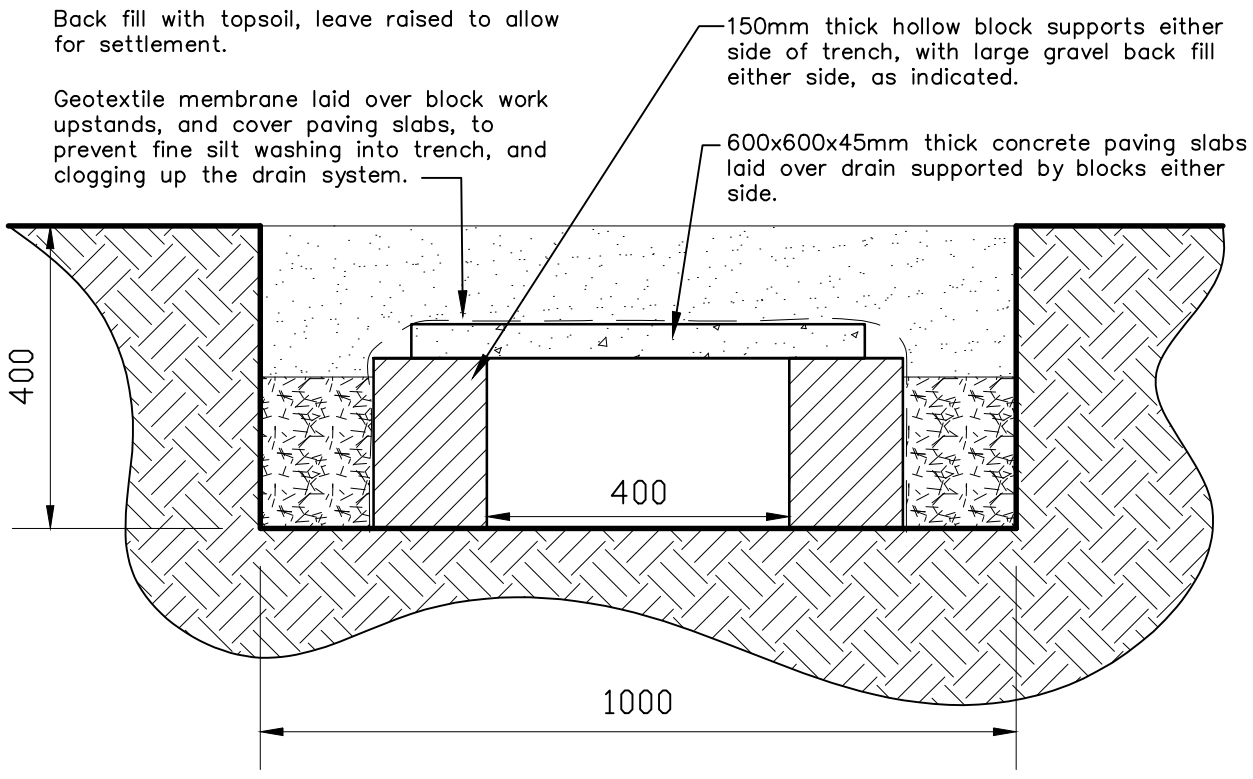
le from t is dra in .
Con irm all imen ions on it .
Refer any iscrepan ies to the
Arc itect before wor is pu
in han is dra in in
co ion ith the relevant
ions of the spe i ica ion,
schedule of works and other
dra ing



Long section through trench arch drain

Trench base is to fall at a gradient of 1:20 for the first 4 to 6 M. One metre before the end of the trench is to be almost flat, and the final metre of the trench is to rise at a gradient of 1:5.

When excavating be careful not to smear or compact the base. The length of the trench arch drain is to be determined on site following a perculation test.



Cross section through trench arch drain

102

WCP
THE WHITWORTH C

Chartered Architects and Surveyors
18 Hatter Street,
Bury St.Edmunds,
Suffolk,
IP33 1NE.

-

Client

Job itle
Trench Arch Survey

ing itle
Trench Arch Drain De-ail

Scale		
1:10	NC	9/08
.	Drwg N ./Re 01	Checked b ·

Figure A3.13: TAD Schematic, St. Mary, Woolpit

Appendix 4: Supplementary Information (DAC Survey)

This appendix documents information received in emails and telephone calls, provided in relation to questions on the DAC Survey. DAC Secretaries, DAAs and architects may have provided answers for more than one of the questions below. The document is structured in order of survey question, and then by Diocese.

DAC SURVEY

Question 1: Were any trench arch drainage systems installed in your diocese in 2011, 2012, 2013, 2014 and/or 2015?

Chelmsford

DAA: *"I have filled in the form, but I am afraid I will be of no use to you as I don't know what a trench arch drain is. It's possible we haven't encountered any - at least not under that name. We have dealt with assorted French drains and narrow-bore water pipes."*

Durham/Newcastle

Architect (serves both Diocese): *"I am an architect working for parishes in Durham and Newcastle Diocese. It happens that I am also a member of the Durham DAC, which may be why I have received your questionnaire which I have read. I do not have time to fill it in as you would wish and it doesn't allow me to say the basics. Instead I offer this from my experience of installing two trench arches and being denied building regulation approval for a third. Where trench arch can be demonstrated to be technically viable (i.e. where use will be very low, where there has been a successful soil percolation test according to the calculations set and where there is suitable flattish land without burials) there is still a triple lock on such drains - building control, the environment agency and the DAC all have to approve. Building control will not agree where ANY other form of drainage is viable. The Environment Agency will not agree where any watercourse might possibly be affected (I don't remember their limit but I think it was hundreds of meters).*

The DAC will not agree where any burial or archaeological deposit might be affected. Trench Arch is correspondingly rare. Concern that archaeological impact might not be properly assessed by the DACs and their archaeological advisors/members is, in my experience, misplaced. Another example - I am about to design a WC in a medieval church. I have never suggested trench arch because the churchyard will be dense with burials and other possible archaeological deposits AND because building control will not allow trench arch where there is any possible sewer connection (which there is here, albeit at a good distance and across a road which will be expensive). Even the drain excavation in a churchyard path will need archaeological oversight."

Hereford

DAA: *"There have been many proposals for trench arches but I can't recall which ones have actually been installed."*

Lincoln

DAC Secretary: *"I have come up against a bit of a stumbling block regarding your questionnaire. You ask us to list churches that have had trench arch drains. To do this we would need to retrieve, from the county archives, all applications over the last five years and then look through all the plans to see whether they had trench arch drains or not."*

Architect: *"Aware but not involved in any projects yet"*

Norwich

DAA: *"I do not have details of any TA's installed in 2010-3. It would be possible work this out through the diocesan records, but I am told these have been archived. All applications for major drainage works are automatically covered by a clause which states that an archaeological watching brief should be carried out in accordance with a written brief. So any archaeological work done during these years should have been described in a "grey literature" report and submitted to the Norfolk Historic Environment Service. Such reports will have been filed under HER record numbers and I do not think there would be any way of searching under the term "Trench Arch". There is a small possibility that Suffolk churches in the diocese should also be taken into account."*

Rochester

DAC Secretary: *"I have completed the questionnaire, but it won't be any help to you as I'm really not sure if any trench arch drains have been installed."*

Architect: *"I know of one Architect in Canterbury Diocese, who is considered the 'world's expert' in these drainage systems (indeed, he is just installing one in one of my former Churches in my care….). I have no experience in the Rochester Diocese."*

Sodor and Man

DAC Secretary: *"I have consulted with a couple of people in the diocese who understand these things and they inform me that we do not have any trench arches."*

Southwark

DAC Secretary: "*We definitely haven't had any of these installed in our diocese over the past twenty years!"*

DAA (also DAA for London): stated that he has never come across any TA drainage systems, so he has no observations to make.

St. Albans

DAC Secretary: *"We understand that a formal (paper not digital) report was produced by Albion Archaeology for Stevington (their Doc 2011/127) and this may be available via the HER. Nothing of significance was found, as expected given the shallow depths involved.*
It is likely that the DAA was consulted about some of the other projects, but he has not retained any records of this. His response, where made, is likely to have been along the lines of no archaeological objections bearing in mind the shallowness of the intervention, having taken the particular circumstance of the churchyard into account. The DAA considers that trench-arch systems are a great advance archaeologically on large plastic cess-pits which cut through lots of burials."

Question 1a: Have any trench arch systems been proposed but not installed in your diocese? If so, why were they not installed? (Please give church and parish where possible)

Durham

Care of Churches Secretary: The architect for St. Andrew's church, Dalton le Dale thought about but then rejected the TAD for this site, located in a valley (le Dale) with heavy clay soil.

Hereford

Historic England/Hereford DAC: *"In my role as Hereford DAC, I see quite a few trench arch proposals for sanitation in rural churches. Advice on their archaeological impact and potential mitigation is invariably given by the Diocesan Archaeological Adviser, who also sits on the DAC. I deal with the Coventry DAC. Although we talk about trench-arch from time to time I am not aware of any that have actually been installed in the Diocese recently, although the DAC officers will have a better idea of that than myself. And, of course, the archaeological adviser."*

Norwich

County Archaeologist: *"TADS had been scheduled for 2014 at St Mary, East Carleton, and St Mary Erpingham. In both cases, faculties were granted but the drains have not yet been installed. At St. Mary's East Carleton, the system had been chosen over composting toilets and is to be located on the east side of the church. Both developments will be archaeologically monitored if they eventually go ahead."*

Rochester

Architect: a proposal for one church was turned down because of the probable effect on adjacent archaeology and risk of bad smells; connecting into a main sewer (albeit at additional cost) was available (precise church not given).

Question 2: How many trench arch drainage systems were installed in your diocese in 2011, 2012, 2013, 2014 and/or 2015?

Bath and Wells

Architect: *"3 or possibly 4 as of yesterday! These are at St Nicholas, Kelston; St Marys, Charlcombe; St Julians, Wellow; and as of yesterday St Johns Hinton Charterhouse. Of the 4, St Julian's is aiming for an internal WC at the west end of the church; the others are for external WC cabins. All are for intermittent use. Can't say more at present."*

Derby

Architect: *"at least 1 a year".*

Gloucester

DAC Secretary: *"We have had three installations since 2011: Stretton Grandison St Lawrence; Llangarron St Deinst; and Bucknell St Mary - all are working well."*

Question 3: Please can you list the churches where they (TADS) have been installed?

Bath and Wells

Architect: currently working with 3 local parish churches in the Bath & Wells Diocese on trench arch drainage schemes but these are at the planning stage. Aiming to route the trenches through areas 'apparently free of graves' but clearly there is still a risk of exposing shallow, unmarked remains. B&NES Building Control appear to be both relaxed and confident about these installations, although their response in some cases has been to say 'no application required'.

Architect: *"We have only carried out one Trench-arch installation (St. Barnabas, Brooking), which was in the churchyard of a 19th c. church built on a new (greenfield) site and therefore with minimal archaeological impact."*

Blackburn/Lincoln/Sheffield/York

Architect: *"I have installed at least five Trench Arch systems over the course of the last seven years. These have been in the dioceses of Sheffield, Lincoln and York. They have been installed at All Saints Preston (Hull), Snaith Priory (Selby), St Martins Seamer (Scarborough), Thornton Curtis Church (Barton on Humber) and St Laurence Adwick le Street (Doncaster). The last one was installed about a month ago. In all cases we have located these in partnership with archaeologists and this has involved the development of a written scheme of investigation. To my knowledge all of the systems have been installed without any significant disturbance to articulated skeletons. We do pull up bone fragments but we never encounter a full burial. That has been a real success of the systems. Overall, the systems work very well in my opinion. The amount of material discharged into them is very small and we often have to recommend that churches flush the lavatory two or three times a week just to keep the system active and stop it drying out. As an adaptation to the suggested layout in the*

Gloucester DSE paper we have added an external interceptor chamber close to where the system leaves the church and also just before the start of the trench arch itself. This is so that we have got access to the system if we need to let the ground rest. An earlier system we put in nearly 7 years ago seems to be functioning fantastically well with no signs of any settlement of the ground where it was installed. There is also no difference in the colour of the grass which seems to be growing as abundantly as neighbouring areas. We have also installed a combination of a trench arch and a pumped system (with macerator). It would be interesting to know whether the system works better with a 'liquid feed' for the worms rather than solid. I've been doing a lot of work with the environment agency, getting them comfortable with these systems in the district in which I am working."

Blackburn/West Yorkshire

Architect: *"I have been involved in 3 trench arch drains schemes all of which included Archeological watching briefs and planning approval from Craven District Council. These were at: Mary's Coniston with Kilnsey; Hubberholme church; St. Peter's Rylstone. All in the Diocese of West Yorkshire and the Dales."*

Durham

Architect: *"Trench arch drainage has been considered for a number of Durham churches as follows: Holmside (Burnhope) St John the Evangelist – installed and OK as far as I know. Merrington St John the Evangelist - installed and OK as far as I know. Dalton le Dale St Andrew – thought about but rejected for this site which is in a valley (le Dale) with heavy clay soil. Witton Gilbert St Michael installed and OK as far as I know. High Spen – installed and OK as far as I know. Currently a biolet system is under consideration for Sadberge."*

Architect: *"I have designed and project managed two trench arch installations in the Diocese of Durham, both at sensitive sites (both from a heritage and archaeological viewpoint) - St. Michael & All Angels, Witton Gilbert (grade II) and St. Laurence's Church, Pittington (grade I)."*

Exeter

DAC Secretary: *"We have had 3 trench arch systems installed since 2011 (that we can recall), as follows: Bondleigh, St James (architect now retired), Chittlehampton, St Hieritha, West Alvington, All Saints."*

Gloucester

DAC Secretary (temporary): *"faculties have been granted for 6 schemes but I do not know if they have been implemented."*

Architect: *"All our (this architect firm) trench arch systems (not all in churchyards) have been installed following the guidance available on the Gloucester DAC website. Apart from the normal locations on the drains leading to the trench arch we have not used inspection chambers. The only occasion we had to inspect a trench arch itself was one installed at a country house to provide facilities for visitors. Here, a blockage occurred when paper towels had been flushed down the toilet on a regular basis. We were able to access the drain by lifting some of the slabs over the trench arch. We discovered that the paper towels had dropped into the trench arch and had slowly built up to eventually block the end of the drain pipe. This was easily removed. A hand dryer was installed and the use of paper towels, discontinued."*

Hereford

DAC secretary: *"As most of our 400+ churches are in rural locations, TA remains the most cost effective way of providing a WC for a church. The Diocesan Archaeology Advisor attends all DAC meetings and will usually make a site visit to assess the likely impact of the scheme and make recommendations accordingly."*

Norwich

DAA: "*It would be possible work out a full list of churches through the diocesan records, but I am told these have been archived. All applications for major drainage works are automatically covered by a clause which states that an archaeological watching brief should be carried out in accordance with a written brief. So any archaeological work done during these years should have been described in a "grey literature" report and submitted to the Norfolk Historic Environment Service. Such reports will have been filed under HER record numbers and I do not think there would be any way of searching under the term "Trench Arch". There is a small possibility that Suffolk churches in the diocese should also be taken into account."*

DAA: *"In 2014 two faculties were issued: St Mary, Erpingham - application withdrawn but a new application will be made for an alternative system (treatment plant in adjoining car park; reason for this change uncertain). St Mary, East Carleton - work not yet done (for an existing lavatory, trench arch c.7m east of chancel, quite close to a tree)."*

Oxford

Architect: "*We are just about to start work on site installing a trench arch soakaway at St Mary's Church, Childrey, Oxon. I also know of trench arch soakaways installed at Meysey Hampton and Avening churches, both in Gloucester diocese."*

Architect: *"I have little to contribute, since as yet I have not done a trench arch scheme, although I am likely to do one next year at Pyrton, Oxford Diocese."*

Peterborough

Architect: *"I have put in trench arches at Great Oakley, Grafton Underwood and Glapthorne, all in Northamptonshire. As far as I am aware they all work well and the local archaeologists were in attendance during the excavation but they found little of interest."*

Salisbury

DAC Secretary: *"The use of trench arch drainage as a possible option has been raised during site visits to individual churches but there have been very few of the systems actually installed in Salisbury Diocese. I have not completed the questionnaire myself as we would have to search individual applications for details of proposed drainage and we do not have the resources for this. Although we use a database to record applications we rarely distinguish, in the written schedule of works, the form of drainage proposed. Over the course of time, I can recall that the use of trench arch drainage as a possible option has been raised during site visits to individual churches but there have been very few of the systems actually installed in our Diocese. In fact, I can only recall one which was at Avebury parish church in Wiltshire (the architect here was Raymond Winrow, Slade Smith and Winrow, Bradford on Avon). I believe there may be one or two more, elsewhere though."*

Southwell and Nottingham

Architect: *"I know of a trench arch which was installed in 2009 (outside your date range) at Holy Cross church at Epperstone in Southwell and Nottingham Diocese. I am working on plans for some new trench arches but these will be installed in 2016 or later."*

St. Albans

DAA: The DAA considers that trench-arch systems are a great advance archaeologically on large plastic cess-pits which cut through lots of burials.

West Yorkshire and the Dales

Architect: *"I do believe that trench arch systems are a brilliant solution to the provision of WCs in our rural churches. So long as the ground drains reasonably effectively, there really should be nothing that can go wrong. I specifically avoid installing inspection hatches as they should not be necessary and I am keen to avoid possible sources of unpleasant smells. Similarly, I have not installed any forms of vent into the chambers. The process of flushing and introducing oxygenated water with each flush should be more than adequate. The process of decomposition is surely no different to normal burials, excepting that the deposits are replenished. The rate of solid deposits is unlikely to be more than 5 a month. I do make sure that the WCs concerned do not utilise any toxic non- degradable cleaning products or bleaches or flush any inappropriate materials."*

Worcester

DAA: *"I am concerned as I believed trench arch drainage to be the least damaging, given that it is shallow. I appreciate that this research project is not finished but would like to know the main concerns around this form of construction."*

York

DAC secretary: Approximately 30x trench arch drainage systems in York diocese. The DAC strongly encourage their use. The only problems ever encountered with these types of systems relate to local authorities. Often find getting approval difficult – authorities are "unsure what to approve" because these systems have no moving parts. Positive reasons for having TA systems installed include: cheap installation cost; they need little maintenance; no need for man holes and they don't need to pay drainage rates because they are not connected to the mains drainage.

Question 4: Briefly, what did the trench arch comprise and how was it constructed?

Derby

Architect: A TAD should be a standard construction which is 450mm deep with a 400mm width between concrete blocks, laid loose on soil with inspection chambers at either end (7 metres apart), no air vents and concrete slabs on top with visqueen dpm of block then turf laid back. laid on a slight slope down and then a slight slope up. Drawings of these available on request.

Gloucester

DAC Secretary: *"The design of all three installations is that of Environmental Solutions Ltd, who were commissioned to produce this for Gloucester Diocese in 2001. In the cases of Stretton and Llangarron the TA is located under one of the churchyard paths; at Bucknell it is on the north side between a row of modern burials."*

Oxford

Architect: *"There is a trench arch for the kitchen waste water and a 300mm inspection chamber just before the outlet to the arch. This is more for rodding the pipe work and outlet than inspecting the arch detail itself. I would be very surprised to find any problems with it because it does not take solid waste. We can check it next time on site but from recent visits to the church no signs of the arch were visible from above."*

Southwell and Nottingham

Architect: *"The one at Holy Cross was constructed 9m long and was of dry laid blocks, capped with slabs, located about 10m to the north of the church. It was located within an existing path and close to trees. It was selected because composting toilets are not liked (maintenance issues), space was not*

really available (due to burials) for a septic tank and the nearest mains drainage was over 40m to the south of the church and 4m lower because of the topography."

Question 5: Why was a trench arch chosen over other options (for example, connecting to the main sewers; composting toilets; septic tank, etc.)?

Gloucester

DAC Secretary: *"In all three cases there is no mains sewer in the village. Use of the buildings is modest and the cost of installing a septic tank (assuming access for maintenance vehicles is possible), prohibitive. Examples of composting WCs in other churches in the Diocese have not been successful, nor welcomed by users. As most of our 400+ churches are in rural locations, TA remains the most cost effective way of providing a WC for a church. The Diocesan Archaeology Advisor attends all DAC meetings and will usually make a site visit to assess the likely impact of the scheme and make recommendations accordingly."*

Question 10: Were any of the installations archaeologically monitored?

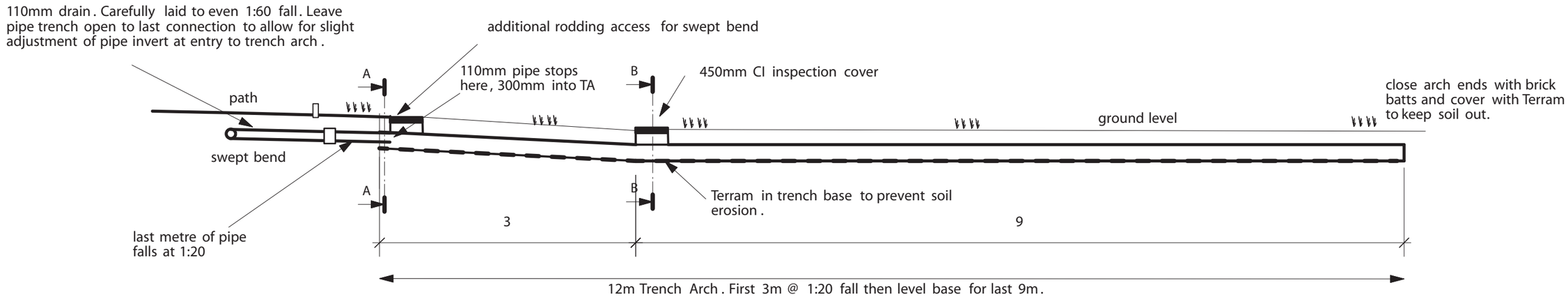
Gloucester

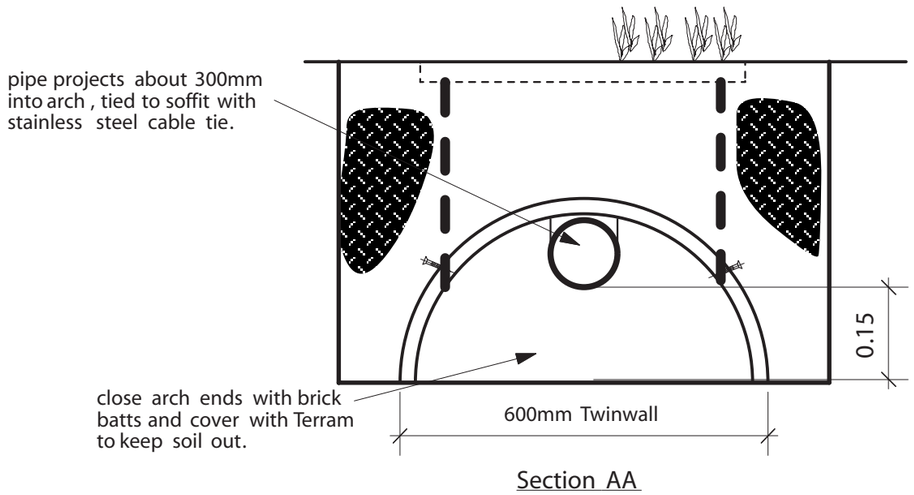
DAC Secretary: *"Archaeological services for Stretton and Llangarron were provided by Church and Site Archaeological Services (Monmouth); I do not know who carried this out at Bucknell."*

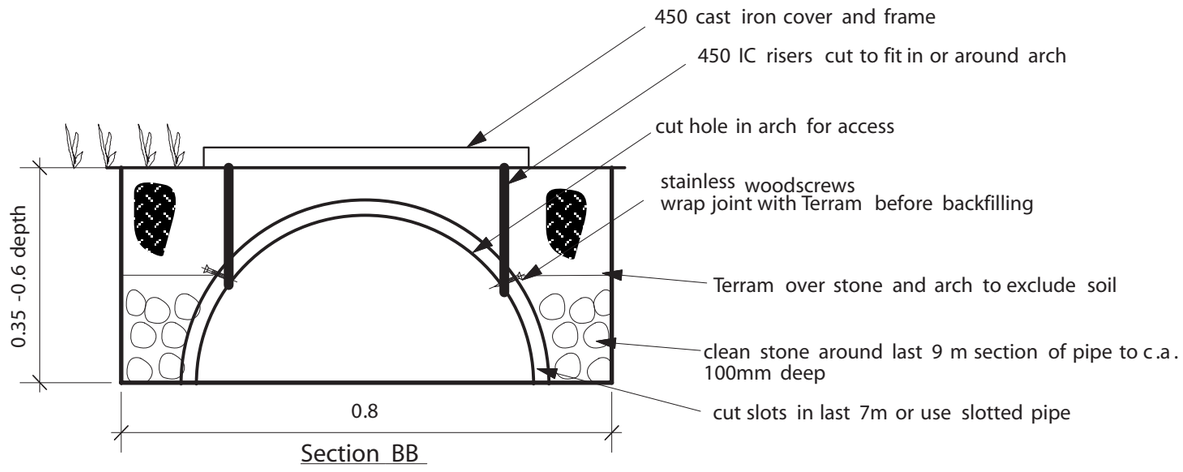
Former DAA: *"I would recommend a watching brief if I thought one was necessary and it was then up to the parish to appoint a competent professional to do the work; if asked, I would recommend somebody".*

	Ground level	Drainage	invert	cover/depth	
Door threshold	10 .00	Soil pipe at WC	9 .6	0 .3	
path @ start of TA	9 .82	Pipe at start of TA	9 .43	0 .29	10 m @ 1:60 fall
	9 .82	TA invert @ start	9 .28	0 .54	Trench depth
5m along TA	9 .62		9 .13	0 .49	Approx depth
10m along TA	9 .46		9 .13	0 .33	Approx depth

Approximate levels to check feasibility based on 300mm cover at start of drain run (400 should be possible) - mark out on site before commencing excavation .
Trench arch should ideally be no deeper than 600mm .







NOTE
Refer to Architect's drawing . This schematic is to inform the final design .

Levels are indicative and must be checked when setting out.
If in doubt ask . Generally the trenches should be kept as shallow as possible to minimise excavation and tp utilise the topsoil for infiltration.

Title: Trench Arch section Kenfig St Mary Magdalene	DRG . No .: Ken 001	
	CLIENT: Caroe & Partners	
ELEMENTAL SOLUTIONS BS 308	DATE: 12/08/11	DRAWN: Nick Grant
	SCALE: 1:50/1:10 @A3	Dimensions: m

Figure 1: Drawings of a standard TAD, with inspection chamber

B1 - St. Luke, Winmarleigh
B2 - St. Paul, Caton
B3 - All Saints, Preston
BR1 - Christ Church, Swindon
BR2 - St. Andrew, Blunsdon
BR3 - All Saints, Lydiard Millicent
BR4 - St. Mary's, Cricklade
BW1 - Christ Church, Coxley
BW2 - The Blessed Virgin Mary, Cossington
BW3 - Christ Church, Redhill
BW4 - The Blessed Virgin Mary, Stanton Drew
BW5 - Holy Trinity, Walton
BW6 - St. Nicholas, Kelston
BW7 - St. Mary's, Charlcombe
BW8 - St. Julian's, Wellow
BW9 - St. John's, Hinton Charterhouse
CA1 - St. Andrew's, Dacre
CA2 - St. John, Newton Reigny
CA3 - St. Kentigern, Mungrisedale
CA4 - All Saints, Penruddock
CA5 - St. Michael, Barton
CH1 - St John, Little Maplestead
CO1 - St. Mary and Holy Cross, Alderminster
CO2 - All Saints, Sherbourne
DE1 - Charles King and Martyr, Peak Forest
DE2 - St. James, Smisby
DE3 - St. Michael and All Angels, Church Broughton
DE4 - St. Lawrence, Great Barlow
DE5 - Holy Trinity, Middleton-by-Wirksworth
DE6 - St. George, Ticknall
DU1 - St. John the Evangelist, Holmside
DU2 - St. John the Evangelist, Merrington
DU3 - St. Michael and All Angels, Witton Gilbert
DU4 - St. Patrick, High Spen
DU5 - St. Lawrences, Pittington
EL1 - St. Michaels, Chesterton
EX1 - St. James, Bondleigh
EX2 - St. Hieritha, Chittlehampton
EX3 - All Saints, West Alvington
EX4 - St. Barnabas, Brooking
GL1 - All Saints, Shortwood
GL10 - All Saints, Newland
GL11 - Holy Trinity, Avening
GL2 - St. Johns, Pitchcombe
GL3 - St. John the Evangelist, Cinderford
GL4 - St. Mary, Bibury
GL5 - St. Mary, Norton
GL6 - St. Mary, Meysey Hampton
GL7 - St. Mary the Virgin, Berkeley
GL8 - St. Mary, Frampton on Severn
GL9 - St. Katharine's, Wormington
GU1 - St. Mary and All Saints, Dunsfold
H1 - St Lawrence, Stretton Grandison
H2 - St Deinst, Llangarron
H3 - St Mary,Bucknell
L1 - St. Barts and St. James, Waterfall
LI1 - St. Mary's, Old Leake
LI2 - St. Mary's, Weston
LV1 - Christ Church, Eccleston
N1 - St. Andrew's, Hartburn
N2 - St Mary, East Carleton
O1 - St. Mary's, Childrey
O2 - St. Luke, Stoke Hammond
O3 - St. Mary, Pyrton
O4 - St. Mary the Virgin, Kirtlington
PE1 - St. Mary and St. John, Brington
PE2 - St. James the Apostle, Grafton Underwood
PE3 - St. Peter and St. Paul, Scaldwell
PE4 - St. Leonard, Glapthorne
PE5 - St. Andrew, Wold
PO1 - St. Peter, Bishops Waltham
SA1 - St. James, Avebury
SA2 - St. Peter, Monkton Farleigh
SA3 - St. Swithins, Compton Bassett
SA4 - St. Katharine's and St. Peter's, Winterbourne Bassett
SEI1 - St . Mary, Shotley
SEI10 - St. Mary's, Combs
SEI11 - All Saints, Hundon
SEI2 - St. Mary, Little Finborough
SEI3 - St. Mary, Nettlestead
SEI4 - All Saints, Darsham
SEI5 - St. Andrew, Norton
SEI6 - St. Peter, Baylham
SEI7 - St. Mary's, Kersey
SEI8 - St. Mary's, Woolpit
SEI9 - All Saints, Drinkstone
SH1 - St. John the Baptist, Wadworth
STA1 - All Saints, Odell
STA2 - All Saints, Southill
STA3 - St. Mary, Stevington
T1 - St. Winnow, Lostwithiel
WI1 - Christ Church, Hatherden
WI2 - St. Mary the Virgin, Abbotts Ann
WO1 - St. James, Harvington
WY1 - St. Mary's, Coniston
WY2 - St. Michael and All Angels, Hubberholme
WY3 - St. Peter's, Rylstone
WY4 - St. James, Grewelthorpe
Y1 - St. Nicholas, Stillington
Y2 - St. Cuthbert, Crayke
Y3 - St. Peter's, Brafferton
Y4 - All Saints, Skipsea
Y5 - St. Hilda, Danby

X:\nNHPP 7063 Trench Arch Drainage in churchyards\010Geomatics\03 GIS Projects\Site_Locations_231115.mxd*gary.jones*07/03/2016

Figure 2: Distribution of TADs as indicated by DAC survey (church names have been prefixed by their unique identifier used in this study, the letters referring to their respective diocese. See table 1 for key)

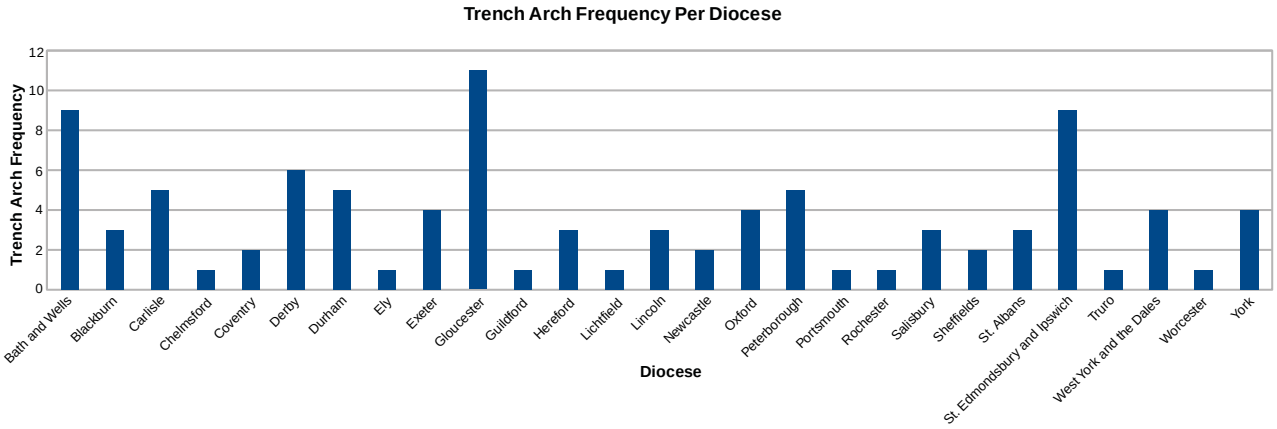


Figure 3: Number of TAD installations by diocese, as indicated by DAC survey

\\SAMBA-2\Projects\n\NHPP 7063 Trench Arch Drainage in churchyards\010Geomatics\03 GIS Projects\Figure4_SoilType_150216.mxd*gary.jones*07/03/2016

Figure 4: TADs installations with reference to soil texture (based on NSRI Soilscapes data)

\\SAMBA-2\Projects\n\NHPP 7063 Trench Arch Drainage in churchyards\010Geomatics\03 GIS Projects\Figure3_Drainage_150216.mxd*gary.jones*19/02/2016

Figure 5: TADs installations with reference to drainage properties of soils (based on NSRI Soilscapes data)

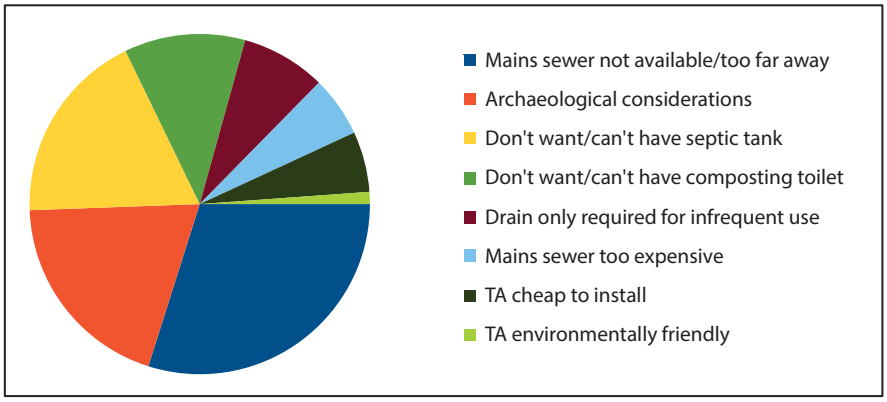


Figure 6: Reasons given in DAC survey why TADs installed (note that this includes multiple reasons given by some churches)

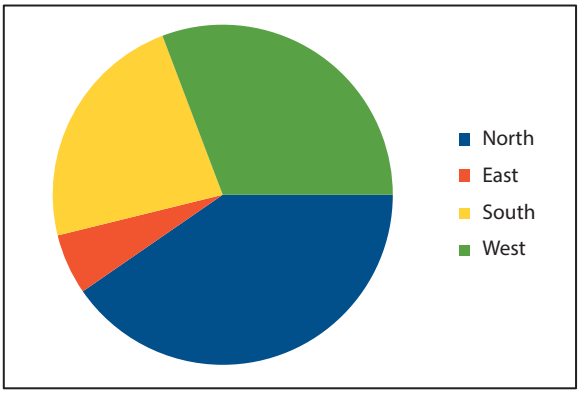


Figure 7: Location of TADs in relation to church (taken from DAC survey data)

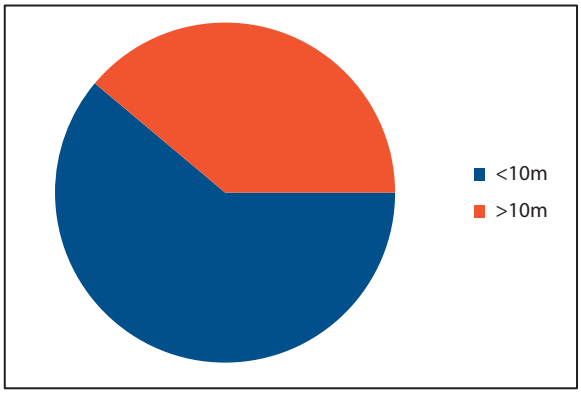


Figure 8: Distance of TADs from church (taken from DAC survey data)

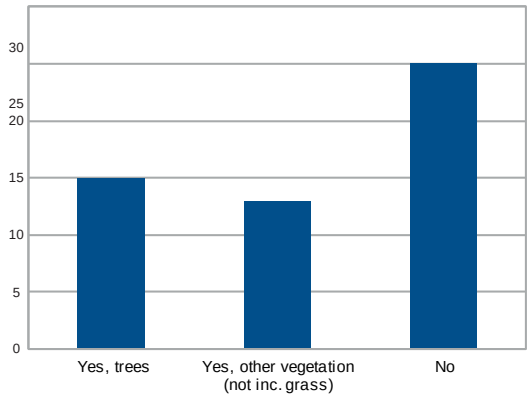
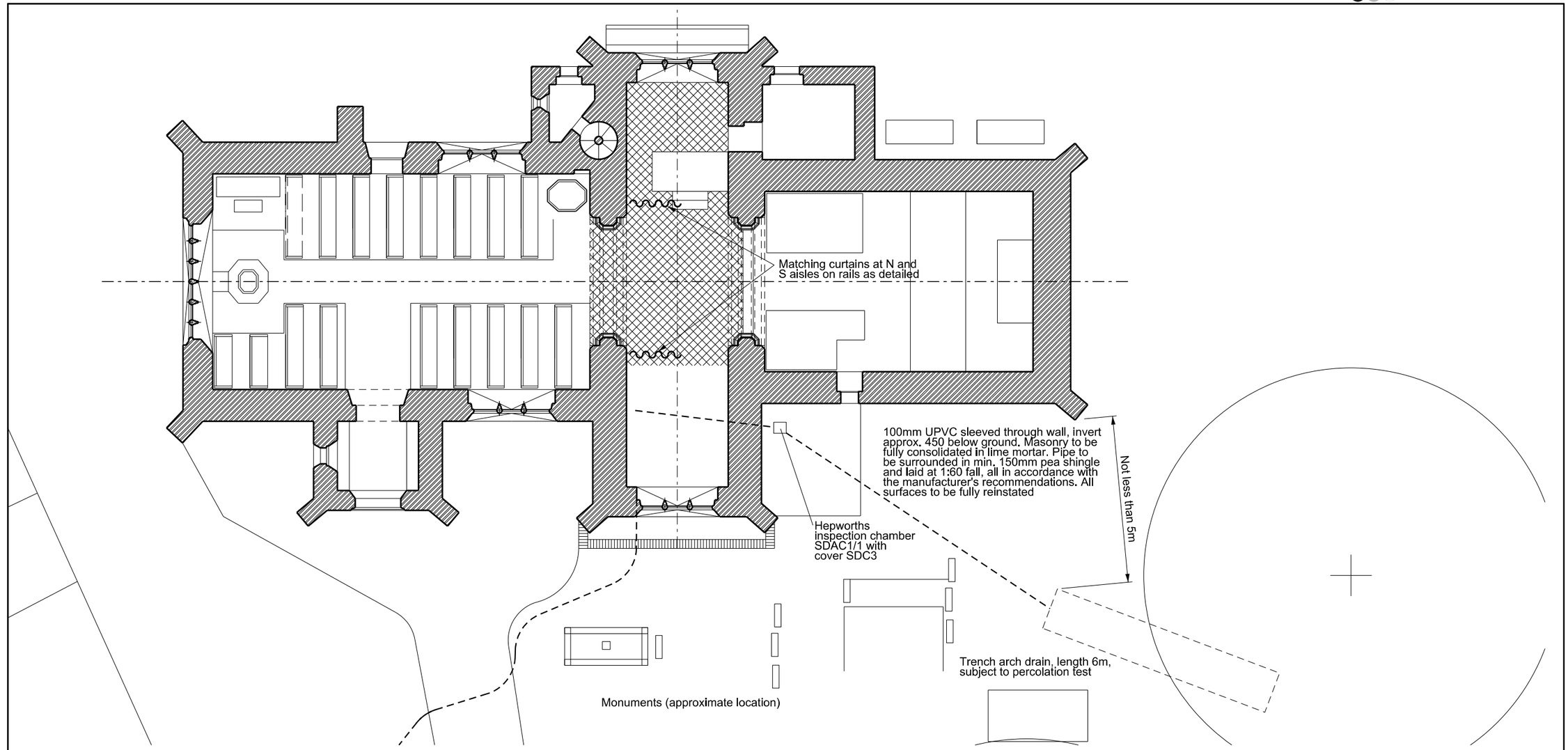
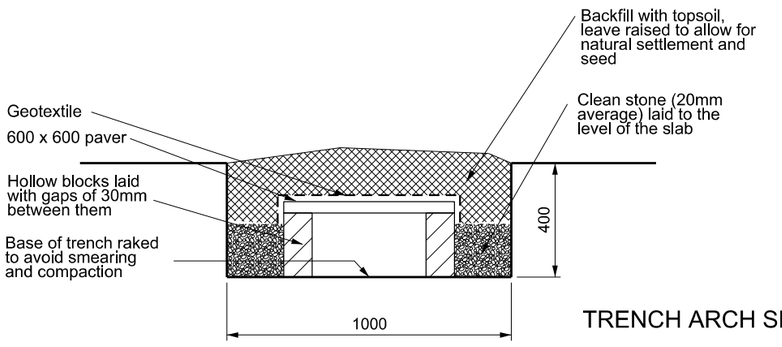


Figure 9: Frequency of TADs installations next to trees/other vegetation (taken from DAC survey data)

- 1 - The basic TAD form is retained, but the width and depth of the excavated trench, as well as the gradient of the trench base may differ from the recommendations
- 2 - The basic TAD form is retained, but a double drainage chamber is constructed (i.e. three parallel rows of hollow concrete blocks capped by two rows of paving slabs)
- 3 - The basic TAD form is retained, but the arch is constructed from brick.
- 4 - The basic TAD form is retained, but built to different dimensions. The parallel rows of concrete blocks line the long sides of the trench. No space is left either side of the blocks for the inclusion of gravel.
- 5 - The basic TAD form is retained, but the concrete blocks are anchored down with rebar.
- 6 - The basic TAD form is retained, but a pumped system with macerator included.
- 7 - A plastic half pipe is laid the full length of the trench to create a void instead of the concrete TAD structure. The pipe may be perforated, may be covered with geotextile, and the sides/top of the trench backfilled with gravel, stone or topsoil.

Figure 10: Distribution of TADs design variations identified in this study





TRENCH ARCH SECTION

SHENSTONE & PARTNERS
ARCHITECTS PLANNERS SURVEYORS

ST LUKES CHURCH STOKE HAMMOND

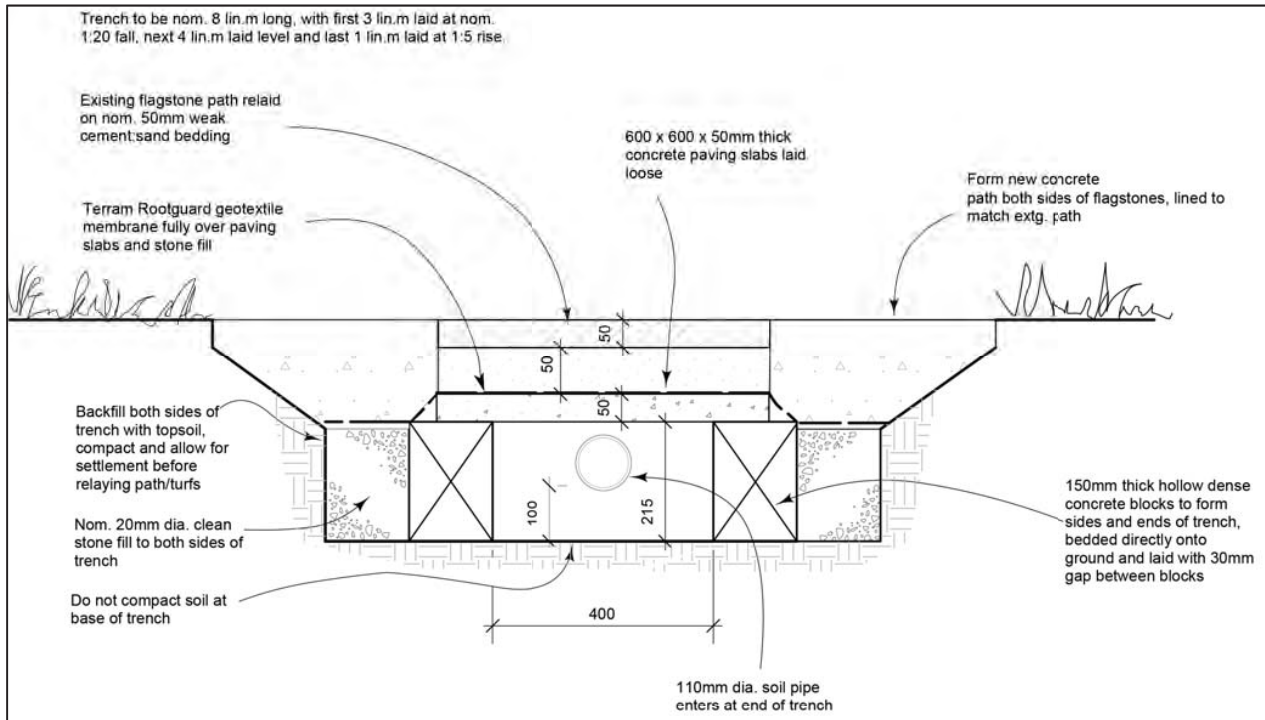
TEA POINT
DRAINAGE AND SITE PLAN

rev.	amendment	drawn	date

job No.	OD 43	drawing No.	revision
scale	1:100 [A3]	9	
date	17/03/09		
drawn	JD	checked by	

St.Paul's Institute, 302 The Highway, London E1W 3DH. shenstone@btclick.com
Tel. 0 2 0 7 4 8 1 4 4 4 8 Fax. 0 2 0 7 4 8 1 4 5 4 5

Figure 11: Architect's plan for a tea point and associated TADs at St. Luke's church, Stoke Hammond, Oxford diocese



Section through Trench Arch Soakaway

ANDREW TOWNSEND ARCHITECTS
HISTORIC BUILDINGS CONSULTANTS
MARLBOROUGH HOUSE 2 BROMSGROVE FARINGDON OXON SN7 7JQ
Tel 01367 242639 *Email* info@andrewtownsend.co.uk *Fax* 01367 242835

project	St Mary's Church Childrey, Oxon for Childrey PCC
drawing	Trench Arch Soakaway
date	June 2014
scale	NTS Drawing original is A3 size
drg. no.	940: WD11
rev.	B

Figure 12: Architect's drawing of a TAD for St. Mary's church, Childrey, Oxford Diocese

Figure 13: TAD Installation in progress, St. Mary's church, Childrey, Oxford diocese

Figure 14: TAD installation working shot, Christ Church, Hatherden, Winchester diocese

Figure 15: TAD installation in progress, Christ Church, Hatherden, Winchester diocese

Figure 16: TAD installation working shot, Christ Church, Hatherden, Winchester diocese

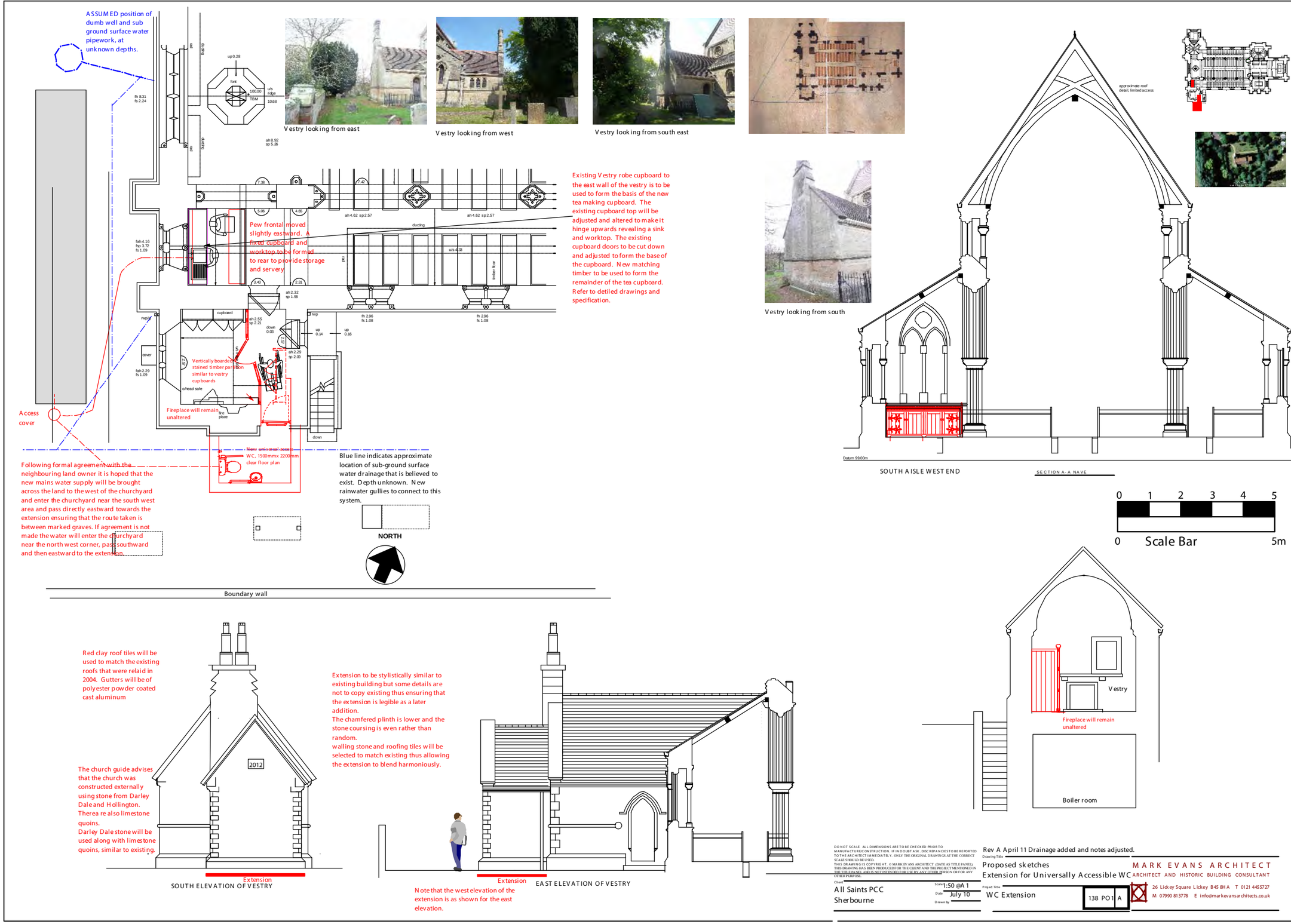
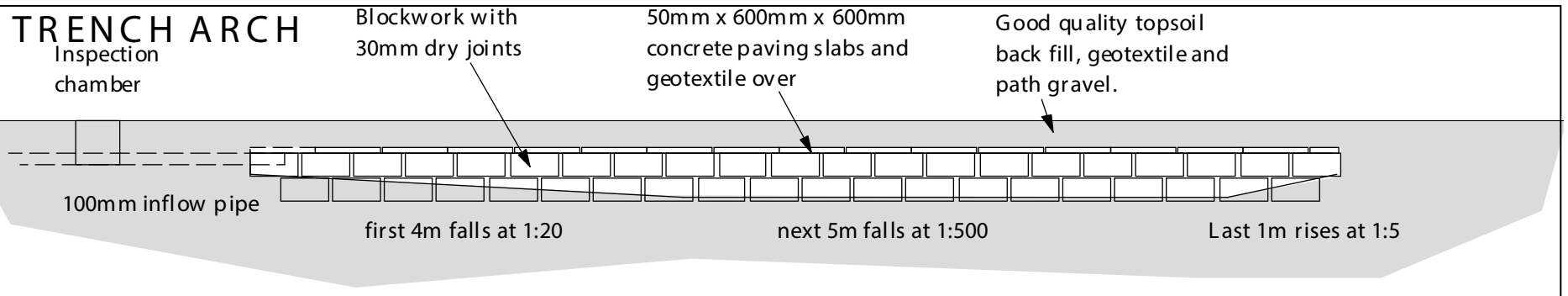
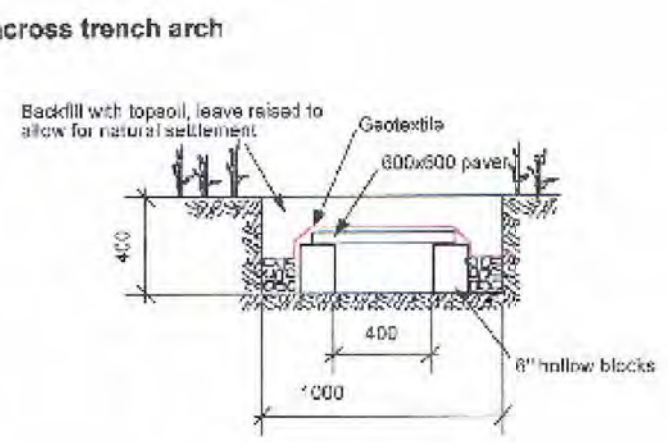


Figure 17a: Architect's plans and drawings for a TAD installation at All Saints' Church, Sherbourne, Coventry diocese

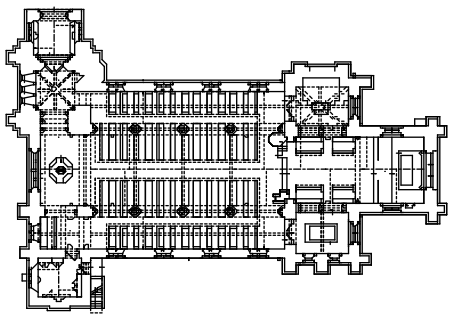
TRENCH ARCH

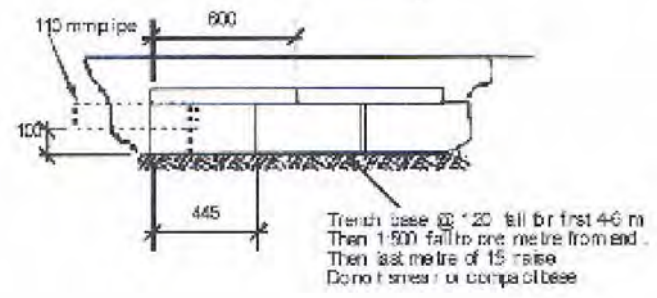


SECTION THROUGH TRENCH ARCH DRAIN



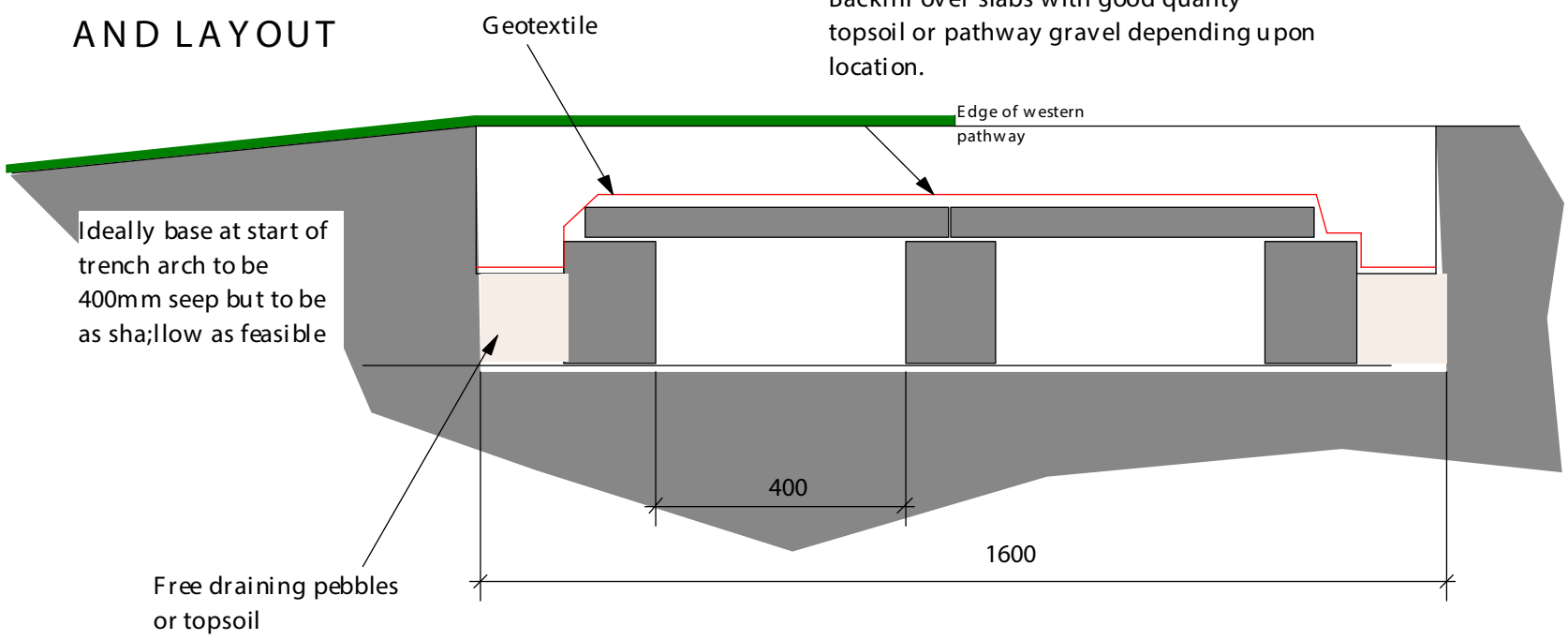
NOTE This detail shows a typical single width trench. Here, two side by side trenches are required, see drawn detil.





REFER TO 138 P01 AND SCHEDULE OF WORKS FOR FULL DETAIL AND LAYOUT

50mm x 600mm x 600mm heavy duty paving slabs set onto hollow concrete blocks with 300mm wide perpend joints. Backfill over slabs with good quality topsoil or pathway gravel depending upon location.



DO NOT SCALE. ALL DIMENSIONS ARE TO BE CHECKED PRIOR TO MANUFACTURE/CONSTRUCTION. IF IN DOUBT ASK. DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY. ONLY THE ORIGINAL DRAWINGS AT THE CORRECT SCALE SHOULD BE USED.

Client: All Saints PCC Sherbourne

Scale: 1:50 1:10 @A 3

Date: Aug 11

Drawn by:

Drawing Title: Proposed Trench Arch Drainage

Project Title: Extension for Universally Accessible WC

WC Extension

138 P12

MARK EVANS ARCHITECT
ARCHITECT AND HISTORIC BUILDING CONSULTANT
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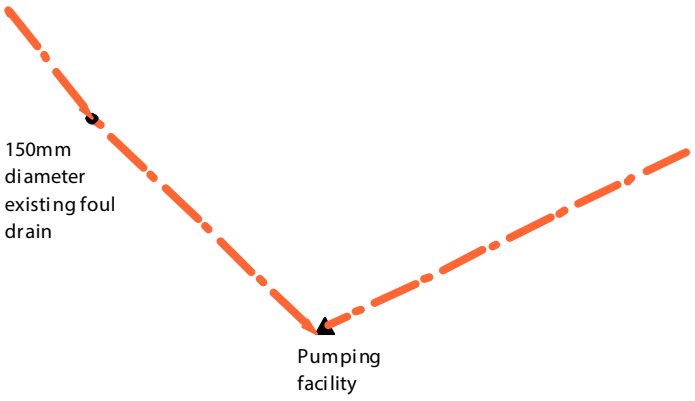
M 07990 813778 E info@markevansarchitects.co.uk

Figure 17b

O:\N_codes\NHDRAINCO*CAR*02.03.16



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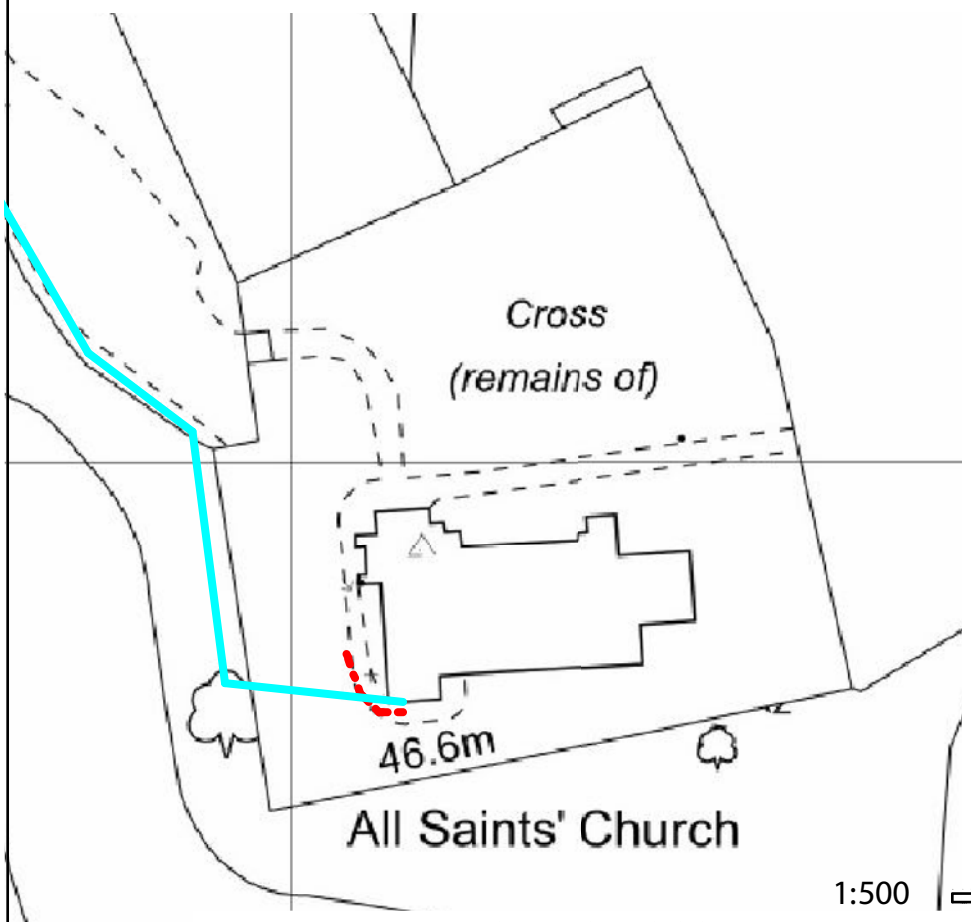

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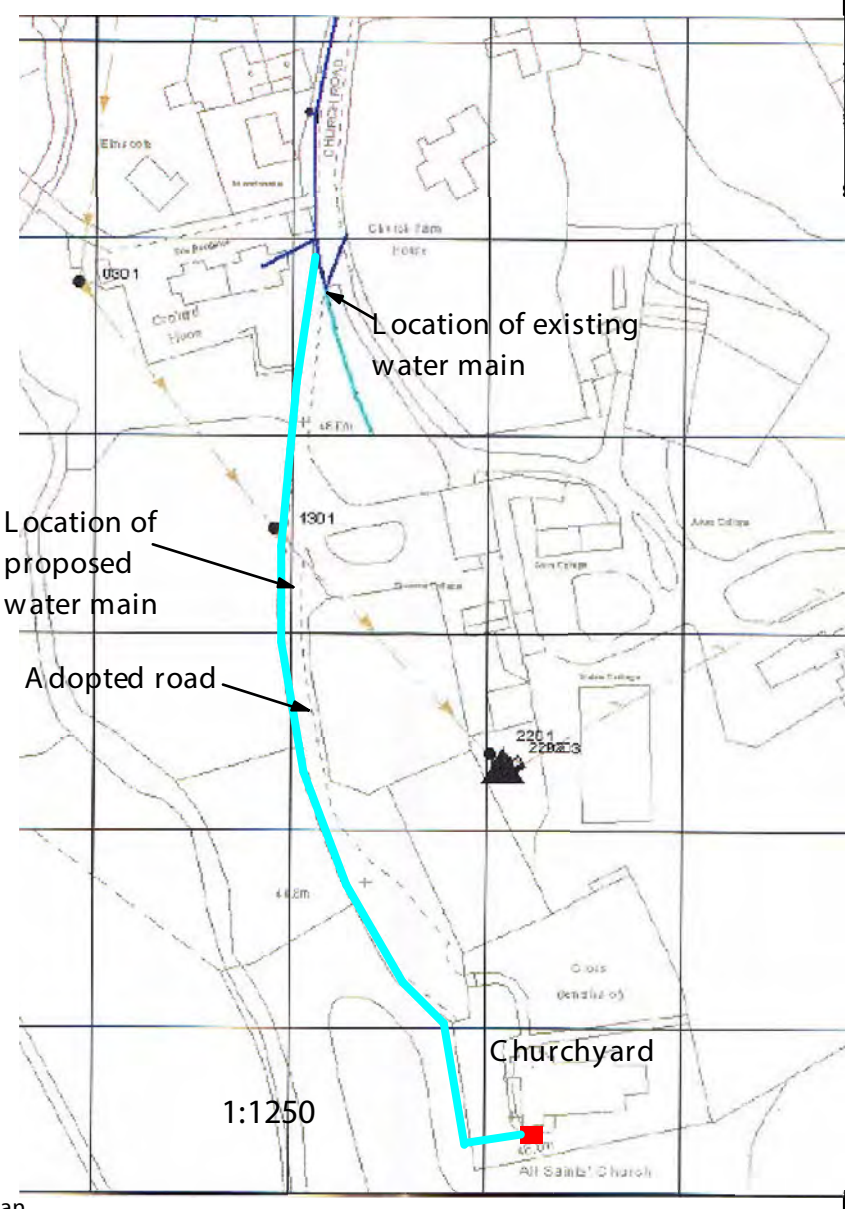

1:1250

DO NOT SCALE. ALL DIMENSIONS ARE TO BE CHECKED PRIOR TO MANUFACTURE/CONSTRUCTION. IF IN DOUBT ASK. DISCREPANCIES TO BE REPORTED TO THE ARCHITECT IMMEDIATELY. ONLY THE ORIGINAL DRAWINGS AT THE CORRECT SCALE SHOULD BE USED.

Client
All Saints Church PCC
Sherbourne

Scale 1:1250 1:500@A2
Date Oct 10
Drawn by

Drawing Title
Site Location Plan
Extension for Universally Accessible WC

Project Title
WC Extension All Saints
Church Sherbourne

138 PO2

Figure 17c

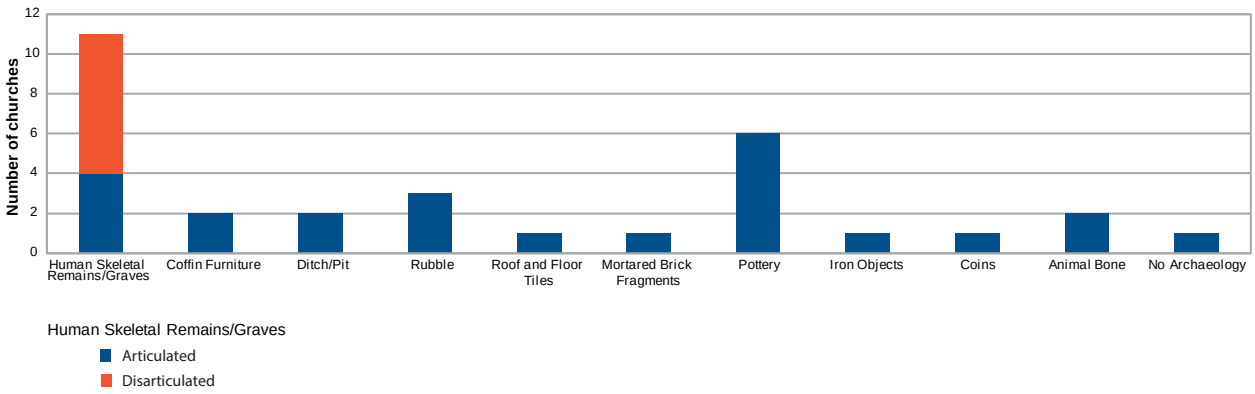

Figure 18: Different types of archaeological remains encountered during TAD installations

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