YORK CITY COUNCIL
ARCHAEOLOGICAL DEPOSIT MONITORING
AT 44/45 PARLIAMENT STREET, YORK

REPORT DETAILING THE PROGRAMME OF MONITORING CONDUCTED BETWEEN JUNE 1995 AND APRIL 1998

Report: R1182
305387

MAY, 1998

ARCHAEOLOGICAL DEPOSIT MONITORING AT 44/45 PARLIAMENT STREET, YORK

REPORT TO YORK CITY COUNCIL DETAILING THE PROGRAMME OF MONITORING CONDUCTED BETWEEN JUNE 1995 AND APRIL 1998

1.0 INTRODUCTION

In June 1995 an environmental monitoring programme was established by Hunting Technical Services (HTS) at a site of archaeological importance in the city of York [1]. The work was undertaken at the request of York City Council who wished to investigate and monitor both the character of the archaeological deposits present and also the burial environment surrounding them. This second objective was of particular importance because the burial environment, both its characteristics and stability, is thought to play a vital role in the preservation *in situ* of a sites archaeological deposits.

This report of the monitoring data collected by HTS should be read in conjunction with a previously prepared report, in which the original project design and work undertaken to establish the monitoring programme is documented [1].

2.0 SITE LOCATION AND PROJECT BACKGROUND

The project site is located within York city centre, primarily on the site of the former Curry's Electrical Store at 44/45 Parliament Street (NGR SE 6044 5180). At the time of the project's inception the site was 'L' shaped, with access onto both Pavement and Parliament Street, as shown Plan YCC-01/03. The site was selected because it formed part of the redevelopment and expansion proposals for Marks & Spencer plc who owned and operated the adjacent store. The proposals included demolition of the former Curry's Electrical Store and then expansion of the Marks & Spencer store into a new buildings to be constructed on the site.

Within the disused Curry's store and prior to the demolition work an archaeological evaluation was conducted in 1994/95 by York Archaeological Trust (YAT) [2]. The work, involving hand excavation of a 3.0 by 3.0 metre trench to a depth of 2.0 metres, revealed archaeologically important deposits from the Medieval, Post-medieval, and Modern period. The Medieval deposits included various inorganic (e.g. iron, pottery and building materials) and organic finds (e.g. leather, wood, bone and horn) that were preserved *in situ* within a variable soil like matrix. This soil deposit was described as; a wet or very wet (possibly saturated) organic rich silty clay possessing inclusions of ash, charcoal and industrial waste. Much of the indeterminate organic material present was thought to be 'manure' or 'cess' and was probably faecal in origin.

The trench excavated by YAT not only provided an opportunity to investigate and therefore describe the archaeological deposits present, it also presented an opportunity to install a range of monitoring devices. Because the devices selected and their method of installation have been previously described in HTS's earlier report to York City Council, only a summary is presented here [1].

In brief the devices selected permit repeated monitoring, at the same location, and in a relatively non-destructive manner over a period of at least five years. The devices do not monitor directly the state of preservation within the archaeological deposits, but instead they provide data on a number of parameters which are considered to be important in understanding the preserving burial environment surrounding the deposits. These parameters include possible changes in the deposit's moisture content, and changes in the chemistry of free water which is present within the deposits as a probable perched water table. A summary of the devices installed and the parameters they monitor is given in table 1 below, and their location at the project site is given in Plans YCC-01/03 and Plan YCC-01/04.

Table 1: Monitoring devices installed at 44/45 Parliament Street

Type of monitoring device (and number installed)	Location of device	Parameters monitored by device
Dipwell (1)	Within deposits below the pavement of Parliament Street	Water level within dipwell (metres above Ordnance Datum), and recovery of sample for the determination of water chemistry parameters*
Neutron Probe Tube (2)	Within deposits below the pavement of Parliament Street	Moisture content of deposits at 100 mm intervals down the archaeological profile
Moisture Cell (13)	Within deposits below shop floor of new Marks & Spencer store	Resistance (used to estimate moisture content) and temperature of deposits at the point of installation of each cell
Suction Sampler (5)	Within deposits below shop floor of new Marks & Spencer store	Recovery of water samples from deposit at the point of sampler's installation for the determination of water chemistry parameters*

* The water chemistry parameters were determined using a range of portable dip probes that measured; temperature, electrical conductivity, pH, dissolved oxygen, and redox potential.

The installation of monitoring devices was originally conducted between 14th June and 19th June 1995, and the methods used plus the depths to which the devices were placed are detailed in HTS's original installation report [1]. Unfortunately, on the 7th or 8th October 1995 damage was caused to several of the monitoring points by various construction operations being carried out as part of the site's redevelopment. The damage was largely confined to the suction samplers, and as a result two of the samplers (sampler 6 and 7) were found to be damaged beyond repair while the remaining three required minor repairs to their sampling tubes. To compensate for a loss of the two samplers an additional sampler was installed by HTS on 18th October at a position close to the original sampler 7. The archaeological profile through which the replacement sampler was installed appeared to be very similar to that encountered when the original sampler was installed, and therefore it has been incorporated into the monitoring programme as the new sampler 7. The depth of installation for the monitoring devices which required installation down a borehole is summarised in table 2, and the point of installation achieved with the moisture cells is summarised in table 3.

Table 2: Depth of monitoring device's installed down a pre-formed borehole

Monitoring Device, with identifying number	Top of monitoring device (metres AOD)	Base of monitoring device (metres AOD)
Neutron Probe Tube 1	13.40 (top of tube in manhole)	9.43
Neutron Probe Tube 3	13.22 (top of tube in manhole)	9.27
Dipwell 2	13.43 (top of dipwell in manhole)	7.37
Suction Sampler 4	14.30 (upper surface of former shop floor)	8.39
Suction Sampler 5	14.30 (upper surface of former shop floor)	9.10
Suction Sampler 6	14.30 (upper surface of former shop floor)	9.30
Suction Sampler 7	14.30 (upper surface of former shop floor)	8.46

Suction Sampler 8	14.30 (upper surface of former shop floor)	8.02

With the exception of the two neutron probe tubes, the above monitoring devices were installed within boreholes that passed to the base of, or through, the highly organic archaeological deposits (largely Medieval or earlier). Underlying the organic deposits there was generally encountered a greyish brown clay which was identified as a reworked soil.

Table 3: Depth and position of moisture cell installation into archaeological deposit

Cell Number	Face within inspection chamber into which cell is installed	Parameter monitored by cell	Depth to cell from ground level, (metres AOD)*	Distance cell inserted into deposit (mm)
1	North facing	Resistance & Temperature	13.18	50
2	North facing	Resistance & Temperature	12.52	85
3	West facing	Resistance	13.05	85
4	West facing	Resistance & Temperature	12.49	85
5	East facing	Resistance & Temperature	13.35	100
6	East facing	Resistance	13.20	100
7	East facing	Resistance & Temperature	12.95	114
8	East facing	Resistance & Temperature	12.62	100
9	South facing	Resistance & Temperature	13.31	160
10	South facing	Resistance	13.08	115
11	South facing	Resistance	12.84	110
12	South facing	Resistance	12.66	110
13	South facing	Resistance & Temperature	12.50	112

* Ground level taken as the upper surface of the former shop floor, recorded as 14.30 m AOD.

All the monitoring devices were installed at a depth which would permit the recovery of monitoring data from the organic archaeological deposits only. Most of the devices recover data from a single point in the archaeological profile, i.e. for the moisture cell it is the deposit immediately surrounding them, and the suction sampler it is from water drawn through the deposits surrounding the device's porous ceramic tip. In contrast, the neutron probe tube permits the recovery of data from the near surface of the archaeological deposit to a total recording depth of 3.8 metres. Because the first reading is taken at a depth of 400 mm (the first 300 mm of tube is exposed within the manhole chamber created within the pavement) an effective deposit depth of 3.4 m can be monitored by the neutron probe.

3.0 GROUND INTRUSIVE CONSTRUCTION ACTIVITIES AFFECTING THE PROJECT SITE

In June 1995, and at the time of HTS's involvement in the project, the site was occupied by the disused Curry's electrical store. The building was constructed on a piled foundation that included a 'modern' concrete ground floor slab, which had been laid over a pre-existing and possibly Victorian concrete basement floor. Below the basement floor were known to be a number of possibly Victorian cellars that had been backfilled with construction debris, possibly when the Curry's building was built. In November 1994 the first archaeological excavation at the site were conducted by YAT, who excavated an evaluation trench through the concrete floor and into the underlying archaeological deposits [2].

In 1995 YAT excavated a 10.0 metre long by 1.0 metre wide and 1.4 metre deep trench that bisected the original evaluation trench excavated in 1994, the original trench was also re-opened to create a 3.0 by 3.0 metre and 2.0 m deep inspection chamber [3]. The location of the trench and inspection chamber is shown on Plan YCC-01/04. Within both excavations a total of six 50 mm diameter boreholes were constructed by HTS using a lightweight 'vibro-hammer' corer unit. A further borehole, and two 40 mm diameter hand augered boreholes, were also constructed by HTS at three locations in the pavement of Parliament Street, located immediately infront of the site. Following installation of the monitoring devices and on completion of the archaeological works, the exposed archaeological deposits were protected by a membrane and then the trench and most of the inspection chamber were backfilled. The central area of the inspection chamber was kept open to form a brick lined access chamber from which the operation and maintenance of the monitoring programme by HTS would be conducted. All backfill operations were undertaken by YAT, who used clean 'builders' sand and then above builders debris to surface level. Other than the works to repair damage to several of the monitoring points in October 1995, as described earlier, no further ground intrusive operations were conducted by either YAT or HTS.

Almost immediately following establishment of the monitoring programme, the ground work phase of the site's redevelopment by Bovis (on behalf of Marks & Spencer) was initiated. Though this involved the careful demolition of the internal walls and floors of the Curry's building, it is not thought to have involved extensive ground intrusive operations. Where possible the foundations of the demolished building were left *in situ* and either reused in the new development or made redundant. For example, one pile cap was incorporated into a temporary foundations for the tower crane used during re-development of the site. Some local breaking out of sections of the concrete basement slab and existing pile caps was necessary but this is not thought to have directly disturbed surviving *in situ* archaeological deposits.

Though construction of the new building was to involve re-use of existing foundations, there was also a requirement for the construction of a number of new cast *in situ* concrete piles. Undertaken in October 1995 they were formed using a rotary piling rig that formed a borehole through the archaeological deposits and into site's the natural bedrock. Once formed the piles were connected by new ground beams, the concrete for which was again cast *in situ*. As part of these ground works there was also the importation and compaction of up to 600 mm of Type 1 fill, placed to form a sub-base for the new ground-floor concrete slab that was laid and tied into the existing slab of the adjacent Marks & Spencer building [4]. These works and how they were located in relation to the archaeological monitoring trench are shown on Plan YCC-01/05. In this plan the close proximity of piles from the former Curry's building and a ground beam constructed in late November/early December 1995 (as part of the sites redevelopment) are shown.

Following completion of the ground works and formation of the new foundations there was construction in early 1996 of the steel frame for the new building. Work on the new building and then expansion of Marks & Spencer continued without interruption until, in November 1996, the store's new food department that had been moved to the project site was opened to the public. During work to redevelop the site HTS successfully conducted monitoring visits on almost a monthly basis, depending on access restrictions caused by demolition of the Curry's building. Following the stores full opening in November 1996 the sixteen monitoring visits conducted since then have been completed by HTS in the evening after the store had closed to the public.

Works associated with redevelopment of the site did not affect the monitoring points located in the pavement of Parliament Street, and these have been monitored on a near monthly basis on the same day as the monitoring devices located within the store.

4.0 RECOVERY OF MONITORING DATA

4.1 Introduction

Almost immediately following installation of the various monitoring devices in mid-June 1995 a regular monitoring programme was established by HTS. This has centred round the undertaking of monthly visits to the project site in order to collect the monitoring data and where necessary to maintain the installed devices. Including the first visit that was conducted on 27th June 1995 a total of 30 visits have been successfully completed, the last being on 15th April 1998. In addition to collecting data from the monitoring devices, information on the weather affecting the project site has been obtained by HTS. The supply of weather data and the procedures for recovery of data from each of monitoring device are summarised in the following five sections.

4.2 Weather Data

To obtain site specific data the Meteorological Office has used their MORECS system to derive weather data from several of their stations that are located closest to the project site [5]. Though the system was developed for an agricultural user, the data is made applicable to the project site by pre-selecting a reference ground cover. Though a hard-standing cover is not available, a bare soil with no crop cover is thought to provide data of most relevance to this project. The MORECS system provides data on the following parameters: monthly totals for sunshine (hours), rainfall (mm), potential and actual evaporation (mm); a calculated soil moisture deficit (mm); and a mean monthly temperature (°C). The data provided for the period November 1995 to April 1998 is reproduced in appendix 1.

Appendix 1 also includes a value for the air temperature within 44/45 Parliament Street that was recorded with a portable temperature sensor during each monitoring visit.

4.3 Water Level Data

During each monitoring visit a level of the water column within the dipwell is recorded using an electrical dip-meter, the level is then reported as metres above Ordnance Datum (m AOD). Given the ‘natural’ clay soils revealed during installation of the dipwell, the water is thought to represent a perched groundwater table that is located above the clay and within the archaeological deposits.

Water level data recorded during the thirty monitoring visits is summarised on figure 1 and is reproduced in appendix 2.

4.4 Water Chemistry Data from the Dipwell and Suction Samplers

Following recording of the water level the dipwell is sampled in order to assess the water chemistry of the groundwater. The recovered sample is immediately analysed using a range of dip-probes supplied by Solomat Ltd. that enable the following water chemistry parameters to be reported; temperature (°C), electrical conductivity (ms/cm), pH, dissolved oxygen (% saturation), and redox potential (mV). The data recovered for the period June 1995 to April 1998 is summarised on figures 2 to 6, and is reproduced in appendix 2. Figure 2 which summarises the temperature of each water sample also includes the air temperature recorded within 44/45 Parliament Street during each monitoring visit (see section 4.2)

Further data on the chemistry of water that surrounds the sites archaeological deposits is obtained by the analysis of samples recovered from the five suction samplers. The method of recovery involves the creation of a vacuum in order that water is drawn from the archaeological deposits, through the sampler's porous ceramic tip, and into the main body of the device [1]. A pressure is then created to force the collected water up a sample tube and into a sample bottle at ground level, all tubes from the five suction samplers terminate within the brick lined access chamber that is located in the shop floor. The recovered water sample is again immediately analysed using the range of dip-probes, and the resulting data is shown on figures 2 to 6 and within appendix 2.

4.5 Soil Moisture Data from the Neutron Probe Tubes

The moisture content of the archaeological deposits surrounding two access tubes installed below the pavement of Parliament Street is assessed using a portable neutron probe, developed and supplied by the Institute of Hydrology [6]. The data recovered during each monitoring visit is converted into estimated volumetric moisture content using a calibration line developed for a soil with a dominant clay/peat characteristic [1]. This project's required use of a standard, rather than a site specific, calibration line necessitates that the moisture content data is reported as estimated and not absolute values. Therefore this report's interpretation of the data will concentrate on identifying trends, both the changing moisture content with time between successive monitoring visits, and with depth down the profile on any one occasion.

The estimated moisture contents at 100 mm intervals down both access tubes are reported in appendix 3, and they are summarised on figures 7 and 8.

4.6 Soil Moisture and Temperature Data from the Moisture Cells

The moisture cells are connected to one of three dataloggers which have been configured to log at 30 minute intervals the resistance of all thirteen cells, and temperature from eight of the cells. The cells from which temperature is recorded are 1, 2, 4, 5, 7, 8, 9 and 13. In addition, using an external sensor built into each datalogger, they are set to log at 30 minute intervals the air temperature immediately surrounding the datalogger. The measured changes of the cell's resistance are used as an indicator of moisture content changes within the archaeological deposit that is in intimate contact with the cell (decreases in moisture content are reflected by increasing resistance values). The thermistor built into each cell is used to estimate the *in situ* temperature of the archaeological deposits that are again in intimate contact with the cell.

Stored data from the dataloggers is recovered during each monitoring visit and following processing the resistance and temperature data values are displayed as change against time (see figures 9 to 17). The figures are grouped according to the four archaeological profiles into which the cells were installed. For example; figures 9 and 10 summarise the resistance and temperature data from cells 1 and 2 that are located within the north facing profile, and figures 11 and 12 summarise the same parameters from cells 3 and 4 located in the west facing profile (as illustrated on Plan YCC-01/04). The final figure (figure 17) summarises the air temperature logged by each datalogger. The quantity of data recovered from the dataloggers requires that the enclosed figures represent a single data value from the end of each day for which data is available. This is shown on the figures as a solid black line for the period 30th July 1996 to 15th April 1998, during which the dataloggers were permanently connected to the moisture cells. Prior to this period the dataloggers were only connected for the duration of each monitoring visit because of concerns over their safety during the then ongoing redevelopment of the site. During this period, from 20th June 1995 30th July 1996, the data points on each figure have been linked by a dotted line. Unfortunately several of the figures indicate a gap in the resistance and temperature data, which was caused when a temporary power failure in two of the dataloggers caused the loss of data from some of the moisture cells.

5.0 DISCUSSION OF MONITORING DATA RESULTS

5.1 Observation Made During the Monitoring Programme

Access to the three monitoring points located within the pavement of Parliament Street was nearly always available during the monitoring period described in this report (June 1995 to April 1998). Other than the seasonal arrival of a small funfair over the Christmas period the pavement area surrounding the monitoring points does not appear to have experienced any unusual traffic movements or ground disturbance (e.g. laying of services or pavement repairs). The *in situ* archaeological deposits have therefore not been subjected to any known form of physical disturbance during the period of monitoring. On several occasions surface water was observed at the base of each manhole chamber, however this was not thought to significantly influence the monitoring data because a bentonite seal constructed around the dipwell and access tubes acted effectively to prevent this water draining down into the underlying archaeological deposits.

Other than construction activities associated with the site's redevelopment (described in section 3.0), there have been no known events which may have resulted in physical disturbance of the monitoring points and surrounding archaeological deposits that are located within the now opened Marks & Spencer store. It is noted however that the access chamber that houses the dataloggers and suction sampler tubes was not sealed until some time in July 1996, and the refrigeration units for the newly created food department were not installed and fully operational until November 1996. The stability which the completion and opening of the store has given to the operating environment of the dataloggers is illustrated by the data of air temperature immediately above each datalogger (figure 17). Since November 1996 the mean air temperature has varied between 12 and 17 °C, compared to between 5 and 23 °C in the preceding 17 month period.

Observations made of the water recovered from both the suction samplers and dipwells noted a frequent 'eggy' smell of hydrogen sulphide gas and a pale yellow colour of the samples. Both are indicators of the anaerobic burial environment from which the water samples have been taken. The samples yellow colour and 'eggy' smell was not so intense in the dipwell samples, which is to be expected given that the water column is in contact with air within the dipwell. Consideration was given to purging the dipwell before recovery of the sample, however the high sediment loading of the water precluded this method of sampling. Over the coarse of the monitoring period the quantity of sediment accumulating within the dipwell has been higher than originally anticipated and this has resulted in the recovery of samples containing increasing amounts of fine black, largely organic, material. In addition the dipwell samples have on occasions had a slight smell of sewerage. Though this has not been proved it is suggested that the groundwater table sampled by the dipwell is being influenced by the nearby public toilets that are also located in Parliament Street.

The known bacterial populations and occasional presence of sediment in the water samples has been linked to the occurrence in May 1996 of a population of insects that were observed within the dipwell and several of the sampling tubes from the suction samplers [1]. The 0.5 to 2.5 mm long wingless insects have been identified by York University as probable springtails, Class Apterygota, Order Collembola. Their numbers are small, particularly in the suction sampler tubes which are flushed after each monitoring visit to remove any insects present.

5.2 Water Level and Water Chemistry Data

The water level present within the dipwell showed little variation with time and, ignoring the probable rogue value in January 1998, a mean level of 10.0 m AOD is reported on figure 1, which is approximately 3.4 metres below ground level (taken as the surface of the pavement).

Comparing the water chemistry data obtained from samples taken from the dipwell and suction samplers there is evident a difference in their character. The dipwell sample recovered during the first 20 monitoring visits generally had a lower temperature than samples from the suction samplers, however this difference is not observed during the last 10 visits (figure 2). During all 30 visits, but more pronounced in 1995, the seasonal changes in ambient air temperature are reflected in the temperatures of the various water samples. Given the remoteness from atmospheric influence's of the suction water samples it is considered that this may be caused by the unavoidable time delay in recovery and then analysis of the sample by the dip-probes. The possible influence of seasonal temperature variations on water held within the archaeological deposits will be further discussed in the interpretation of the moisture cell data (section 5.3.2).

Though still relatively high, the electrical conductivity of the dipwell samples were generally lower than those reported from the suction sampler samples (figure 3) [1]. This may reflect that, unlike the standing water column in the dipwell, the suction samplers are actively drawing water in from the surrounding archaeological deposits which are known to possess high electrical conductivities [1]. Differences between the different suction sampler samples on any one monitoring visit are small indicating that the samples are of similar character in terms of soluble salt concentration.

There occurs little variation in pH between the different samples on any one monitoring visit, and also during the coarse of the monitoring programme (figure 4). The values reported by the portable dip-probes lie within the relatively narrow range of between 6.7 and 7.4.

The data represented by figure 5 (dissolved oxygen) and figure 6 (redox potential) indicate there is a difference in the water chemistry of the samples from the dipwell and suction samplers: samples from the suction samplers generally contain less dissolved oxygen and low, predominantly negative, redox potentials. This indicator of a more anaerobic burial environment is expected because the water obtained by the suction samplers is that which is filling the pores of the archaeological deposits rather than that from a standing water column in a dipwell. The dissolved oxygen and redox potential data, and also the electrical conductivity data, illustrate the period of settling that was originally reported by HTS immediately following installation of the monitoring devices [1]. The data from at least the first two monitoring visits should therefore be ignored.

5.3 Soil Moisture and Soil Temperature Data

5.3.1 Data obtained using the neutron probe

The neutron probe data, used to estimate the moisture content of archaeological deposits below the pavement of Parliament Street, is shown on figures 7 and 8. Near continuous data from the two tubes is available for the period June 1995 to April 1998, and at both locations several trends can be seen:

1. lower and more changeable moisture contents occurs within the near surface archaeological deposits,
2. within approximately the surface metre of deposit two periods of relatively low moisture content occur in September 1996 and 1997, and possibly 1995,
3. moisture contents of the lower lying highly organic archaeological deposits appear to be higher and stable throughout the period of monitoring.

The lower moisture contents reported for the near surface archaeological deposits are thought to be true for the archaeological deposits present because they confirm the observation made of samples recovered in 1995 during installation of the access tubes [1]. This is except for the first recording depth of 400 mm because the low contents in both tubes may be underestimation's of their true values due to the difficulty in operating the neutron probe at the near surface. The visual observations made in 1995 noted both lower moisture contents and a greater frequency of building debris (mainly mortar) in the near surface deposits. The debris was often dense and therefore contains less moisture than a organic soil which generally possess a high water holding capacity. Though the builders debris and other inorganic remains will influence the neutron probe derived data, their fixed position in the profile and low moisture content should not hinder the identification of trends in moisture changes down the profile and between monitoring visits.

The cause of the apparent fall in moisture content in September is not known, but it may be a reflection of the months of high summer temperatures which will have heated the pavement and manhole chamber and so caused loss of water by evaporation from the deposits. The significance of the summer influence on water loss from ground is illustrated by the available weather data (appendix 1). In 1996 and 1997 the highest mean summer maximum temperatures and hours of sunshine occurred between June and September, during which time the highest calculated rates of evaporation are reported.

A peak of elevated moisture contents within the near surface of the deposits surrounding tube 3 is reported for May 1997. It is possible that surface water from the pavement, after heavy rains in May, may have drained into the manhole chamber and so wetted the deposits. However, a bentonite seal constructed to prevent the downward draining of surface water should have prevented this input of water to the deposits. Therefore the peak shown on figure 8 cannot be explained, though it would appear to be a real event because it is reported from monitoring data collected at several sampling depths down the tube.

The water level recorded within the dipwell indicates a groundwater table at about 3.4 metres below ground level. The influence of this water table on the neutron probe data is not evident because the water table is static, and at this depth the deposits are indicated as being naturally very wet or even saturated.

5.3.2 Data obtained using the moisture cells

All moisture cells used at the project site were supplied as dry cells and in this state they had resistance values of 2540000 ohms. Immediately following their installation into the deposits a repeat measurement of their resistance was taken using the same test meter, and values of between 4655 and 670 ohms were recorded. The fall in resistance was caused by the cells wetting up because of the wet deposits into which they were now in intimate contact with. The fall in resistance as the cells came into equilibrium with their surrounding environment took a period of several months, and this is illustrated by the data recovered from the dataloggers (figures 9, 11, 13 and 15). The thermistor within the moisture cells required less time to reach equilibrium and so a similar settling period in the temperature data recorded by the cells is not seen. The observed fall in cell resistance to a low and more stable value is important because it is an indicator of the moisture cell data’s reliability. Though, unlike the neutron probe data, an estimated moisture content cannot be attached to the resistance data the low values are considered to demonstrate the high moisture content of the deposits. For the majority of time for which data is available the cells do not indicate any change toward wetter or drying conditions within the archaeological deposits. The possible exception is the data from cells 1, 8 and 12 which indicate an increasing resistance in the period from about October 1997 to April 1998. Because this trend cannot be explained by the cell’s position within the archaeological profile further data is necessary to investigate if this increase in resistance is a real event.

During the first half of the monitoring period the temperature data recorded by the thermistors within each moisture cell appears to show the slight influence of seasonal air temperature changes (figures 11, 12, 14 and 16). This influence disappears from the data obtained in 1997/98, and this could again be a reflection of the stabling effect the fully opened store has on the site. In general, the data indicates a stable burial environment temperature that is close to that recorded in samples recovered from each suction sampler; approximately 15°C. Unfortunately, the aggressive character of the archaeological deposits, discussed following installation of the moisture cells, appears to have resulted in the failure of thermistors in at least three of the cells (cell 1, 5 and 10).

The installation of moisture cells at differing depths down the four archaeological profiles was undertaken in order to detect changes within the deposits during and following redevelopment of the project site. The main construction impact that was thought likely to cause both a moisture content and temperature change was the construction of new foundations (piling, casting ground beams and ground-floor slab). These operations were undertaken between October and December 1995 and the majority of data does not indicate any sudden change in the monitored parameters. However, because any impact created by the casting of ground beams and ground-floor slab would be focused on the near surface deposits, two events are perhaps significant: 10°C increase in temperature recorded by cell 3 and sudden failure of cell 5 in November 1995. The cells are installed within the near surface of the east and west facing deposit profiles and both events could be linked to the pouring and then curing *in situ* of concrete used to form the ground beam that runs in an east-west direction through the backfilled inspection chamber originally dug by YAT. Above the ground beam would then be formed the ground-floor slab. Further work is needed to develop this idea because it is not supported by temperature data from cell 1 which was installed into the near surface deposits that are located close to, but not actually on the line of this ground-beam.

6.0 CONCLUSIONS AND RECOMMENDATIONS

1. Following the successful establishment of the project in June 1995 a programme of environmental monitoring has been undertaken by HTS for the period June 1995 to April 1998. As a result the data from a total of 30 site visits has been collected and is presented in this report.

2. Information on the moisture content of *in situ* archaeological deposits (to a depth of 3.8 metres) and the depth and quality of a perched water table below the pavement of Parliament Street, and the moisture content and quality of water surrounding deposits below the Marks & Spencer store is available. The monitoring data has been obtained using a combination of a electrical dip-meter (water level), neutron probe (moisture content), portable dip-probes (water quality or chemistry) and moisture cells (moisture content and deposit temperature).

3. Following the initial settling period during which the monitoring devices established an equilibrium with the *in situ* archaeological deposits surrounding them, the monitoring data can be summarised as:

- the perched water-table located within the dipwell in Parliament Street appears to be caused by water being prevented from draining down through the relatively impermeable clay soil deposits that underlie the highly organic archaeological deposits. The water-table is static and there is evidence of possible contamination from the nearby public toilets, also located in Parliament Street, and this may require further investigation,
- within the pavement of Parliament Street the near surface deposits are wet but they experience moisture content changes which may be caused by seasonal weather changes. At depth however the higher moisture content's of the very wet, possibly saturated, deposits appear to be stable during the period for which data is available,
- water samples recovered from the dipwell and suction samplers possess the characteristic smell of hydrogen sulphide which is a good indicator of anaerobic burial conditions. The water chemistry data supports this view because depressed levels of dissolved oxygen and low or negative redox potential values are reported,
- data from the moisture cells indicates that, prior to the opening of the new store, the cells were being influenced by seasonal air temperature changes. This influence was lost once the store was open, and the data until recently indicates stability within the archaeological deposits. Slight increases in resistance of three of the cells is noted but further data is necessary to determine if this is significant. The moisture cells may have detected the impact on the ground from the construction of foundations for the new building on 44/45 Parliament Street, however the results are not conclusive,
- predominantly low and stable burial temperatures are recorded by the moisture cells and water samples recovered from the suction samplers,
- the data obtained from both the suction samplers and moisture cells have not revealed any clearly demonstrable change within the deposits.

4. The various water samples analysed for electrical conductivity constantly record high values, which is consistent with the soil analysis data conducted following installation of the monitoring devices. The relatively high salt concentrations, and generally aggressive ground conditions, are thought to be responsible for the progressive failure of thermistors that are built into the moisture cells.

5. A population of insects (springtails) has been noted in the dipwell and several of the suction sampler tubes. Though undesirable their presence does not appear to have influenced the water chemistry data that is recorded by the various dip-probes. Possible effects of their activity and the site

conditions which promote their survival may require further investigation.

7.0 ACKNOWLEDGEMENTS

HTS express their thanks to York City Council and Marks & Spencer plc for both their funding and assistance in completing this phase of the project. HTS also express their thanks to Environmental Archaeology Unit and York Archaeological Trust for their support in undertaking this monitoring project.

8.0 REFERENCES

[1] Hunting Technical Services Ltd. (February 1996), *Archaeological Deposit Monitoring at 44/45 Parliament Street, York: Report to York City Council Detailing The Installation of Monitoring Points*. Report R1052, Hunting Technical Services, Hemel Hempstead, Hertfordshire.

[2] Bricklow, D. (Ed) (1995), *An Archaeological Evaluation at 44/45 Parliament Street, York.* Evaluation Report Number 1, York Archaeological Trust, York.

[3] Carrott, J. *et al* (April 1996), *Suspected accelerated in situ decay of delicate bioarchaeological remains: a case-study from medieval York*, Report 96/15, Environmental Archaeology Unit, University of York, York.

[4] Department of Transport (August 1986), *Specification for Highway Works part 3*, HMSO, London.

[5] Anon (1992), *Soil Moisture Monitoring on a National Scale: Scientific Background.* Meteorological Office, Bracknell.

[6] Anon (1979), *Institute of Hydrology Probe System IH II, Instruction Manual*. Institute of Hydrology, Wallingford, Oxfordshire.

CONTENTS

PLAN: YCC-01/05 Section through foundations located within 44/45 Parliament Street