STRATASCAN

Geophysical Survey Report

Stanley Bank Slitting Mill
St Helens,
Merseyside

for

St Helens Council

November 2006

J2251

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REGISTERED IFA ORGANISATION

Document Title:	**Geophysical Survey Report** **Stanley Bank Slitting Mill, St Helens, Merseyside**
Client:	**St Helens Council**
Stratascan Job No:	**J2251**
Techniques:	**Detailed magnetic survey (gradiometry)** **Detailed resistance survey** **GPR trial**
National Grid Ref:	**SJ 534 968**

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1 SUMMARY OF RESULTS

Gradiometer and resistivity survey were carried out at the site of the Stanley Bank Slitting Mill. Both surveys have identified anomalies that may represent structural remains; however the anomalies do not correspond well with each other, although some comparison can be made. Areas of positive response and high resistance may relate to structural remains situated throughout the site. An area of low resistance situated in the centre south of the survey area may correspond with a clay seal revealed in the 2006 excavations. Areas of strong magnetic response situated in the centre of the survey area may relate to ferrous debris associated with the Slitting Mill. The GPR trial was unsuccessful in identifying clear evidence of buried structural remains, however timeslice data from a close centre radar may help identify areas of high energy responses that may relate to structural remains.

2 INTRODUCTION

2.1 Background synopsis

Stratascan were commissioned by St Helens Council to undertake a geophysical survey at the site of the Stanley Bank Slitting Mill. This survey forms part of an archaeological investigation being undertaken by St Helens Council.

2.2 Site location

The site is located to the east of St Helens, along side the St Helens Canal, Merseyside at OS ref. SJ 534 968.

2.3 Description of site

The survey area is approximately 1700m² and contains the ruined remains of the Slitting Mill that had been later converted to a corn mill. The underlying geology is Lower Westphalian (A+B), mainly productive coal measures, with overlying blown sand, boulder clay and morainic drift (British Geological Survey South Sheet, Fourth Edition Solid, 2001, British Geological Survey South Sheet, First Edition Quarternary, 1977). The overlying soils are not comprehensively mapped due to its urban environment, but are likely to Salop soils which are typical stagnogley soils. These consist of reddish fine loamy over clayey soils (Soil Survey of England and Wales, Sheet 4 Eastern England).

2.4 Site history and archaeological potential

The following information has been taken from *Stanley Bank Iron Slitting Mill*. St Helens Metropolitan Borough Council. Information Development Unit, Personal Services Department. A762/03/95

Stanley Bank Slitting Mill was built in 1773. It was described as having two wheels as well as workshops and warehouses for the treatment of iron strips and the finished iron bars. The mill was probably one storey high as the Slitting Mill lent itself to single storey buildings. The height of the walls was probably the same as the dam walls remaining today.

During the 1830s the Slitting Mill was made into a corn mill. The conversion may have led to an increase in height of the buildings and a substantial change in the internal machinery. This led to the removal of the rollers and slitters and the introduction of the grinding stones.

The mill finally stopped working at the turn of the 20th century after which it was demolished leaving only the dam wall standing. Later, the dam wall was breached to allow water to drain away. The area behind the dam quickly became woodland.

2.5 Survey objectives

The objectives of this survey are to locate any structural remains that may relate to earlier structures associated with the Slitting Mill. Evidence of earlier structures were revealed during a series of excavations in 2006. A clay layer was identified, sealing the earlier structures that were seen up to two feet below the clay seal.

2.6 Survey methods

Detailed gradiometry and resistivity surveys were carried out across the site in order to assess the area with complementary techniques. More information regarding these techniques is included in the Methodology section below.

3 METHODOLOGY

3.1 Date of fieldwork

The fieldwork was carried out on the 2nd November 2006 when the weather was dry and clear.

3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information.

3.3 Description of techniques and equipment configurations

3.3.1 Gradiometer

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument.

The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a FM256 Fluxgate Gradiometer, manufactured by Geoscan Research. The instrument consists of two fluxgates mounted 0.5m vertically apart and very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background.

3.3.2 Resistance Meter

This method relies on the relative inability of soils (and objects within the soil) to conduct an electrical current, which is passed through them. As resistivity is linked to moisture content, and therefore porosity, hard dense features such as rock will give a relatively high resistivity response, while features such as a ditch which retains moisture give a relatively low response.

The resistance meter used was an RM15 manufactured by Geoscan Research incorporating a mobile Twin Probe Array. The Twin Probes are separated by 0.5m and the associated remote probes were positioned approximately 15m outside the grid. The instrument uses an automatic data logger, which permits the data to be recorded as the survey progresses for later downloading to a computer for processing and presentation.

Though the values being logged are actually resistances in ohms they are directly proportional to resistivity (ohm-metres) as the same probe configuration was used through-out.

3.3.3 GPR

Two of the main advantages of radar are its ability to give information of depth as well as work through a variety of surfaces, even in cluttered environments and which normally prevent other geophysical techniques being used.

A short pulse of energy is emitted into the ground and echoes are returned from the interfaces between different materials in the ground. The amplitude of these returns depends on the change in velocity of the radar wave as it crosses these interfaces. A measure of these velocities is given by the dielectric constant of that material. The travel times are recorded for each return on the radargram and an approximate conversion made to depth by calculating or assuming an average dielectric constant (see below).

Drier materials such as sand, gravel and rocks, i.e. materials which are less conductive (or more resistant), will permit the survey of deeper sections than wetter materials such as clays which are more conductive (or less resistant). Penetration can be increased by using longer wavelengths (lower frequencies) but at the expense of resolution (see 3.4.2 below).

As the antennae emit a "cone" shaped pulse of energy an offset target showing a perpendicular face to the radar wave will be "seen" before the antenna passes over it. A resultant characteristic *diffraction* pattern is thus built up in the shape of a hyperbola. A classic target generating such a diffraction is a pipeline when the antenna is travelling across the line of the pipe. However it should be pointed out that if the interface between the target and its surrounds does not result in a marked change in velocity then only a weak hyperbola will be seen, if at all.

The Ground Probing Radar used was a IDSTR SMA 3 channel system using K2 acquisition software manufactured by Ingegneria Dei Sistemi S.p.A (IDS).

The radar trial was carried out with 200 and 600MHz antennas. These frequencies offer a good combination of depth of penetration and resolution.

3.4 Sampling interval, depth of scan, resolution and data capture

3.4.1 Sampling interval

Gradiometer
Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

Resistivity
Readings were taken at 1.0m centres along traverses 1.0m apart. This equates to 900 sampling points in a full 30m x 30m grid. All traverses were surveyed in a “zigzag” mode.

GPR
Four radar traverses were carried out across the site with both radar frequencies.

Depth of scan and resolution

Gradiometer
The FM256 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.5m centres provides an appropriate methodology balancing cost and time with resolution.

Resistivity
The 0.5m probe spacing of a twin probe array has a typical depth of penetration of 0.5m to 1.0m The collection of data at 1m centres with a 0.5m probe spacing provides an appropriate methodology balancing cost and time with resolution.

GPR
The average velocity of the radar pulse is calculated to be 0.1/ns which is typical for the type of sub-soils on the site. With a range setting of 100ns this equates to a maximum depth of scan of 4m respectively but it must be remembered that this figure could vary by ± 10% or more. A further point worth making is that very shallow features are lost in the strong surface response experienced with this technique.

Under ideal circumstances the minimum size of a vertical feature seen by a 200MHz (relatively low frequency) antenna in a damp soil would be 0.1m (i.e. this antenna has a wavelength in damp soil of about 0.4m and the vertical resolution is one quarter of this wavelength). It is interesting to compare this with the 400MHz antenna, which has a wavelength in the same material of 0.2m giving a theoretical resolution of 0.05m. A 900MHz antenna would give 0.09m and 0.02m respectively.

3.4.2 Data capture

Gradiometer
The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

Resistivity
The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

GPR
Data is displayed on a laptop as well as being recorded onto the hard disk. The data is later downloaded into a computer for processing.

3.5 Processing, presentation of results and interpretation

3.5.1 Processing

Gradiometer
Processing is performed using specialist software known as *Geoplot 3*. This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

Zero mean grid	*Threshold = 0.25 std. dev.*
Zero mean traverse	*Last mean square fit = off*
Despike	*X radius = 1 Y radius = 1*
	Threshold = 3 std. dev.
	Spike replacement = mean

Resistivity
The processing was carried out using specialist software known as *Geoplot 3* and involved the 'despiking' of high contact resistance readings and the passing of the data though a high pass filter. This has the effect of removing the larger variations in the data often associated with geological features. The nett effect is aimed at enhancing the archaeological or man-made anomalies contained in the data.

The following schedule shows the processing carried out on the processed resistance plots.

Despike	*X radius = 1*
	Y radius = 1
	Spike replacement
High pass filter	*X radius = 10*
	Y radius = 10
	Weighting = Gaussian

GPR
The radar plots included in this report have been produced from the recorded data using IDS-GRED software. A standard filter process (a background and vertical band pass filter) was applied to the data to remove background noise.

3.5.2 Presentation of results and interpretation

Gradiometer
The presentation of the data for the survey involves a print-out of the raw data both as grey scale (Figure 3) and as colour plot demonstrating the amplitude of responses (Figure 4), together with a grey scale plot of the processed data (Figures 5 and 11).

Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figure 6).

Resistivity
The presentation of the data for the site involves a print-out of the raw data as a grey scale plot (Figure 8), together with a grey scale plot of the processed data (Figures 8 and 10). Anomalies have been identified and plotted onto the ‘Abstraction and Interpretation of Anomalies’ drawing (Figure 9).

4 RESULTS

Both data sets have identified a series of anomalies that may relate to earlier structural remains, areas of ground disturbance and possible areas of ferrous debris. However, little comparison can be made between the two data sets. This may be due to the achieved depth of penetration of each technique.

Gradiometer

The gradiometer anomalies have revealed a range of magnetic anomalies; these have been abstracted and divided into the following categories:

- Positive area anomalies – possible structural remains or debris
- Positive area anomalies – possible structural debris or ground disturbance
- Strong positive area anomalies with associated negative response – possible ferrous debris
- Negative area anomaly – associated with pipe
- Area of magnetic disturbance – associated with nearby boundary

Positive area anomalies – possible structural remains or debris
In non-urban sites weak positive area anomalies usually represent cut features such as pits or ditches. However within this industrial area, strong anomalies can be expected and may indicate structural remains or debris, as fired bricks would produce a strong magnetic anomalies.

A series of positive area anomalies identified in the centre of the survey area may represent rectilinear structural remains situated under Building 4 in a southwest to northeast orientation (**a**). An additional positive area anomaly has been identified to the south and running parallel to anomaly **a** (**c,d**). These anomalies may represent further evidence for structural remains or debris. A series of parallel area anomalies situated to the north of Building 2 (**h, i** and **j**) may also represent further evidence for structural remains. The northern limits of these anomalies correspond with the present structural remains associated with Building 1. Anomalies **f** and **g** may relate to structural remains or ferrous debris (due to the presence of associated negative anomalies). These anomalies appear to be confined to the interior of Building 2; therefore these anomalies may be associated with these building.

Anomalies **e, k, l** and **m** may represent further areas of structural debris or ground disturbance around the survey area.

Positive area anomalies – possible structural debris or ground disturbance
A series of less well defined positive area anomalies situated across the survey area may represent additional areas of structural debris or ground disturbance. Anomaly **b** may represent structural remains and is of a similar orientation to the structural anomaly **a**. Anomaly **d** may suggest the continuation of anomaly **c**, whereas anomalies **r, s, o** and **p** may represent areas of ground disturbance. Anomaly **q** corresponds to a low resistance area anomaly seen in the resistivity data and may relate to a series of cut features or general ground disturbance.

Strong positive area anomalies with associated negative response – possible ferrous debris
Two areas of bipolar anomalies (strong positive responses with associated negative returns) have been identified situated between Building 4 and Building 2 (**t** and **u**). These strong magnetic anomalies may represent ferrous debris associated with the Slitting Mill.

Negative area anomaly – associated with pipe
A negative area anomaly can be seen in the south of the survey area (**v**). This anomaly may be associated with the pipe recorded in the area.

Area of magnetic disturbance – associated with nearby boundary
Areas of magnetic disturbance can be seen along the western perimeter of the survey area and are associated with the nearby boundary.

Resistivity

A number of clearly defined high and low resistance anomalies have been identified throughout the survey area and may relate to areas of ground disturbance and structural remains. These anomalies have been abstracted and divided into the following categories:

- High resistance area anomalies – possible structural debris or remains
- Moderate high resistance area anomaly – possible structural remains or debris
- Low resistance area anomaly – possible cut feature or disturbed ground
- Low resistance area anomaly - unknown origin

High resistance area anomalies – possible structural debris or remains
A well defined area of high resistance in an approximate north to south orientation can be seen in the centre of the survey area, to the south of Building 2 (**1**). This anomaly may represent structural remains, although a corresponding anomaly cannot be identified with the gradiometer data. Further areas of possible structural remains can be seen in and around Building 6 (**3**) and to the northeast of Building 4 (**4** and **6**). Anomaly **6** may be associated with structural remains identified within the 2006 evaluation trench. Anomaly **4** corresponds to a moderate positive anomaly seen within the gradiometer survey (**b**). Strong discrete anomalies situated in the north of the survey may represent further structural remains (**9** and **10**), however no corresponding

anomalies can be seen in the gradiometer data, possibly suggesting these positive area anomalies may indicate areas of compacted ground. The two large areas of high resistance may represent areas of structural debris or ground disturbance (**2** and **5**). The eastern limits of anomaly **2** correspond with the positive gradiometer anomaly **f**. Anomalies **7** and **8** may correspond to areas of debris associated with the present Building 1.

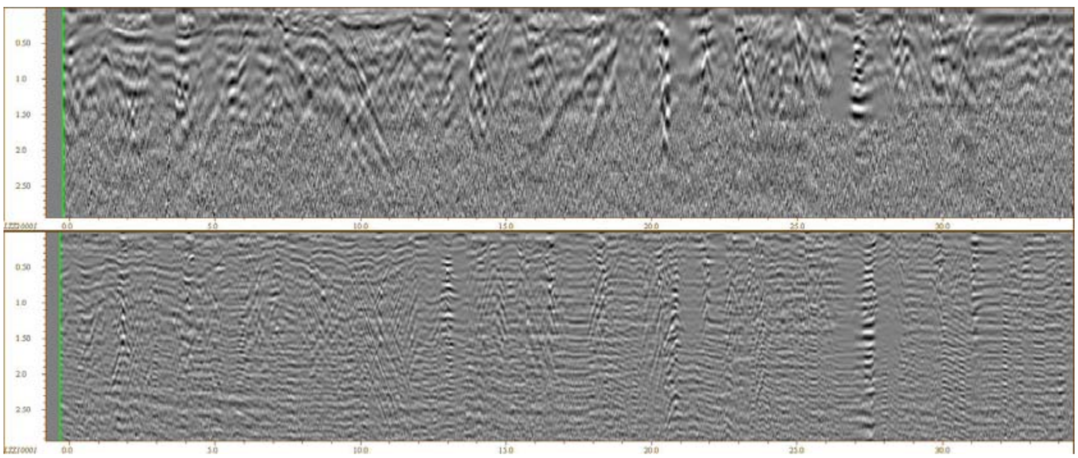
Moderate high resistance area anomaly – possible structural remains or debris
Areas of moderate high resistance may represent the continuation of structural debris and disturbed ground situated throughout the survey area. The moderate high resistance anomaly **18** corresponds with the positive area anomalies **c** and **d** and may indicate further evidence for structural remains.

Low resistance area anomaly – possible cut feature or disturbed ground
Areas of low resistance can be seen throughout the survey area (**12-16**). These anomalies may represent cut features or areas of disturbed ground. Area anomaly **12** is a well defined large area of low resistance situated across Building 4. This anomaly may be associated with an earlier phase of occupation. Anomaly **16** however corresponds to the positive area anomaly **q,** which may suggest that this anomaly represents an area of ground disturbance.

Low resistance area anomaly - unknown origin
A discrete area of low resistance is visible across the centre south of the survey area (**17**). This area anomaly may represent an area of slightly higher water content, creating a lower resistance reading and could be associated with the clay seal identified within a number of trenches excavated in 2006. The northern limits of this anomaly roughly correspond to the possible areas of ferrous debris (**t** and **u**) identified within the gradiometer data.

GPR trial

Four GPR traverses were carried across the site to assess the success and depth of penetration for the location of structural remains, using both 200 and 600MHz antennas. On site interpretation of the radar traverses was difficult and the identification of possible structural remains was not possible. Post processing in the office showed an achieved depth of penetration of up to 1.5 metre, a confident identification of structural remains within the individual radargrams could not be achieved. However, the examination of a timeslice data set (identifying high energy responses from a plan view of an area of close centred radar traverses) may identify further evidence of structural remains.



Example Radargram 1: Showing 200MHz (top) and 600MHz (bottom) radar data penertrationg to a depth of 1.5m

5 CONCLUSION

Both data sets have identified a number of possible structural remains; however they do not correspond well with each other. This may be due to the depths of the identified anomalies and the achieved depth of penetration of each technique. The resistivity data may only be seeing to a relatively shallow depth, or responses at depth are masked by the clay seal, whereas the strong magnetic responses from structures at depth have been identified by the gradiometer. Stronger magnetic area responses may relate to ferrous debris associated with the slitting mill. The northern extents of this ferrous debris appear to correspond with the low resistance area anomaly that may represent the clay seal, possibly indicating the limits of an earlier phase of industrial activity.