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GSB_Prospection@Compuserve**

**GEOPHYSICAL SURVEY
REPORT 98/137**

BURTON WATERS MARINA
Lincolnshire

Client:

LINCOLN archaeology

98/20

Event LI1126 MGS

54521 - Undated

SITE SUMMARY SHEET

98 / 137 Burton Waters Marina, Lincoln

NGR: SK 935 737 (approximate centre)

Location and topography

The site lies about 5km northwest of Lincoln city centre. The application area covers approximately 40ha and is limited by the Foss Dyke to the southwest and the A57 road to the northeast. The proposed development area occupies three adjoining fields all of which are generally level and were free of vegetation at the time of survey. The soils can be grouped as brown sands and gleyic brown sands formed in a parent of fluvioglacial sands and gravels, with intervening horizons of clays locally. Further details can be found in Burton Waters Marina: pilot study (GSB Report 98/112).

Archaeology

The Foss Dyke is adjacent to the south-west of the application area and several flint scatters, believed to be later Mesolithic or late Neolithic/early Bronze Age in date, were noted during field walking by staff of **Lincoln Archaeology (CLAU)**

Aims of Survey

The aims of the survey were to attempt to locate any anomalies of archaeological potential which might be associated with the flint scatters. This survey forms part of a wider investigation by **CLAU**.

Summary of Results *

The levels of magnetic response are low and many of the anomalies recorded are at the limits of detectability. It is for this reason that any archaeological interpretations remains tentative. In Field A (Survey Areas 1 and 2) several weak linear and rectilinear anomalies were located. Ferrous type anomalies associated with field boundaries and scattered debris, and anomalies aligned with the direction of current ploughing were also detected.

In Field B (Survey Areas 3 - 6) several magnetically weak positive and negative linear anomalies were recorded. These are too weak to be interpreted firmly but, in some cases, may reflect former field divisions. A faint circular anomaly was also noted. Ferrous anomalies associated with field boundaries and scattered magnetic debris were also detected.

In Field C, the data are dominated by the response from field drains and scattered ferrous debris. No anomalies of archaeological interest were noted.

*** It is essential that this summary is read in conjunction with the detailed results of the survey.**

SURVEY RESULTS

98 / 137 Burton Waters Marina, Lincoln

1. Survey Area

1.1 Three survey blocks, totalling 6.4 ha, in three separate fields (A to C) were surveyed using gradiometers collecting data at four samples per metre.

1.2 The baselines for the survey grids were set out and tied in by **CLAU**.

2. Display

2.1 Figure 1 is a location plan showing the survey areas at a scale of 1:2500. For ease of display the three survey blocks, in Fields A to C, have been subdivided into nine areas (Areas 1-9).

2.2 Figure 2 is a summary greyscale image of the entire gradiometer data at a scale of 1:2000; Figure 2A is the accompanying summary interpretation diagram at the same scale. Figures 3-32 are XY traces, dot density plots, greyscale images and interpretation diagrams of the survey results for Areas 1 to 9 at a scale of 1:500. These display formats are discussed in the *Technical Information* section at the end of the text.

3. General Considerations - Complicating factors

3.1 Given the flat topography and absence of ground cover, conditions for survey were generally good. However, the cloddy and sticky nature of the soil made walking at an even pace difficult.

3.2 The data contain frequent scattered ferrous type anomalies that are usually considered to reflect modern ferrous debris within the topsoil. However, given the geology it is also possible that some of these responses are the result of magnetic gravels. The most prominent of these responses are noted on the interpretation diagrams, although they are not referred to in the text unless considered especially relevant.

4. Results of Gradiometer survey

4.1 Field A (Areas 1 and 2)

4.1.1 A series of faint parallel linear trends are evident within the data. These coincide with the direction of present ploughing and are concluded to be modern in origin. Two faint linear trends, on a different alignment to the current ploughing trend, have also been detected. The two linears are interpreted as being of possible archaeological interest, however, given their diffuse nature, any interpretation remains tenuous.

4.1.2 A number of faint linear anomalies, perhaps forming an enclosure, have been detected. These have been tentatively interpreted as being of possible archaeological interest.

4.1.3 The southern edge of the data are dominated by the response from an adjacent metal fence.

4.2 Field B (Areas 3 to 6)

4.2.1 The ferrous type responses along the northeastern edge of the survey block are due to an adjacent field boundary and magnetic materials which may originate from the road (the former A57) beyond. A concentration of isolated ferrous anomalies along the eastern margin of the survey area is probably due to contamination from the adjacent buildings.

4.2.2 A circular anomaly, some 30-35m across, has been noted in Area 3. It is very faint and can only really be seen on the summary greyscale (Figure 2). The archaeological interpretation of this anomaly as a circular ditched feature must remain highly cautious.

4.2.3 A diffuse linear anomaly has been detected, running north-south (Area 4). This is interpreted as being of possible archaeological interest, although the anomaly is too weak to give a definitive interpretation.

4.2.4 Two linear anomalies, running approximately north-south (Areas 5 & 6), have been detected and are interpreted as being of potential archaeological significance. Similarly, a linear negative anomaly, aligned approximately east-west along the northern edge of the survey block, has also been detected. The positive and negative anomalies are perpendicular to each other, and it is possible that these responses reflect former field divisions that may be of archaeological interest.

4.2.5 Two smaller negative linear responses are visible to the east of the positive linear, and may also be of archaeological interest, although the weak nature of the responses means any interpretation is tentative.

4.3 Field C (Areas 7 to 9)

4.3.1 The data are dominated by the responses from two groups of parallel linear responses; each group having a different alignment. These are thought to result from the presence of field drains.

4.3.2 No anomalies of archaeological potential have been identified within this survey area.

5. Conclusions

5.1 The general level of magnetic response was low and the anomalies of possible archaeological interest which were detected are very faint, being close to the limits of detectability. At these low levels of signal-to-noise interpretation is considerably more subjective than normal. Each visual inspection of the summary grey scale in particular reveals 'new' patterns that are within the background noise. As a result any archaeological interpretation of these geophysical anomalies remains tentative.

5.2 Ferrous anomalies, associated with field boundaries, former roads and scattered magnetic debris within the soil were detected across all survey areas.

5.3 Field A. Several weak linears and apparently rectilinear anomalies were detected in Areas 1 and 2. Whilst these are of potential archaeological interest, their nature is uncertain.

5.4 Field B. A faint circular anomaly was noted in Area 3. Several positive and negative linear anomalies were detected in Areas 4, 5 and 6. These may be of archaeological interest, however, their nature is unclear. The longest two of these anomalies appear to abut perpendicularly and may reflect former land divisions.

5.5 Field C. No anomalies of archaeological interest were detected in Areas 7, 8 or 9; these areas were dominated by the responses from field drains.

Project Co-ordinators:	D Weston
Project Assistants:	Dr C Gaffney, C Martinez, J Nicholas, A Shields & C Stephens
Date of Survey:	24th - 27th November 1998
Date of Report:	8th December 1998

TECHNICAL INFORMATION

The following is a description of the equipment and display formats used in **GSB Prospection (GSB)** reports. It should be emphasised that whilst all of the display options are regularly used, the diagrams produced in the final reports are the most suitable to illustrate the data from each site. The choice of diagrams results from the experience and knowledge of the staff of **GSB.**

All survey reports are prepared and submitted on the basis that whilst they are based on a thorough survey of the site, no responsibility is accepted for any errors or omissions.

Instrumentation

(a) Fluxgate Gradiometer - Geoscan FM36

This instrument comprises of two fluxgates mounted vertically apart, at a distance of 500mm. The gradiometer is carried by hand, with the bottom sensor approximately 100-300mm from the ground surface. At each survey station, the difference in the magnetic field between the two fluxgates is conventionally measured in nanoTesla (nT), or gamma. The fluxgate gradiometer suppresses any diurnal or regional effects. Generally features up to one metre deep may be detected by this method. Readings are normally logged at 0.5m intervals along traverses 1.0m apart.

(b) Resistance Meter - Geoscan RM4 or RM15

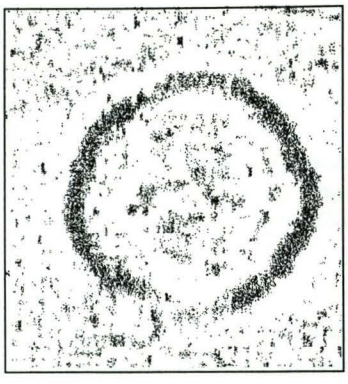
This measures the electrical resistance of the earth, using a system of four electrodes (two current and two potential.) Depending on the arrangement of these electrodes an exact measurement of a specific volume of earth may be acquired. This resistance value may then be used to calculate the earth resistivity. The "Twin Probe" arrangement involves the paring of electrodes (one current and one potential) with one pair remaining in a fixed position, whilst the other measures the resistance variations across a fixed grid. The resistance is measured in Ohms and the calculated resistivity is in Ohm-metres. The resistance method as used for area survey has a depth resolution of approximately 0.75m, although the nature of the overburden and underlying geology will cause variations in this generality. The technique can be adapted to sample greater depths of earth and can therefore be used to produce vertical "pseudo sections". In area survey readings are typically logged at 1.0m x 1.0m intervals.

(c) Magnetic Susceptibility

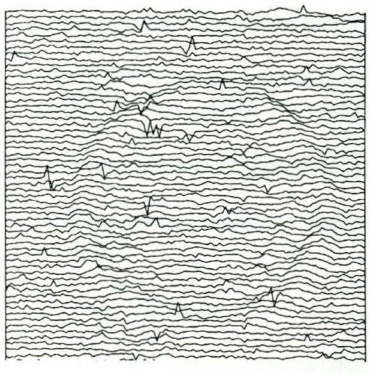
Variations in the magnetic susceptibility of subsoils and topsoils occur naturally, but greater enhanced susceptibility can also be a product of increased human/anthropogenic activity. This phenomenon of susceptibility enhancement can therefore be used to provide information about the "level of archaeological activity" associated with a site. It can also be used in a predictive manner to ascertain the suitability of a site for a magnetic survey. The instrument employed for measuring this phenomenon is either a field coil or a laboratory based susceptibility bridge. For the latter 50g soil samples are collected in the field. Sampling intervals vary widely but are often at the 10m or 20m level.

Display Options

The following is a description of the display options used. Unless specifically mentioned in the text, it may be assumed that no filtering or smoothing has been used to enhance the data. For any particular report a limited number of display modes may be used.

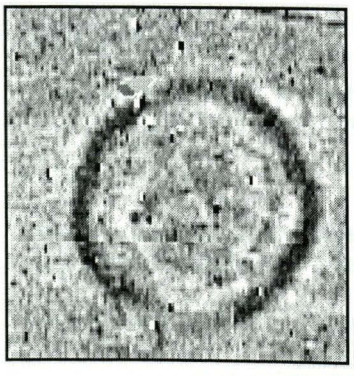


(a) Dot-Density In this display, minimum and maximum cut-off levels are chosen. Any value that is below the minimum will appear white, whilst any value above the maximum will be black. Any value that lies between these two cut-off levels will have a specified number of dots depending on the relative position between the two levels. The focus of the display may be changed using different levels and a contrast factor (C.F.). Usually the C.F. = 1, producing a linear scale between the cut-off levels. Assessing a lower than normal reading involves the use of an inverse plot, This plot simply reverses the minimum and maximum values, resulting in the lower values being presented by more dots. In either representation, each reading is allocated a unique area dependent on its position on the survey grid, within which numbers of dots are randomly placed. The main limitation of this display method is that multiple plots have to be produced in order to view the whole range of the data. It is also difficult to gauge the true strength of any anomaly without looking at the raw data values. This display is much favoured for producing plans of sites, where positioning of the anomalies and features is important.



(b) X-Y Plot This involves a line representation of the data. Each successive row of data is equally incremented in the Y axis, to produce a stacked profile effect. This display may incorporate a hidden-line removal algorithm, which blocks out lines behind the major peaks and can aid interpretation. Advantages of this type of display are that it allows the full range of the data to be viewed and shows the shape of the indiviual anomalies. Results are produced on a flatbed plotter.

This display joins the data values in both the X and Y axis. The display may be changed by altering the horizontal viewing angle and the angle above the plane. The output may be either colour or black and white.



(c) Grey-Scale

This format divides a given range of readings into a set number of classes. These classes have a predefined arrangement of dots or shade of grey, the intensity increasing with value. This gives an appearance of a toned or grey scale.

Similar plots can be produced in colour, either using a wide range of colours or by selecting two or three colours to represent positive and negative values. While colour plots can look impressive and can be used to highlight certain anomalies, grey-scales tend to be more informative.

Terms commonly used in the graphical interpretation of gradiometer data

Ditch / Pit

This category is used only when other evidence is available that supports a clear archaeological interpretation e.g. cropmarks or excavation.

Archaeology

This term is used when the form, nature and pattern of the response is clearly archaeological but where no supporting evidence exists. These anomalies, whilst considered anthropogenic, could be of any age. If a more precise archaeological interpretation is possible then it will be indicated in the accompanying text.

? Archaeology

The interpretation of such anomalies is often tentative, with the anomalies exhibiting either weak signal strength or forming incomplete archaeological patterns. They may be the result of variable soil depth, plough damage or even aliasing as a result of data collection orientation.

Natural

These responses form clear patterns in geographical zones where natural variations are known to produce significant magnetic distortions e.g. palaeochannels or magnetic gravels.

? Natural

These are anomalies that are likely to be natural in origin i.e geological or pedological.

Areas of Magnetic Disturbance

These responses are commonly found in places where modern ferrous or fired materials are present e.g. fencelines, pylons or brick rubble. They are presumed to be modern.

Areas of Increased Magnetic Response

These responses show no visual indications on the ground surface and are considered to have some archaeological potential.

Ferrous Response

This type of response is associated with ferrous material and may result from small items in the topsoil or larger buried objects such as pipes. Ferrous responses are usually regarded as modern. Individual burnt stones, fired bricks or igneous rocks can produce responses similar to ferrous material.

Ridge and Furrow

These are regular and broad linear anomalies that are presumed to be the result of ancient cultivation. In some cases the response may be the result of modern activity.

Ploughing Trend

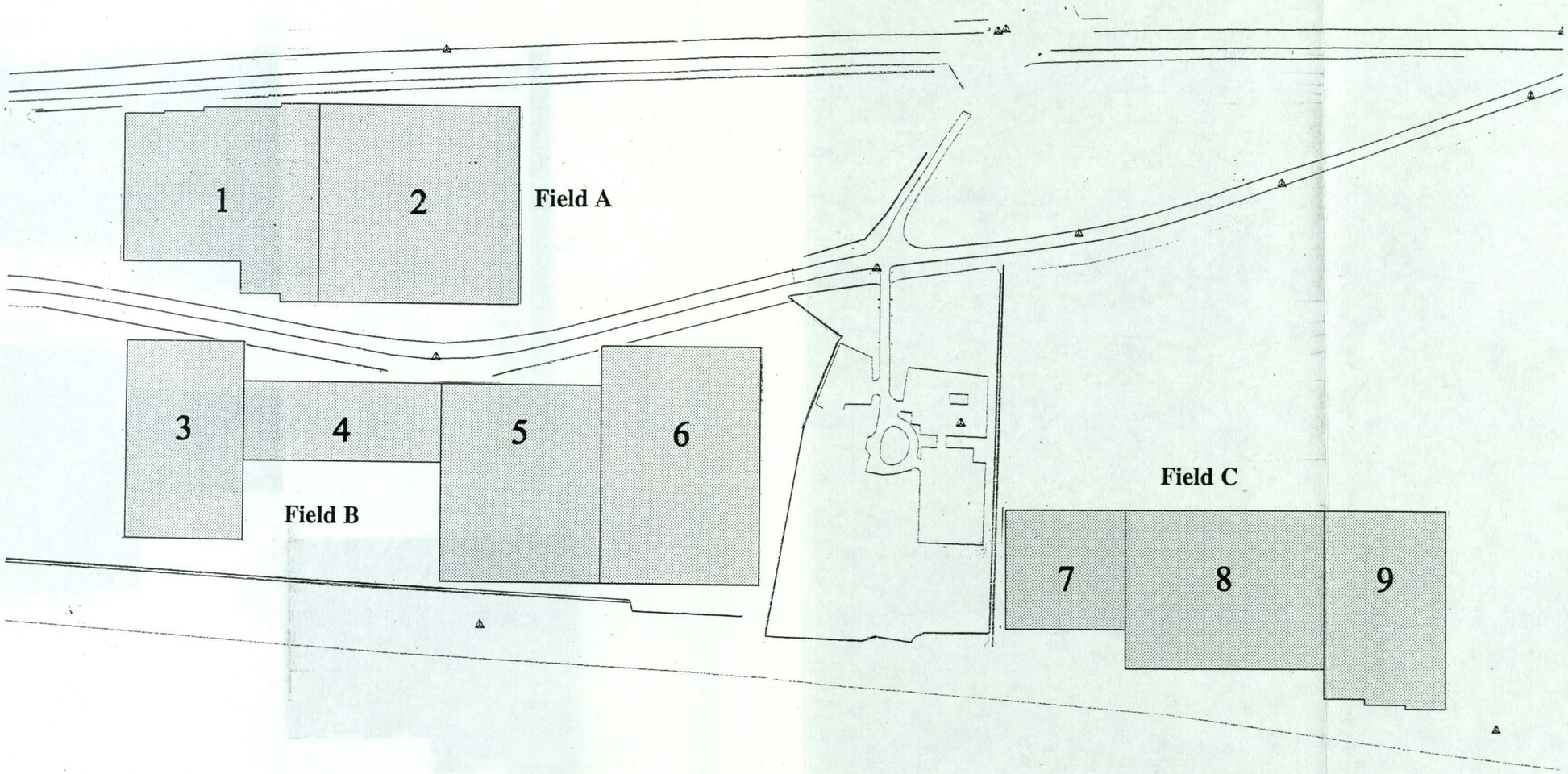
These are isolated or grouped linear responses. They are normally narrow and are presumed modern when aligned to current field boundaries or following present ploughing.

Linear Trend

This is usually a weak isolated linear anomaly of unknown cause or date.

List of Figures

BURTON WATERS MARINA
Location of Survey Areas



Based on a plan supplied by
City of Lincoln Archaeology

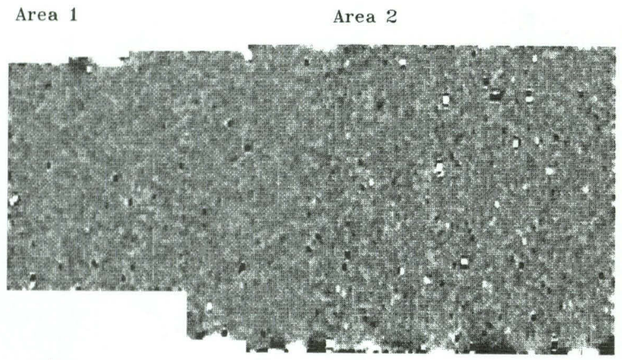
GSB Prospection 98/137

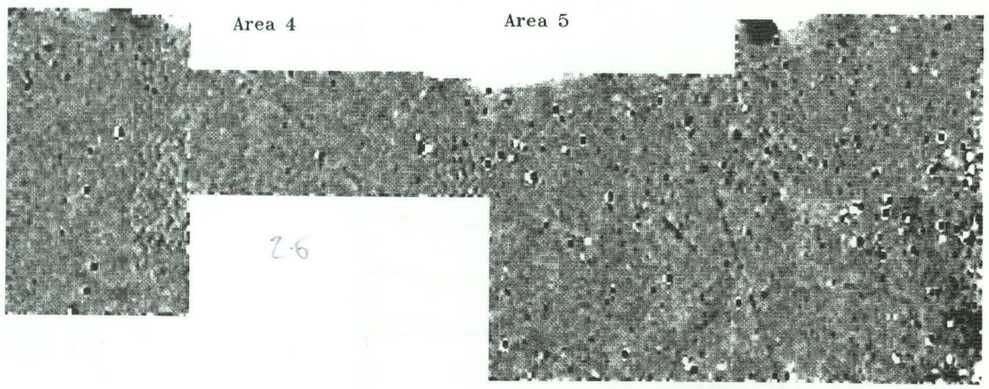
1:2500

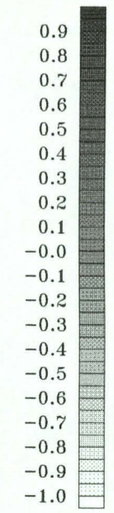
Figure 1

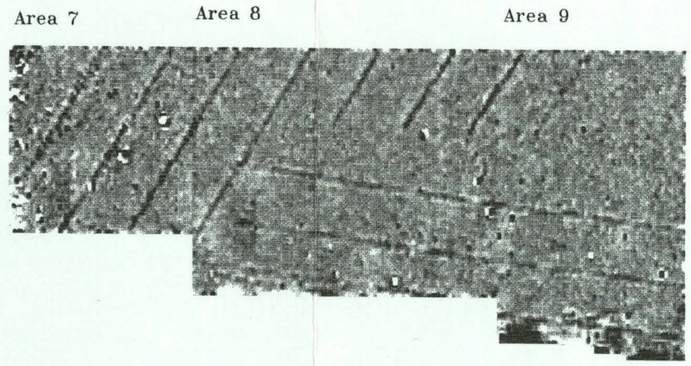
Burton Waters Marina

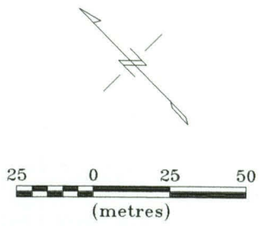
Summary Greyscale







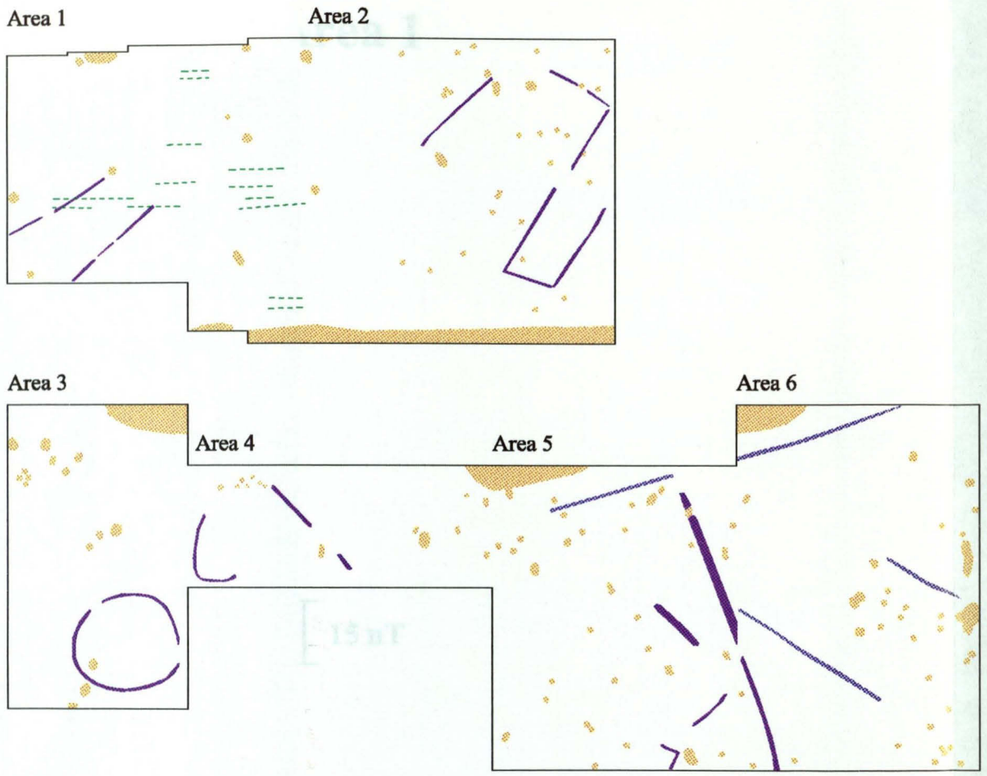


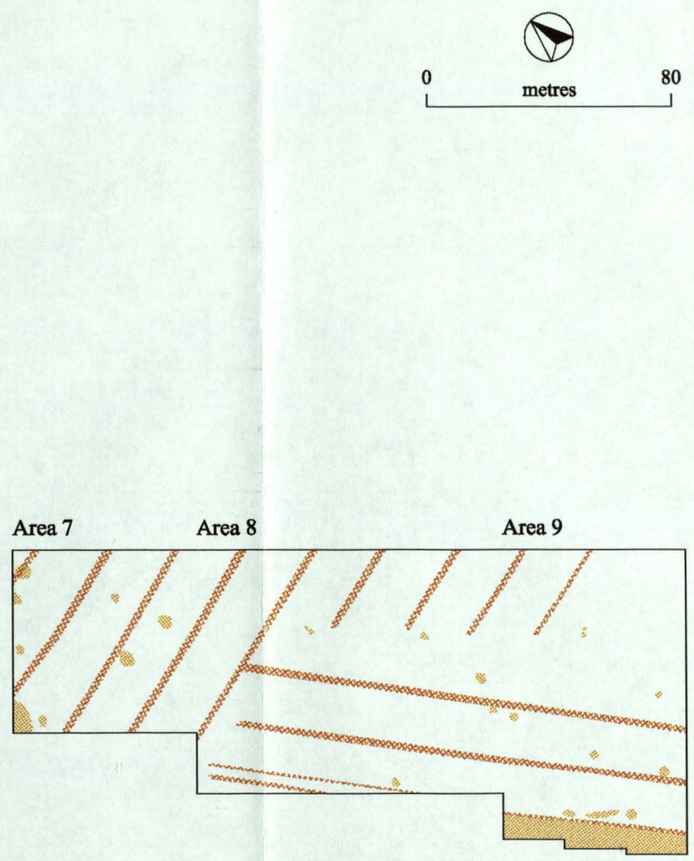


GSB Prospection 98/137

Figure 2

GSB PROSPECTION
PROJECT: 98/137 BURTON WATERS MARINA
TITLE: Summary Interpretation





0 metres 80

?Archaeology

Negative Anomaly

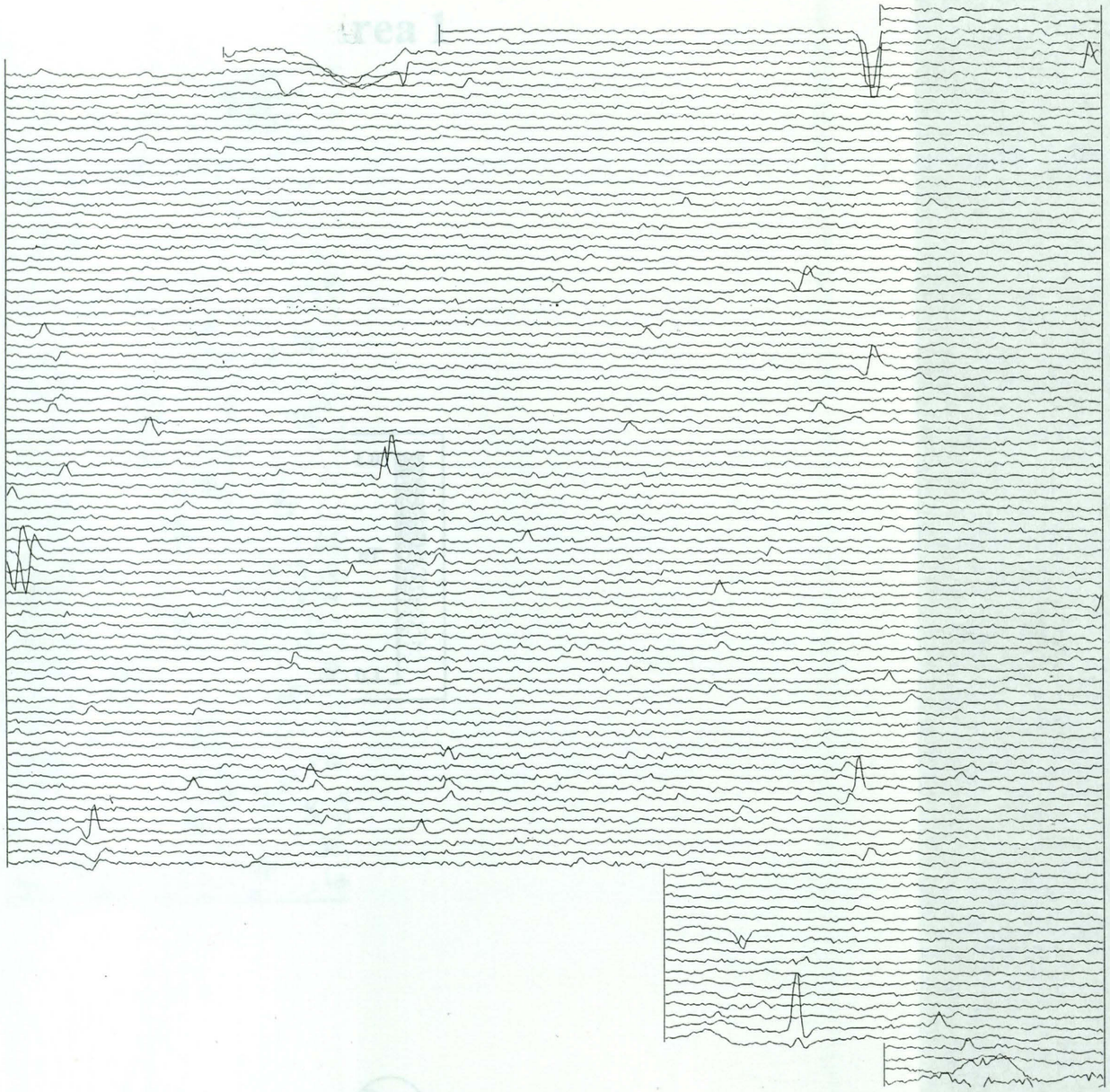
Drain

Ploughing Trend

Ferrous

Figure 2A

BURTON WATERS MARINA
Area 1



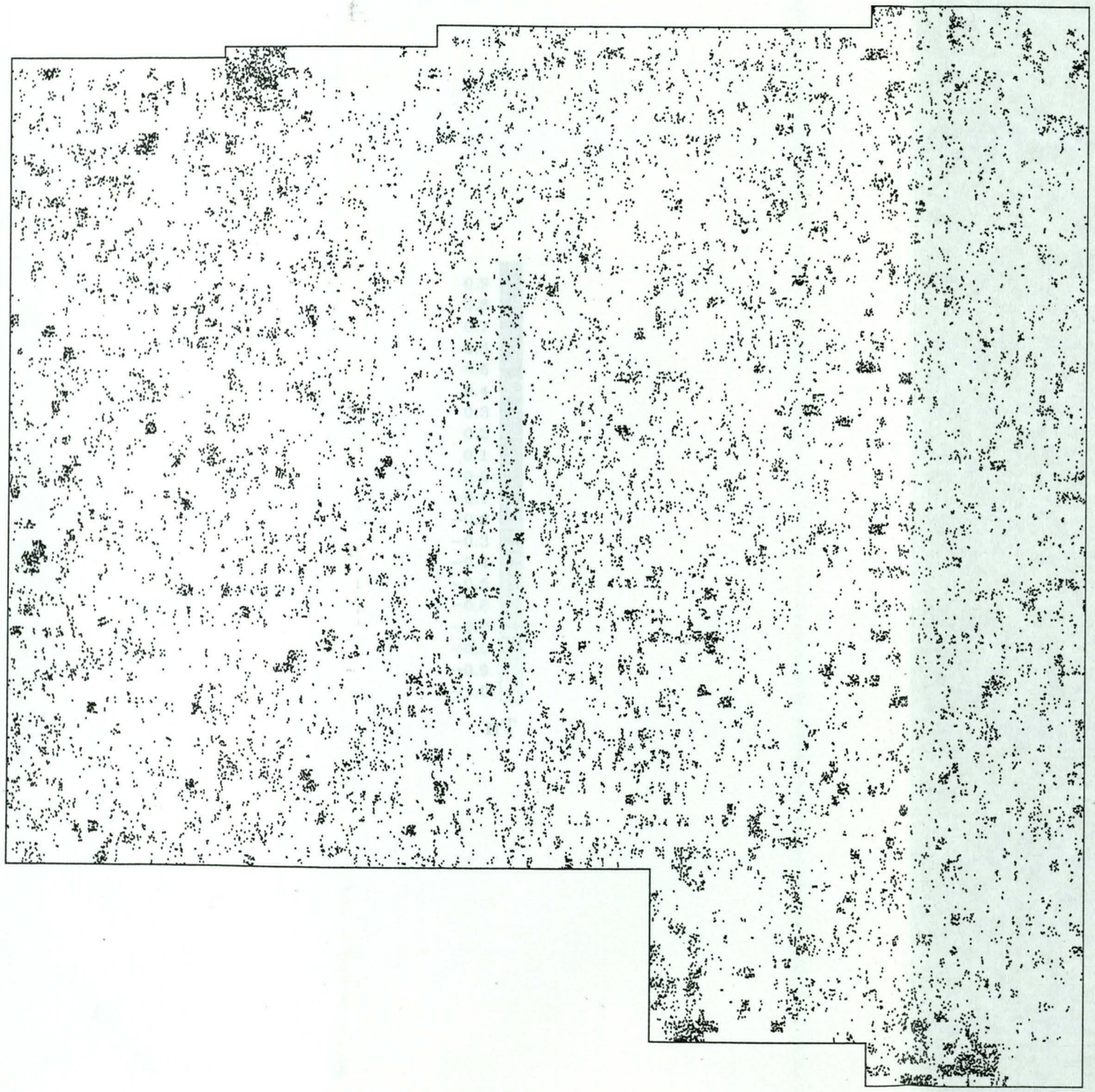
15 nT

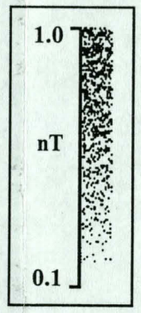
0 m 20

GSB Prospection 98/137

Figure 3

BURTON WATERS MARINA
Area 1





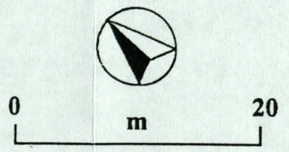


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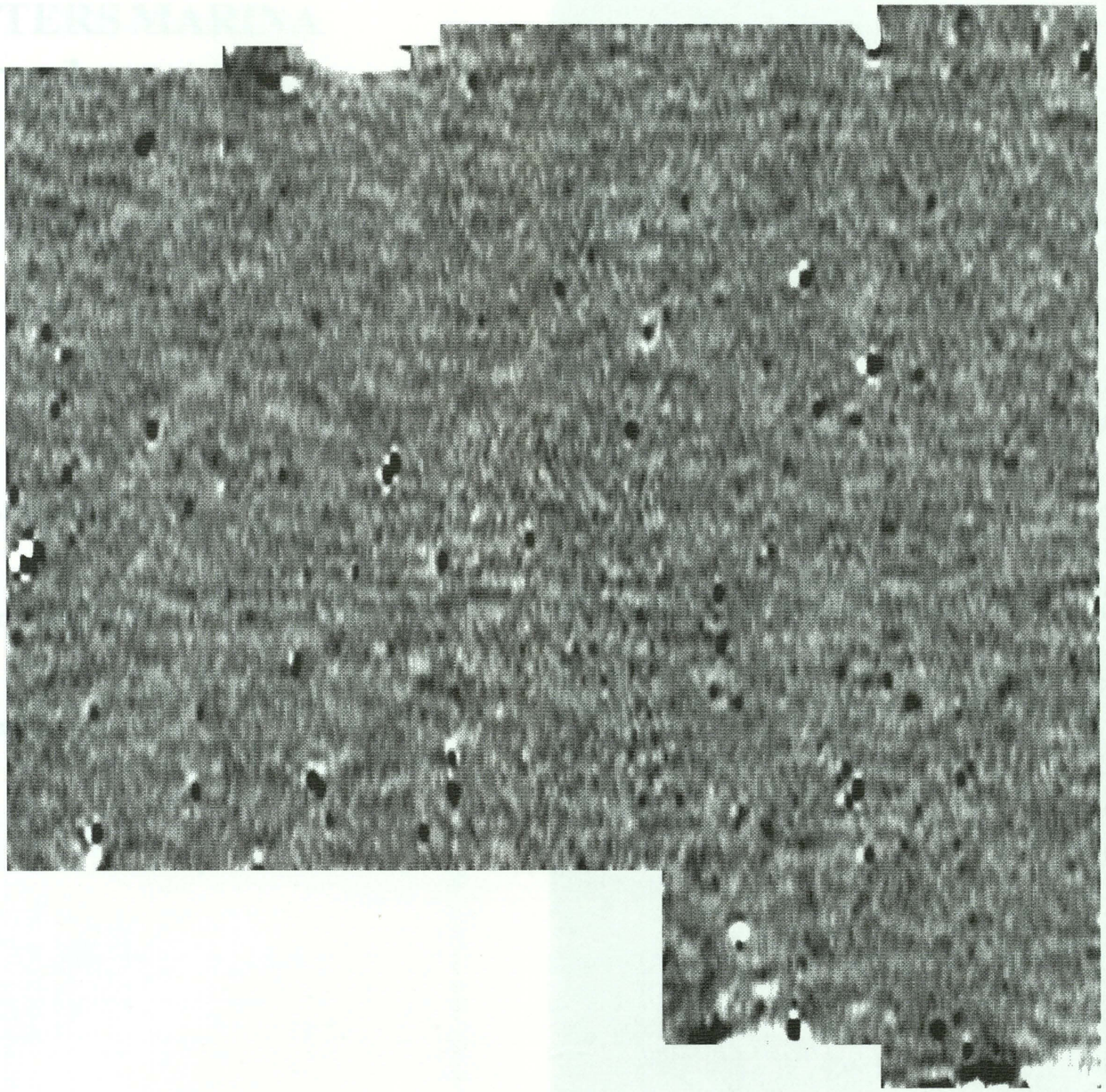
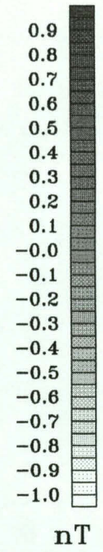
Figure 4

Burton Waters Marina





5 0 5 10 15
(metres)

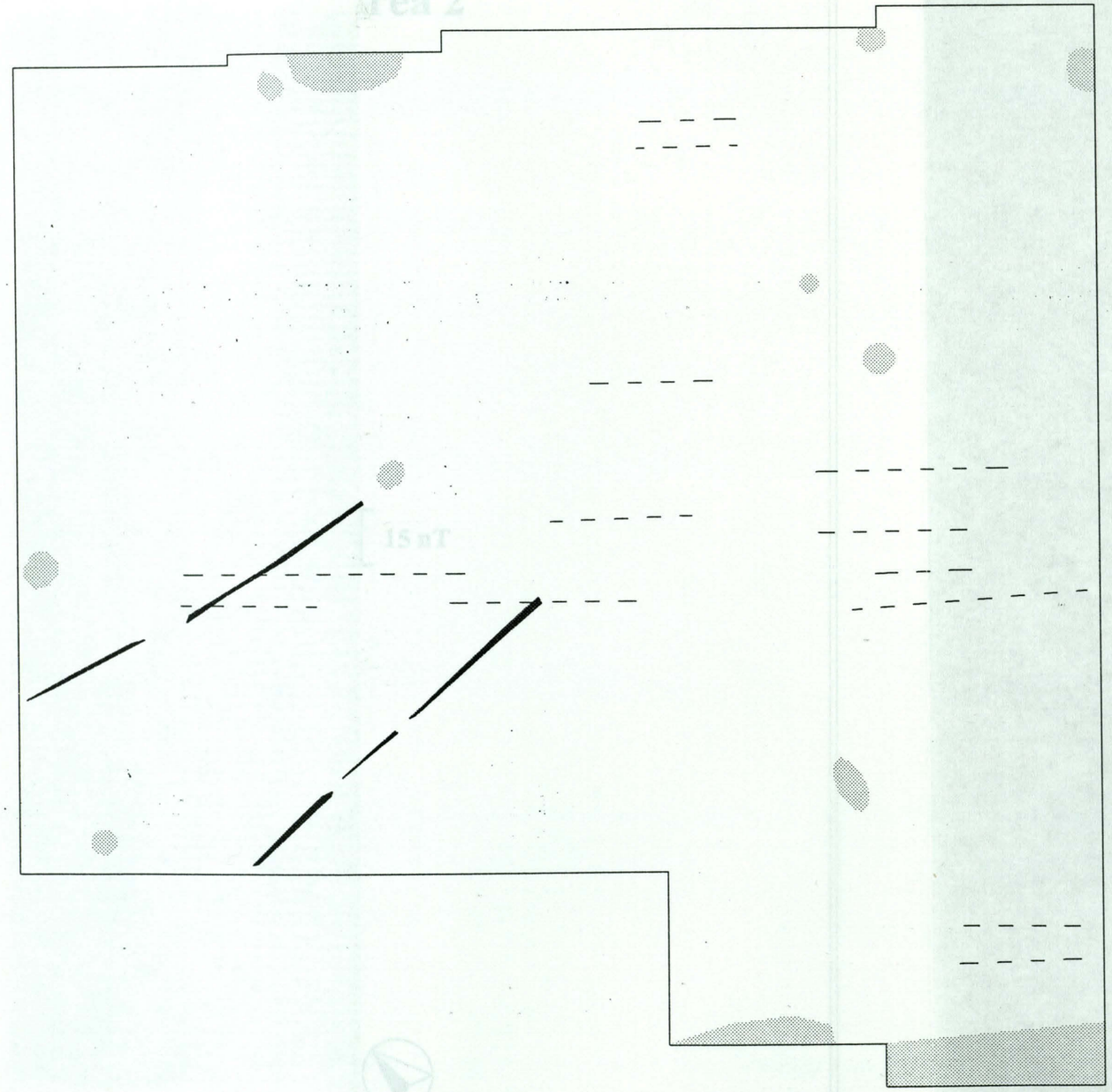
GSB Prospection 98/137

Gradiometer Data

Area 1

Figure 5

BURTON WATERS MARINA
Area 1



?Archaeology

Ploughing Trend

Ferrous

0 m 20

GSB Prospection 98/137

Figure 6

BURTON WATERS MARINA
Area 2

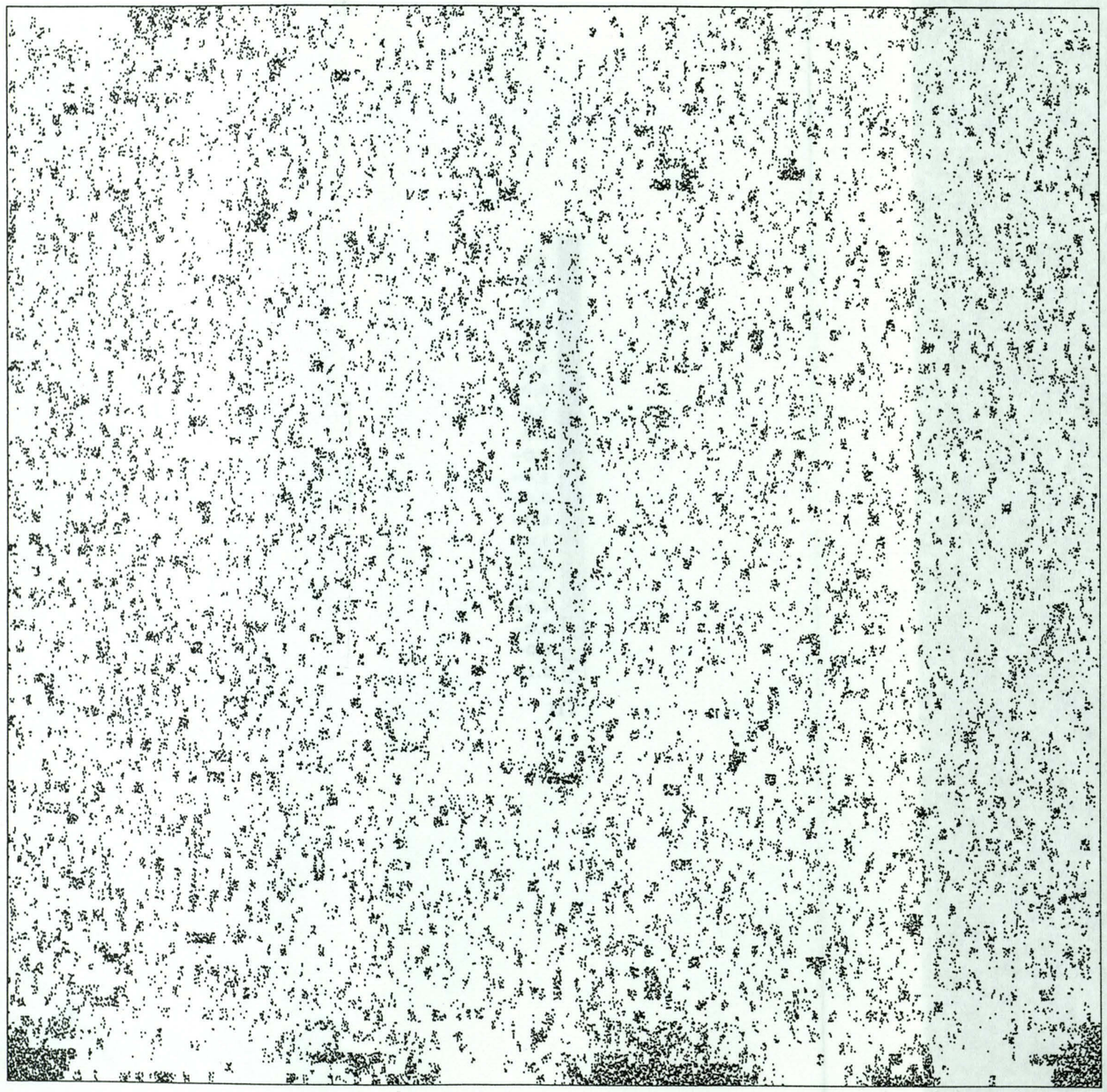
15 nT

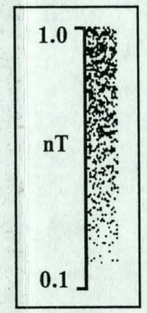
0 m 20

GSB Prospection 98/137

Figure 7

BURTON WATERS MARINA
Area 2





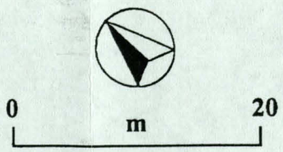
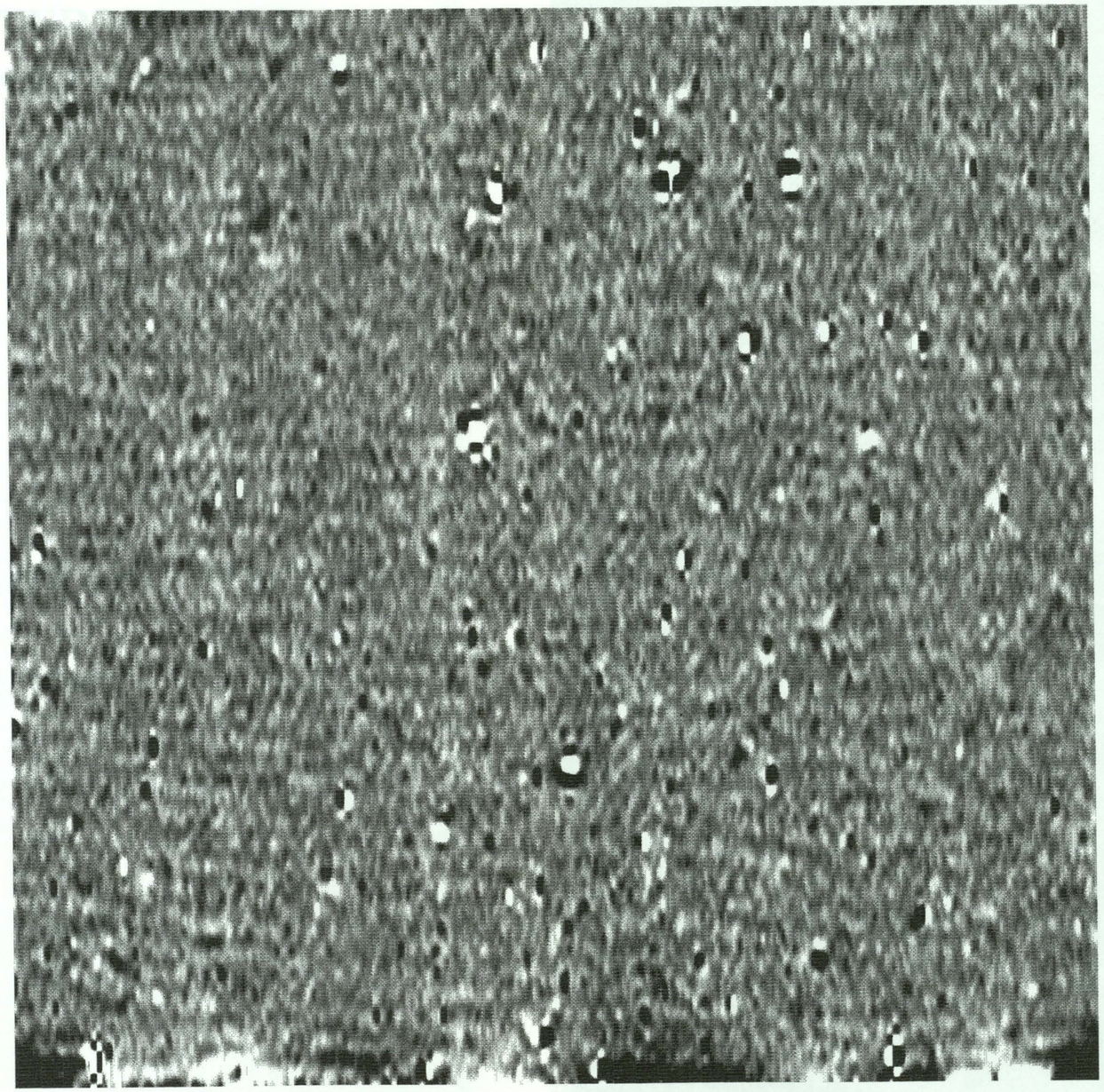
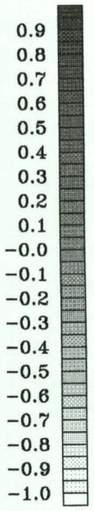


Figure 8

Burton Waters Marina





5 0 5 10 15
(metres)

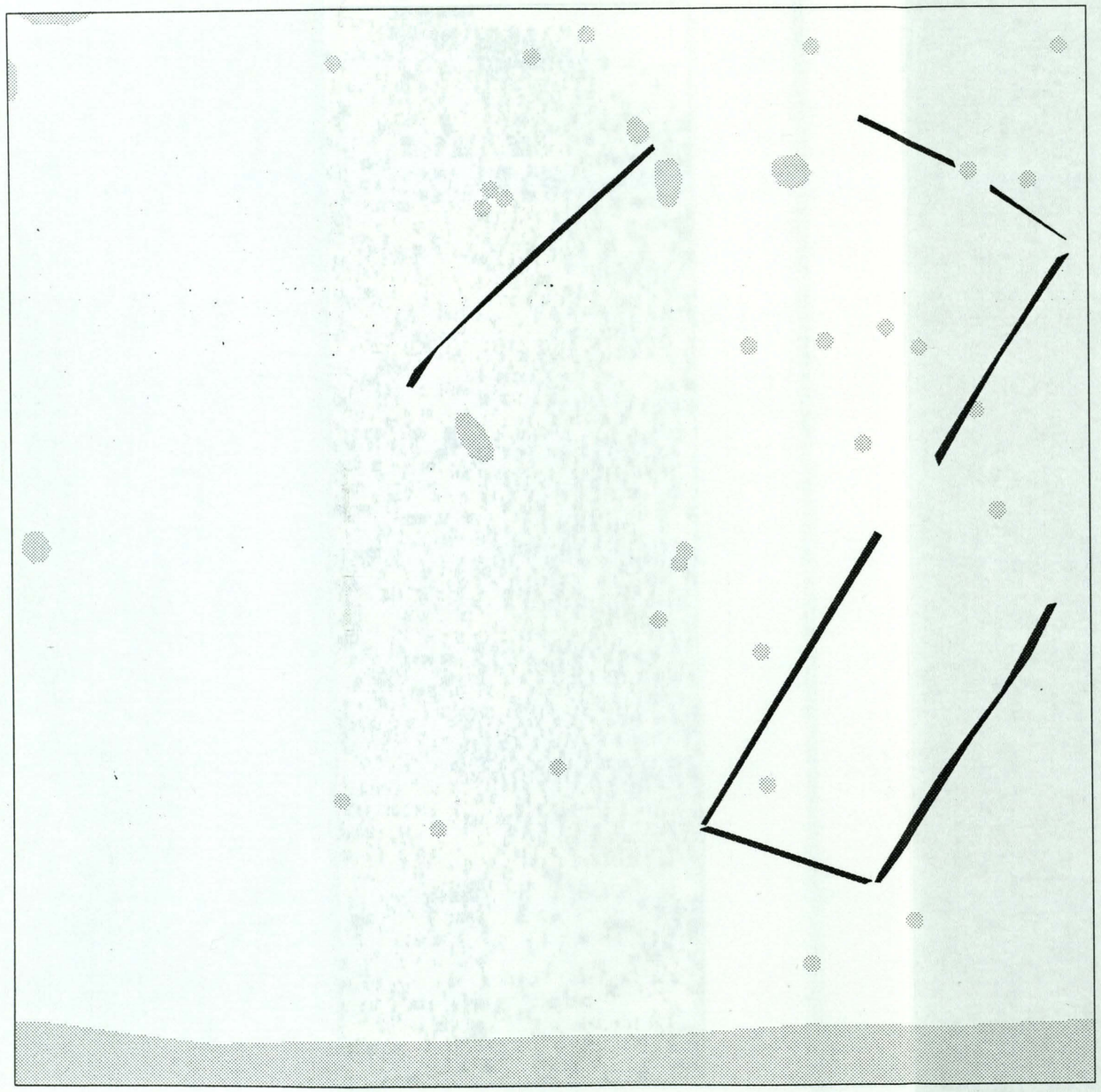
GSB Prospection 98/137

Gradiometer Data

Area 2

Figure 9

BURTON WATERS MARINA
Area 2



?Archaeology

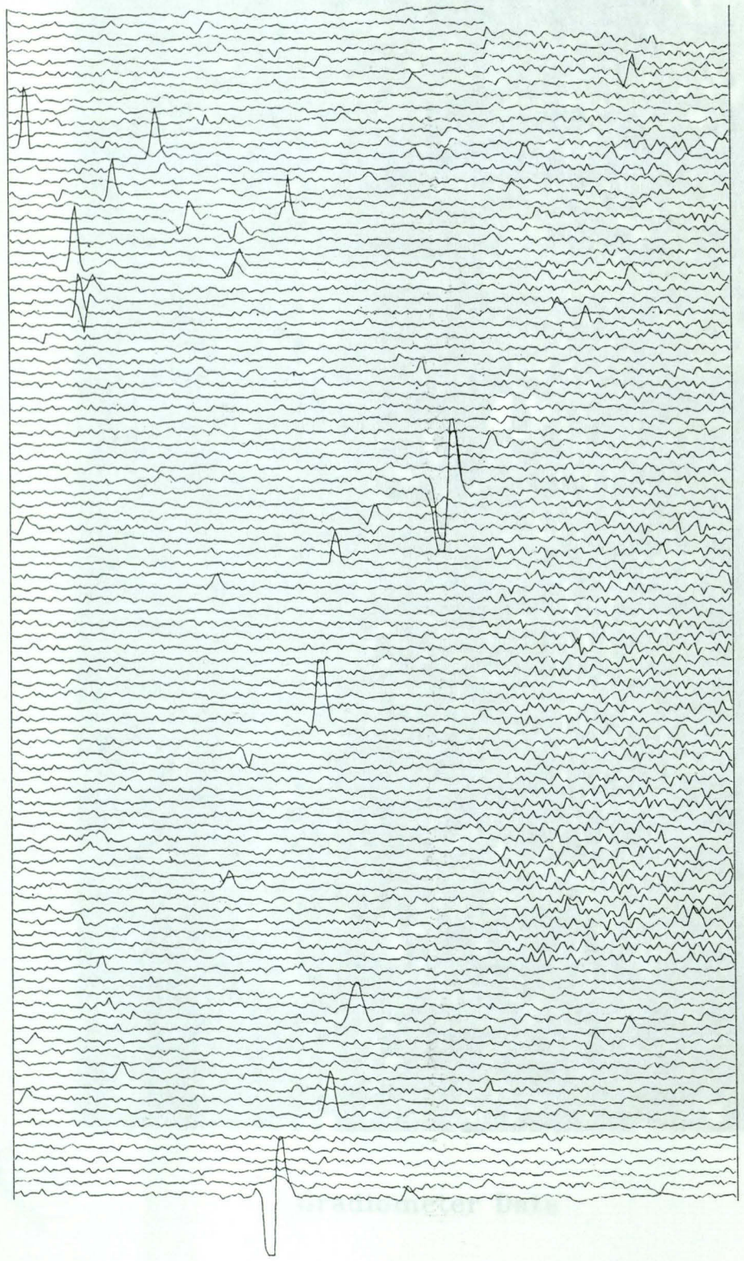
Ferrous

0 m 20

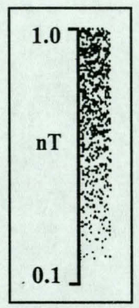
GSB Prospection 98/137

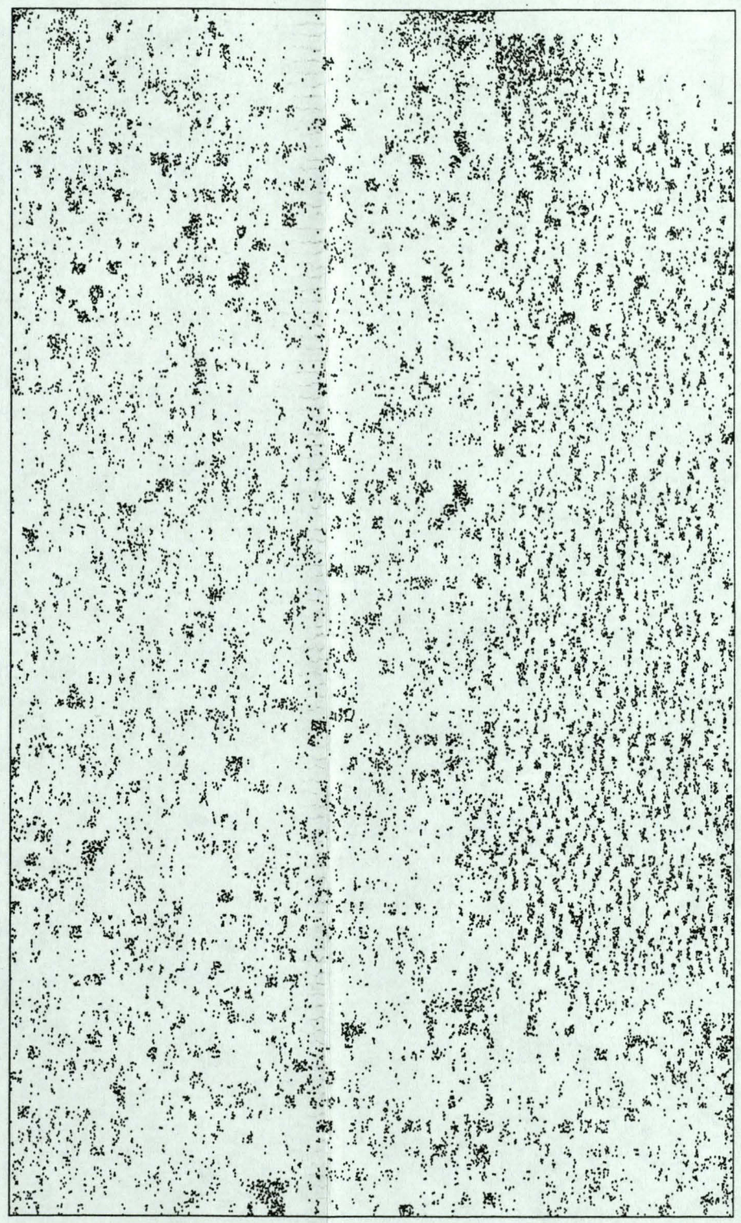
Figure 10

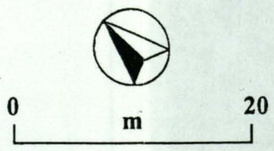
BURTON WATERS MARINA
Area 3



15 nT



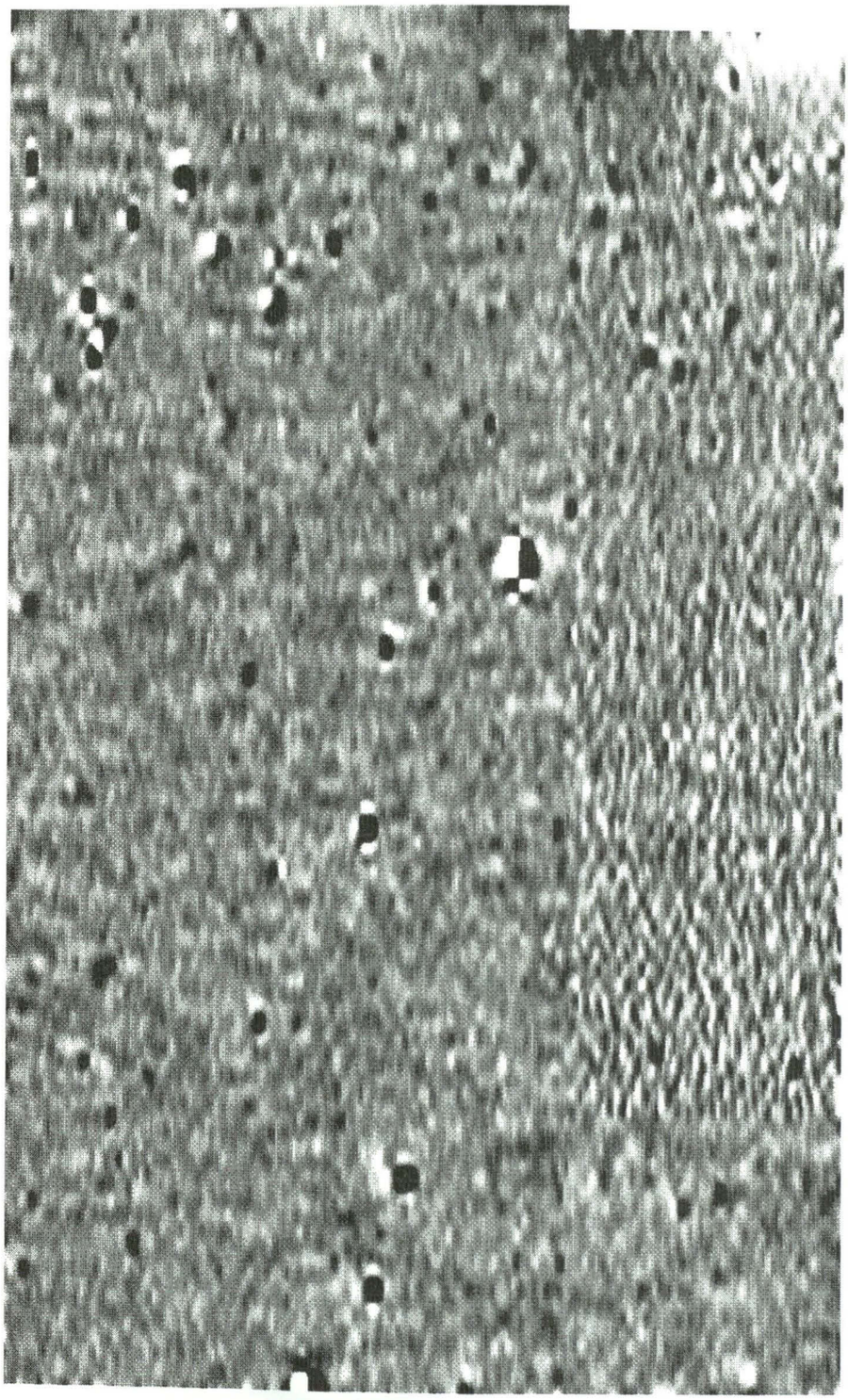




GSB Prospection 98/137

Figure 11

Burton Waters Marina



0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
−0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
−1.0

nT

Gradiometer Data

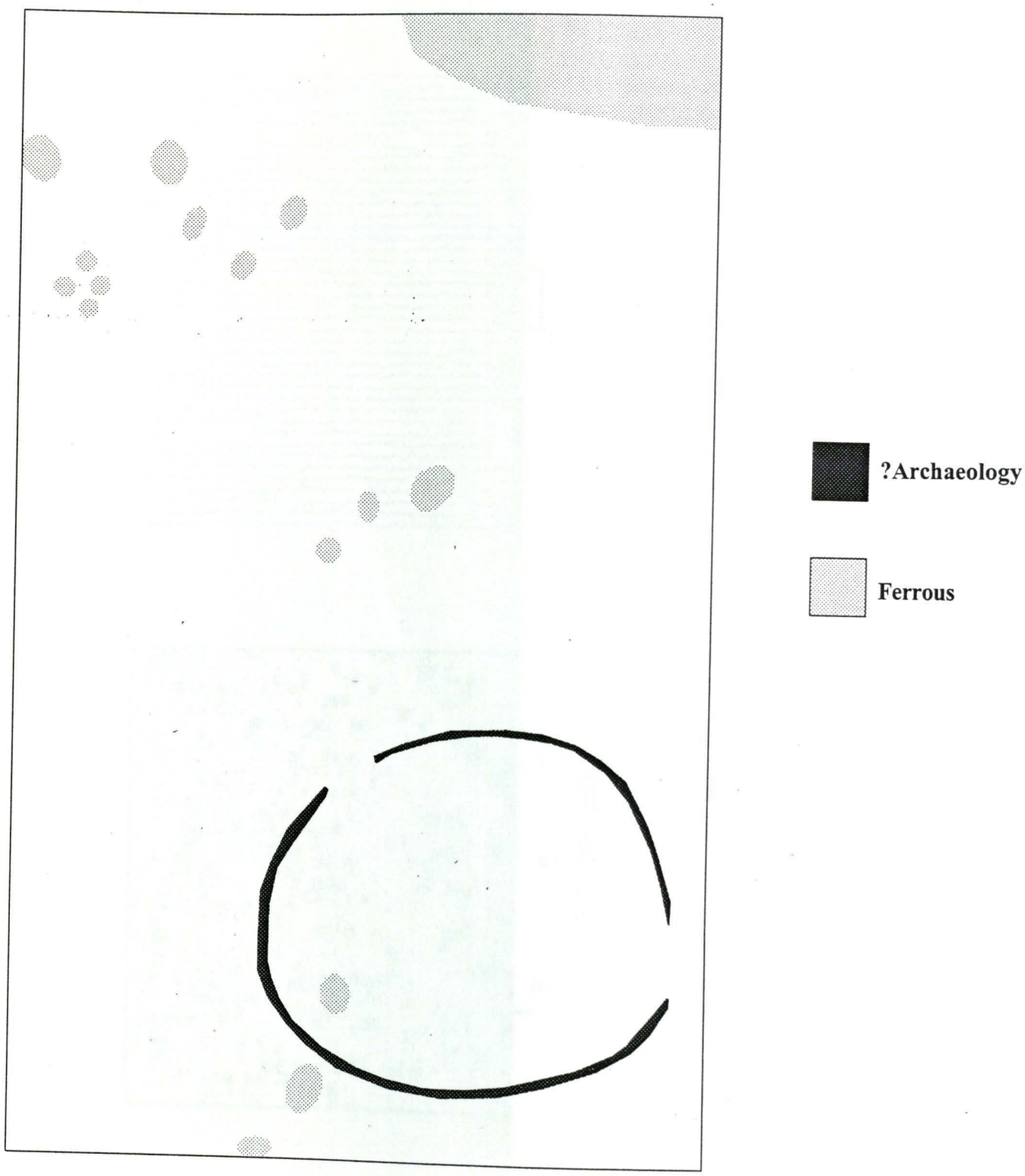
Area 3

10 0 10
(metres)

GSB Prospection 98/137

Figure 12

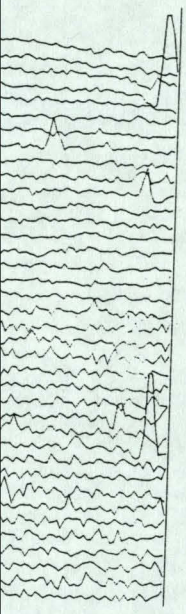
BURTON WATERS MARINA
Area 3



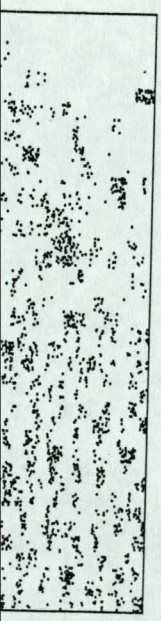
GSB Prospection 98/137

Figure 13

ERS MARINA
4



15 nT



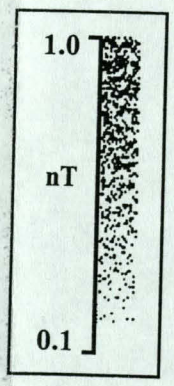
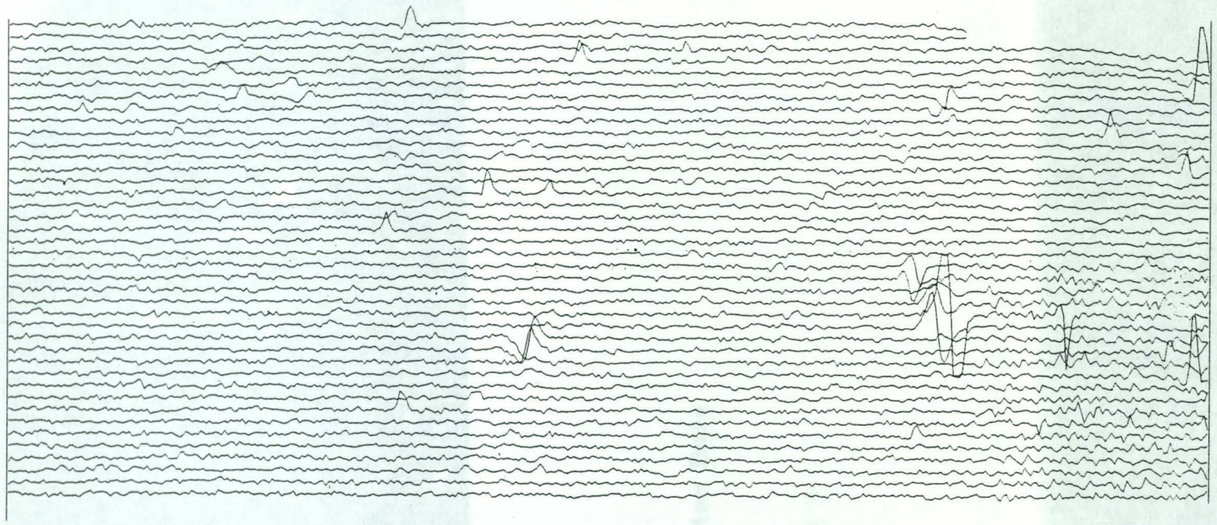
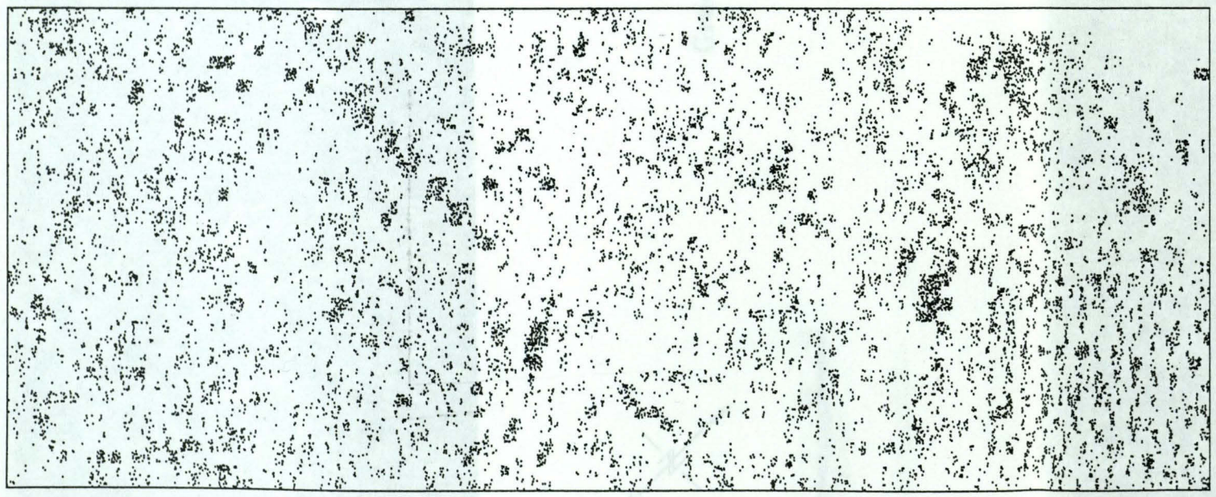


Figure 14

BURTON WATERS MARINA
Area 4



15 nT



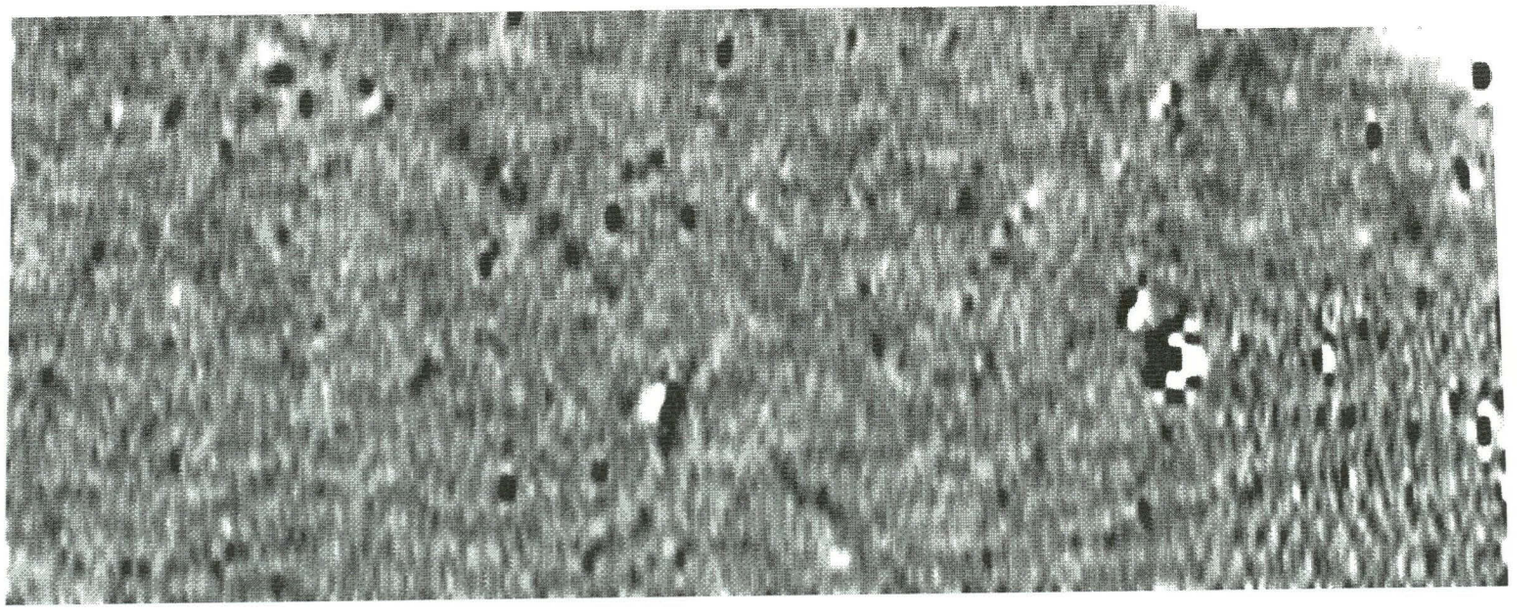
1.0
nT
0.1

0 m 20

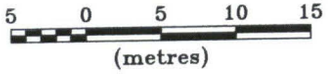
GSB Prospection 98/137

Figure 14

Burton Waters Marina



Gradiometer Data



Area 4

GSB Prospection 98/137

Figure 15

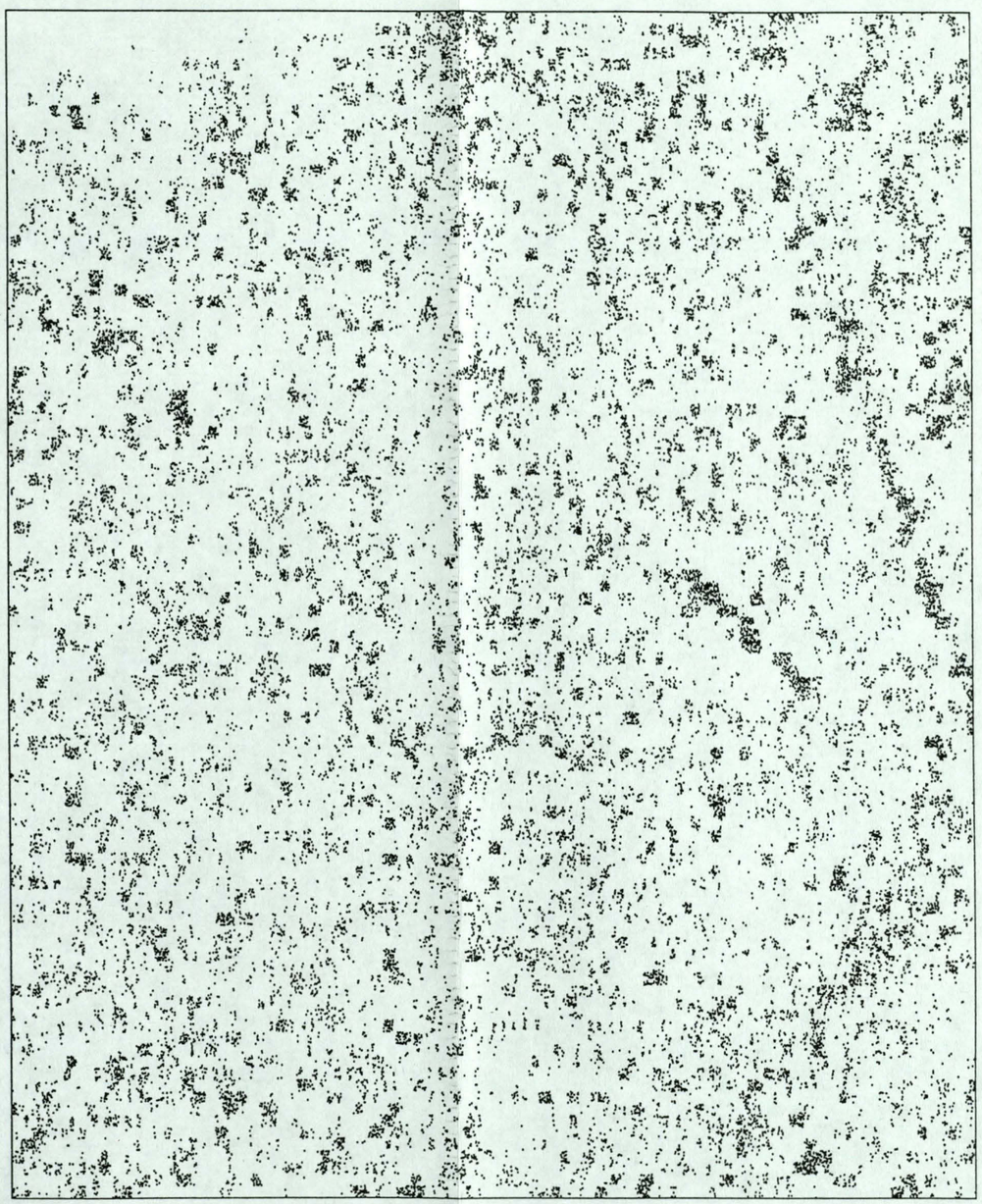
BURTON WATERS MARINA
Area 4

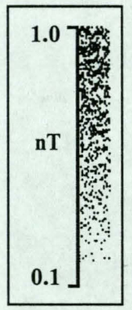
GSB Prospection 98/137

Figure 16

BURTON WATERS MARINA
Area 5

15 nT





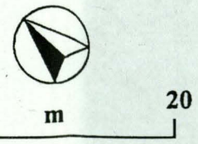
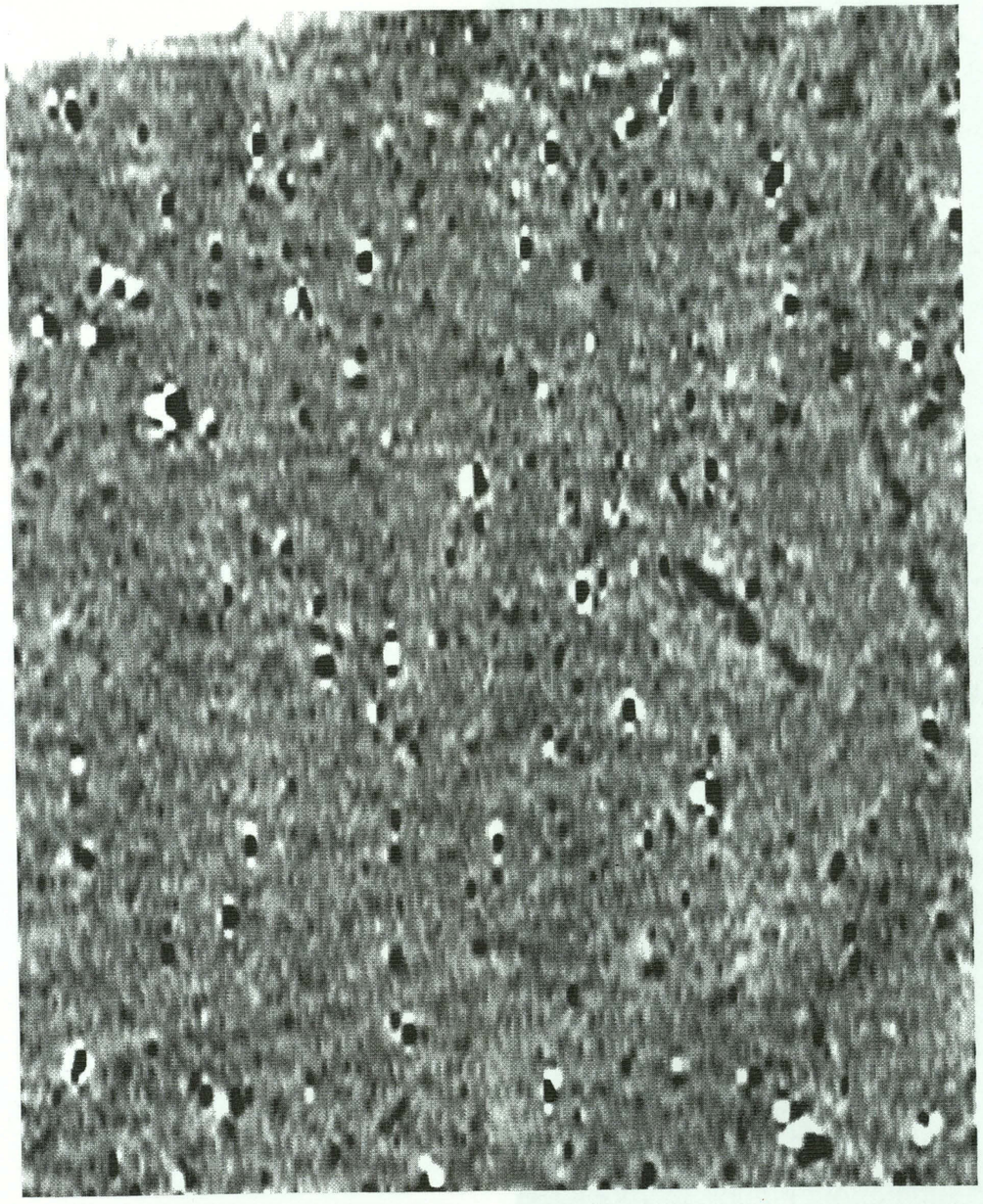
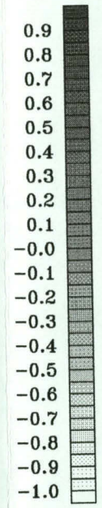
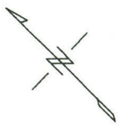


Figure 17

Burton Waters Marina







5 0 5 10 15
(metres)

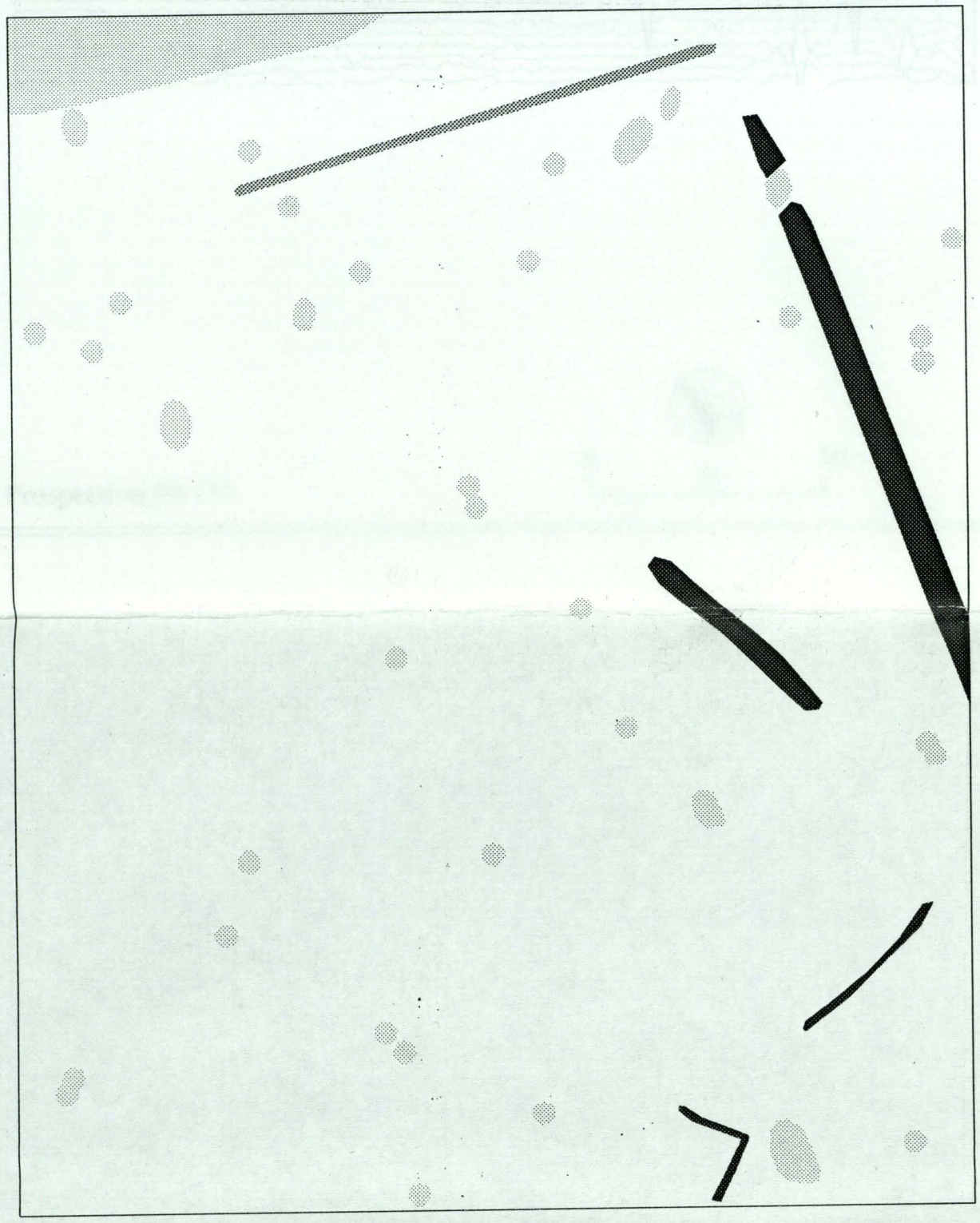
Gradiometer Data

Area 5

GSB Prospection 98/137

Figure 18

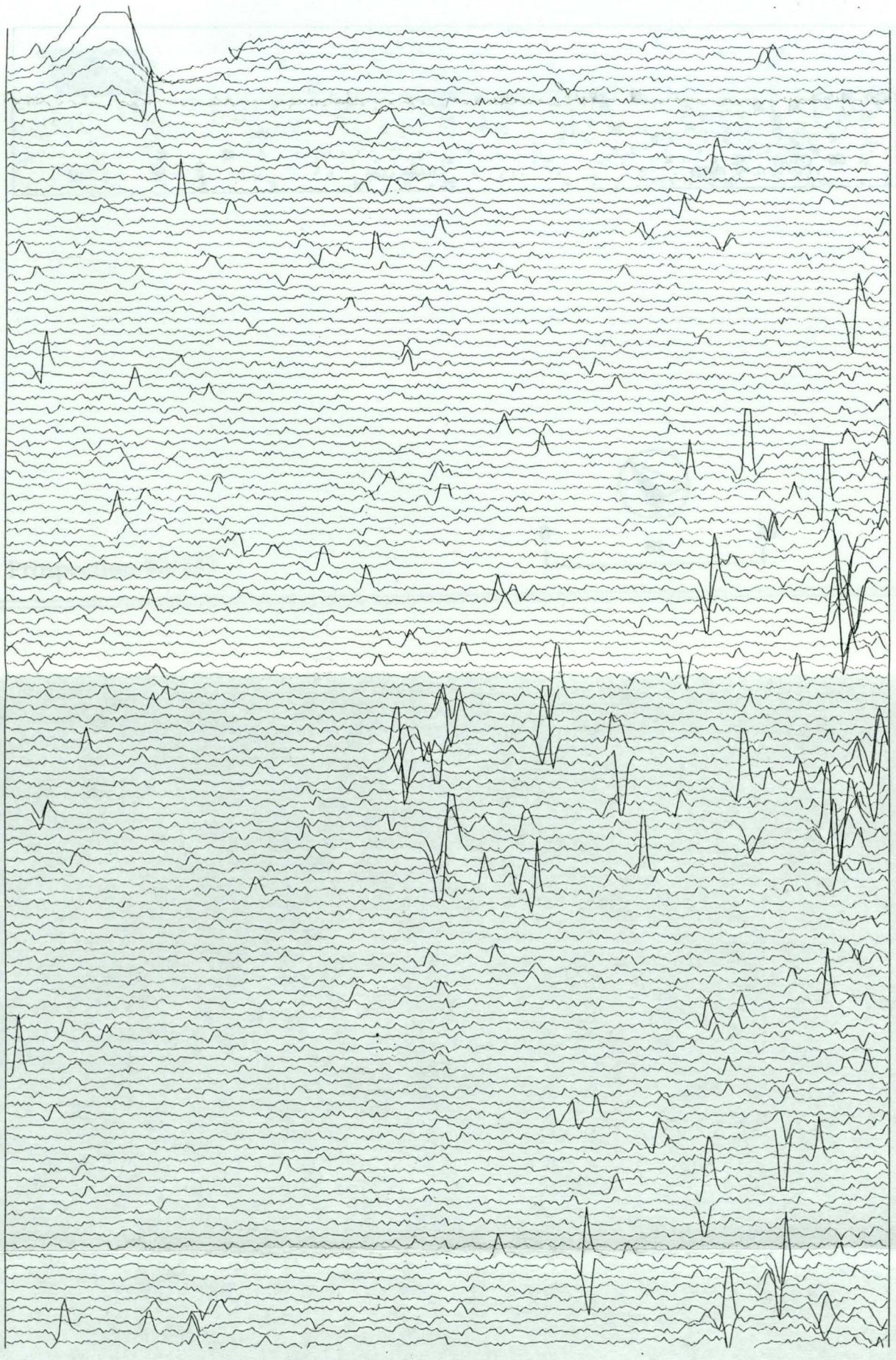
BURTON WATERS MARINA
Area 5



GSB Prospection 98/137

Figure 19

BURTON WATERS MARINA
Area 6



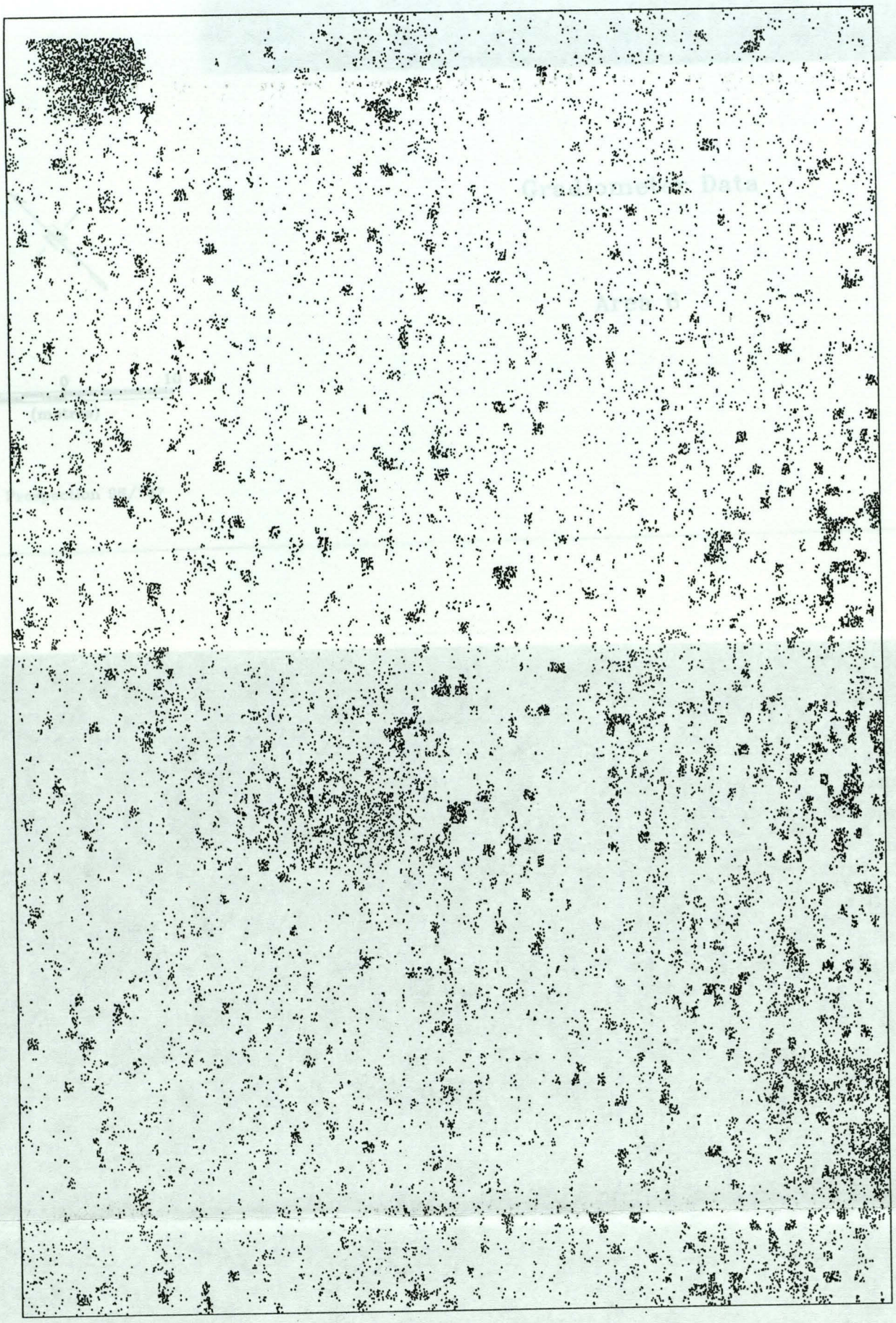
15 nT

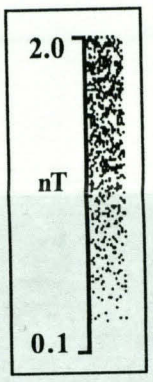
0 m 20

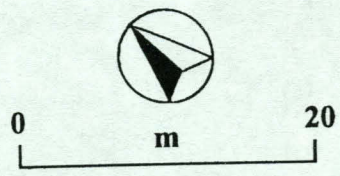
GSB Prospection 98/137

Figure 20

BURTON WATERS MARINA
Area 6



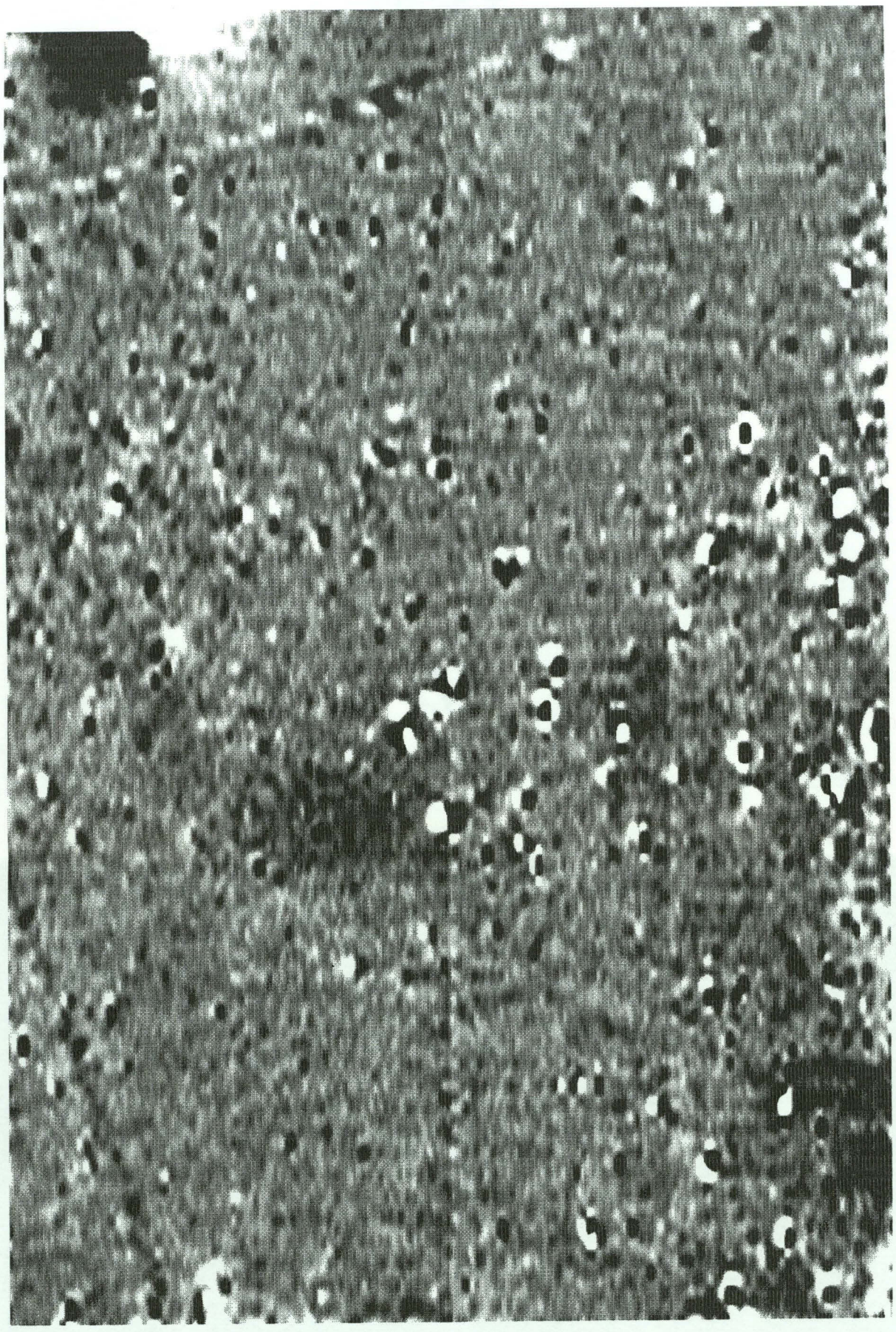




GSB Prospection 98/137

Figure 21

Burton Waters Marina



0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
−0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.7
−0.8
−0.9
−1.0

nT

Gradiometer Data

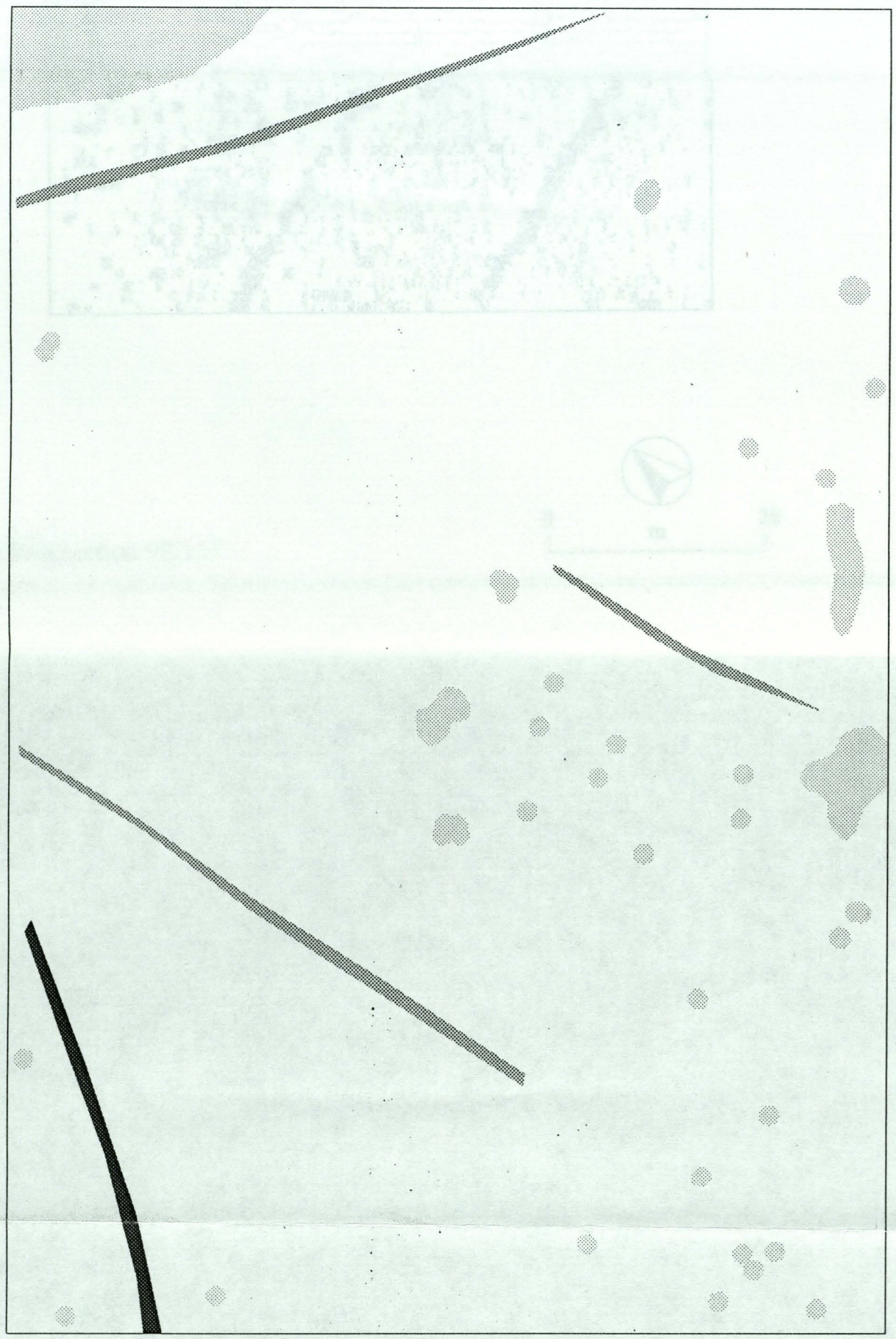
Area 6

10 0 10
(metres)

GSB Prospection 98/137

Figure 22

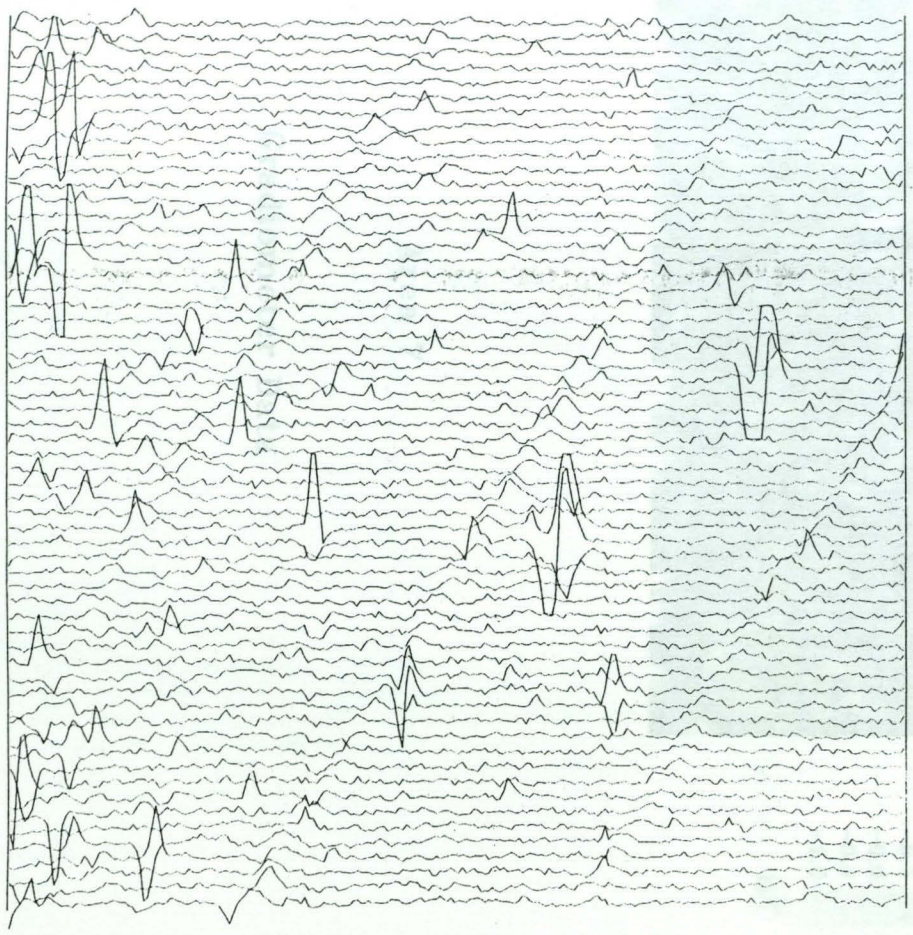
BURTON WATERS MARINA
Area 6



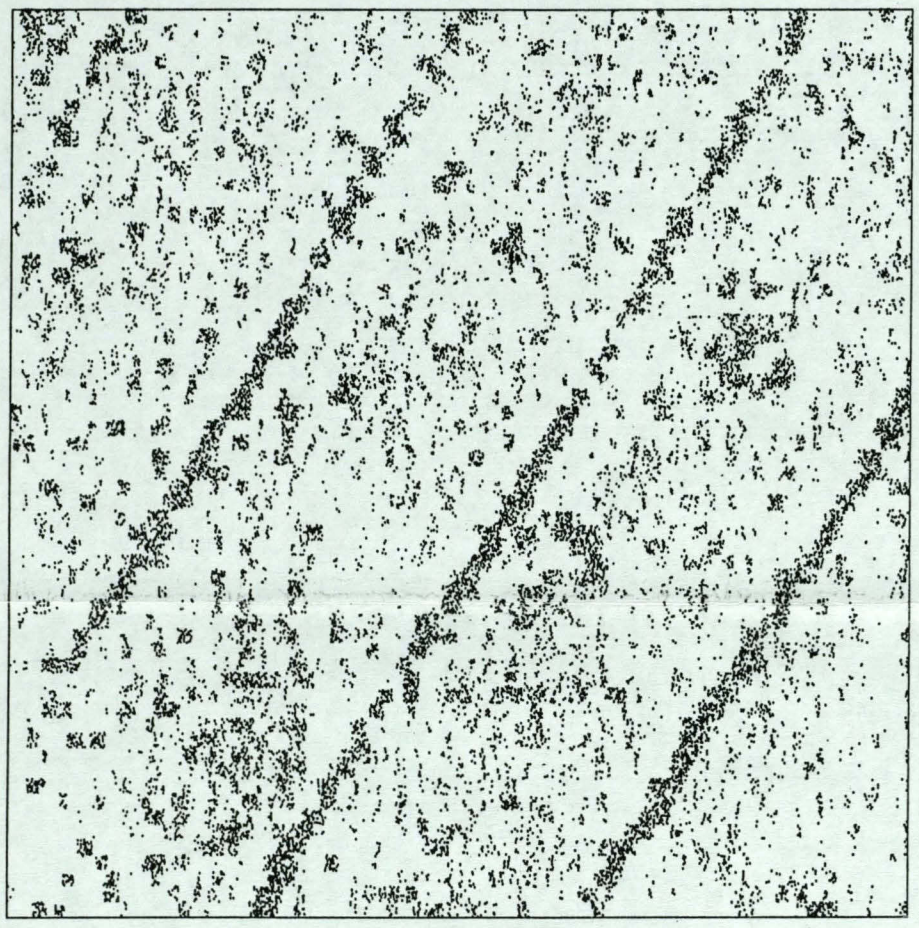
GSB Prospection 98/137

Figure 23

BURTON WATERS MARINA
Area 7



15 nT



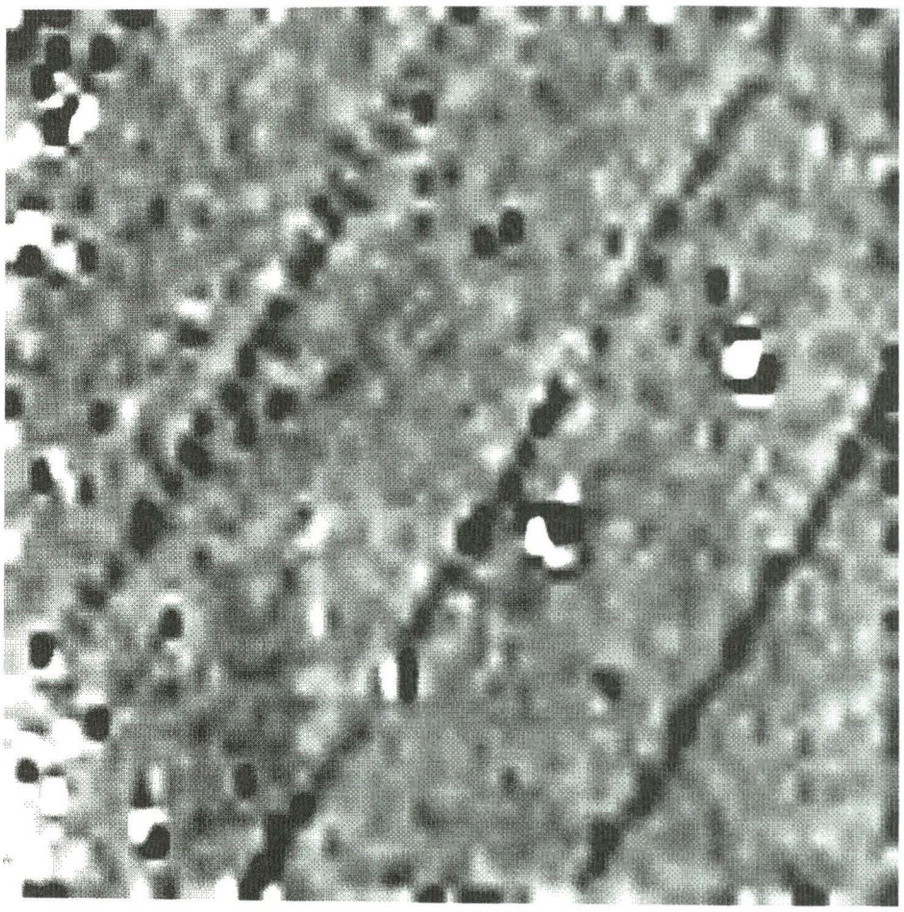
1.0
nT
0.1

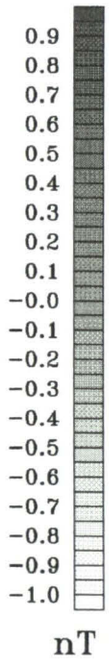
0 m 20

GSB Prospection 98/137

Figure 24

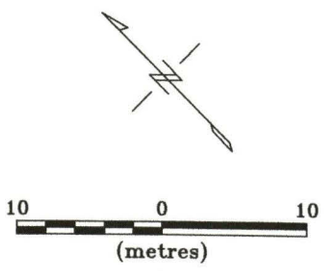
Burton Waters Marina





Area 7

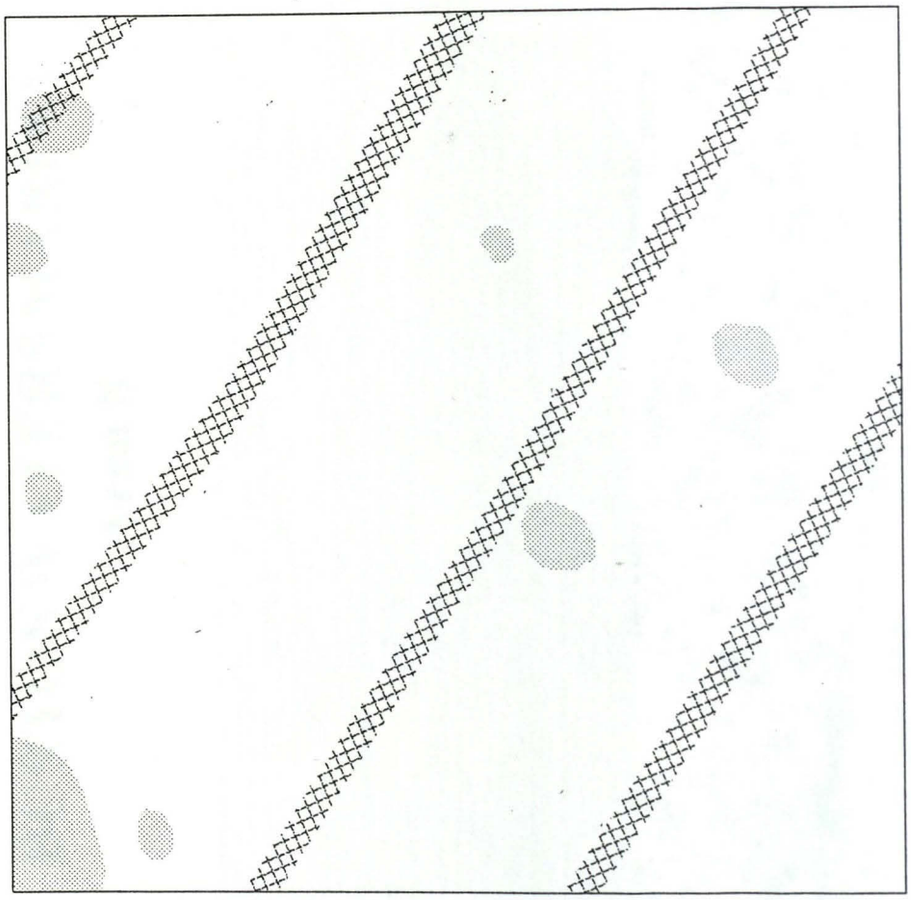
Gradiometer Data



GSB Prospection 98/137

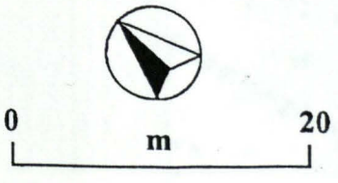
Figure 25

BURTON WATERS MARINA
Area 7



Drains

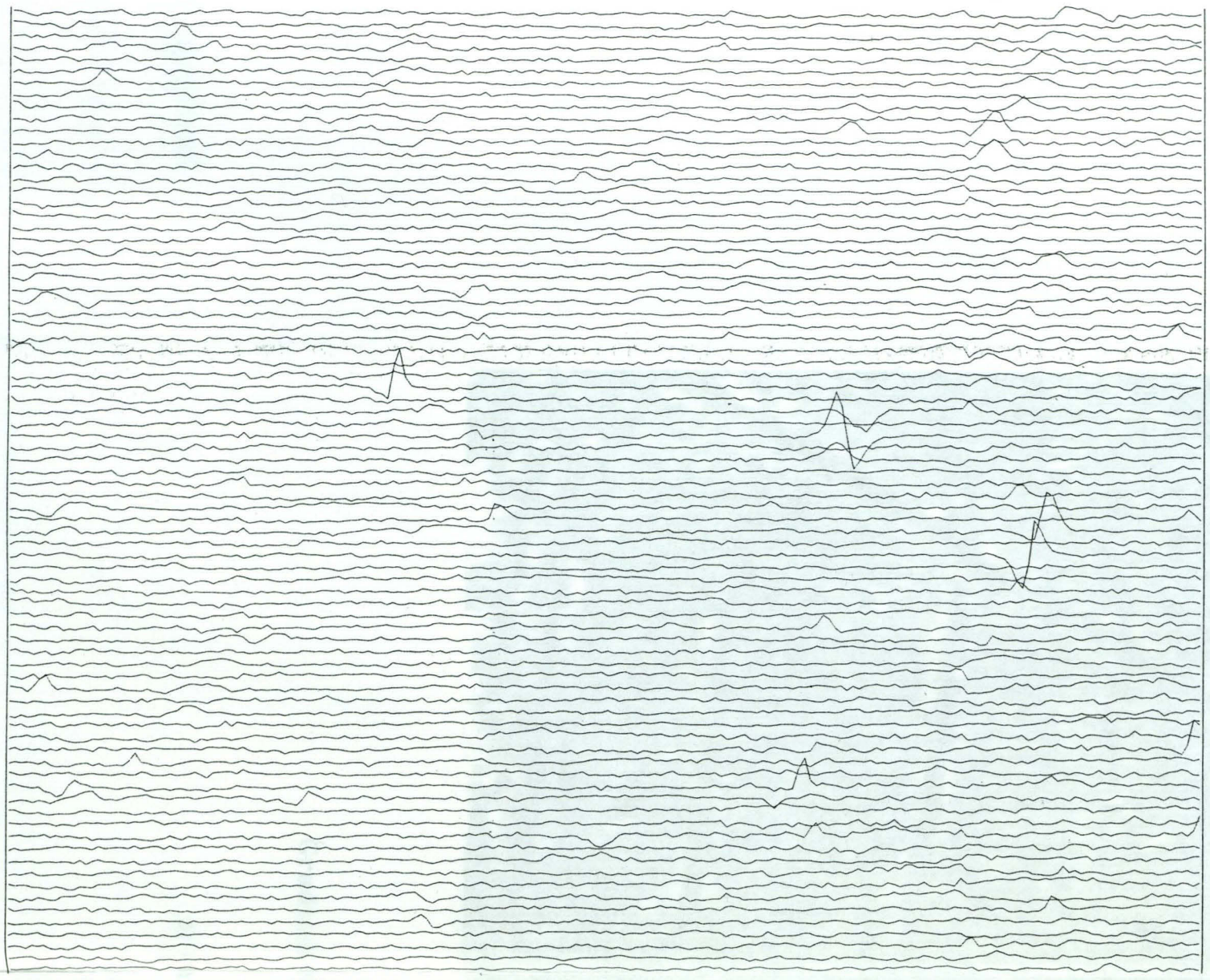
Ferrous



GSB Prospection 98/137

Figure 26

BURTON WATERS MARINA
Area 8



15 nT

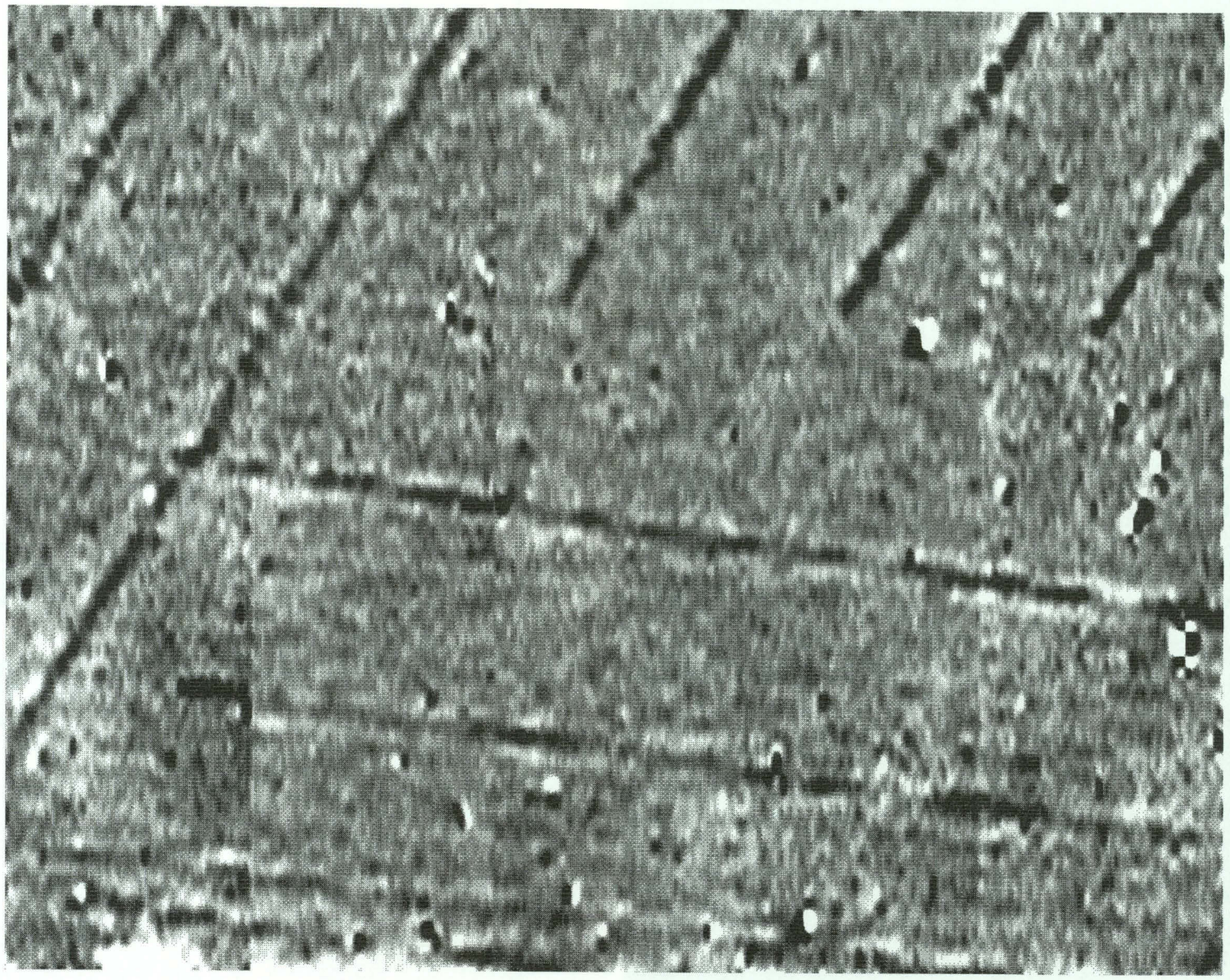
1.0
nT
0.1

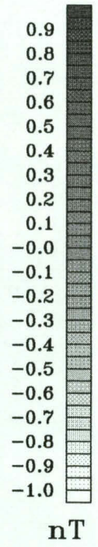
0 m 20

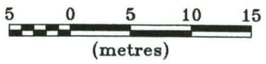
GSB Prospection 98/137

Figure 27

Burton Waters Marina







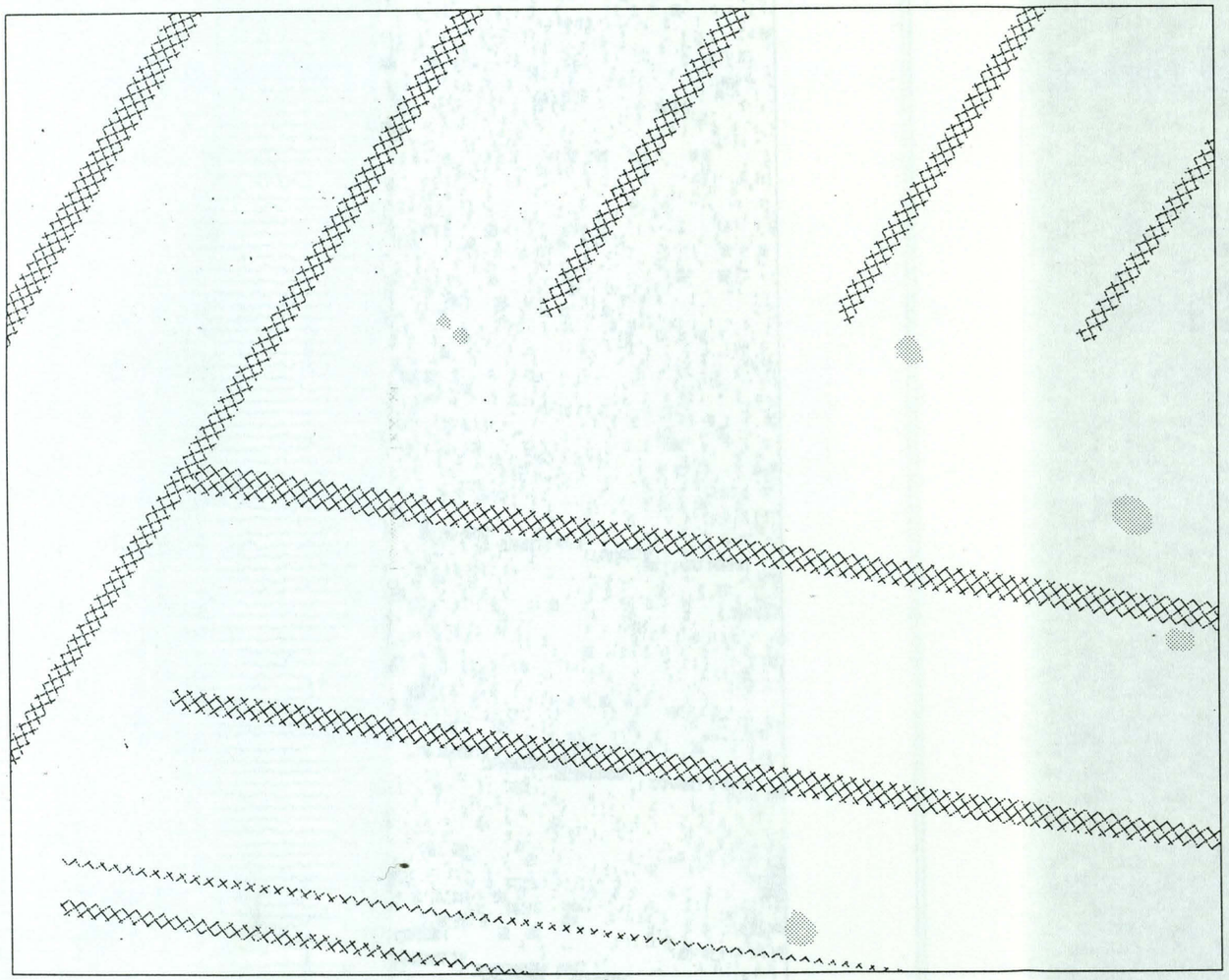
GSB Prospection 98/137

Gradiometer Data

Area 8

Figure 28

BURTON WATERS MARINA
Area 8



Drains

Ferrous

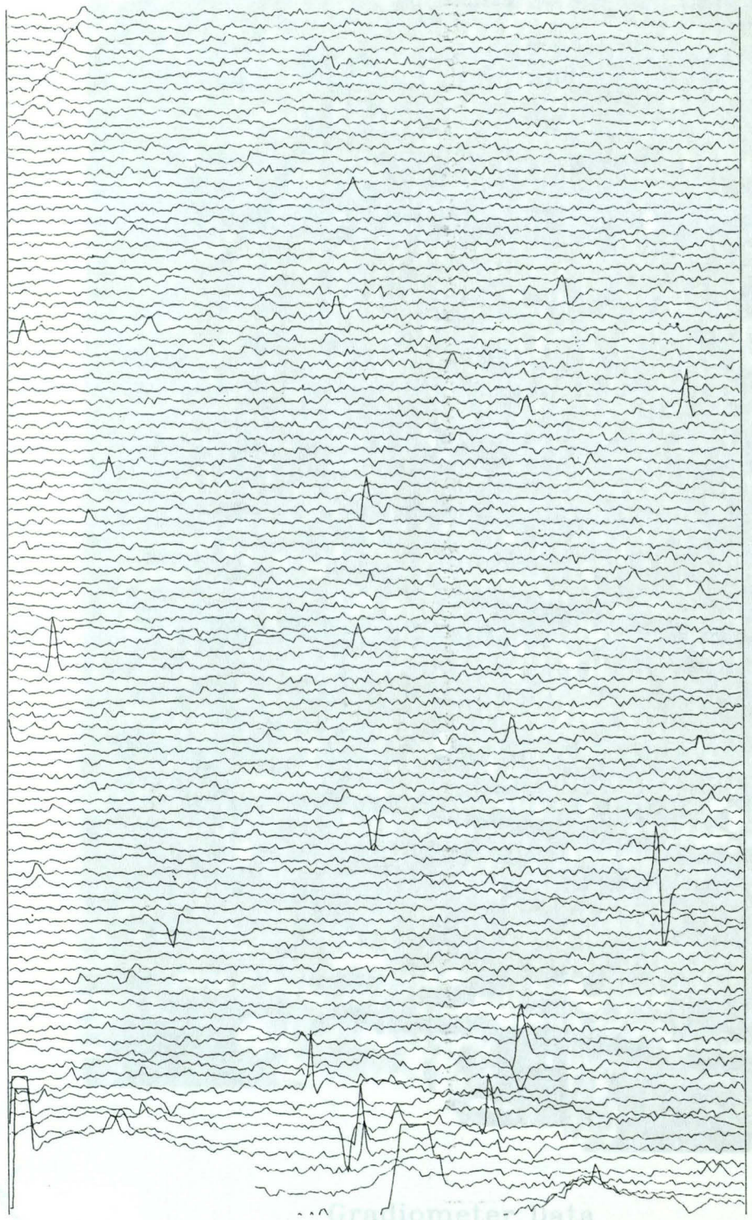
0 m 20

GSB Prospection 98/137

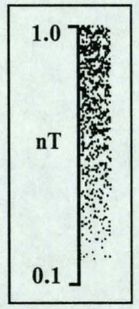
Figure 29

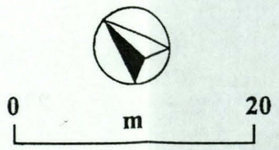
BURTON WATERS MARINA

Area 9



15 nT

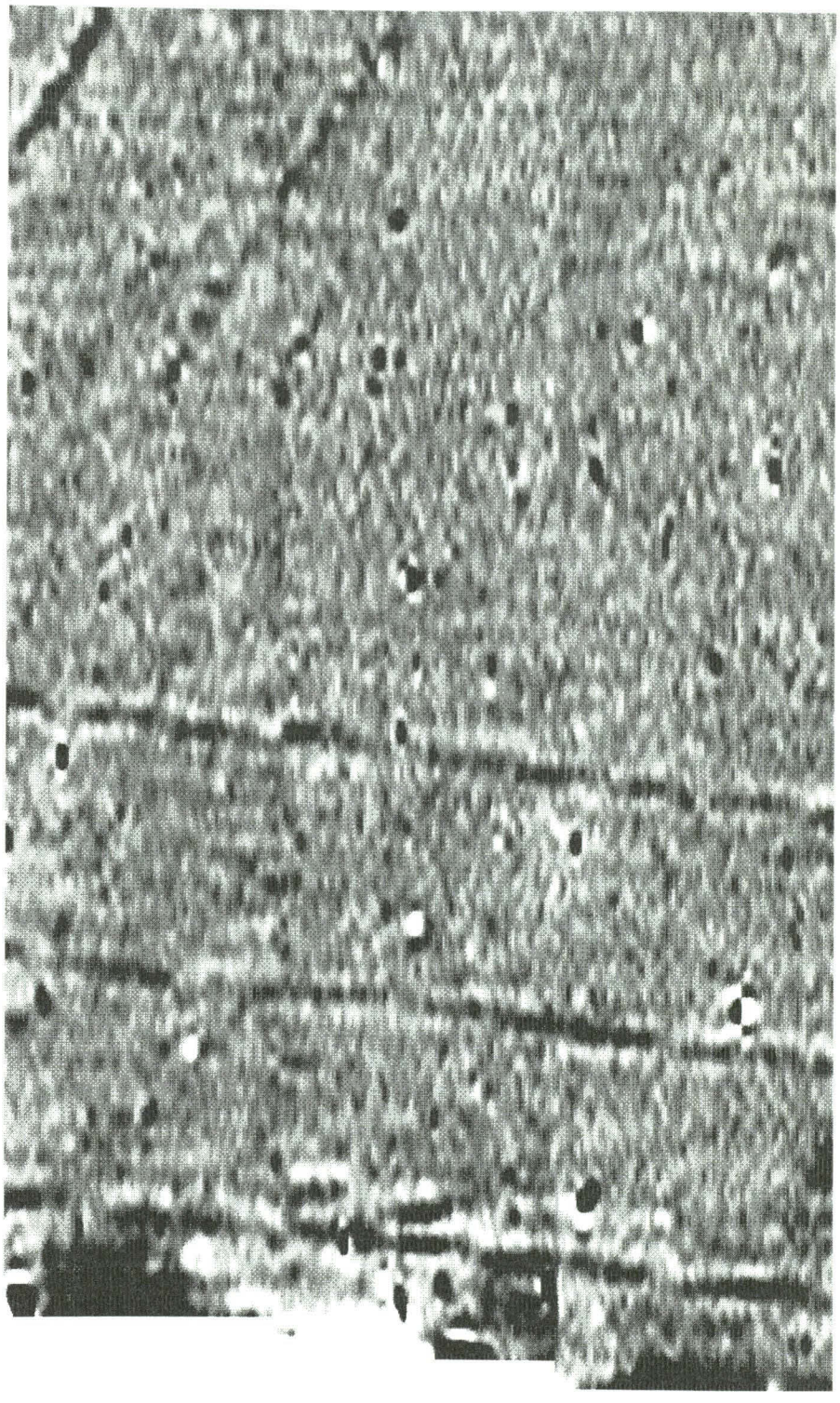


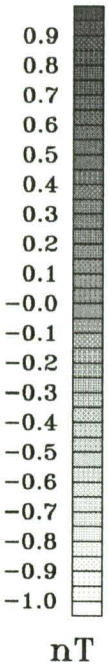


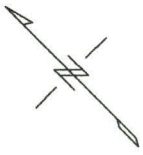
GSB Prospection 98/137

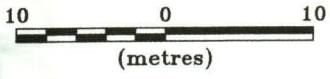
Figure 30

Burton Waters Marina









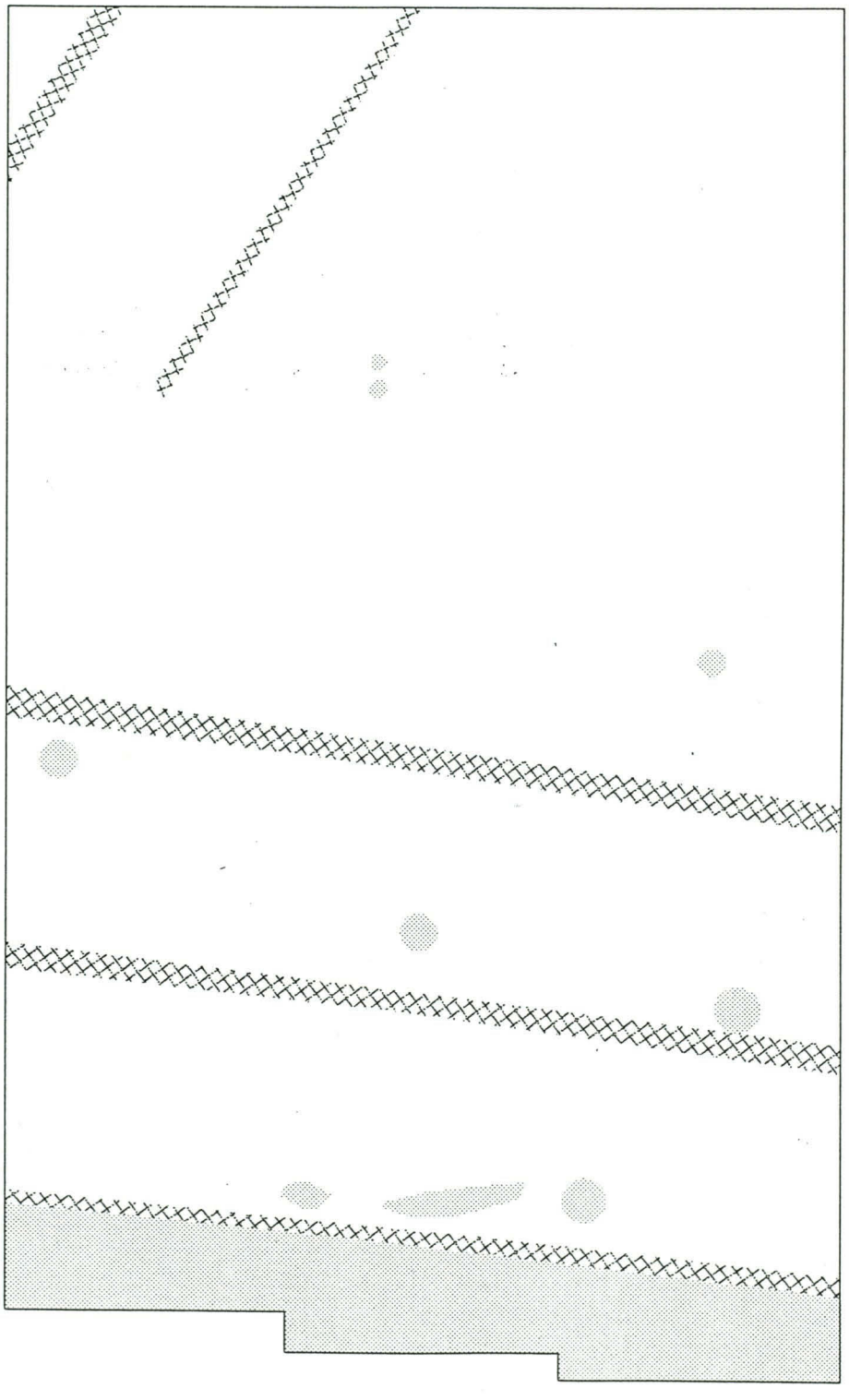
Gradiometer Data

Area 9

GSB Prospection 98/137

Figure 31

BURTON WATERS MARINA
Area 9



Drains

Ferrous

0 m 20

GSB Prospection 98/137

Figure 32