APPENDIX13.2.1
Side Scan & Magnetometer Report

1.0 Background

Galway Harbour Company is proposing to relocate the existing commercial working harbour to a new modern deep-water facility about 1 km from the existing harbour. A representation of the proposed development is shown in Fig 1.1. A combined magnetometer and sidescan sonar survey was carried out to inform the archaeological assessment of the development area. Water depths associated with the footprint of the development vary from 0.5m near shore to over 10m offshore.

Figure 1.1: Representation of the proposed development of Galway Harbour with Mutton and Hare Islands lying to the west and east respectively

1.1 Site Location

The development lies to the south of the present harbour and terminates between Mutton and Hare islands, which lie to the west and east respectively (Figure 1.2).

Figure 1.2: ING location map of the area of the proposed development

The outer footprint of the proposed development lies within ING co-ordinates 130300E to 131200E and 222800N to 224400N.

1.2 Previous archaeological assessment

An underwater archaeological impact assessment was carried out by Eachtra Archaeological Projects in 2004. This involved a desk study of cartographic sources, review of the DoEHLG Shipwreck Inventory and documentary research. A geophysical survey, by a sub-contractor, using sidescan sonar and magnetometry was carried out which was used to inform a subsequent dive survey. The geophysical survey, as far as can be determined, consisted of analogue paper records of single sidescan sonar and magnetometer transects. The overall report on this work by Eachtra was submitted to DoEHLG.

1.3 Previous geophysical surveys

In addition to the surveys carried out in 2004, other geophysical work has been carried out as part of the geotechnical assessment of the proposed development and as part of the INFOMAR project carried out by the Geological Survey of Ireland and the Marine Institute.

The geotechnical assessment used a sub-bottom profiler survey to assess sediment thickness or depth to bedrock under the footprint of the development. The survey used boomer equipment along transects initially 20m apart and subsequently, due to bad weather, 40m apart. An isopach map showing depth to bedrock in metres below the seabed has been produced. The depth varies from 0 to over 10m, which implies that some parts of the footprint have the capacity to support and/or contain buried archaeology.

The INFOMAR project has carried out a number of surveys the most archaeologically relevant being an airborne LiDAR survey that covered the near-shore shallower areas of the Bay where shipborne geophysical surveys cannot be carried out. The output of the LiDAR survey is in the form of very high-resolution bathymetry.

1.4 Archaeological potential

The archaeological potential of the development area is discussed in the report by Eachtra in 2004. The report stated that there would be no direct negative impact on the site. In referring to the geophysical survey, the report stated that the interpreted geophysics was regarded as archaeologically negative. However, considering the intensity of marine activity in the harbour area throughout the centuries, there is a strong potential for archaeological material to remain buried.

1.5 Geology

The generalised onshore geology of Galway Harbour area is given in Figure 1.3.

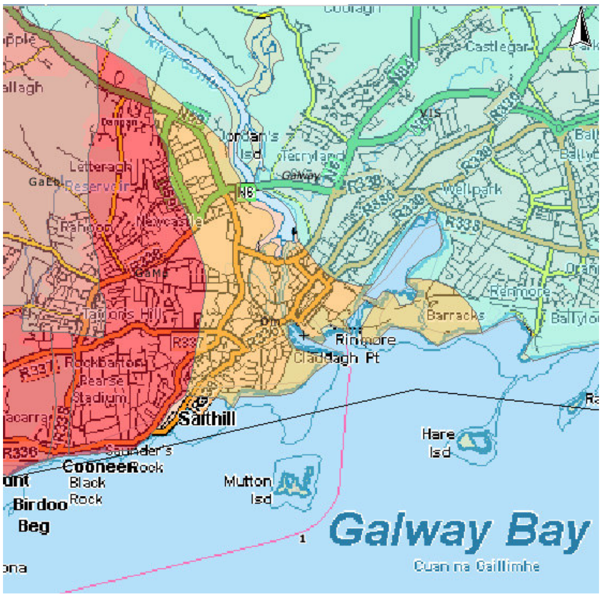


Figure 1.3: Geology map of Galway Harbour area (from GSI online bedrock map of Ireland).

The regional Geological Survey of Ireland mapping indicates the bedrock in the development area to be made up of a metamorphic assemblage of meta-gabbros, gneissic granite (known as the Galway granite) and also Carboniferous limestone. The onshore outcrop of the assemblage lies to the northwest of the area whilst the Carboniferous lies to the east and south. The onshore contact between the rock types is largely defined by the River Corrib, which flows through Galway City into Galway Bay. The Galway granite is composed of a number of granite types, some of which are known to be magnetic. In the southern part of Galway Bay Carboniferous rocks lie on top of the granite, which, from geophysical evidence, dips, under the Bay and the landward mass to the south. The sediments in the inner bay are likely to be derived from erosion of nearby bedrock lithologies and the result of glacial activity, which could transport exotic sediments, rocks and boulders from some distance.

1.6 Geophysical prospectivity

The area was difficult to survey given the water depth, sometimes rocky nature of the shoreline and many intact and severed moorings. In order to maximise coverage, areas containing obstructions were surveyed at high water with some transects parallel/sub-parallel to the shoreline.

The magnetometer survey was difficult to carry out in the shallowest water and in the vicinity of moorings given the layback or lag of the towfish behind the survey vessel. Whilst the outcrop and sub-crop of possibly magnetic granitic rocks and sediments did not reduce the effectiveness of the sidescan sonar survey, there was some interference on transects that had to avoid moorings.

2.0 Geophysical Survey

2.1 Survey strategy

The ultimate aim of the survey was to record digital magnetometer and sidescan sonar data that could be used to produce interpreted maps and profiles. The magnetometer data is presented in a combination of contour maps and profile data. The sidescan sonar survey data was mossaiced to provide 100% coverage of the seabed and these maps and profiles integrated with the magnetic survey data to produce possible archaeological targets for a dive survey

The survey was carried out either side and during periods of high water in order to maximise survey coverage in shallow water areas and areas with intact or severed moorings. The survey area enclosed both the limits of the 2004 surveys and the current footprint of the development. The ING co-ordinates of the survey area are 130300E to 131200E and 222800N to 224400N.

The instruments used were swept frequency sidescan sonar (Starfish 450F) and a caesium vapour marine magnetometer (Geometrics G881). The magnetometer data was corrected for diurnal variation using a fixed landward base station with synchronised clock. The output of both mobile survey instruments was displayed underway on a VDU for survey and quality control purposes.

2.2 Navigation and transect spacing

A global positioning system (Trimble ag132) operating in differential mode (DGPS) was used to record the vessel tracks and provide input both to a helmsman's display (Hypack) and the dataloggers associated with the magnetometer and sidescan sonar. The differential correction was obtained from the Irish Marine Radiobeacon Network. The survey was carried out along transects typically 20m apart to ensure over 100% overlap of the sidescan sonar data. The majority of transects were run in a north – south orientation, tidal and weather condition and moorings caused variation to this orientation. The 20m transect spacing compensated for small changes in line spacing and therefore sidescan seabed coverage is very close to 100%.

2.3 Guidelines

The survey followed Department of Environment, Heritage and Local Government (DoEHLG) guidelines as provided by the DoEHLG Underwater Archaeology Unit (Appendix 1)

3.0 Magnetic Survey

3.1 Data processing and presentation

The magnetic data was acquired in MagLog, the acquisition software provided by Geomatrix. Geomatrix also supplied two other software packages, MagMap and Geosoft for processing and analysis of the data. MagMap was used to convert the binary survey files acquired by Maglog into ASCII data. The following streams of information were extracted from the survey files;

- Latitude
- Longitude
- Total Field
- Signal Strength
- Line Number
- Time
- Date

The following processing steps were applied before analysis of the data could be performed for archaeological assessment;

1. Convert WGS84 Latitude and Longitude into TM75 Irish National Grid coordinates.
2. Apply base station correction to remove diurnal variations from data.
3. Apply positional lag correction to account for distance between magnetometer and GPS antenna.
4. Produce maps and profiles with appropriate scales for archaeological assessment.

All these stages were applied in Geosofts Oasis Montaj software.

3.1.1 Base station correction

A magnetic base station is a magnetometer located at a fixed position which acquires magnetic readings at regular intervals (normally between 1 second and 2 minutes). A graph of typical readings for one day (June 2nd 2010) during the survey is shown below in Figure 3.1.

For this survey magnetic base station data was acquired from the Valentia Met Station. They record a magnetic reading every 60 seconds. A base value of 48650nT was subtracted from the total field measurements for each day. The remaining figure, generally between 1 and 70nT was subtracted from the total field measurements on the survey vessel. The survey magnetometer was acquiring 10 readings per second; therefore the diurnal correction was interpolated between each base station reading at the corresponding time stamp every minute. Figure 3.2 shows the combined base station and lag correction on a short section of survey line 26, which appears like a simple dc shift due to the short time interval.

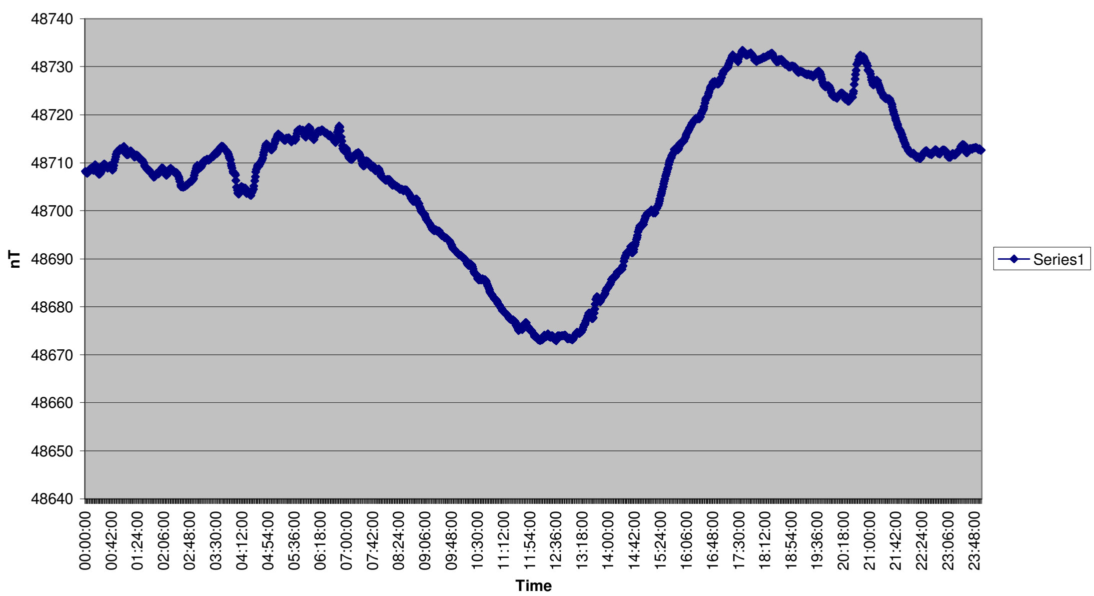


Figure 3.1: Total field diurnal variation measured at Valentia Met station on June 2nd 2010

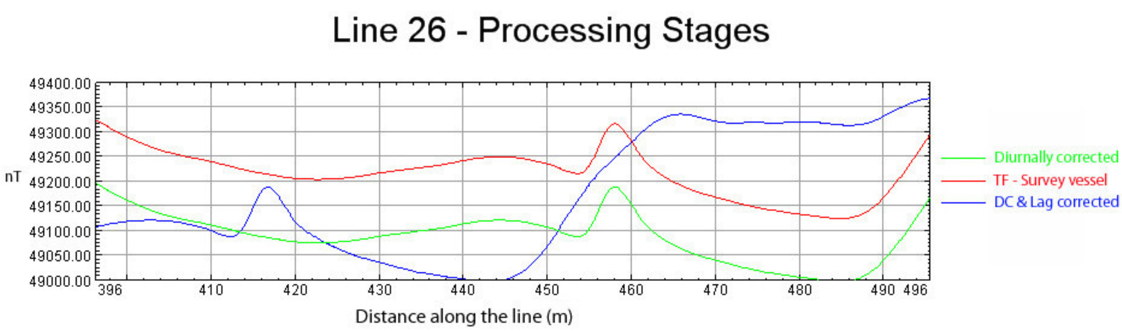


Figure 3.2: Graph showing the two corrections applied to the survey magnetic data – diurnal and lag, for a 100m section along line 26.

3.1.2 Lag correction

The lag correction accounts for the difference between the position of the GPS receiver and that of the magnetometer. The magnetometer was towed by approximately 40m of magnetometer cable which transmitted the magnetic readings back to a laptop on board. This cable was supported by a rope to take the pull from the boat and by buoys to keep the cable and magnetometer from hitting the seafloor during tight turns in the shallow water and avoidance of moorings (Figure 3.3). It should be noted that even after the lag correction has been applied, the positional accuracy of the magnetic data is accurate only to within +/- 5m. This is due to the fact that the magnetometer was rarely in a straight line directly behind the boat due to wavy nature of the survey path as the pilot navigated across currents, wind and moorings. Subtle changes in boat speed between 2 and 4 knots also changed the tautness of the magnetometer cable which could lead to variations of several metres in the straight line length of the cable being towed between the boat and the magnetometer.

Figure 3.3: The magnetometer being towed between moorings during survey.

3.1.3 Data presentation

When the corrections were applied the data was gridded in Oasis Montaj to produce a Total Magnetic Intensity (TMI) map for the area. The gridded data has been presented in two different types of colour presentations, linear and histogram equalisation. The magnetic maps show the variation in the magnetite content in the bedrock for the area. The bedrock is made up of a metamorphic assemblage of meta-gabbros, gneissic granite and carboniferous limestone. The Geological Survey of Ireland bedrock map for the area is shown in Figure 3.6. The meta-gabbros have a higher proportion of the magnetic mineral, magnetite than the granitic sections of the bedrock. The map data can be broadly described as high in the north, low in the centre and high in the south. Geologically this equates to meta-gabbros in the north and south of the survey area with gneissic granites in between.

The linear map shows that the southern high is the most prominent. This is also evident from looking at the 2D profile of line 47 in Figure 3.7. The magnetic variations within the data seen are due to geology. It is not possible to identify magnetic anomalies due to potential archaeology from this map presentation of the data as they are far more subtle than the geologic variations. To do this we must examine the 2D profiles for each line. Figure 3.7 shows the magnetic variation of the bedrock over the 1.4km of survey line. It appears quite variable, however when viewed over a more detailed scale of just 100m the relatively gradual variations of the geologic magnetic response can be seen. (Figure 3.8).

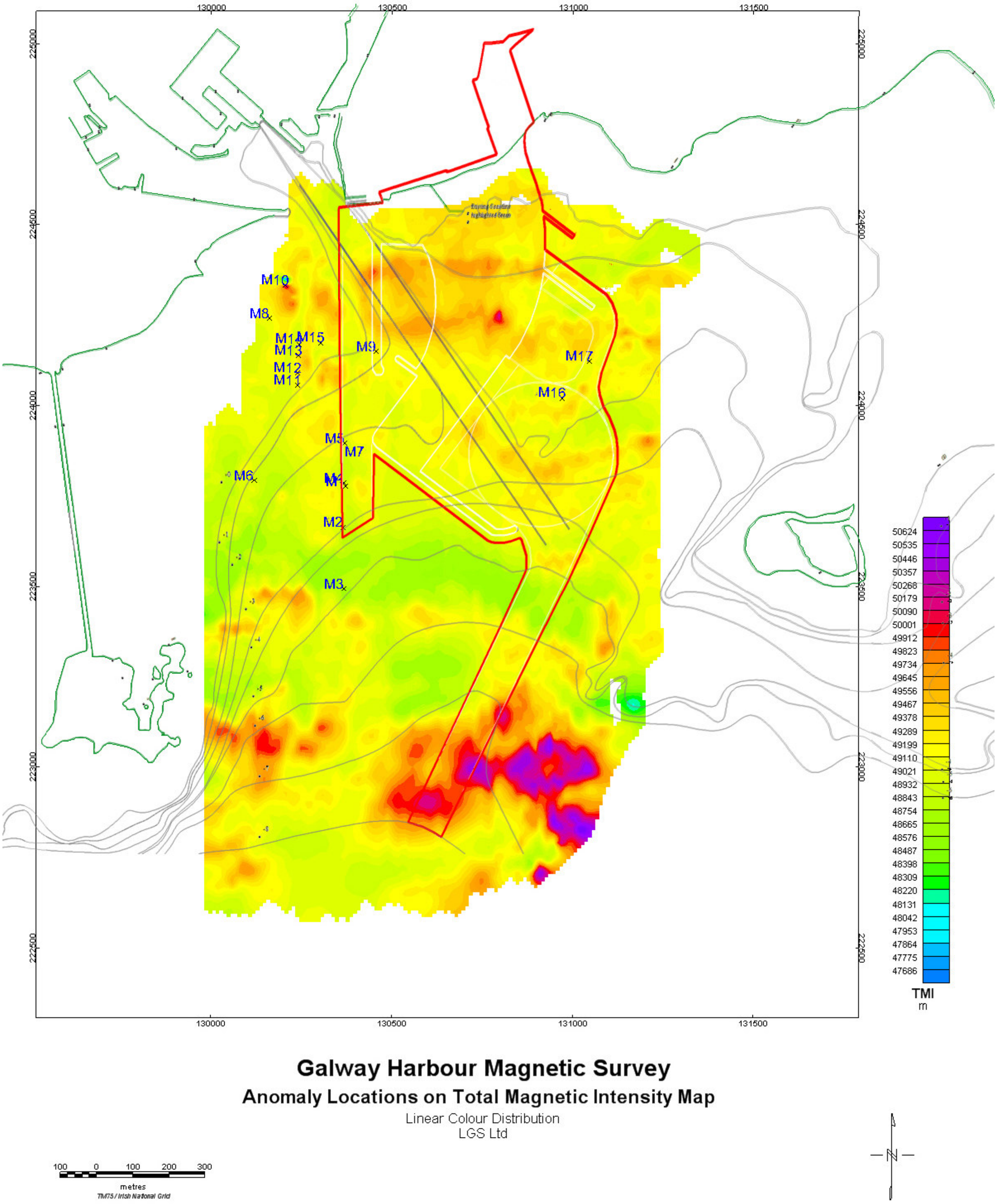


Figure 3.4: Magnetic map for Galway Harbour Survey – Linear Colour Distribution

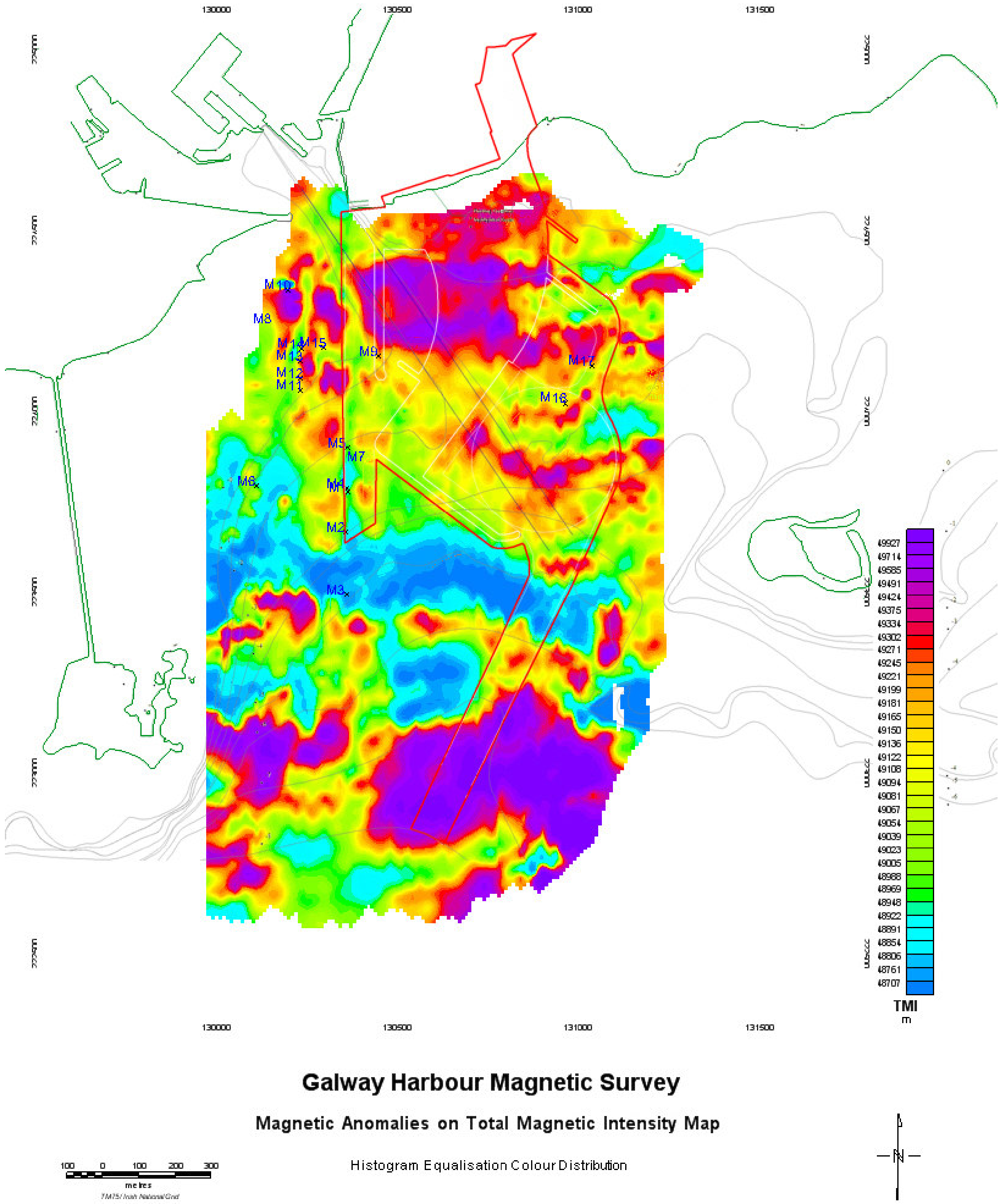


Figure 3.5: Magnetic map for Galway Harbour Survey – Histogram Equalisation Colour Distribution

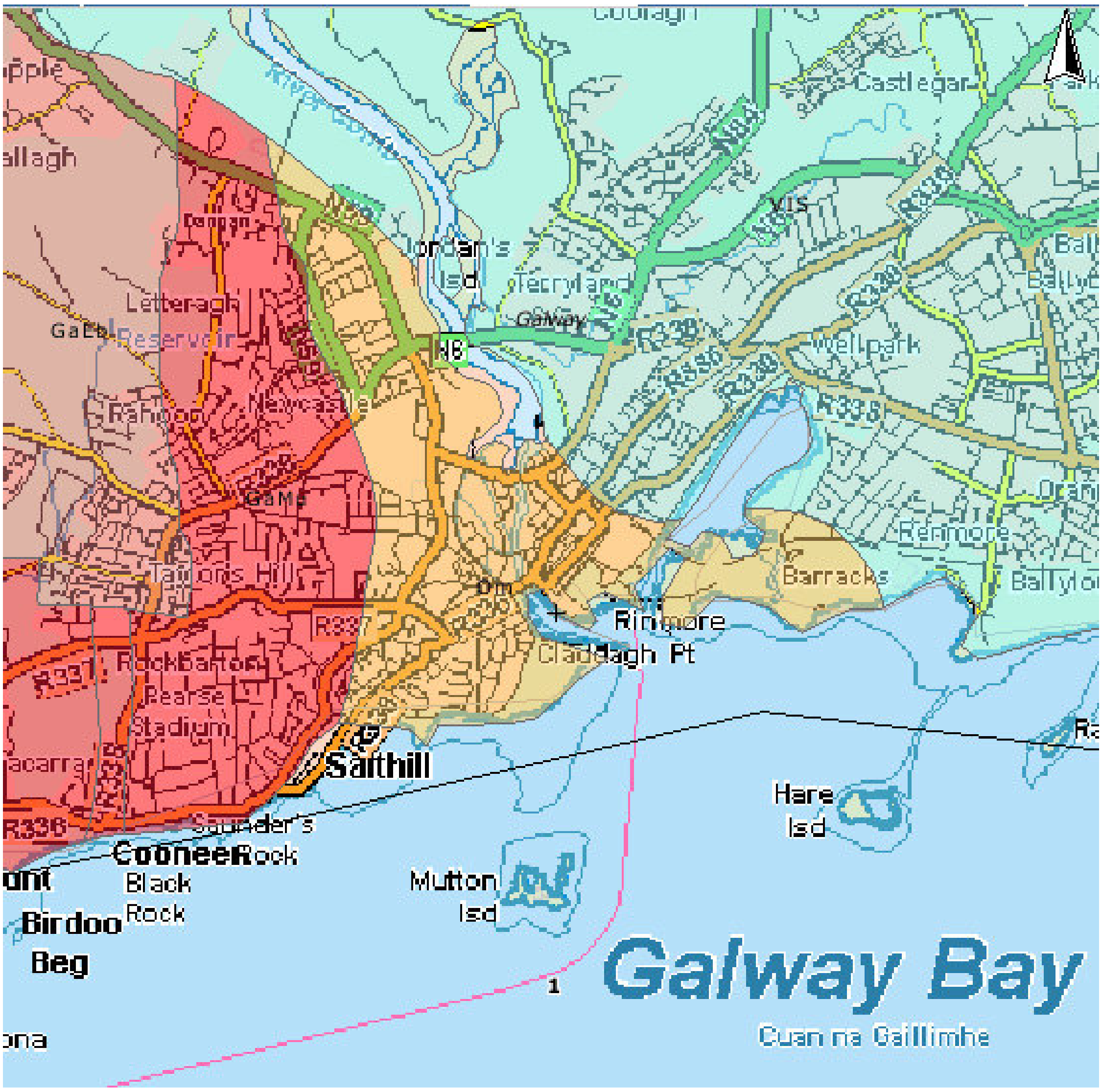


Figure 3.6: Geology map of Galway Harbour (from GSI online bedrock map of Ireland).

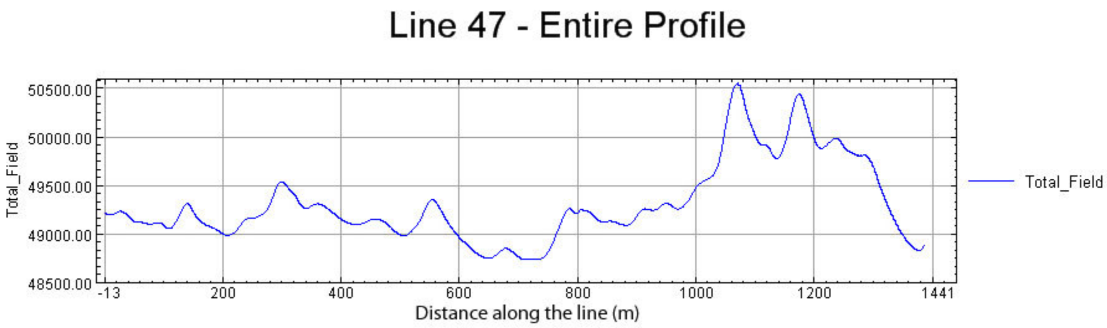


Figure 3.7: Magnetic profile across entire line, 1.4km showing a dynamic range of almost 2000nT.

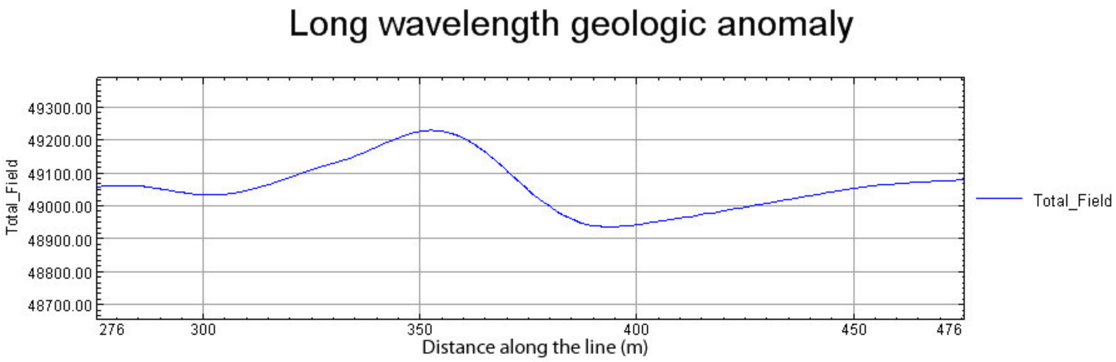


Figure 3.8: Long wavelength variation of magnetic data over 200m.

The magnetic response measured represents the cumulative magnetic response of all magnetic sources beneath the survey vessel from deep to shallow. Changes in the magnetite content in the bedrock from deep sources (100m to several kilometres) are represented by long wavelengths such as the one shown in Figure 3.8 above. This survey was looking for the magnetic response of metallic artefacts on the seabed or buried within the shallow sediments from depths less than 20m. Therefore anomalies that have a wavelength of less than 20m with small to medium peak to trough amplitudes, generally anywhere between 5 and 200nT are being sought.

3.1.4 LiDAR Data

The Marine Institute acquired LiDAR data over Galway Bay coastline in 2008 to map the bathymetry shallow water areas (less than 20m), that are not possible to survey by deeper water survey vessels. This data is now in public domain and has been added in to the analysis.

The data are presented in its processed form as 5 x 5m gridded data. This means that objects on the seafloor less than 5m in dimensions could possibly be missed. It is however a significant advance on existing Admiralty Chart contour data and with well chosen colour and shading techniques of the grid data, subtle changes in seabed topography on the decimetre scale can be identified. Only one of the magnetic anomalies identified could be said to have a possible bathymetric expression. This is detailed in the following results section.

Figure 3.9 on the next page shows the gridded LiDAR data over an extended area beyond the proposed harbour footprint and shows the seamless nature of the data between land and sea.

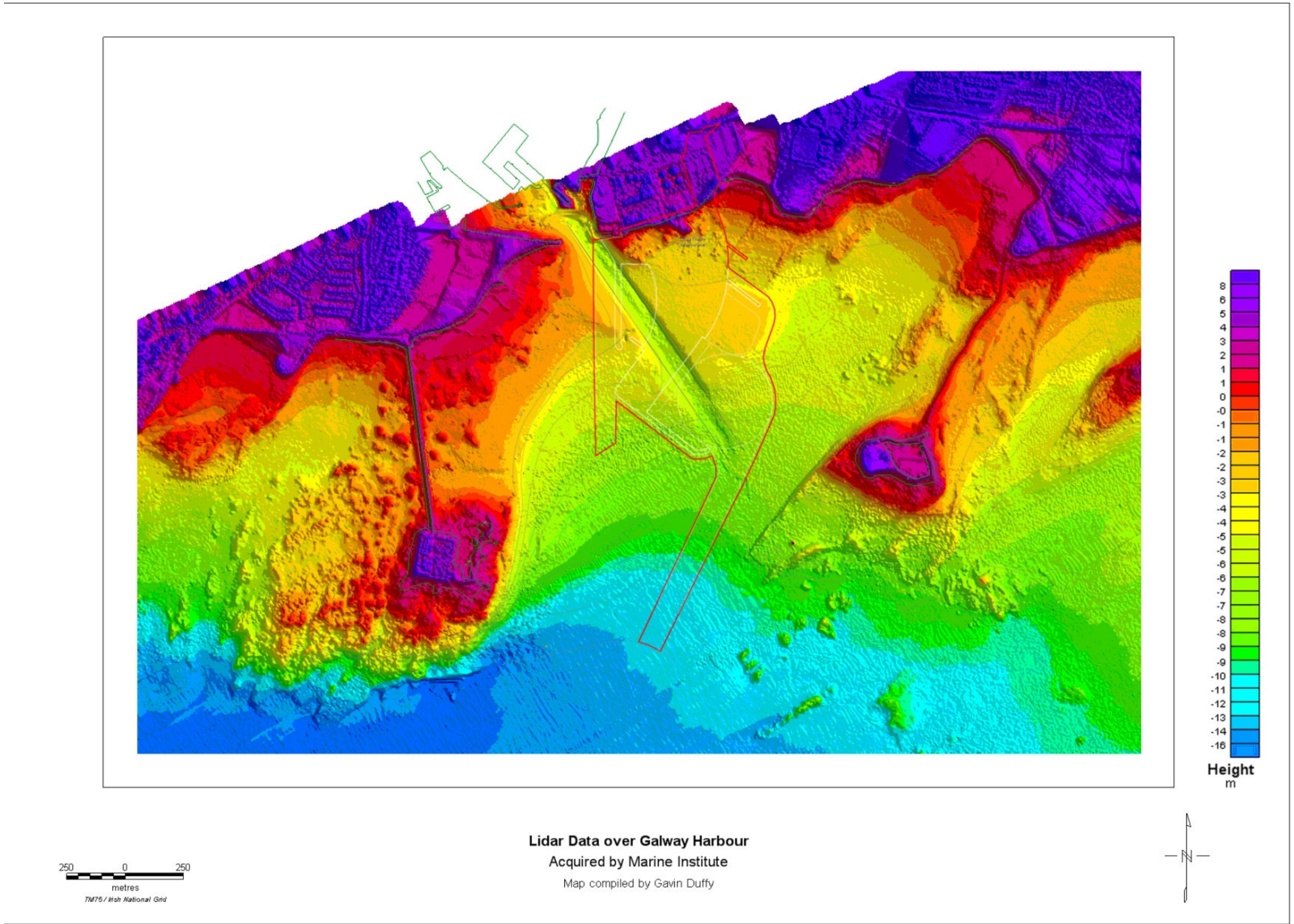


Figure 3.9: Shaded relief bathymetry over Galway Harbour coastline between Salthill and Renmore.

3.2 Results

Although the range and type of response to be expected from a shallow magnetic response, which could potentially be due to a metallic archaeological artefact have been set out, it must be borne in mind that magnetic anomalies are 'non-unique'. This means that there is always more than one possible explanation for the response that is measured. Some of the anomalies presented could be due to localised variations in the bedrock at or near the top of the rock, glacially-derived sediments, or they could simply represent modern metallic waste, such as scrap metal.

The magnetic data was examined line by line along 100m sections and within as small an amplitude range as possible, generally less than 600nT. 17 magnetic anomalies were identified in all and their locations have been plotted in Figures 3.4, 3.5 and 3.10. It is interesting to note that they all occur within the northern half of the survey area, which would be the most prospective area in terms of archaeological potential, being closest to the coast. It is however most prospective for more modern metallic waste also.

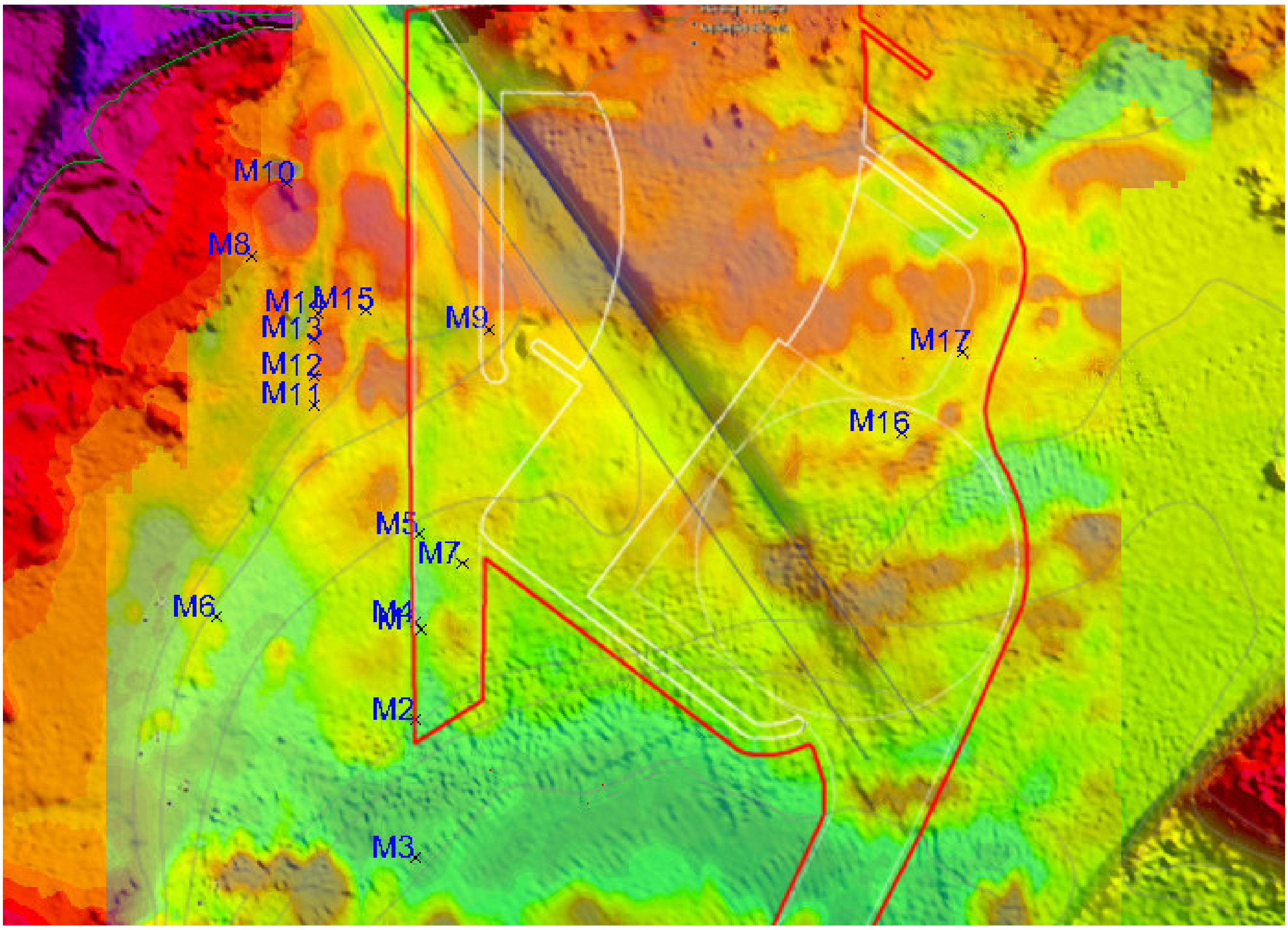


Figure 3.10: A close-up view of the location of the magnetic anomalies identified, plotted on a semi-transparent magnetic map, overlaid on a shaded relief bathymetry surface generated from the Marine Institutes 2008 LiDAR survey.

9 of the anomalies occur within the footprint of the new harbour. The other 8 are outside on the western extent of the harbour footprint. The amplitude of some of the anomalies are so large, that it is highly unlikely they are due to archaeological artefacts, however they are anomalous magnetic responses and therefore have been listed as such. The along line profile of each anomaly is presented in Fig 3.11 with Table 3.1 giving listing details such as location, anomaly size and width. A qualitative assessment of the magnetic source as to how likely the anomalies could be due to an archaeological

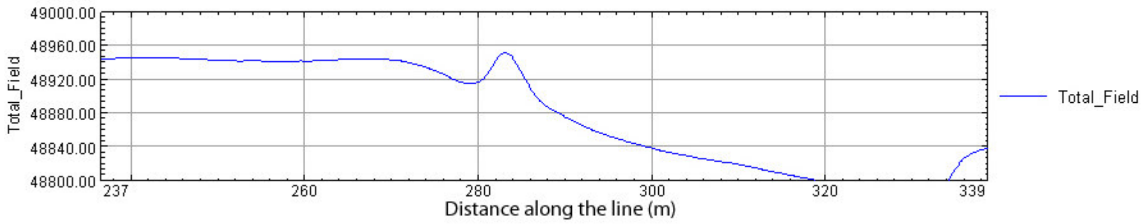
artefact as also been assigned to each anomaly. The anomalies have classified among three broad categories;

P: Possible archaeological source (less than199nT)
U-P: Unlikely but still Possible (200 – 399 nT)
U: Unlikely (greater than 400 nT)
Any anomalies with a wavelength greater than 20m have also been assigned 'Unlikely'.
The two most likely archaeological artefacts to be detected by a magnetic survey are an iron or copper clad boat or an anchor. It is worth noting the magnetic response from artefacts on other archaeological surveys. In 1999 a survey of La Surveillante, a French ship in Bantry Bay, gave a magnetic response of between 60 and 100nT depending on the direction the ship was travelling. The ship was copper clad and had several iron canons on board.

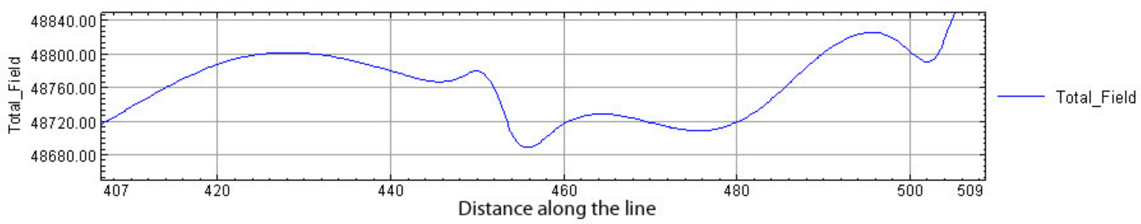
In 2000 a survey on the river Shannon at Clonmacnoise (Duffy et al, in press) got a magnetic response of 60nT from bog iron ore. Forward modelling of a calculated equivalent response showed that this could have been due to a block of iron 2m x 2m x 0.2m in dimension. The magnetic susceptibility of modern processed pure iron was applied to the modelling however; ancient iron smelting methods would produce a less pure and therefore slightly less magnetic iron ore.

Most of the anomalies presented are actually larger than those seen in the two surveys discussed above. It could be said that they are more likely to be due to modern metallic waste sources or shallow geologic variations from what are quite magnetic rocks. However, only a dive survey can possibly confirm this one way or the other.

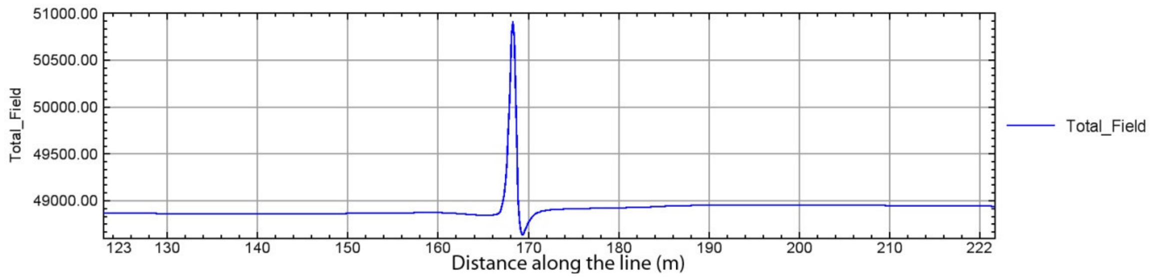
Line 6 - anomaly 1



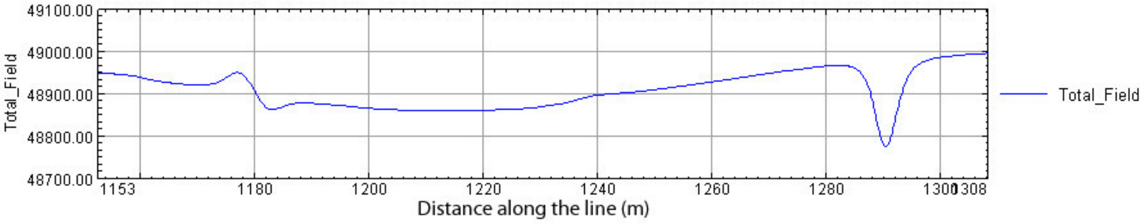
Line 6 - anomaly 2



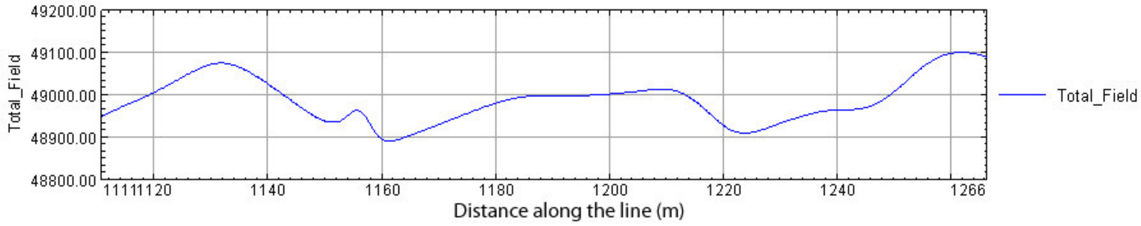
Line 6 - Anomaly 3 - large



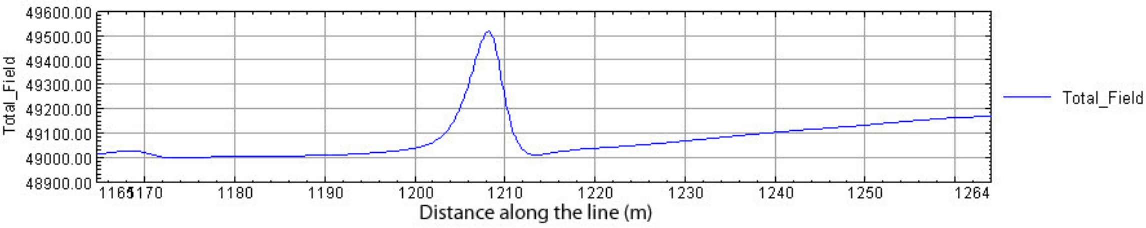
Line 7 - anomalies



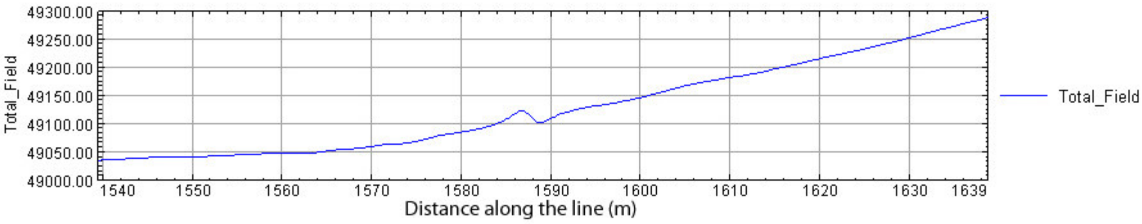
Line 8-1 - anomaly



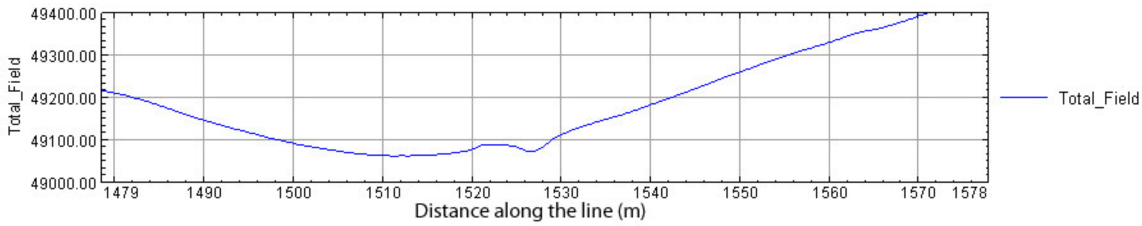
Line 9 - anomaly



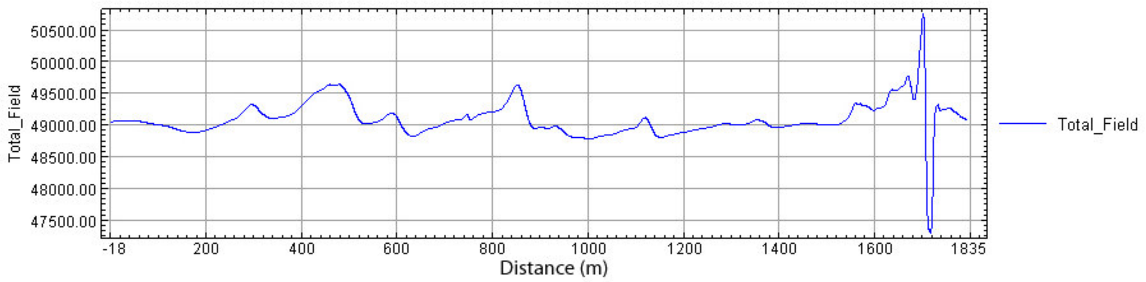
Line 10-1 - anomaly



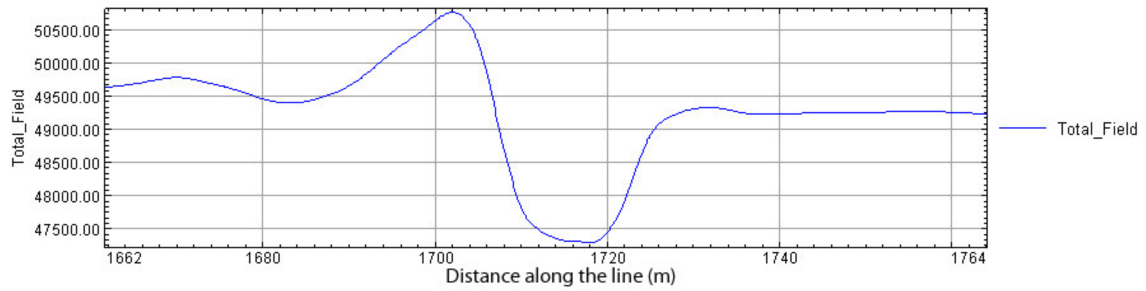
Line 11 - anomaly



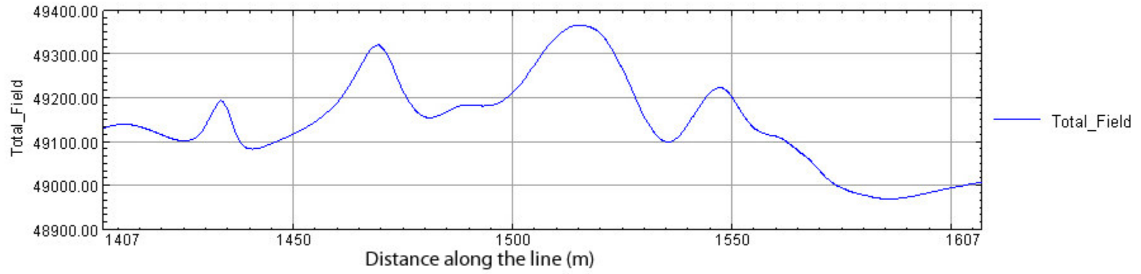
Line 12-1 - Entire profile



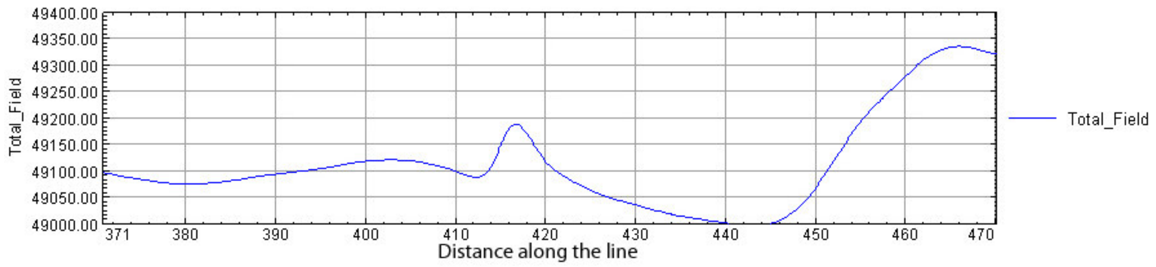
Line 12-1 - Biggest Anomaly



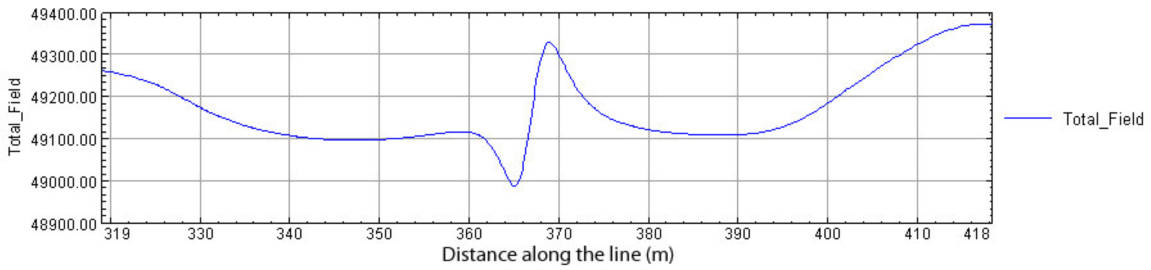
Line 14-1 - anomalies



Line 26 - anomaly



Line 49 - Anomaly



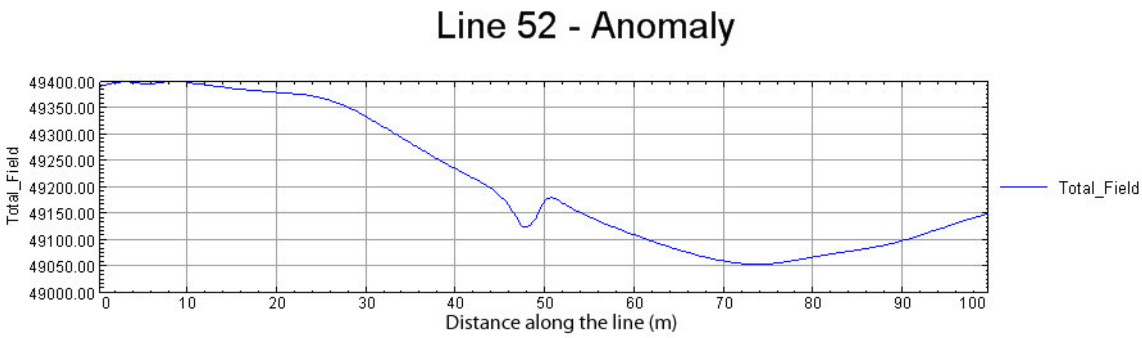


Figure 3.11: Magnetic profiles along survey lines for anomalies listed in Table 3.1

Anomaly	Line	X - Irish National Grid	Y – Irish National Grid	Anomaly Width (m)	Peak to Trough Amplitude (nT)	On Harbour Footprint (Y/N)	Archaeological Potential P / U-P/ U
M1	6	130365.6	223777.7	10	40	Y	P
M2	6	130358.1	223665	15	60	Y	P
M3	6	130359.8	223494.5	6	2400	Y	U
M4	7	130359.8	223787.1	15	80	Y	P
M5	7	130362.6	223897.1	15	200	Y	U-P
M6	8.1	130112.4	223793.4	10	50	N	P
M7	9	130417.2	223860.1	10	600	Y	U
M8	10.1	130155	224242.7	5	40	N	P
M9	11	130450	224151.1	10	15	Y	P
M10	12.1	130198.4	224333.3	20	4000	N	U
M11	14.1	130232.6	224056.7	10	100	N	P
M12	14.1	130232.1	224092.2	20	150	N	P
M13	14.1	130234	224139.3	30	250	N	U
M14	14.1	130237.2	224170.3	15	120	N	P
M15	26	130297.4	224174.9	10	100	N	P
M16	49	130963.7	224021.7	15	320	Y	U-P
M17	52	131038.6	224123.6	10	100	Y	P

Table 3.1 List of magnetic anomalies identified and their attributes

3.3 Discussion

Table 3.1 shows that of the 9 anomalies that fall within the harbour footprint, only 5 are possible archaeological artefacts, being anomalies M1, M2, M4, M9 and M17. M1 and M4 could possibly be due to the same magnetic source as they occur very close to one another on adjacent lines 6 and 7. However if this is the case the magnetic source is closer to point M4 that M1 as its anomaly is almost twice that of M1. Two anomalies within the harbour footprint are deemed possible but unlikely, those being anomalies, M5 and M16. M3 and M7 are deemed unlikely to be the result of archaeological artefacts.

The largest and possibly the most interesting anomaly is M10, approximately 150m due south of the tip of Nimmos Pier in less than 2 metres of water. This anomaly appears on Line 12-1 for which the entire profile plotted to show that this anomaly is bigger than even the most magnetic rocks in the area, at 4000nT. When looked at in detail, one sees that its peak to trough distance is just 20m so it is from a shallow source. A close look at the gridded bathymetry data in this area shows a 30m long north-west south-east linear on the seabed just adjacent to the magnetic anomaly (Figure 3.12). This linear is a ridge just 20cm proud of the seabed. It may be possible to investigate this area at low water tide to identify the nature of the ridge and the possible source of this significant magnetic anomaly. This is outside of the Harbour footprint but is worth investigation nonetheless.

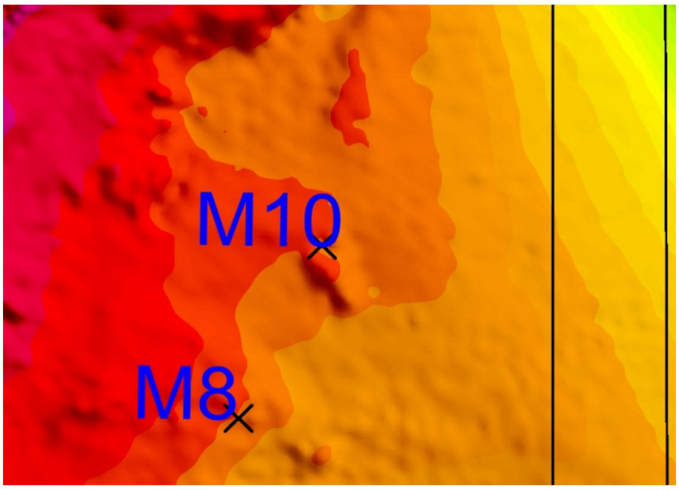


Figure 3.12: A closer look at the shaded relief bathymetry grid in the vicinity of magnetic anomaly M10.

4.0 Sidescan Sonar Survey

4.1 Survey Specification

A line spacing of 20m was selected to allow for the overlap of successive survey lines. The sonar range was set to 50m on either side of the survey vessel. Within the 100m survey swath the close line spacing compensated for vessel offline drift caused by tides and wind direction whilst maintaining a survey speed of 2 knots. There were survey difficulties with moorings and buoys at the western margin of the survey area and the close line spacing also allowed for fine adjustment of the line spacing thus avoiding obstacles.

The planned survey line layout is shown in Figure 4.1.

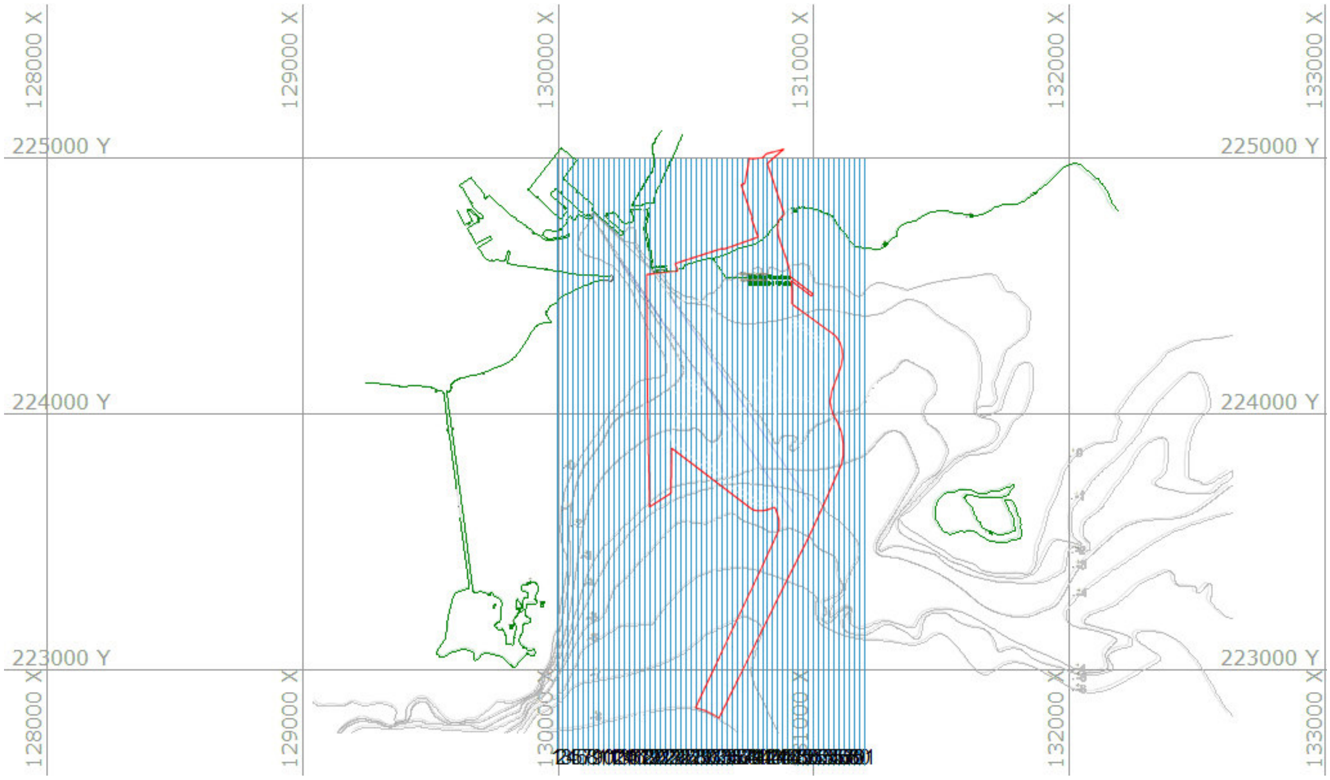


Figure 4.1: Planned sidescan sonar line layout

Additional West – East fill-in lines were run in prospecting mode in shallow water sub-parallel to the northern shoreline.

4.2 Data Acquisition

The survey lines were acquired in zig-zag mode up to 4 hours either side of high water. Inshore areas were surveyed at high water to maximise coverage in these areas. The sidescan sonar fish was mounted on a pole deployed on the port side of the survey vessel. The fish was flown at a constant depth beneath the waterline which gave a satisfactory clearance of the hull of the survey vessel.

Sidescan sonar data acquisition was controlled using Hypack software which also logged the position of the GPS antenna which was mounted on the sidescan sonar pole. Some difficulties were experienced with the Hypack software which locked out at times during the survey. This resulted in small gaps in the survey coverage along certain lines. These gaps were compensated for or filled-in by the overlap of adjacent lines. The sidescan sonar coverage is shown in Figure 4.2

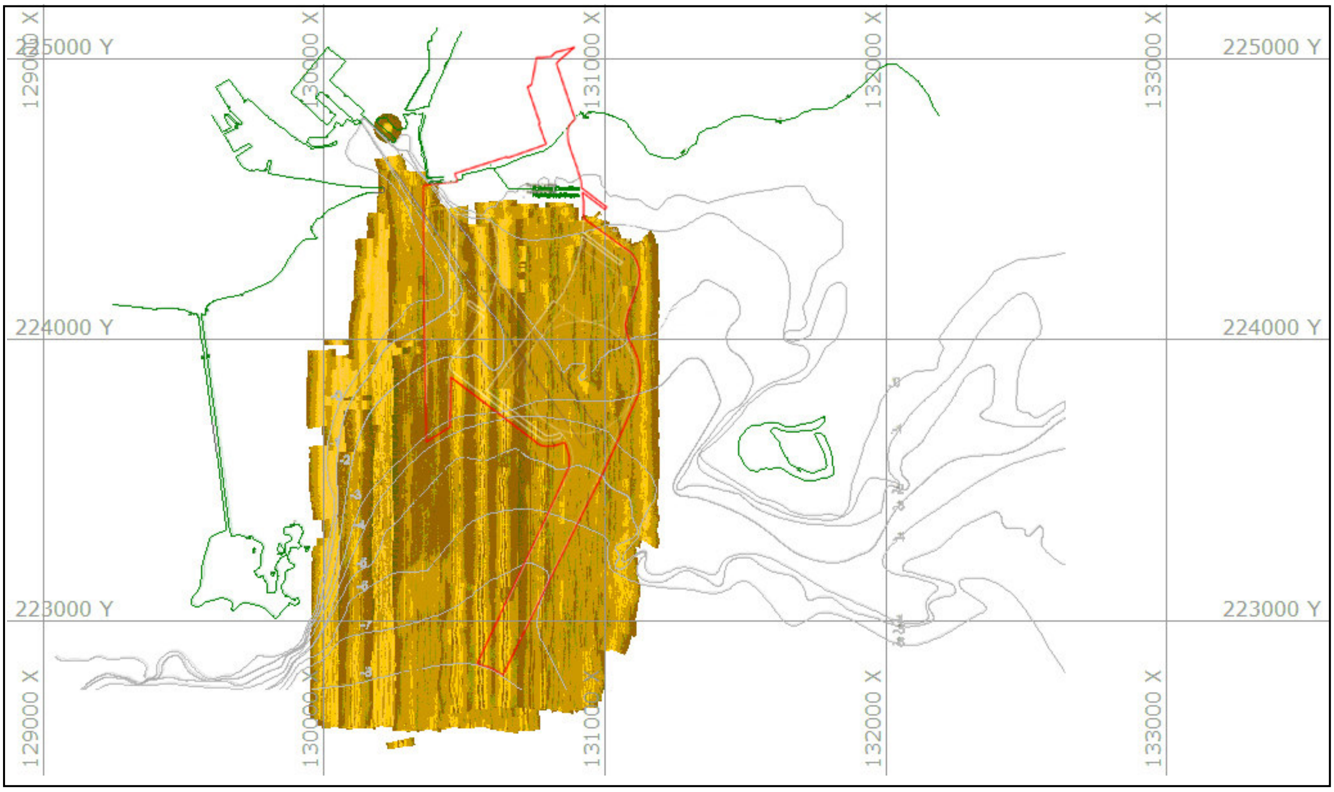


Figure 4.2: Sidescan sonar coverage

4.3 Data Processing

The data were processed using the sidescan processing utility in Hypack. The data were processed in batches which corresponded to each day's acquisition. The first step was to remove the effect of water depth. This was achieved on a line by line basis by the on-screen digitising of the response due to the water column. The next step was examination of each line by playing it back in Hypack and marking possible anomalies. This process also allowed for the Irish National Grid Reference of the centre of each anomaly to be picked and stored simultaneously with the capture of an image of the anomaly. Each anomaly was automatically named with the time it was surveyed and this was also written to a datafile. The location of the 18 anomalies picked is given in Figure 4.3 and tabulated in Table 4.1

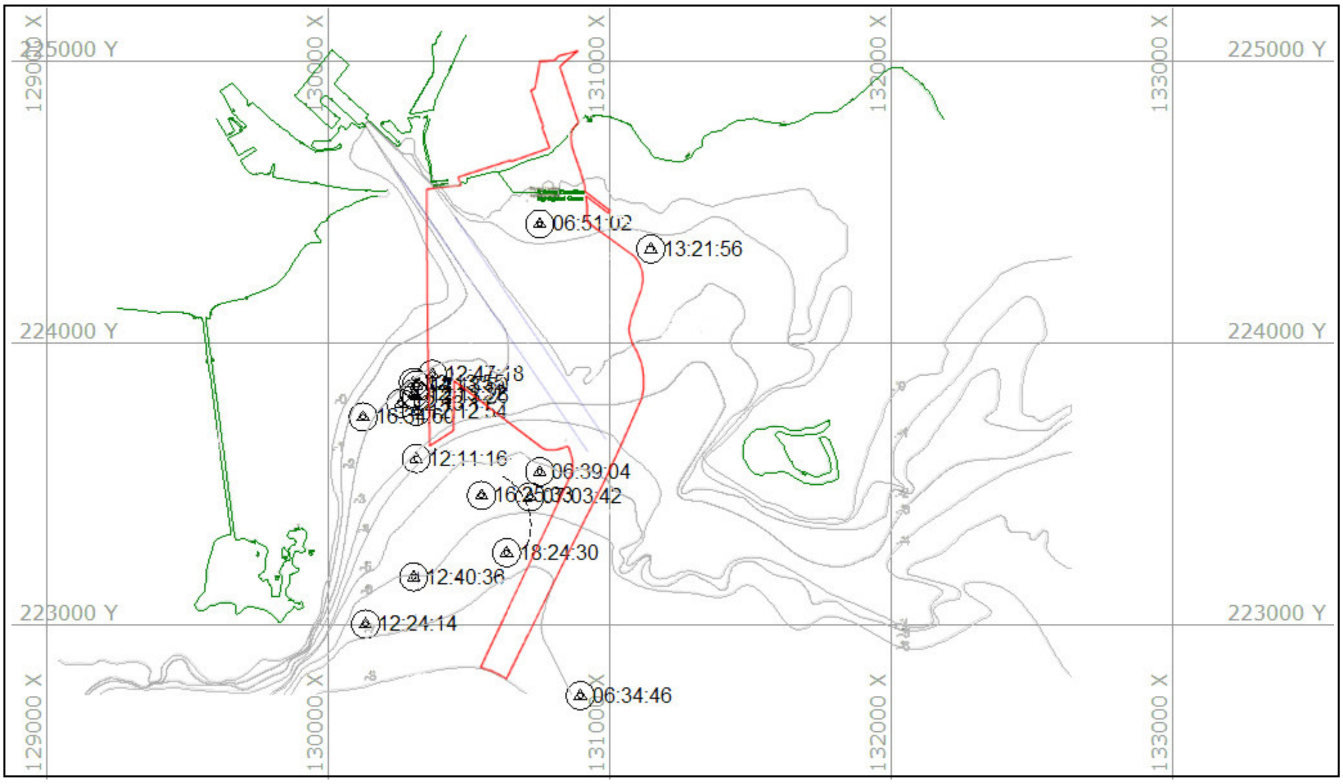


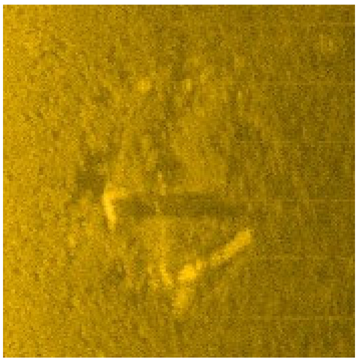
Figure 4.3: Location of anomalies picked from individual sidescan sonar lines

Anomaly	ING East	ING North	Anomaly	Survey Date
12:13:55	130301.20	223861.00	12:13:55	05/28/2010
12:13:32	130303.90	223821.40	12:13:32	05/28/2010
12:13:11	130256.40	223787.10	12:13:11	05/28/2010
12:12:54	130311.40	223758.90	12:12:54	05/28/2010
12:11:16	130311.40	223590.90	12:11:16	05/28/2010
12:13:26	130312.00	223811.70	12:13:26	05/28/2010
12:13:50	130312.70	223852.00	12:13:50	05/28/2010
12:47:18	130369.30	223889.80	12:47:18	05/28/2010
12:40:36	130302.60	223170.60	12:40:36	05/28/2010
16:25:33	130543.80	223459.70	16:25:33	05/28/2010
18:24:30	130632.70	223256.50	18:24:30	05/28/2010
16:34:60	130122.70	223738.40	16:34:60	05/29/2010
12:24:14	130131.60	223002.70	12:24:14	05/30/2010
06:39:04	130750.50	223543.60	06:39:04	06/01/2010
06:51:02	130750.60	224423.70	06:51:02	06/01/2010
07:03:42	130716.50	223455.00	07:03:42	06/01/2010
13:21:56	131145.90	224334.80	13:21:56	06/01/2010
06:34:46	130895.10	222748.70	06:34:46	06/02/2010

Table 4.1: Location of anomalies shown in Figure 4.3.

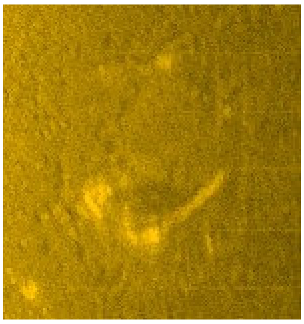
4.4 Data Presentation

An image of each anomaly is given and described below :



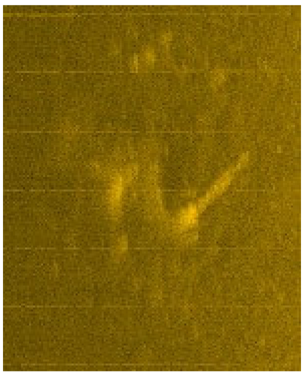
Anomaly 12:13:55

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



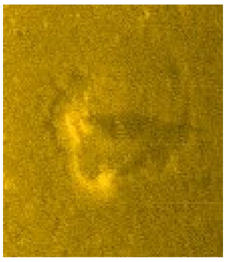
Anomaly 12:13:32

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



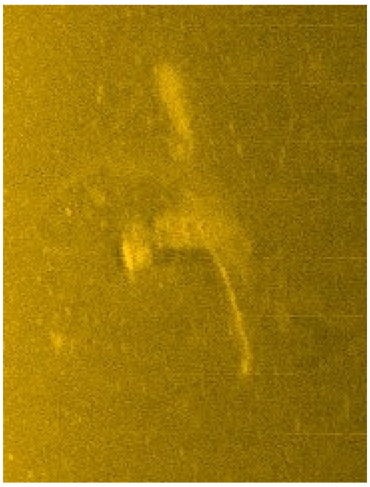
Anomaly 12:13:11

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



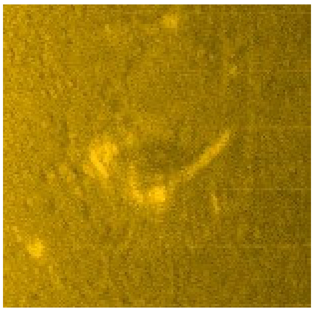
Anomaly 12:12:54

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with tether and scoured area



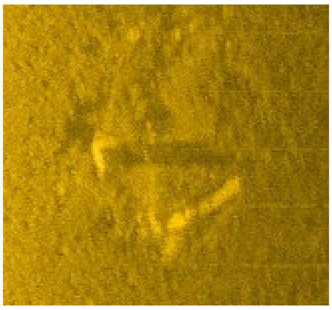
Anomaly 12:11:16

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with tether and scoured area



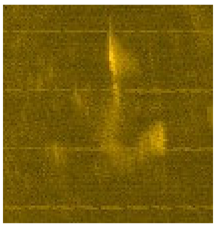
Anomaly 12:13:26

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



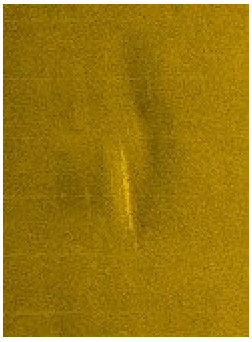
Anomaly 12:13:50

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



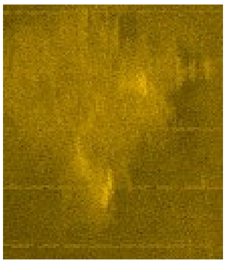
Anomaly 12:47:18

This anomaly lies in the western area which contains many moorings. It could be due to a mooring with scoured area



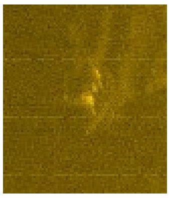
Anomaly 12:40:36

This anomaly lies in the western area which contains many moorings. It could be due to a sunken mooring with tether and scoured area



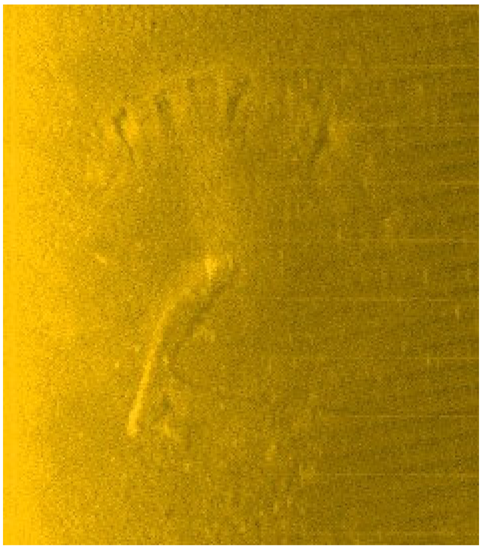
Anomaly 16:25:33

This anomaly could be due to a partially covered mooring



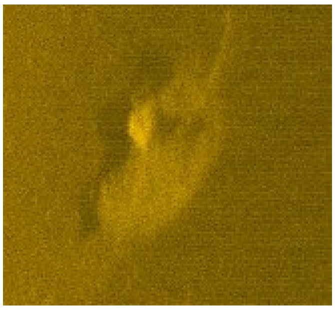
Anomaly 18:24:30

This anomaly appears to have some spherical components



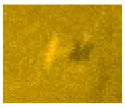
Anomaly 16:34:60

This anomaly is likely to be due to an object at the end of a mooring moving with the tide



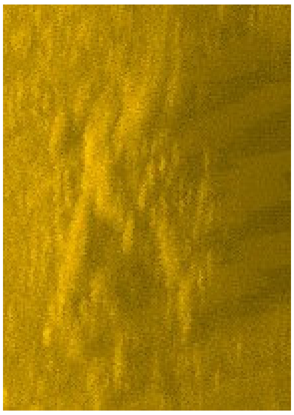
Anomaly 12:24:14

This anomaly is likely to be due to a mooring and its tether



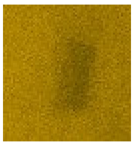
Anomaly 06:39:04

This is a small irregular anomaly which could be a rock or boulder



Anomaly 06:51:02

This anomaly could be geological in origin

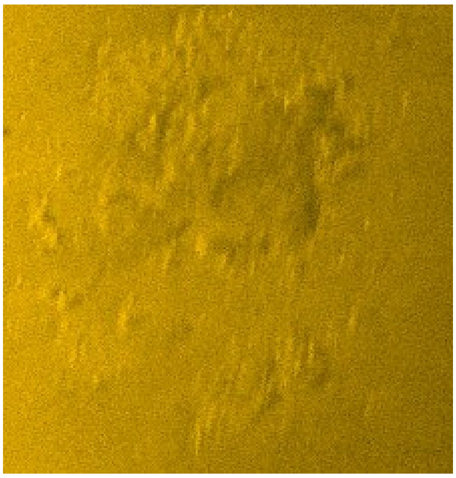


Anomaly 07:03:42

This anomaly appears to be rectangular in nature

Anomaly 13:21:56

This anomaly is likely to have a geological origin



Anomaly 06:34:46

This anomaly is likely to have a geological origin

5.0 Conclusions

A series of sample magnetic and sidescan sonar anomalies have been presented. There are some discrete magnetic anomalies of which one could be due to archaeology. The majority of the sample sidescan anomalies presented are likely to be due to moorings or the scouring effects of the mooring's tether. There are some anomalies which are likely due to geology or geological processes.

6.0 Recommendations

It is recommended that magnetic anomaly M10 and a selection of other magnetic anomalies are investigated by a dive survey. Selected sidescan anomalies in the western area should be the subject of a dive survey to confirm they are due to moorings. Selected anomalies likely to be due to geology or geological processes should be investigated by dive survey.