5.

FIELD REPORT

SIDE SCAN SONAR AND SUB-BOTTOM SURVEY

CLOGGA POINT,

CO. WICKLOW,

IRELAND.

ON BEHALF OF

Irish Mussel Seed Company

Geomara

Geomara Job Number: G16003

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Reviewed by: Eoghan Kieran

Date: 22 February 2015

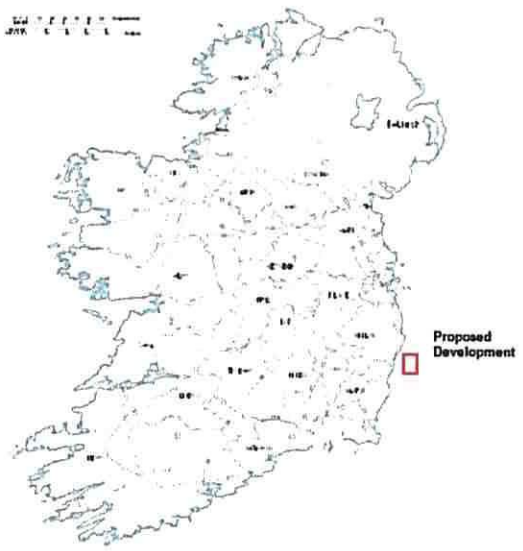
Contents

1 Introduction

Geomara were commissioned by Irish Mussel Seed Company Limited to undertake a program of marine geophysical survey at Clogga Bay, Arklow, Co. Wicklow. The program of survey consisted of a side scan sonar survey and sub bottom profiler survey. It was undertaken on the 11th of February 2016 in advance of a proposed Aquaculture development and was designed to establish the physical conditions across the site.

1.1 Site Location

The proposed site of the Aquaculture development is off the coast of Co. Wicklow at Clogga Point, 4km south of Arklow town (Figure 1 and Figure 2). The proposed site measures 1000 m N-S and 500 m E-W. The coordinates of the site boundary are shown in Figure 1.



Easting	Northing
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326469.821	168715.372
326470.076	167615.265
325870.136	167615.280

UTM 29	UTM 29
693238.967	5848884.596
693838.683	5848892.921
693854.221	5847793.117
693254.445	5847784.797

Lat	Long
52 45 18.72	6 8 11.1474
52 45 18.216	06 7 39.18
52 44 42.65	6 7 40.692
52 44 43.151	6 8 12.6594

Figure 1. Site Location

1.2 Bathymetry

The Admiralty Chart depicts the depth of water in the area of the proposed development is between 6m and 12m, as shown in Figure 2.

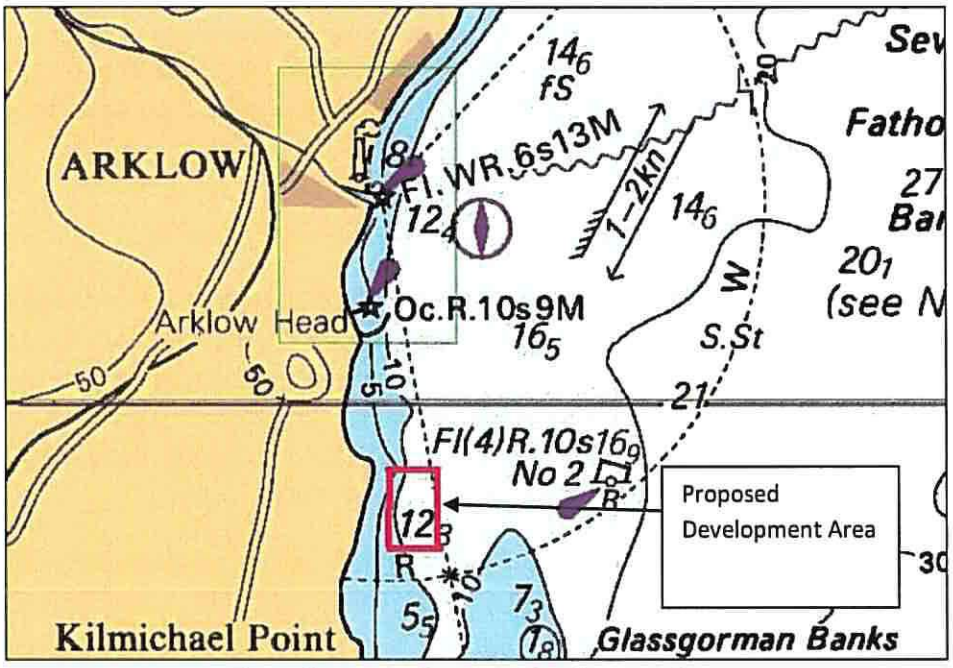

Figure 2. Proposed Development Area

1.3 Geology

According to the Geological Society of Ireland the onshore bedrock for Clogga Point is described as; Lower Middle Ordovician slate / sandstone / greywacke / conglomerate. The bedrock along the coast of Wicklow and North Wexford is described as Cambrian Silurian dolerite / dolostone / claystone / mudstone / conglomerate.

No offshore geotechnical investigations have been undertaken within the proposed development area, however a desktop study specific to the proposed development area has been undertaken (ARUP 2014). The desktop study describes a previous offshore site investigation carried out approximately 5km north of the proposed site. The geology and sedimentology is described as "superficial deposits, moderately weak to moderately strong PHYLLITE and SILTSTONE was encountered from 6.4m below sea bed level (bsl) to 10.25m bsl. Based on tactile assessment and Point Load Indices of <1MPa the bedrock was described as moderately weak to moderately strong."

No records of any other geotechnical investigations carried out in this nearshore or offshore area could be retrieved.

2 Field equipment

The following survey equipment was deployed in order to best achieve the aims of the survey and to comply with the scope of works.

2.1 Vessel

Geomara undertook the geophysical survey on board the P4 licensed, 6.5m rigid inflatable Tachtronics. The vessel was configured so that the side scan sonar was towed from the port side of the vessel, while the sub bottom profiler was deployed utilising a rigid pole mount system from the starboard side of the vessel.

2.2 Sidescan sonar

Side scan sonars are acoustic devices which produce a two-dimensional image of the seabed with near photographic quality and are used primarily to establish the seabed conditions identify objects that are on or proud of the seabed. The system, also known as a towfish, is towed directly from the survey vessel. The intensity of the acoustic reflections from the seafloor is recorded in a series of cross-track images. When stitched together along the direction of motion, these images form a waterfall view of the sea floor within the swath (coverage width) of the beam.

The Klein 3500 UUV HydroScan used for this survey is a high resolution, compact side scan sonar for shallow water applications. The HydroScan features real-time dual frequency operation at both 455 and 900 kHz. The 455 kHz bandwidth provides excellent detection of medium-to-large size objects at ranges exceeding 175 meters (350 meters total swath), while the 900 kHz bandwidth provides the highest possible resolution at up to 75 meters range (150 meters total swath).

The system was operated on the dual frequencies simultaneously, with the data recorded on Klein's proprietary data collection software, Sonar Pro. The range of the system was set to 75m each side, thereby providing an effective swath range of 150m. Line planning software ensured that 4 no. N-S orientated 1km long survey lines recorded at 50m spacing, thus providing for 100% overlap on all lines. In addition, 5 no. E-W orientated cross lines were recorded at 200m intervals as a means of data validation and quality assurance.

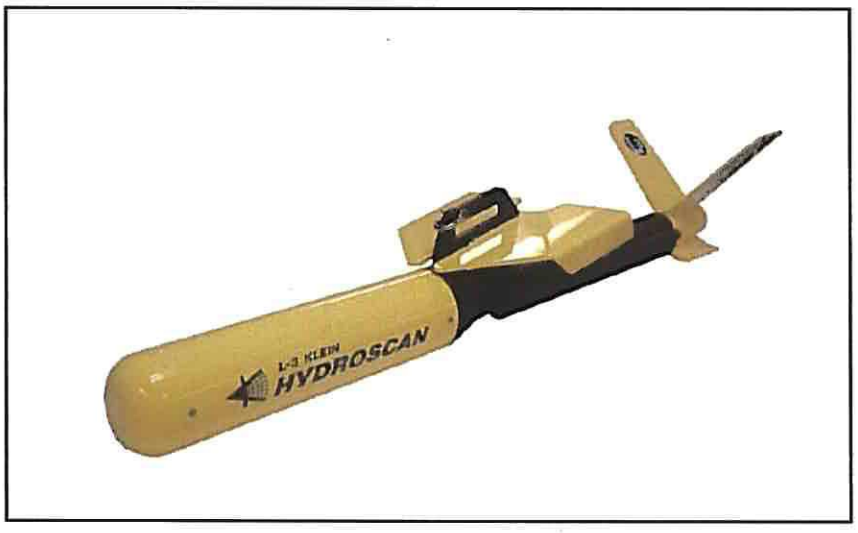

Plate 1. Klein 3500 HydroScan Towfish

2.3 Sub Bottom Profiler

Sub-bottom profilers are seismic-acoustic systems that can penetrate the seabed to establish changes in sediments and detect and image structures buried within the sediments. The three systems most commonly used for high-resolution surveying are the boomer, pinger and chirp systems. Whereas the boomer system provides best results for coarser sediments, the pinger and chirp systems deliver greater detail for finer sediments.

The Knudsen Pinger SBP system used for this survey is a dual frequency unit that is controlled by proprietary software allowing for high quality sub bottom data acquisition. The Pinger SBP system was set up using a low frequency 3.5 kHz projector ideally suited for hard sand bottom. The pole mounted transducer is a small lightweight assembly that produces high quality data. The Pinger features chirp transmission and a large aperture receiver using the latest PVDF technology that provides higher directivity. Another advantage of the Pinger SBP receive array is its wide bandwidth. The same receive array can be used simultaneously for multiple frequencies.

The system was operated on 3.5 kHz range, although as the system operates on the 'chirp' modulated frequency system, effective sonar frequencies were transmitted and received outside this frequency. The data was recorded on Knudsen proprietary data collection software, Echo Plus. Although greater penetration could be achieved by the system, the visual range was set to 30m. The sub bottom profiler data was recorded in simultaneously to the side scan sonar data. Thereby, the same survey lines were recorded. These were based on the 5 no. 1km, N-S orientated lines, spaced at 50m intervals and the 5 no. E-W orientated cross lines, spaced at 200m apart.

Plate 2. Knudsen Pinger SBP

2.4 Positioning

Vessel and equipment positioning was provide by a Trimble SPS 461 heading and position DGPS. The Trimble SPS461 is a dual-frequency GPS Heading receiver, which provides DGPS accuracy position from SBAS, OmniSTAR VBS, MSK Beacon, or external RTCM DGPS corrections. Using a pair of dual-frequency antennas, the SPS461 GPS Heading receiver computes the precise vector between the two antenna phase centres to provide a heading with the option of either pitch or roll for precise platform, vehicle, or vessel orientation.

Plate 3. Trimble SBS 461

2.5 Navigation

Vessel navigation was provided by Hypack 2014. Hypack is the most widely used hydrographic software package in the world. It enables users to create and follow pre-determined and pre-configured survey lines. It uses GPS input to calculate navigation errors and provides the helmsman with cross track and off track measurements.

3 Survey Design

The survey lines were planned using Hypack 2015 (Figure 3). The project planning aspect of this software allows for accurate line planning in advance of the project. It allowed the team to design the survey lines, determine their length and orientation as well as spacing apart. Hypack 2015 has a real time data acquisition aspect. This was also used during the survey as the vessel navigation software. It provided the vessel skipper with real time navigation and positional data during the survey.

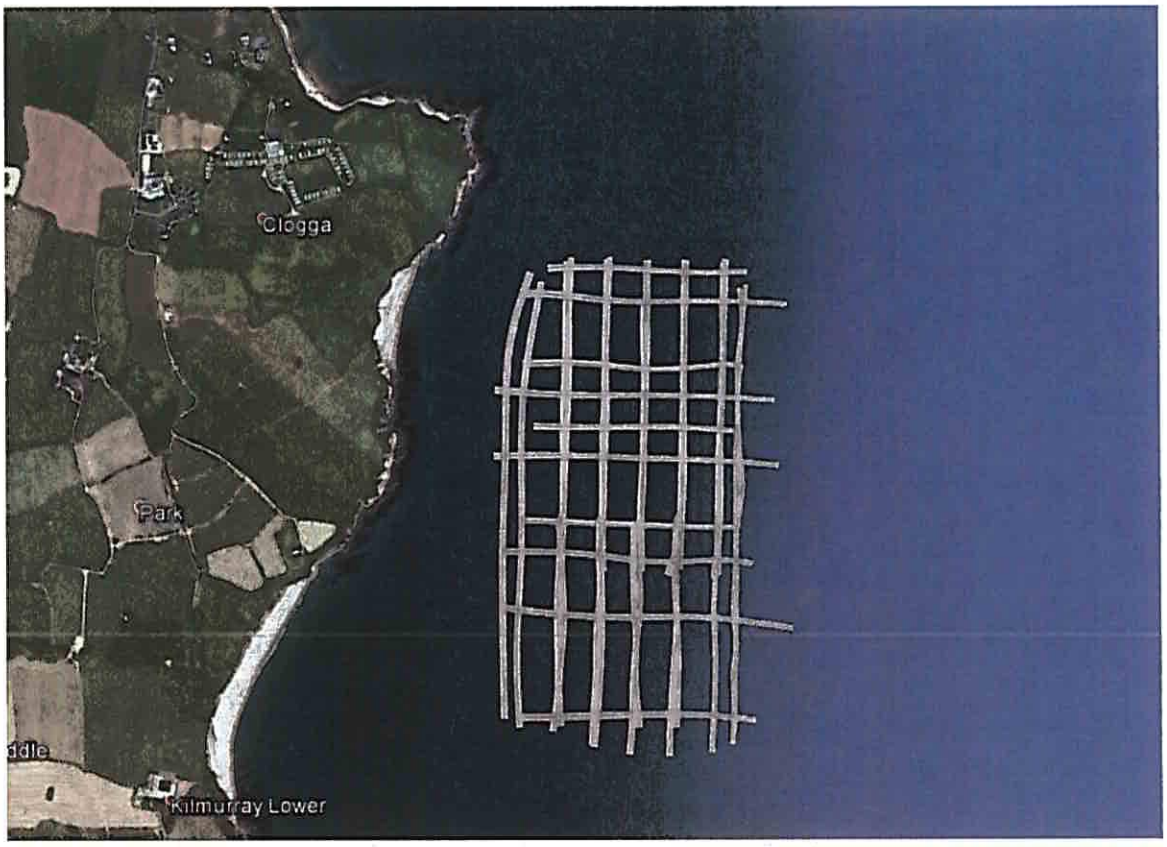

Figure 3. Recorded Survey Lines

4 Data Acquisition and Processing

4.1 Sub bottom profiler data acquisition

The sub bottom data was recorded to SEG-Y digital format using proprietary Knudsen SBP software. The SEG-Y is the most commonly recorded format used in sub bottom geophysical surveys as it allows for easy processing and integration of positional data from a differential GPS thereby providing real time locational information.

4.2 Side Scan Sonar data acquisition

Sidescan sonar data was recorded to XTF digital format via Klein's own proprietary software Sonar Pro. All the data are transmitted to the surface on Klein TPU digital link via a coax cable. Sonar Pro allows the user to determine ping rate and transmit frequency and also provides real time sensor information such as sonar signal intensity, sonar trace imagery and positional information thus allowing the surveyor to QC all data being collected.

4.3 Data Processing

Sonarwiz 6 was the data processing software used for the side scan and sub-bottom data interrogation. It enables the user to geo-locate and describe targets of potential interest. It permits the creation of side scan sonar mosaics and also allows for cross reference of side scan sonar, sub bottom profiler and magnetic anomaly locations. The software allows the user to export processed data in various forms such as geo-tiff and shapefile.

Below is the Sonarwiz data processing flow chart for Side Scan Sonar and Sub Bottom Profiler Data;

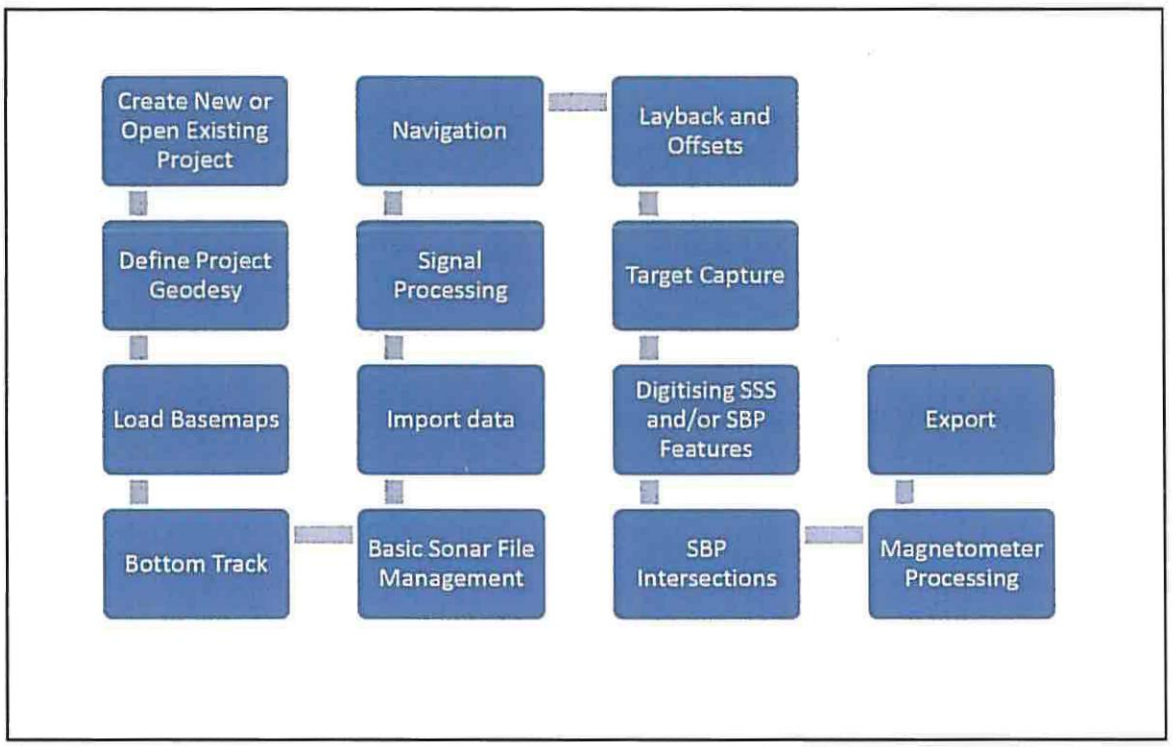

Figure 4. Sonarwiz 6 data Processing Flow Chart

5 Survey Results

5.1 Side Scan Sonar

The data was processed and geo-referenced in Sonar Wiz 6. The resultant imagery was analysed to identify the seabed conditions and locate any anomalies or obstructions. It indicated that the seafloor in the survey area consisted mostly of sand, with some gravelly sand and sandy gravel pockets. . 4 no. sidescan sonar lines were recorded. A total of 4.58 linear kilometres of seafloor was ensonified over the course of the survey.

5.1.1 Line 1:

Side scan sonar line 1 was a S-N orientated line which measured 1.176 km in length. It was the most easterly recorded line. The sonar trace indicated that the line was comprised of rippled sand. In the southern section of the sonar trace the uniform sand appears to have gravel or harder sediment deposits.

5.1.2 Line 2:

Line 2 was a N-S orientated line which measured 1.163 km in length. Similar to line 1 the sonar trace indicated that the line comprised of sand ripples interspersed with gravel or harder deposits.

5.1.3 Line 3:

Line 3 was a S-N orientated line which measured 1.139 km in length. Similar to lines 1 and 2 the sonar trace indicates the presence of uniform sandy ripples with some more reflective possible gravel pocketed sections. The northern section of this line has a number of small boulders, each of which sit on a uniform sandy seafloor. The boulders each have accompanying scour trails, indicative of the predominant tidal regime in the area.

5.1.4 Line 4:

Line 4 was a N-S orientated line which measured 1.11 km in length. It was the most westerly of the recorded sidescan sonar lines. The sonar trace indicates the presence of uniform sandy ripples in the southern section with a more reflective possible gravel banked centre section.

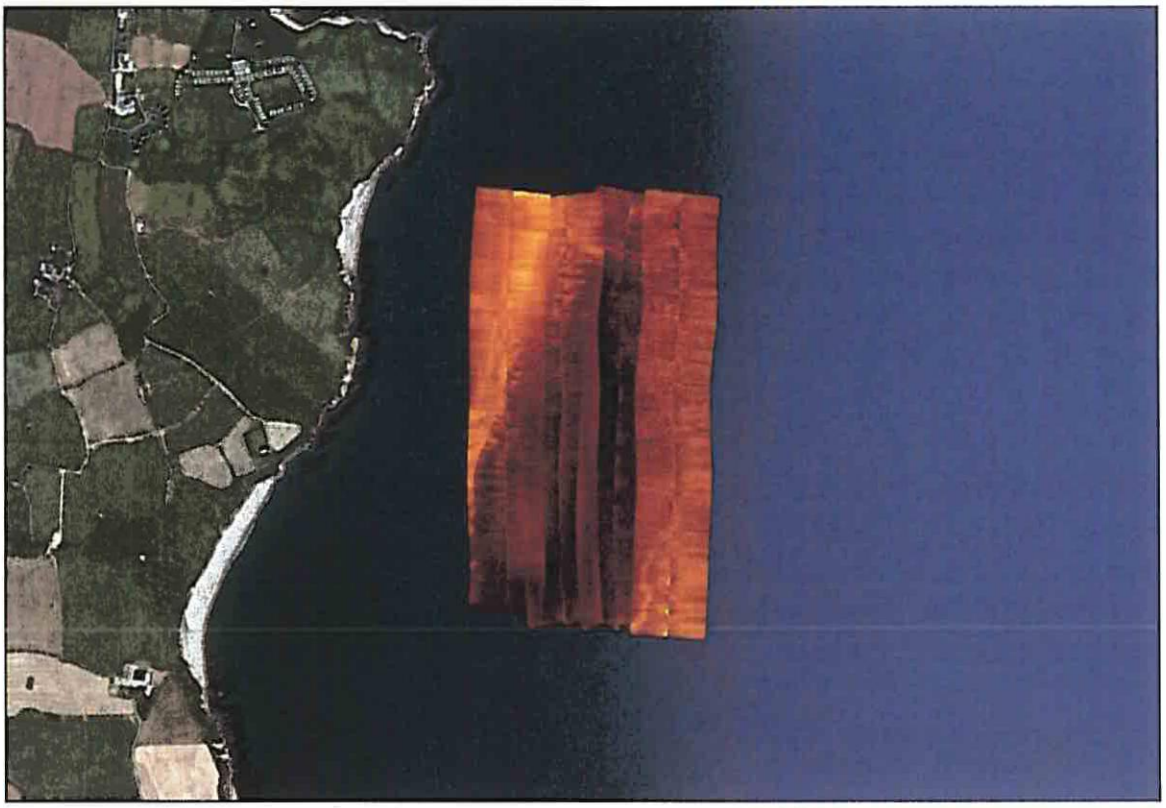

Plate 4. Side Scan Sonar Mosaic of survey area.

5.2 Sub Bottom Profiler

A total of 32 sub bottom profiler lines were surveyed throughout the area, these comprised of 22 N-S orientated lines and ten cross lines which ran from E-W. A total of 26.12 km of sub bottom data was recorded over the duration of the survey. The data indicates that a narrow, thin superficial layer of apparent mobile unconsolidated sand overlies almost the entire site. This horizon measures 0.5 – 0.5m in depth and overlies a more cohesive substrate. The second stratigraphic horizon measures between 4.9 and 7.2m in depth.

The findings of this survey appear to correlate with the findings of the desktop study and the findings of the survey previously undertaken 5km to the north.

5.2.1 Mainline 1:

Mainline 1 was a N-S orientated line measuring 1.12km in length. It was the most easterly of the sub bottom lines surveyed in the area. The sonar trace shows a relatively flat seafloor with a slight rise in the seafloor toward the south. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A sub-surface feature was noted at

52 44.989 N, 006 07.675 W. This feature consisted of horizon which dipped from 1m below the seafloor surface to7m below the seafloor surface from N-S. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

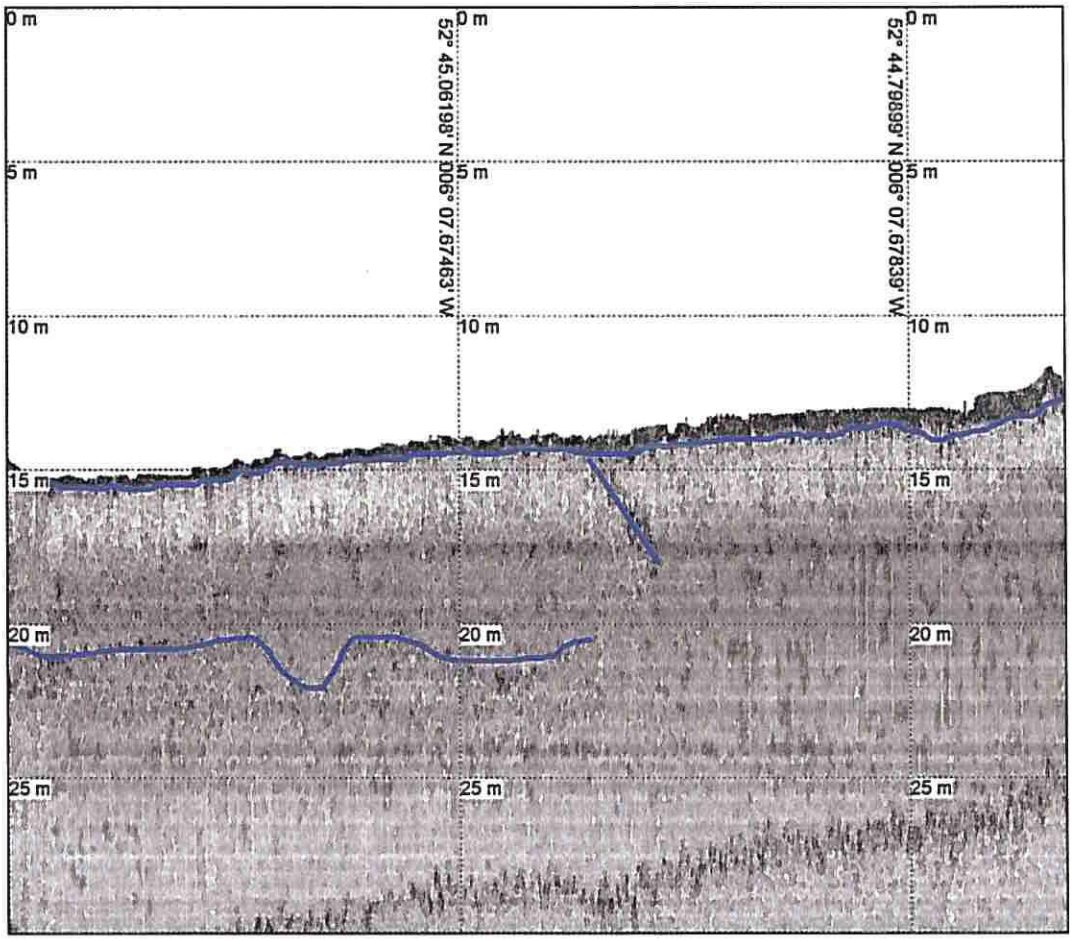

Plate 5. Mainline 1

5.2.2 Mainline 2:

Mainline 2 was a S-N orientated line measuring 1.15km in length. A slight rise in the seafloor from south to north was noted in the sonar trace. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. This horizon seems to split toward the northern end of the sonar trace. A sub surface feature was noted in the sonar trace at 52 44.95N, 006 07.11 W. This feature resembled a channel in shape, its depth varied between 1m and 3m. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

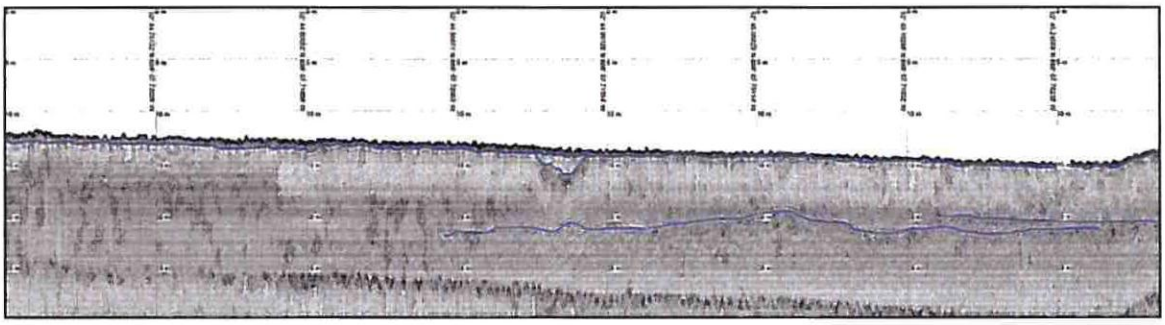

Plate 6. Mainline 2

5.2.3 Mainline 3:

Mainline 3 was a S - N orientated line which measured 1.04 km in length. The sonar trace shows a relatively flat seafloor with a slight rise in the seafloor toward the north. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. This horizon appears to split into two at the northern end of the sonar trace. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

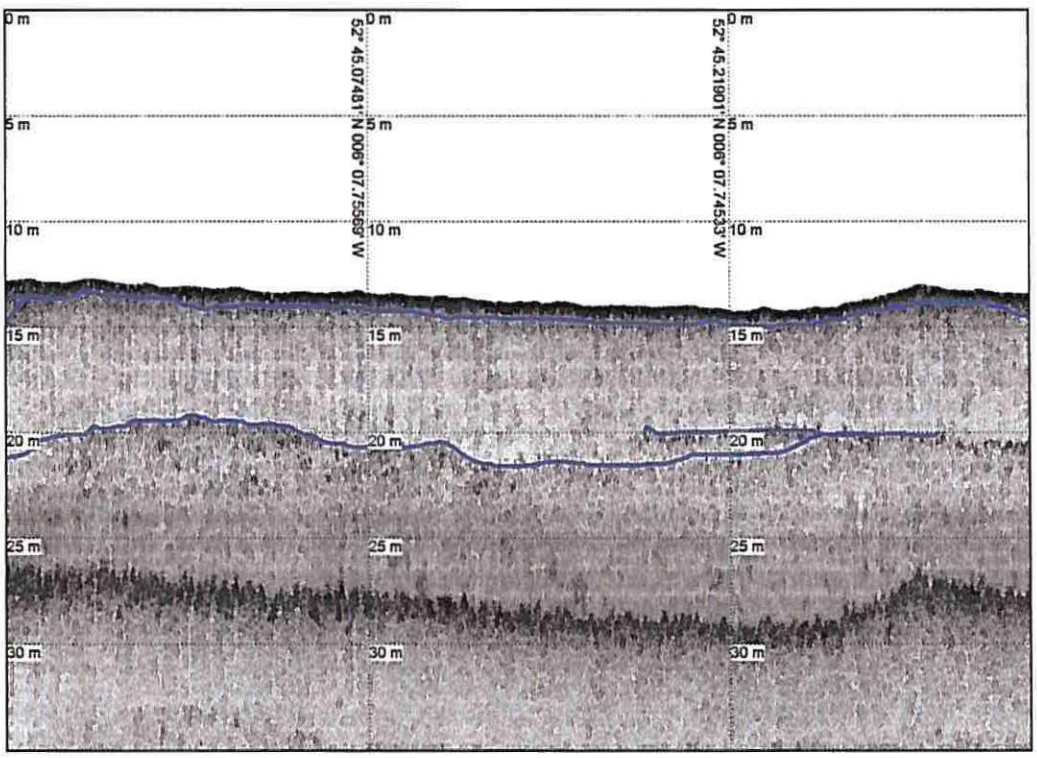

Plate 7. Mainline 3

5.2.4 Mainline 3 (b):

Mainline 3 (b) was a S-N orientated line which measured 599m in length. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A sub surface feature was noted in the sonar trace at 52 44.914N, 006 07.761 W. This feature resembled a channel in shape, its depth varied between 1m and 3m. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

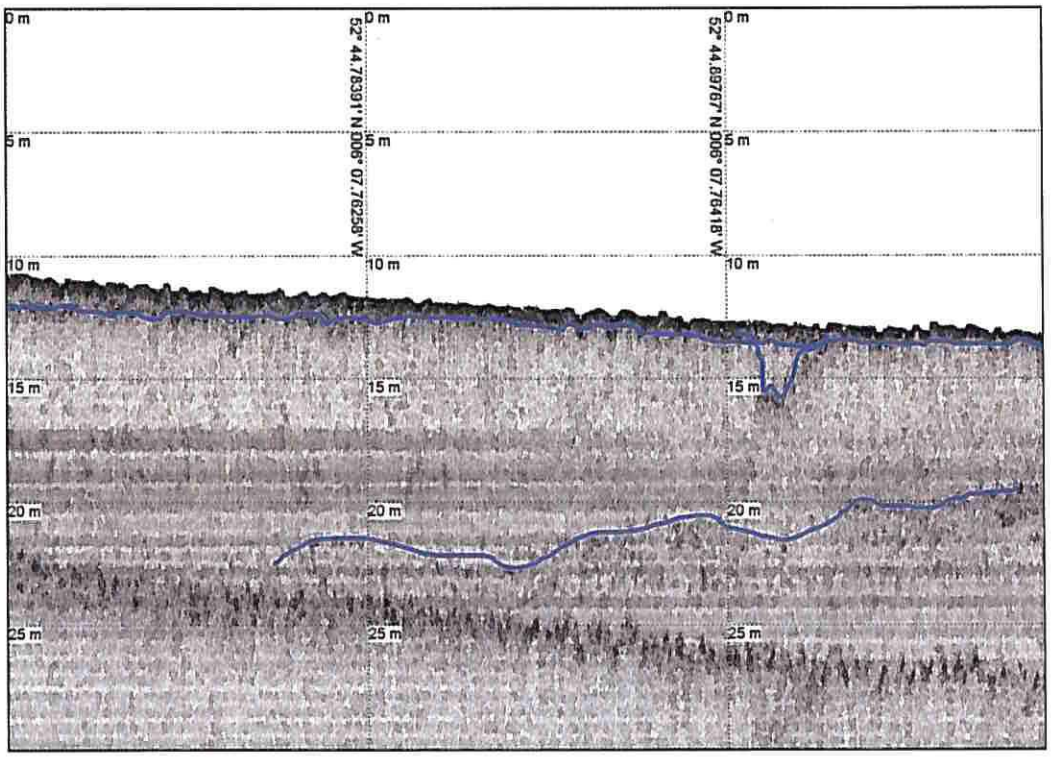

Plate 8. Mainline 3(b)

5.2.5 Mainline 4:

Mainline 4 was a N - S orientated line which measured 1.048 km in length. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

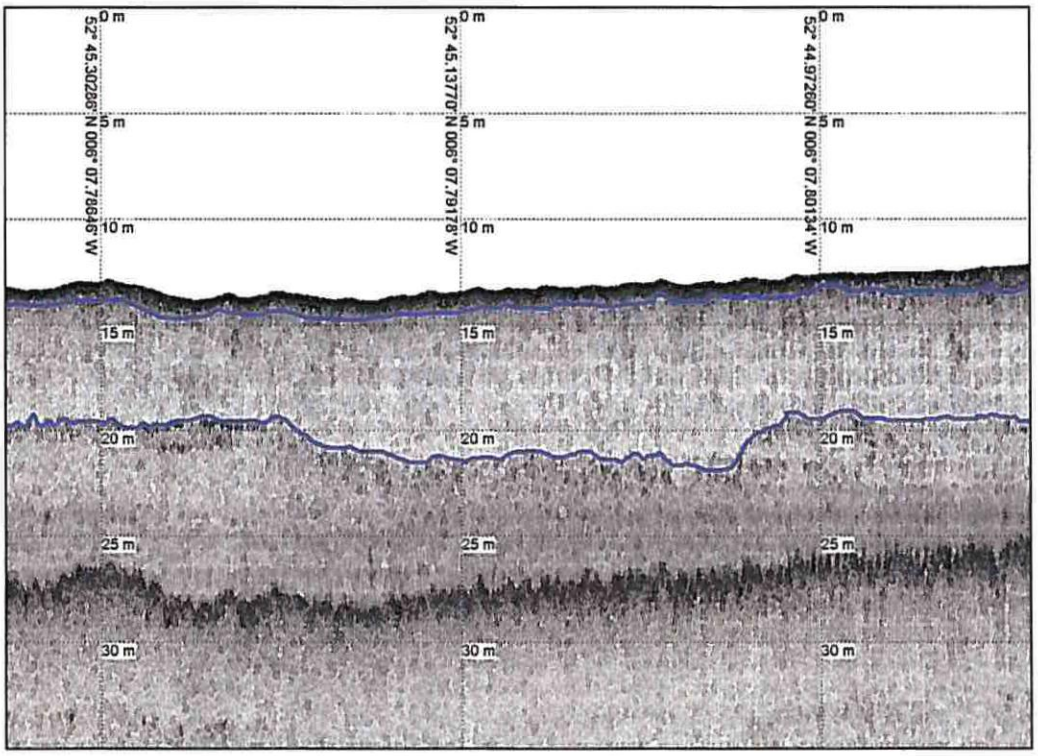

Plate 9. Mainline 4

5.2.6 Mainline 4(b):

Mainline 4(b) was a N-S orientated line measuring 533m in length. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A sub surface feature was noted in the sonar trace at 52 44.90047 N, 006 07.816 W. This feature resembled a channel in shape, its depth varied between 1m and 3m below the seafloor surface. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered

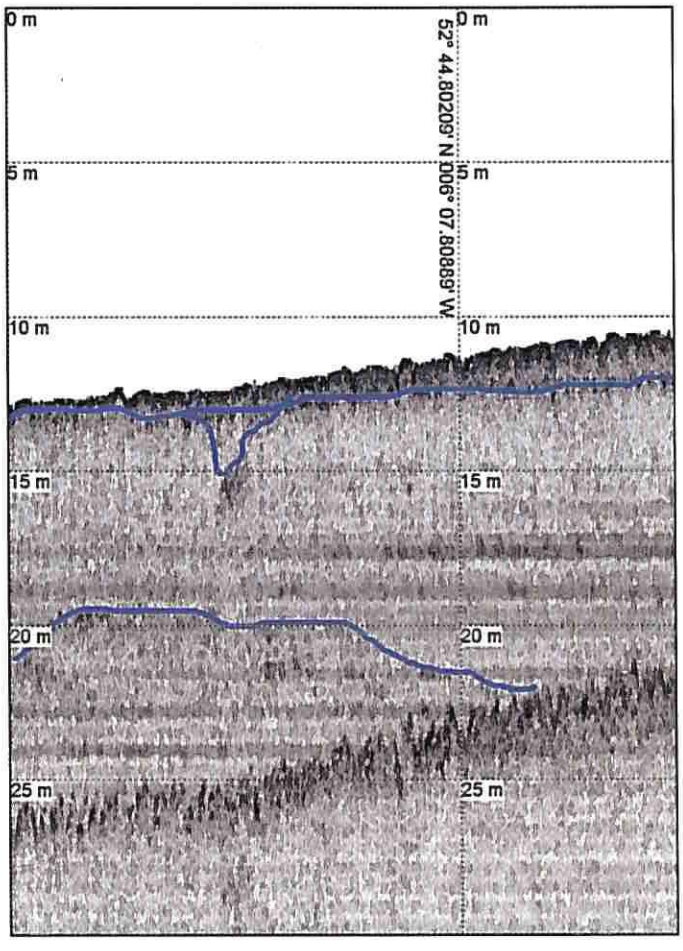

Plate 10. Mainline 4(b)

5.2.7 Mainline 5:

Mainline 5 was a S - N orientated line which measured 1.023 km in length. The small seafloor undulation noted on the two previous traces was less pronounced in this area. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A multiple reflector of the seafloor was noted beneath the bedrock. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

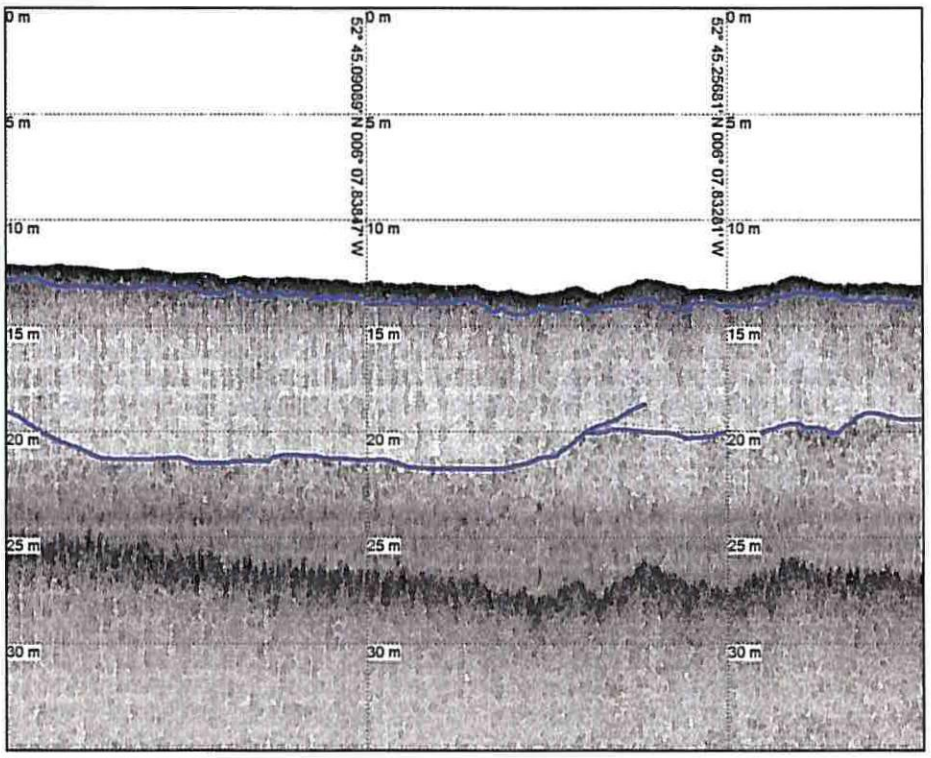

Plate 11. Mainline 5

5.2.8 Mainline 5(b):

Mainline 5(b) was a S-N orientated line which measured 627m in length. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. In the sonar trace it appears that the horizon referred to as 'bedrock' is truncated by the multiple reflector of the sonar data. A sub surface feature was noted in the sonar trace at 52 44.8703 N, 006 07.84905 W. This feature resembled a channel in shape, its depth varied between 1m and 3m below the seafloor surface.

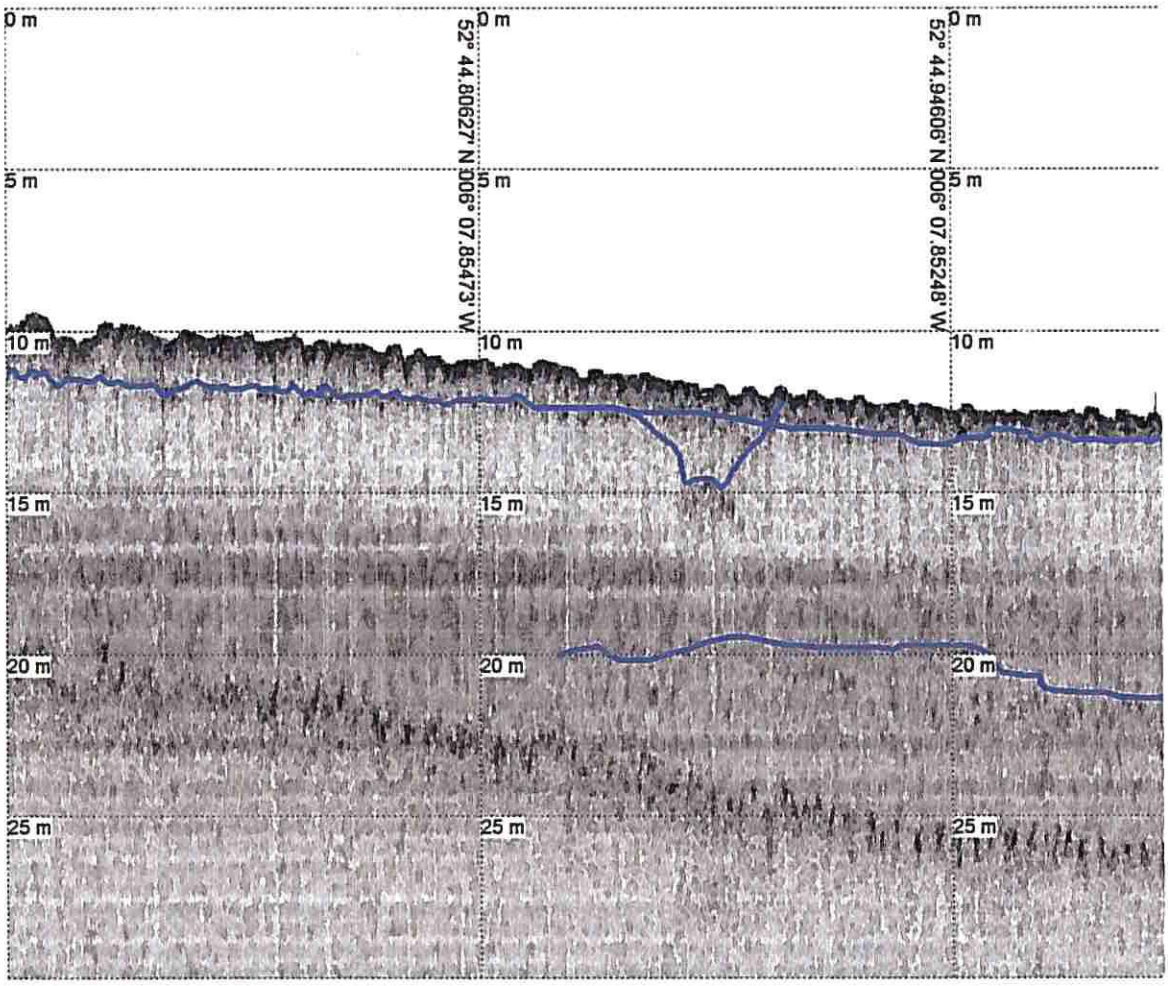

Plate 12. Mainline 5(b)

5.2.9 Mainline 6:

Mainline 6 was a N-S orientated line which measured 1.056 km in length. The small seafloor undulation noted on the two previous traces was less pronounced in this area. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. The bedrock layer appeared to be deeper towards the northern end of the line and then decreased in depth towards the south.

A small gas-like structure is visible towards the centre of the presented processed data trace. This anomaly was not present on the raw recorded data and should not be considered. It is a derivative of the application of a swell filter during data processing. A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

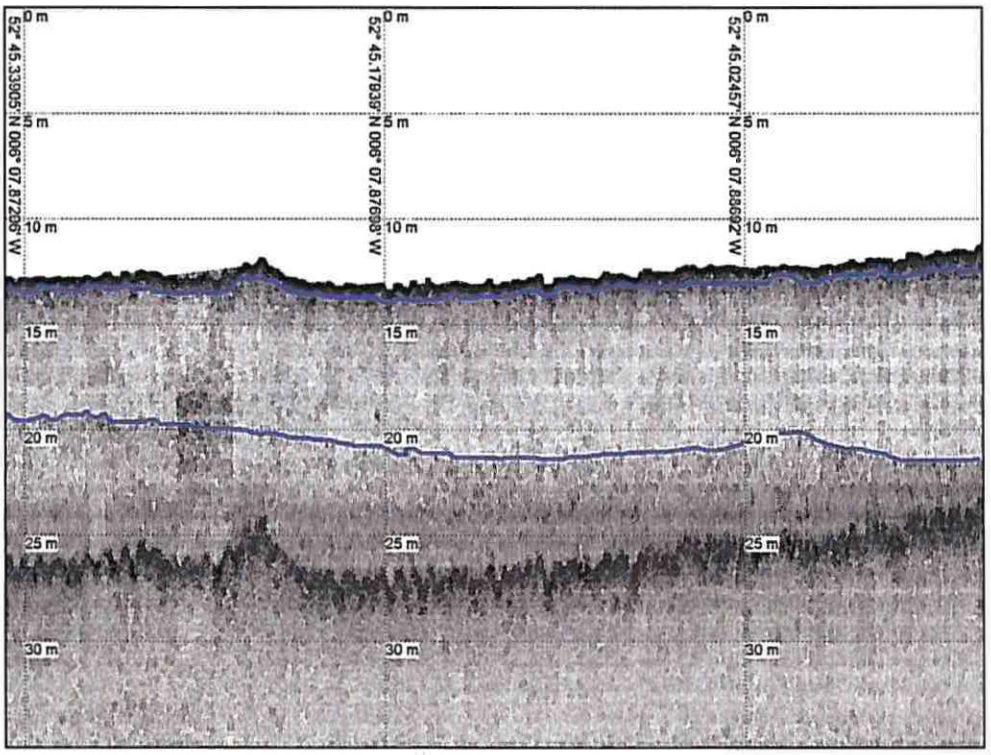

Plate 13. Mainline 6

5.2.10 Mainline 6(b):

Mainline 6(b) was a N-S orientated line which measured 511m in length. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. A sub surface feature was noted in the sonar trace at 52 44.87864 N, 006 07.9084 W. This feature resembled a channel in shape, its depth varied between 1m and 4m below the seafloor surface. A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

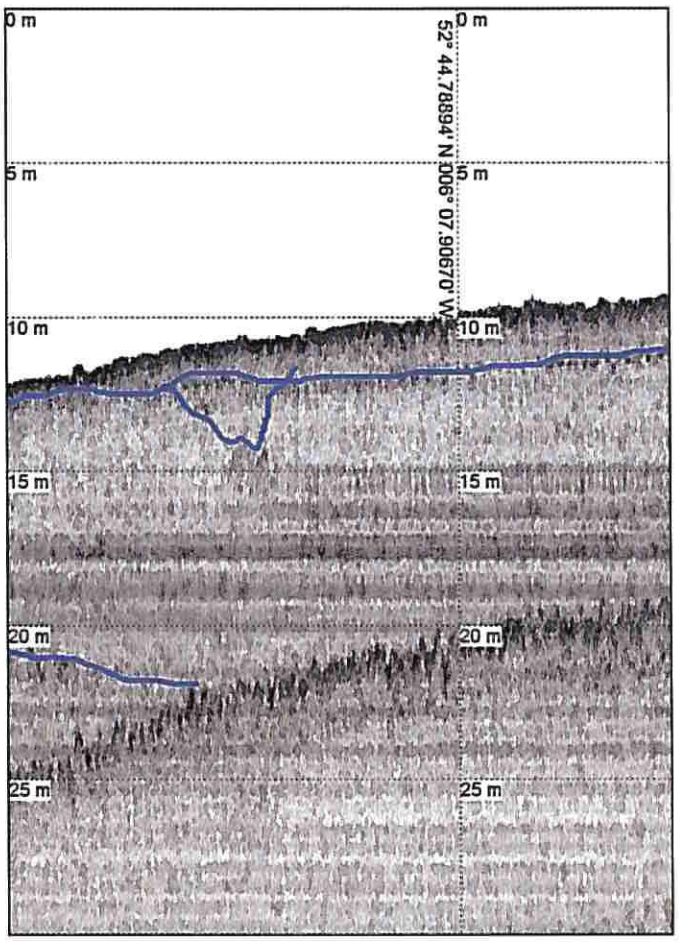

Plate 14. Mainline 6(b)

5.2.11 Mainline 7:

Mainline 7 shows a dipping seafloor towards the centre of the survey line, with a shallow rise towards the end. It indicates the presence of three discernible subsurface horizons beneath this survey line. The line data acquisition was prematurely stopped on this line owing to positional instability. As a result of this instability, data QC protocols determined that the line data collection should be ended.

Notwithstanding this, 680 m of S – N orientated data was collected along this line.

The uppermost of these was clearly represented as a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth. It overlay an undulating basal horizon which has been interpreted as bedrock. Reflection of this basal horizon was not a comprehensive as on previous lines, however the return signal strength and form are clearly different to the above and so the location of this basal horizon is easily discernible.

A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

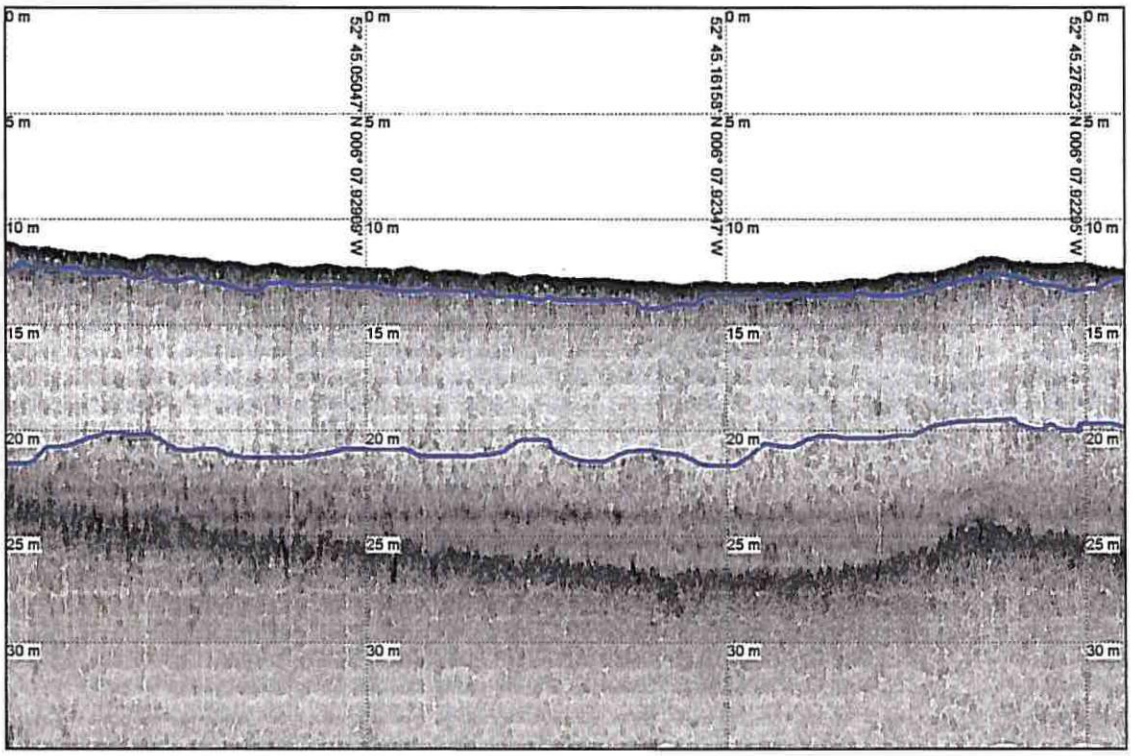

Plate 15. Mainline 7

5.2.12 Mainline 7(b):

Mainline 7(b) was S-N orientated line which measured 599m in length. . The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. This horizon can be seen in the sonar trace until it is cut short by the multiple of the seafloor. A sub surface feature was noted in the sonar trace at 52 44.85269 N, 006 07.93605 W. This feature resembled a channel in shape, its depth varied between 1m and 3m below the seafloor surface

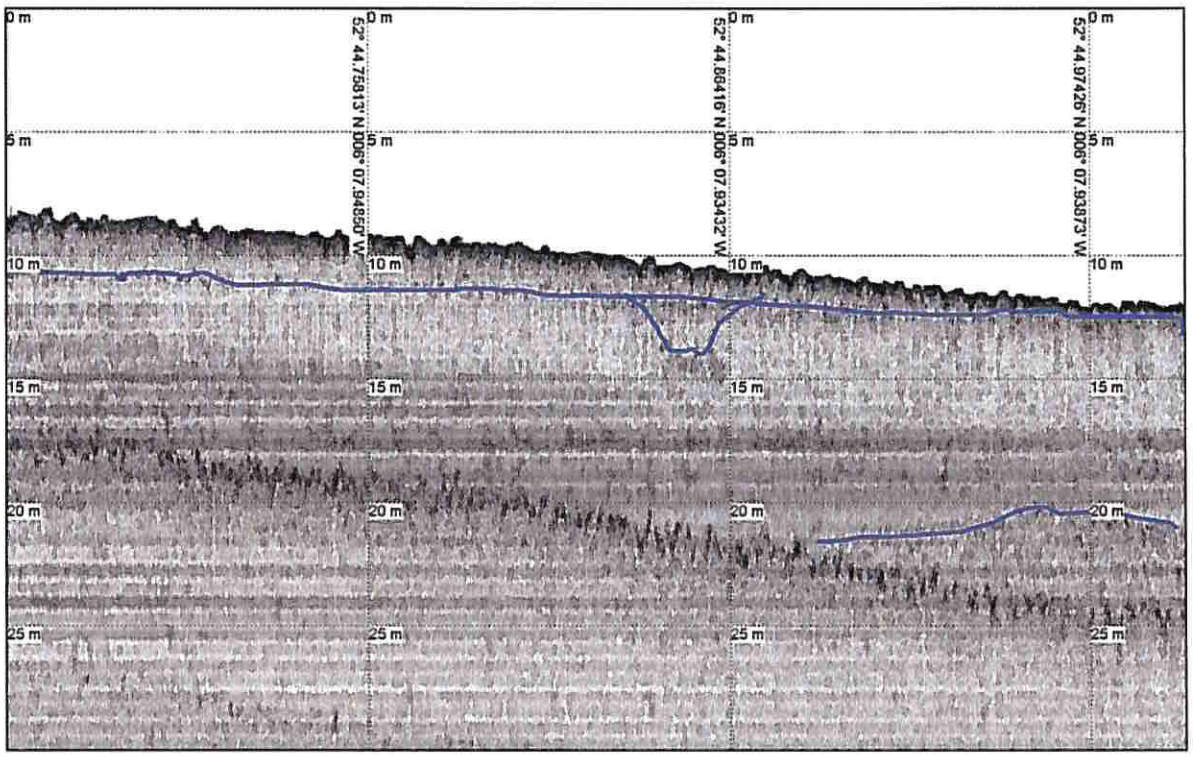

Plate 16. Mainline 7(b)

5.2.13 Mainline 8:

Mainline 8 was a N - S orientated line which measured 1.048 km in length. The data indicates that there are four discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon was relatively flat with a small rise in the centre and also at the southern end. It directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth. A third stratigraphic horizon was noted on the northern end of the line. It measured c. 2.5m in depth and 409m in length. The data appeared to indicate that the layer represented an unconsolidated horizon, possibly gravel. Immediately underlying this layer was the undulating basal horizon which has been interpreted as bedrock. The bedrock layer appeared to be shallower towards the northern end of the line and then increased in depth towards the south.

A small gas-like structure is visible towards the centre of the presented processed data trace. This anomaly was not present on the raw recorded data and should not be considered. It is a derivative of the application of a swell filter during data processing. A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

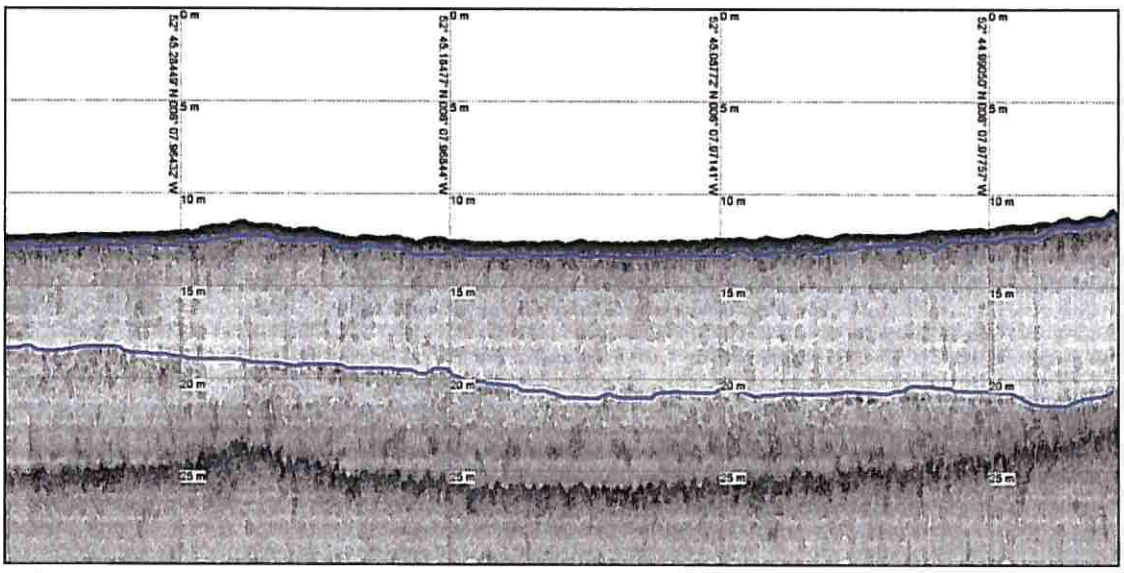

Plate 17. Mainline 8

5.2.14 Mainline 8(b):

Mainline 8(b) was a N-S orientated line which measured 586m in length. The seafloor in this line slopes down gently from south to north. The sonar trace outlines that there are three discernible sediment horizons. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. The next layer consisted of a horizon which varied in depth from 1 to 3.5m in depth. The third stratigraphic horizon which is assumed is bedrock lies at a depth of c. 10m in the northern section of the sonar trace. This layer overlaps with the multiple of the seafloor towards the southern end of the trace. A sub surface feature was noted in the sonar trace at 52 44.85487 N, 006 07.98231 W. This feature resembled a channel in shape, its depth varied between 1m and 4.5m below the seafloor surface

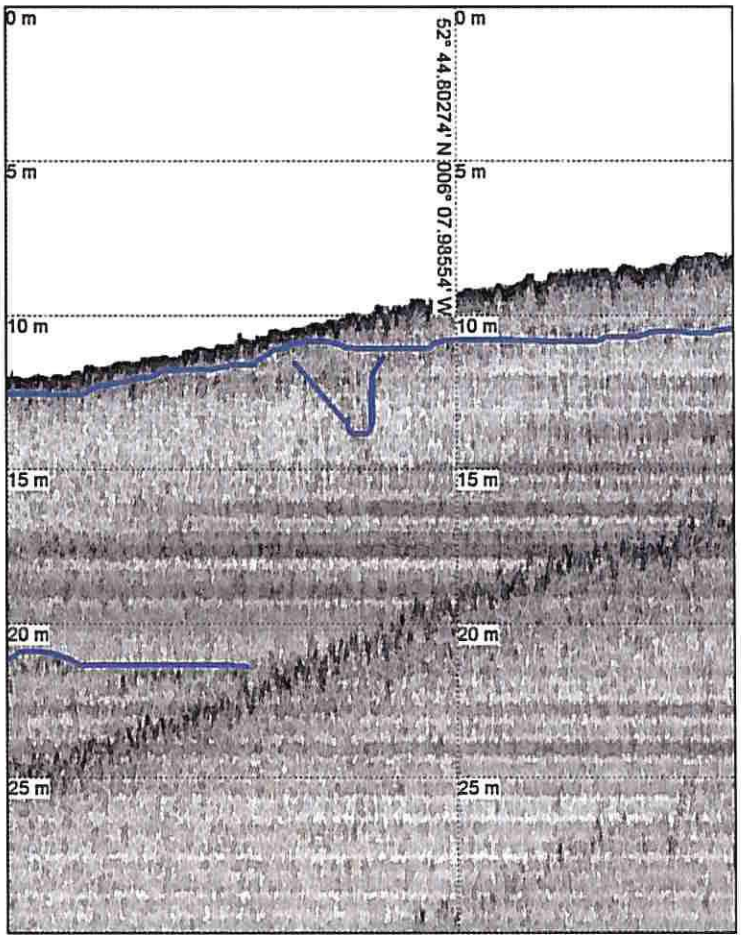

Plate 18. Mainline 8(b)

5.2.15 Mainline 9:

Mainline 9 was a S - N orientated line which measured 1.039 km in length. The data indicates that there are four discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon was relatively flat with a small rise in the centre and also at the southern end. It directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth. Almost exactly mirroring the previous, Mainline 6, a third stratigraphic horizon was noted on the northern end of the line. It measured c. 2.5m in depth and 421m in length. The data appeared to indicate that the layer represented an unconsolidated horizon, possibly gravel. Immediately underlying this layer was the undulating basal horizon which has been interpreted as bedrock. The bedrock layer appeared to be shallower towards the northern end of the line and then increased in depth towards the south.

A small gas-like structure is visible towards the centre of the presented processed data trace. This anomaly was not present on the raw recorded data and should not be considered. It is a derivative of the application of a swell filter during data processing. A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

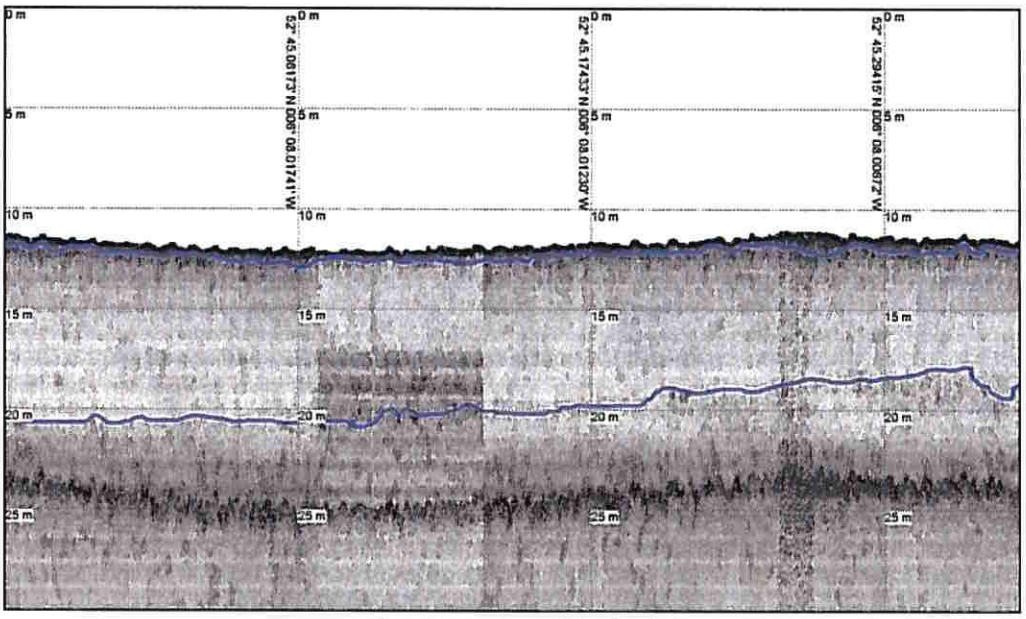

Plate 19. Mainline 9

5.2.16 Mainline 9(b):

Mainline 9(b) was a S-N orientated line which measured 575m in length. The seafloor in this area slopes gently downward from south to north. The data indicates there are three discernible sedimentary horizons. The uppermost of these varies in depth from 2m in the southern end of the trace to less than 1m in the northern section. This horizon overlies a partial horizon in the centre of the sonar trace which lies approximately 3m below the surface and measures approximately 5m in length. The deepest horizon can be seen in the northern end of the trace and is then truncated in the data by the multiple reflector of the seafloor. A sub surface feature was noted in the sonar trace at 52 44.832 N, 006 08.031 W. This feature was flat and it lay at a depth of between 4.5m and 5m below the seafloor surface. It is possible that this feature is related in some way to the other 'channel shaped' features in previous sonar traces.

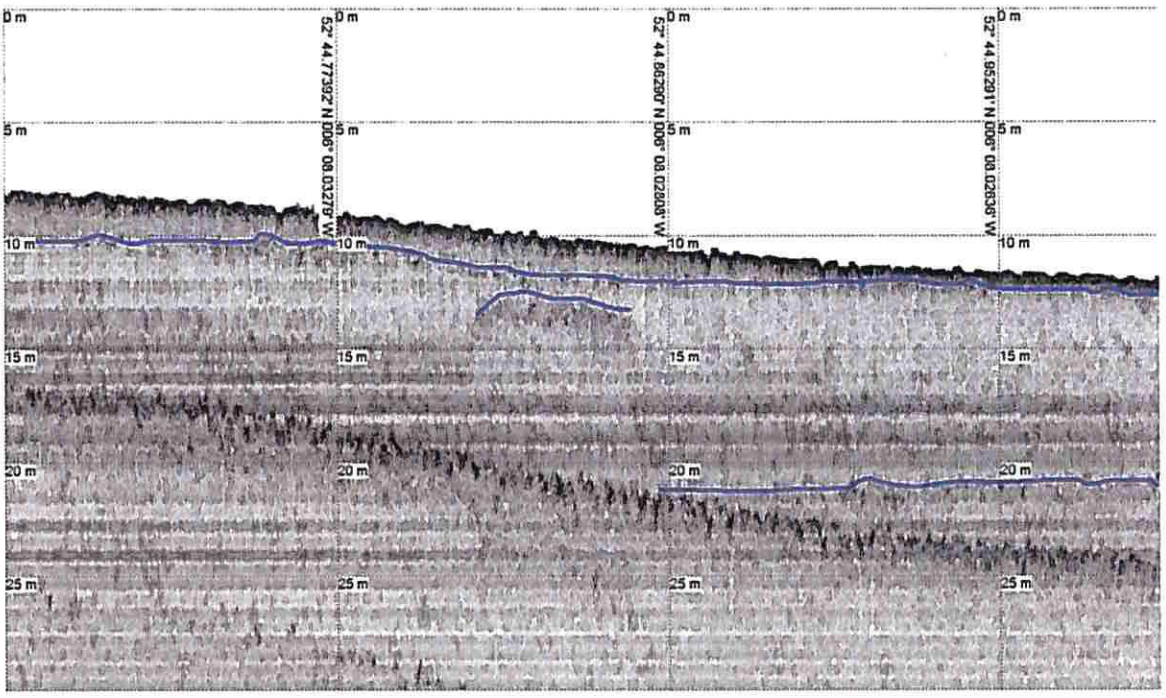

Plate 20. Mainline 9(b)

5.2.17 Mainline 10:

Mainline 10 was a N - S orientated line which measured 1.062 km in length. It showed a slowly southerly orientated dipping seafloor, which gently rises again in the south

The small seafloor undulation noted on the previous traces was less pronounced in this area. The data indicates that there are three discernible subsurface horizons in this area. The uppermost of these was a thin 0.4 – 0.6m deep mobile sediment. This horizon directly overlay a horizon which was represented on the sonar trace by a uniformly consistent stratigraphic sequence. The deposit measured 4.9-7.1m in depth and overlay an undulating basal horizon which has been interpreted as bedrock. The bedrock layer appears to have a distinct southerly slope.

A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

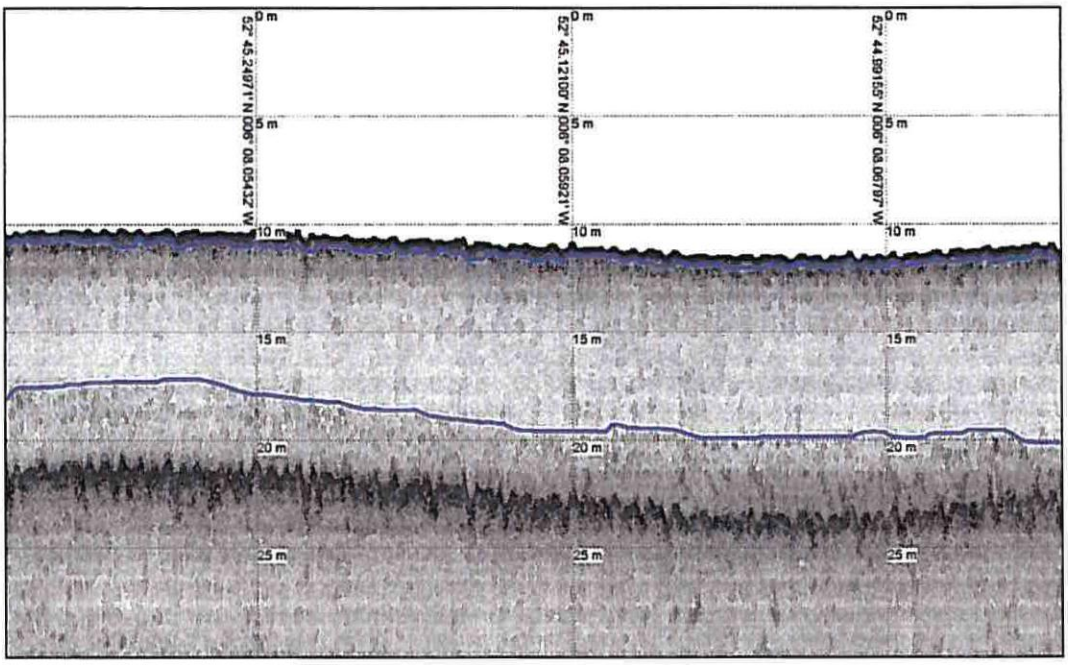

Plate 21. Mainline 10

5.2.18 Mainline 10(b):

Mainline 10(b) was a N-S orientated line which measured 528m in length. Similar to mainline 9(b) the seafloor in this area slopes gently downward from south to north. Three discernible horizons are seen in the sonar trace. The uppermost of these varies in depth from 2m in the southern end of the trace to less than 1m in the northern section. This horizon overlies a partial horizon in the centre of the sonar trace which lies approximately 3m below the surface and measures approximately 5m in length. The deepest horizon can be seen in the northern end of the trace and is then truncated in the data by the multiple reflector of the seafloor. A sub surface feature was noted in the sonar trace at 52 44.809 N, 006 08.0747 W. This feature resembled a channel in shape, its depth varied between 1m and 3m below the seafloor surface.

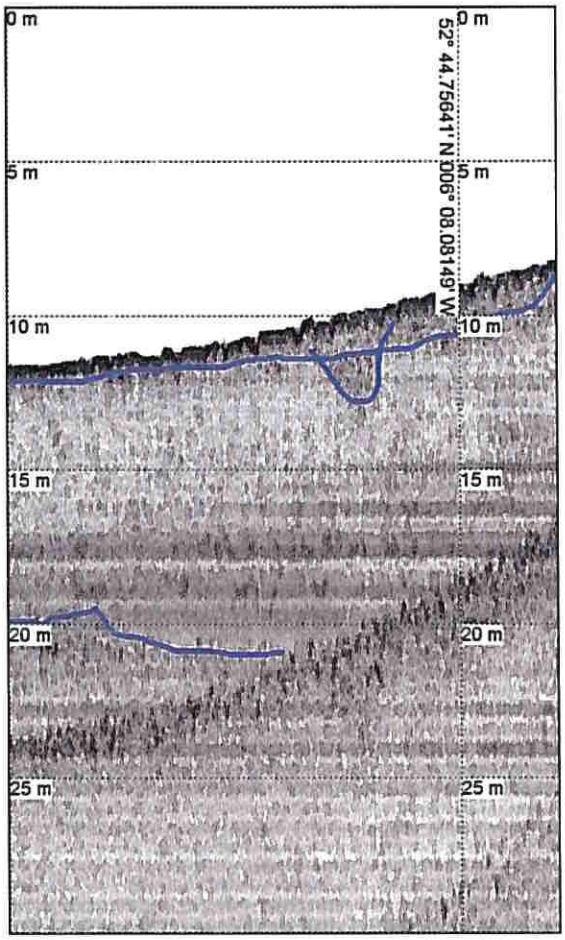

Plate 22. Mainline 10(b)

5.2.19 Mainline 11:

Mainline 11 was a 1.035m long, S-N orientated line which was almost a complete replica of Mainline 8. The three previously mentioned horizons where present at the same depths and the distinct southerly slope of both the seafloor and bedrock were visible.

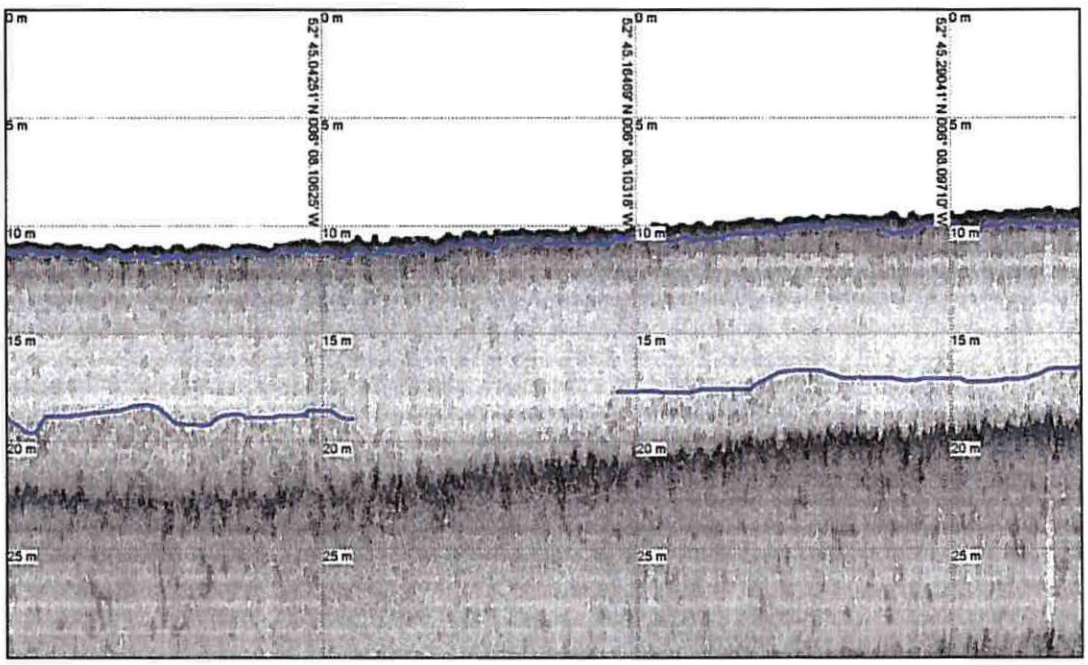

Plate 23. Mainline 11

5.2.20 Mainline 11(b):

Mainline 11(b) was a S-N orientated line which measured 547m in length. The seafloor in this area slopes gently downward from south to north. The data indicates there are three discernible sedimentary horizons. The uppermost of these varies in depth from 2m in the southern end of the trace to less than 1m in the northern section. The deepest horizon can be seen in the northern end of the trace and is then truncated in the data by the multiple reflector of the seafloor. A sub surface feature was noted in the sonar trace at 52 44.7959 N, 006 08.11943 W. This feature resembled a channel in shape, its depth varied between 1m and 2.5m below the seafloor surface

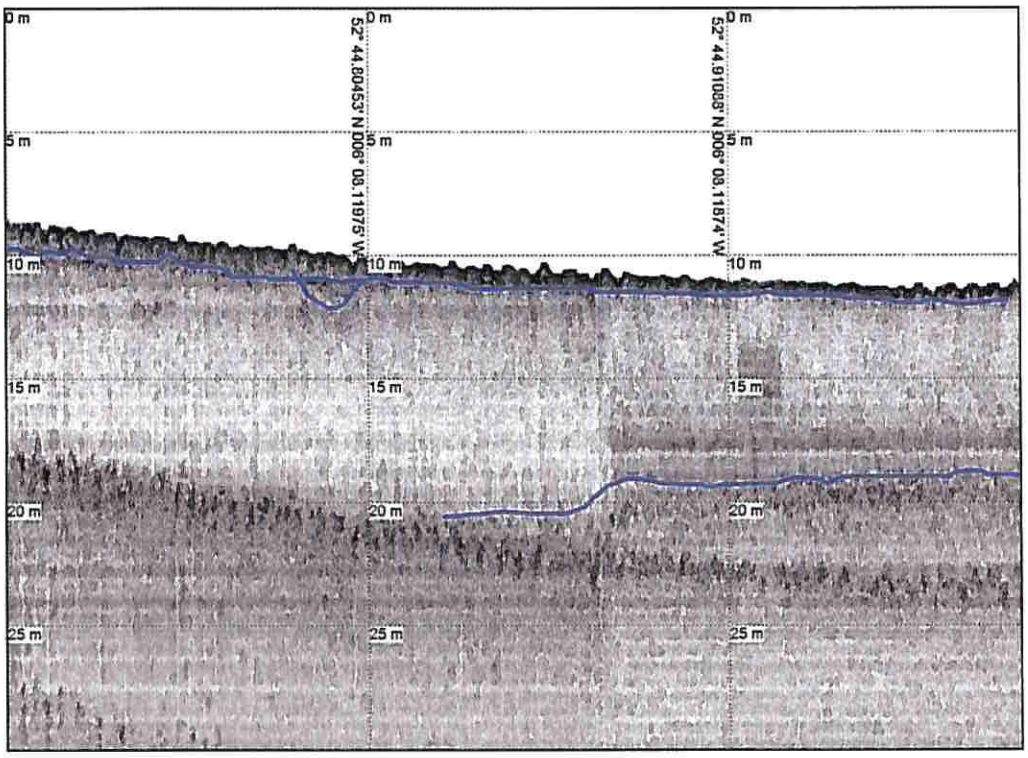

Plate 24. Mainline 11(b)

5.2.21 Mainline 12:

Mainline 12 was a N-S orientated line which measured 1.127 km in length. The sea state at the time of survey for this line of data was quite poor and so the resolution seen in other traces is not present. Notwithstanding this however the data indicates that there are two discernible subsurface horizons in this area. The uppermost of these measured between 0.6 and 1.5m in depth. This layer is continuous throughout the sonar trace. Towards the southern end of the line another partial horizon can be seen at a depth of c.10m below the seafloor surface. This horizon has been interpreted as bedrock. This bedrock layer is truncated by the multiple reflector which can be seen to mirror the seafloor surface.

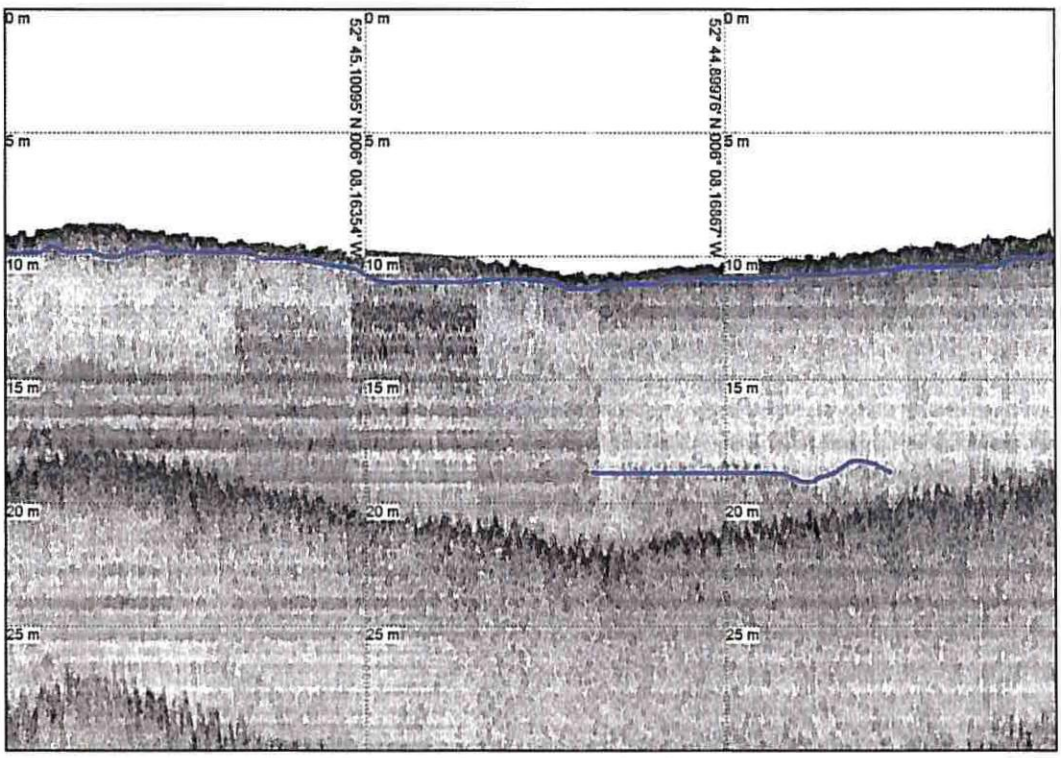

Plate 25. Mainline 12

5.2.22 Mainline 13:

Mainline 13 was a N-S orientated line which measured 1.13km in length. Similar sea state conditions were encountered at the time of survey as those for Mainline 12. This had a negative impact on the resolution of the data. A reflector can be seen in the sonar trace at a depth of between 1-2 m below the seafloor surface. In the central area of the survey line a deeper horizon appears. It is located approximately 8m below the seafloor. It is likely that this deeper reflector is a continuation of the 'bedrock' reflector noted in many of the sonar traces. A multiple reflector of the seafloor was noted beneath the bedrock layer. This was clearly evident as it mirrored the seafloor surface and thus should not be considered.

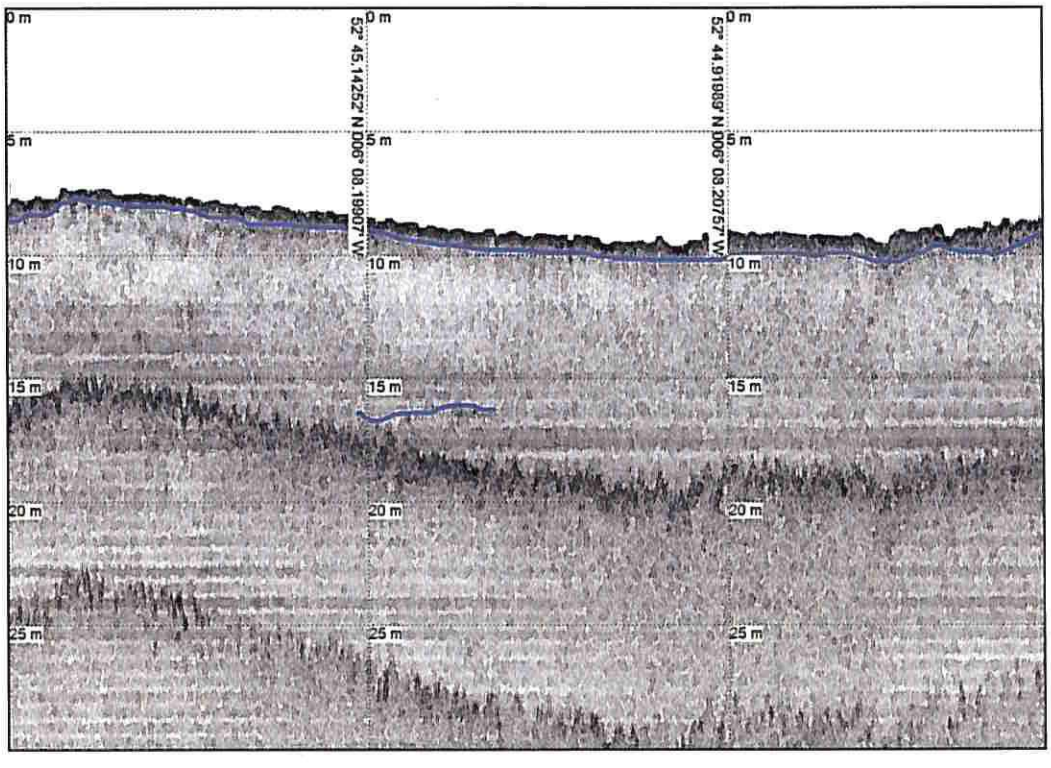

Plate 26. Mainline 13

5.2.23 Crossline 1:

Crossline 1 was an E - W orientated line which measured 512.5 m in width. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present.

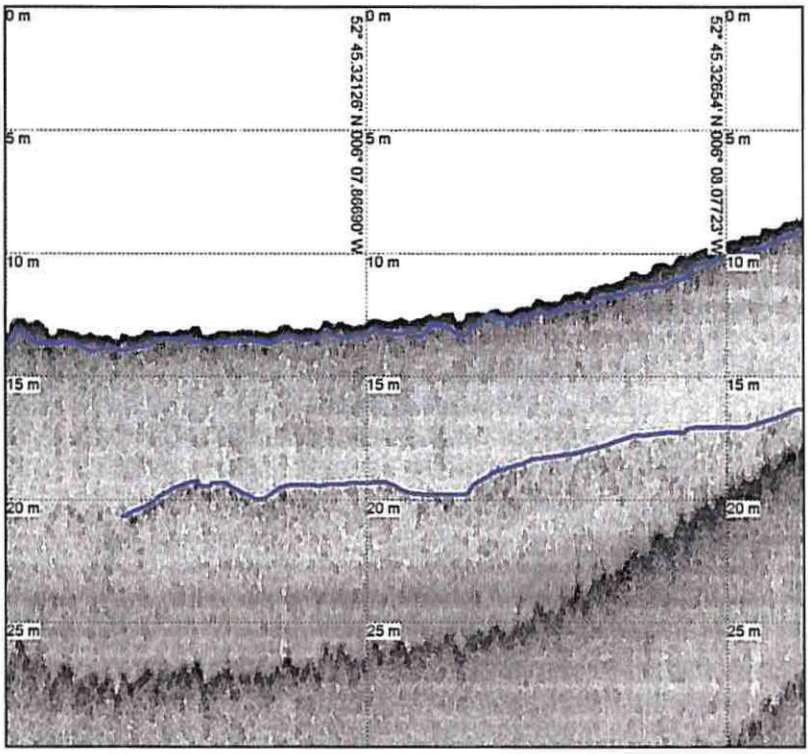

Plate 27. Crossline 1

5.2.24 Crossline 1(b):

Crossline 1(b) was a E-W orientated line which measured 683m in length. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present.

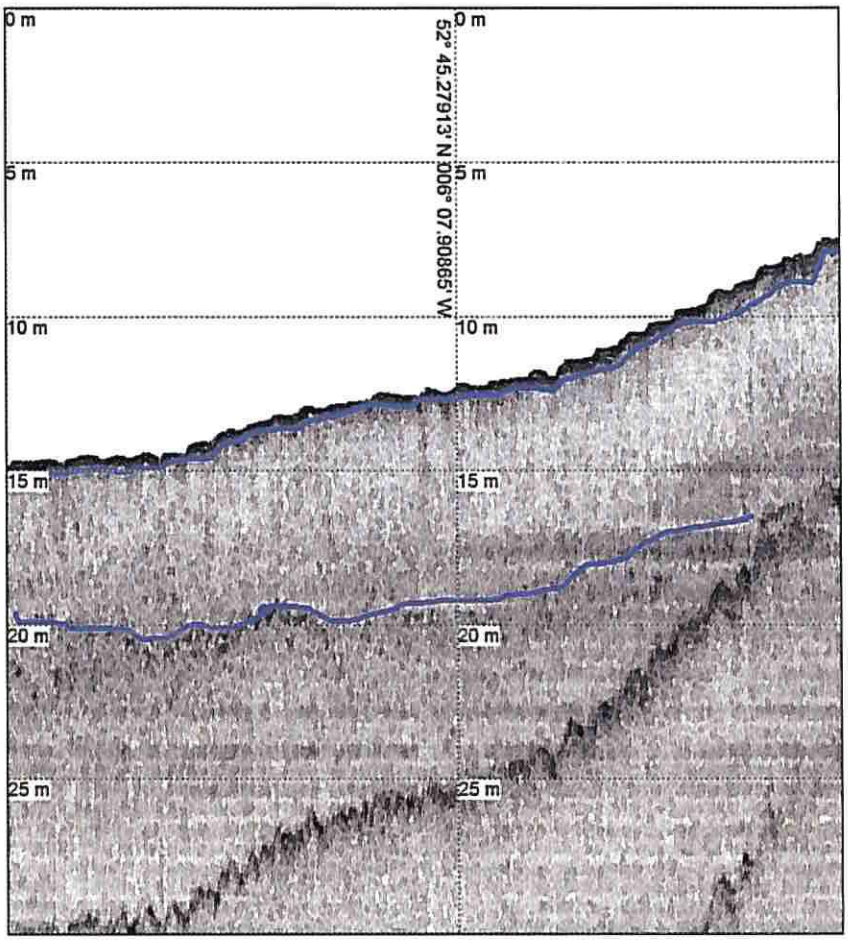

Plate 28. Crossline 1(b)

5.2.25 Crossline 2:

Crossline 2 was a W-E orientated line which measured 625m in width. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present.

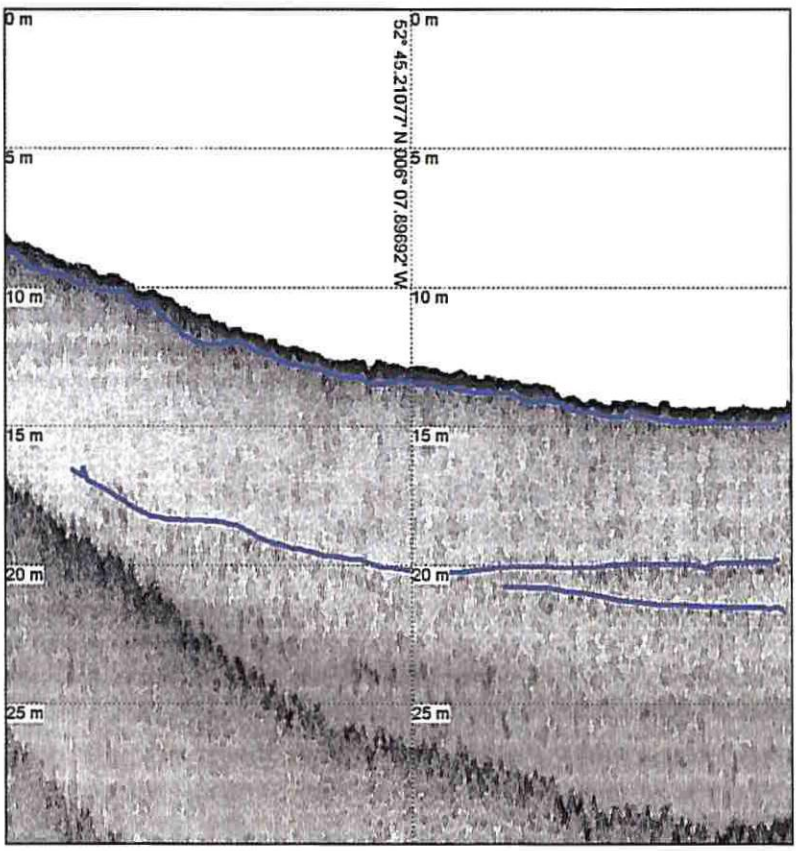

Plate 29. Crossline 2

5.2.26 Crossline 2(b):

Crossline 2(b) was a W-E orientated line which measured 716m in length. The sonar trace shows a clear easterly slope in the area. . The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present.

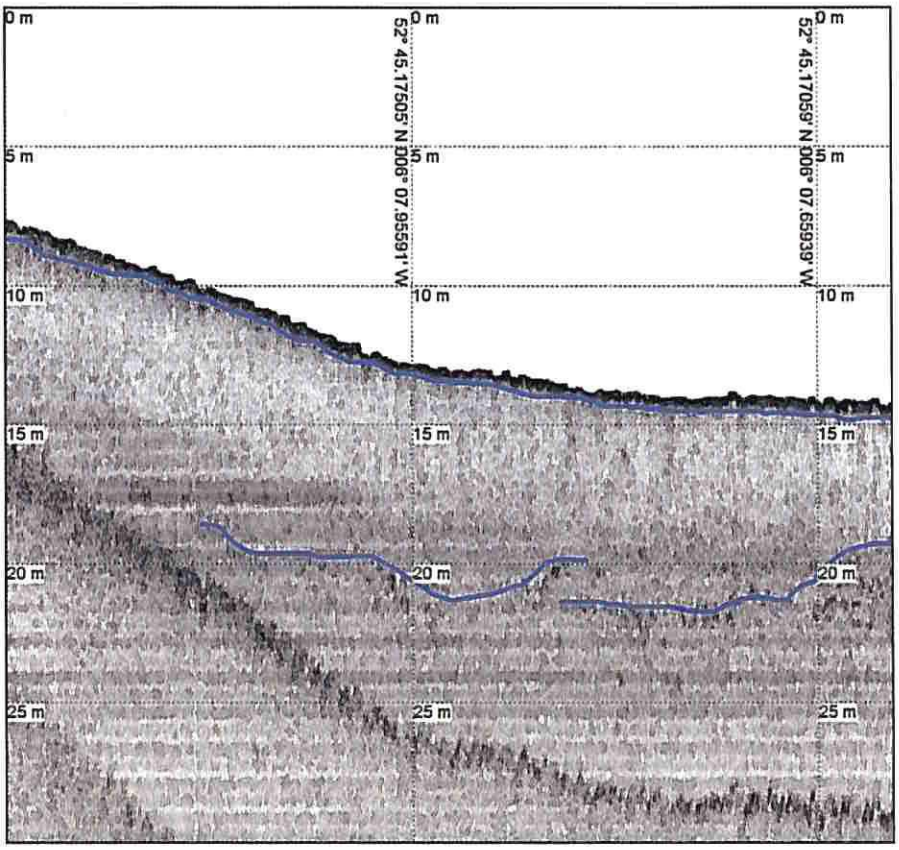

Plate 30. Crossline 2(b)

5.2.27 Crossline 3:

Crossline 3 was an E - W orientated line which measured 527 m in width. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present. A small possible gravel patch was also noted overlying bedrock on eastern end of the line. This horizon was also noted on the N – S orientated lines

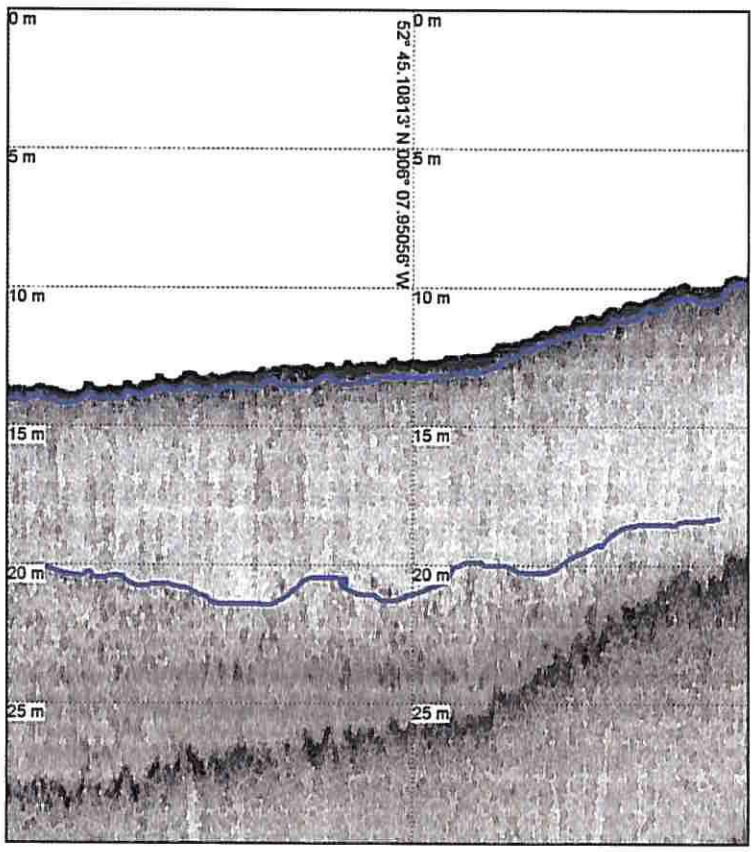

Plate 31. Crossline 3

5.2.28 Crossline 3(b):

Crossline 3(b) was a E-W orientated line which measured 727m in length. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present.

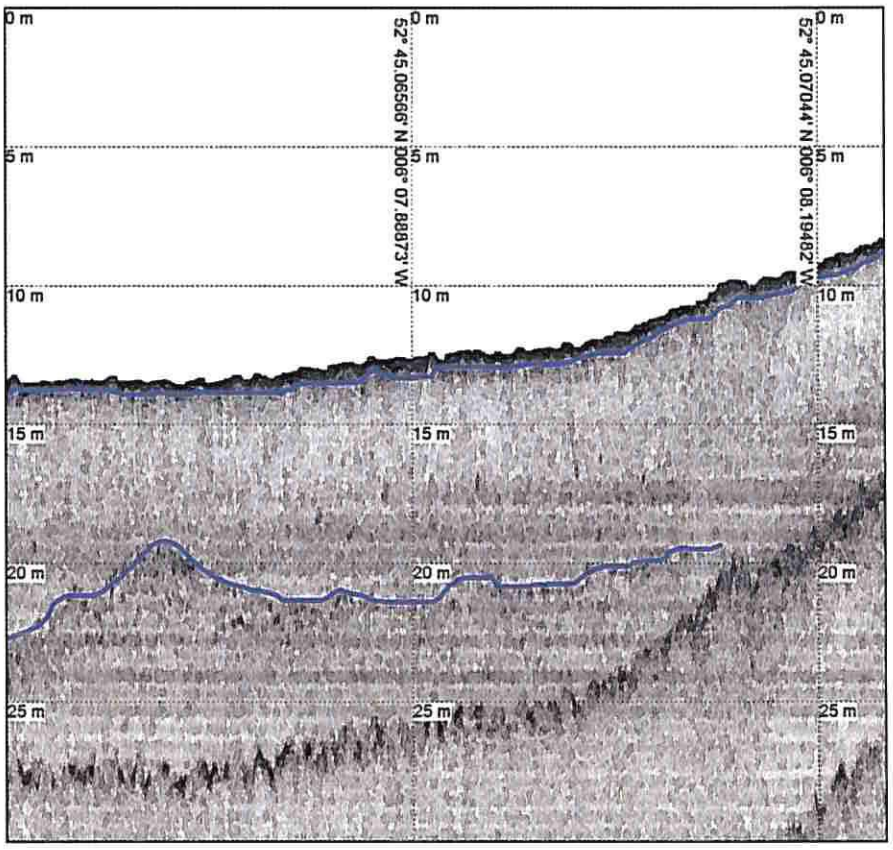

Plate 32. Crossline 3(b)

5.2.29 Crossline 4:

Crossline 4 was a W-E orientated line which measured 538m in width. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present. A small possible gravel patch was also noted overlying bedrock on eastern end of the line. This horizon was also noted on the N – S orientated lines

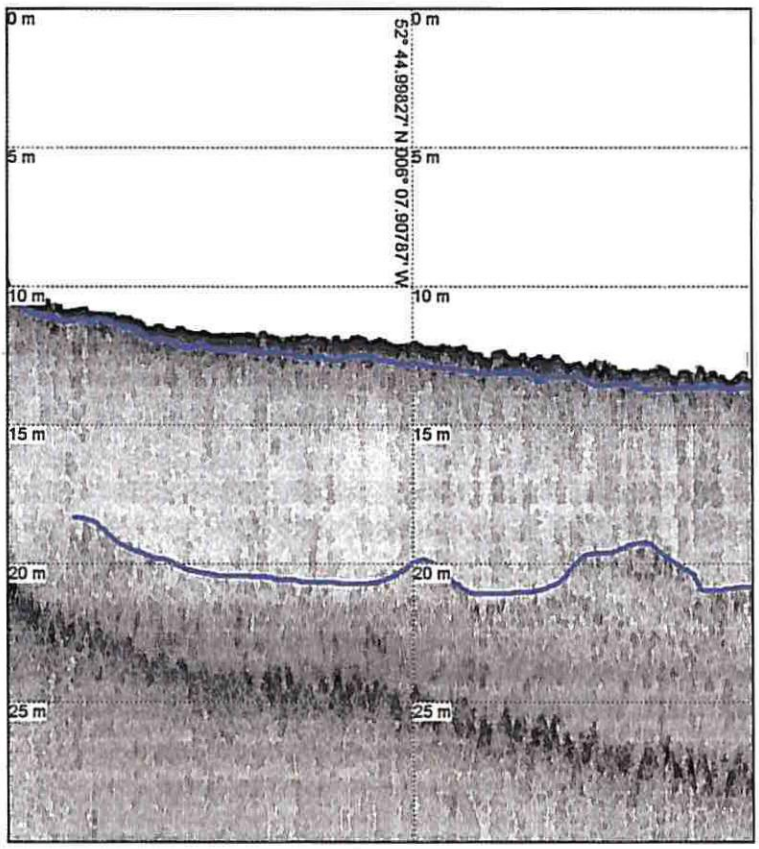

Plate 33. Crossline 4

5.2.30 Crossline 4(b):

Crossline 4(b) was a W-E orientated line which measured 642m in length. This trace shows a clear easterly slope to the area. The same three principal horizons of mobile sand, consolidated material and bedrock, which were noted on the N – S orientated survey lines were all present. A sub surface feature was noted in the sonar trace at 52 44.949 N, 006 07.690 W. This feature resembled a channel in shape, its depth varied between 1m and 2.5m below the seafloor surface

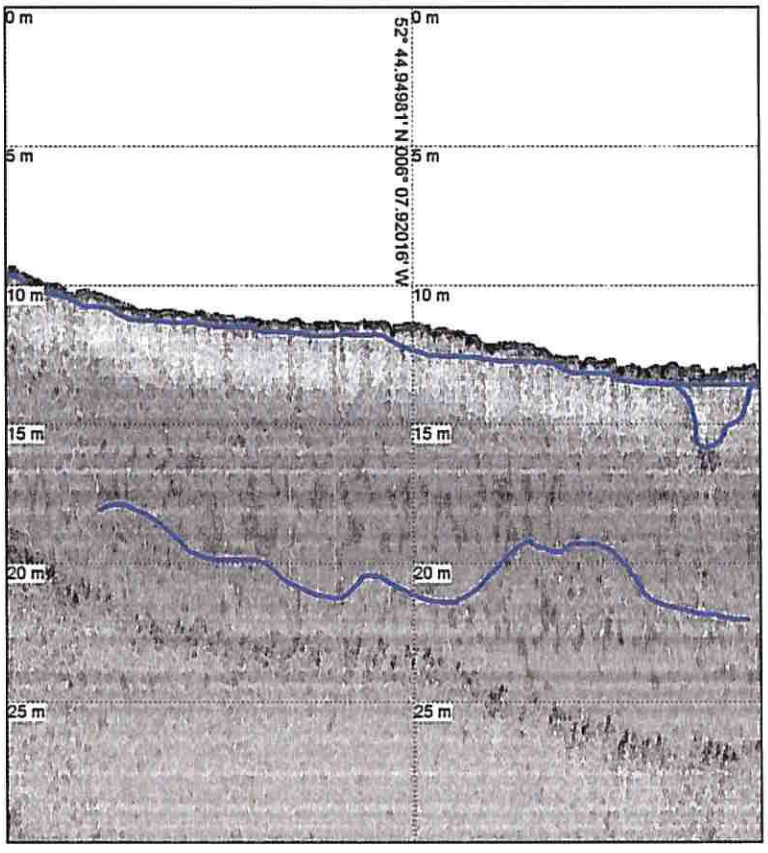

Plate 34. Crossline 4(b)

5.2.31 Crossline 5:

Crossline 5 was a E-W orientated line which measured 745m in length. This trace shows a clear easterly slope to the area. Only the two uppermost horizons of mobile sand and consolidated material, which were noted on the N – S orientated survey lines were present. At the time of survey the sea state has deteriorated and may have led to the loss of resolution further down in the sonar trace. A sub surface feature was noted in the sonar trace at 52 44.8499 N, 006 07.946 W. This feature resembled a channel in shape, its depth varied between 1m and 3m below the seafloor surface.

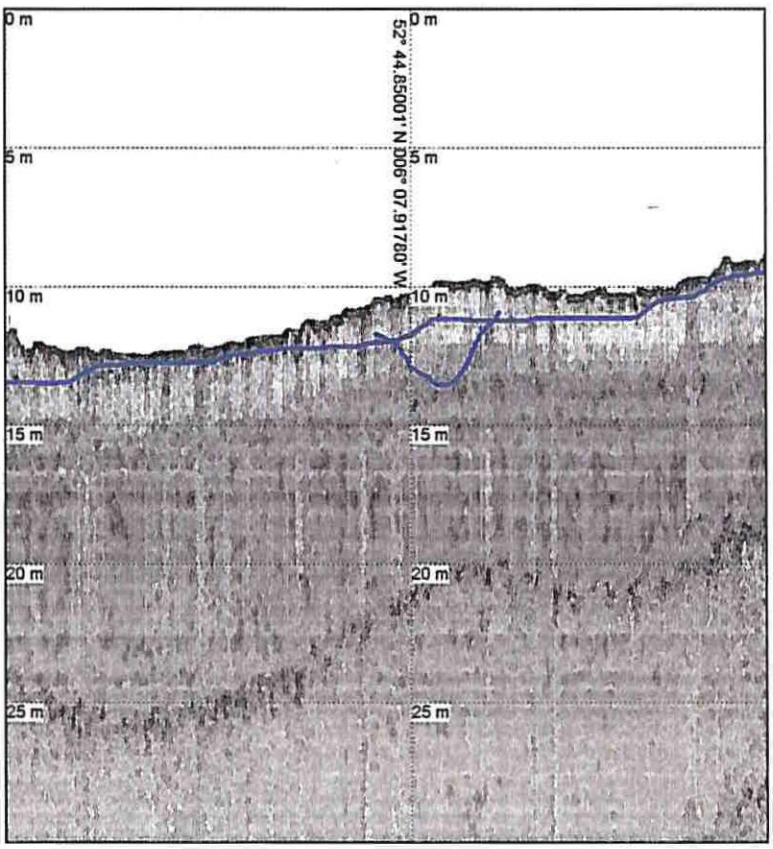

Plate 35. Crossline 5

5.2.32 Crossline 6:

Crossline 6 was a W-E orientated line which measured 603m in length. Similar to crossline 5, two of the principal horizons from the mainline sonar traces are present. The horizon which was interpreted as bedrock is not noted in this sonar trace. At the time of survey the sea state has deteriorated and may have led to the loss of resolution further down in the sonar trace. A sub surface feature was noted in the sonar trace at 52 44.7351 N, 006 08.178 W. This feature resembled a channel in shape its depth varied between 1m and 2.5m below the seafloor surface.

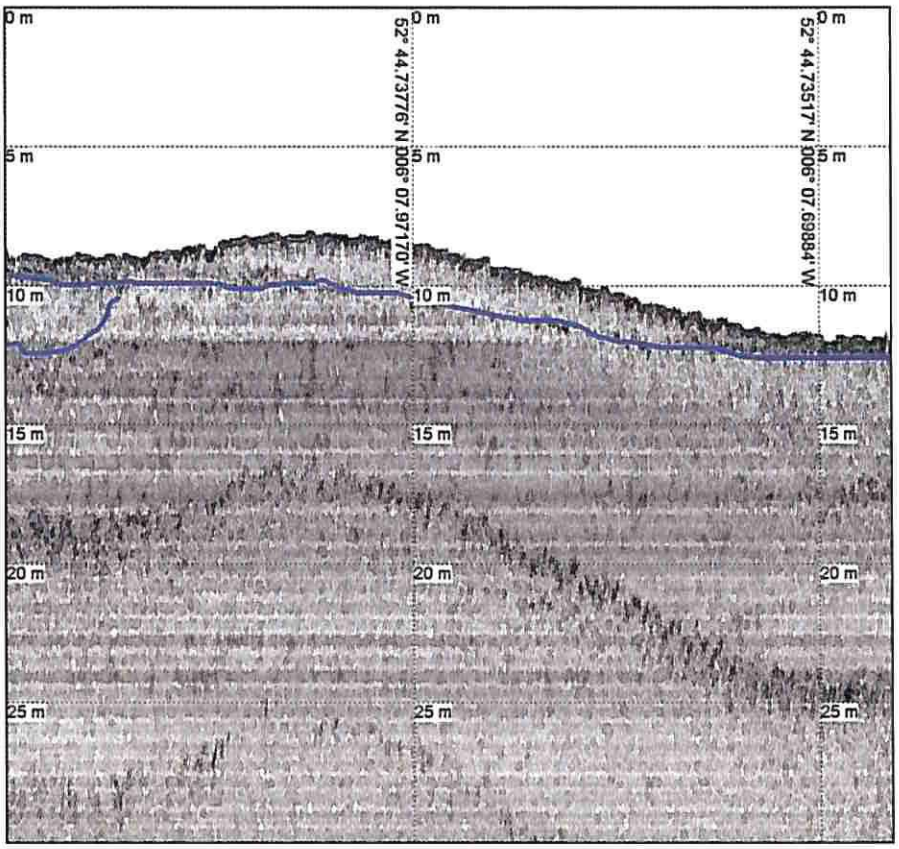

Plate 36. Crossline 6

6 Conclusions

The results of the survey indicate that there is a distinct west to east slope to the site topography. Four distinct stratigraphic horizons were noted across the site. These comprised, an uppermost mobile sand horizon which measured 0.4-0.7m in depth and was present throughout the entire site.

Underlying this was a 4.9-7.1m depth of uniformly cohesive material, most likely marl. Apparent bedrock was noted throughout the site sloping from west to east. It appeared as a slightly undulating horizon which had pockets of overlying gravel in the east. The finding of this program of survey appear to correlate with the findings of the desktop assessment and the results of a previous geophysical survey undertaken a short distance to the north.

It should be noted however that all measurements are based on interpretation of acoustic data. These are no substitute for undisturbed site measurements.

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