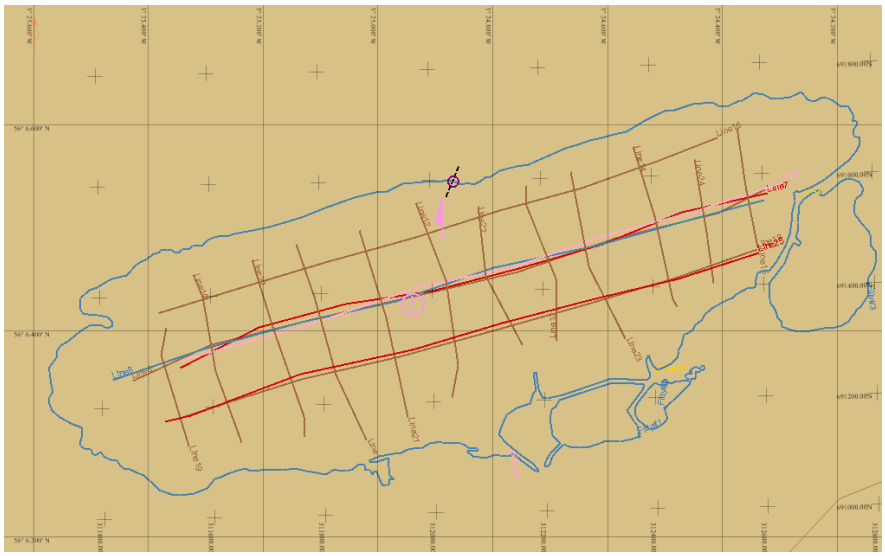
British Geological Survey
NATURAL ENVIRONMENT RESEAR

Surface Tow Boomer Survey of Loch Fitty for Scottish Coal, BGS Report no 2009/02

Marine Programme

Internal Report CR/09/045



BRITISH GEOLOGICAL SURVEY

MARINE PROGRAMME

INTERNAL REPORT CR/09/045

Surface Tow Boomer Survey of Loch Fitty for Scottish Coal, BGS Report no 2009/02

D.G.Wallis

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BRITISH GEOLOGICAL SURVEY

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Foreword

This report is the published product of a study by the British Geological Survey (BGS) as part of a study commissioned by Scottish Coal to ascertain the depth of sediment covering the coal seams beneath Loch Fitty in Fife. The following BGS personnel were involved in the operation described in this report.

David Wallis (Electronics Engineer)

Eileen Gillespie (Navigation)

Alister Skinner (Helmsman).

Acknowledgements

In addition to the BGS staff acknowledged in the Foreword, Neil Gray and Hugh **XXX** contributed to the production of this report.

Contents

Foreword ..... **i**

Acknowledgements ..... **i**

Contents ..... **ii**

Summary ..... **ii**

1 Introduction **1**
1.1 Vessel and Equipment 1

2 GPS **3**

3 Narrative **4**
3.1 Day 1 Operations 4
3.2 Day 2 operations 6
3.3 Day 3 Demobilisation 6

Appendix 1 Daily Summary Loch Fitty STB Survey **7**

Appendix 2 Seismic Log **11**

Photographs

1 Cabin Layout 1
2 Survey Launch Tuppence 2
3 State of weather/water on Day 1 (mob – 23/03/09 – 1500hrs) 5

Summary

This report describes the operational aspects of an investigation commissioned by Scottish Coal into the sediment cover of the coal beneath Loch Fitty in Fife. The principal tools used were a surface towed boomer (STB) and a single beam echosounder

1 Introduction

This report describes a surface towed boomer survey of Loch Fitty using a small boat with a partially covered working space for the installation of the necessary high voltage power supply and recording equipment. The original aim was to try a variety of different settings on the seismic power source and receiving hydrophone. Due to the weather deteriorating during the final day of survey, with poor weather forecast for the remainder of the week, it was not possible to further refine the data collection settings.

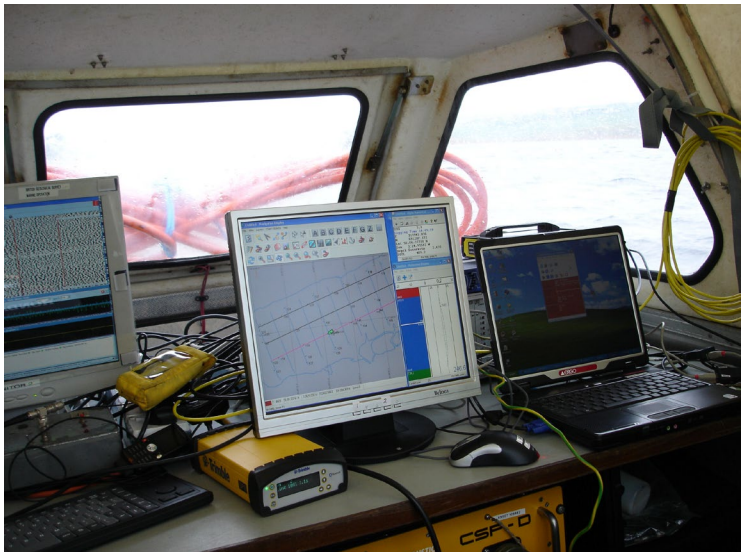
The mobilisation of the equipment was accomplished during the morning of Monday 23rd March with the afternoon being given over to equipment and vessel trials to establish best operating methods and power settings for the boomer source. It also allowed the helmsman some time to familiarise himself with the line-steering display from the navigation program.

1.1 VESSEL AND EQUIPMENT

The vessel chosen for this project was the small 'Buster'™ outboard powered 'Tuppence' provided by ACS Coring Services. The following equipment was installed on the boat:-

- Applied Acoustics CSP2400D HV power supply.
- Trimble Sonarmite single beam echosounder.
- Trimble VRS SPS850 Rover Differential GPS receiver complete with mobile telephone / Bluetooth differential signal correction system.
- EG&G265 surface towed 6 element hydrophone.
- Applied Acoustics A300 boomer plate installed in Applied Acoustics catamaran.
- Ergo laptop running QINSy navigation software.
- BGS custom hydrophone amplifier.
- CODA DA2000 seismic data acquisition system.

The mobilisation was accomplished on the first morning at the loch.



1 Cabin Layout

Cabin layout onboard Tuppence, showing (L>R) Coda Seismic display, Trimble GPS set, QINSy navigation display and QINSy laptop.



2 Survey Launch Tuppence

2 GPS

This set had been hired from Survey Solutions as it was hoped to have a more accurate horizontal resolution, primarily for use with the bathymetry data than could be obtained using the standard Lighthouse Authority beacons differential signal. The differential signal was provided as a ‘virtual’ signal and received on a mobile phone fitted with a Bluetooth transmitter to relay the corrections to the GPS receiver. The set had available a second antenna which was intended to be able to provide heading information. However, the vessel was unable to accommodate this second antenna and as result heading information is CMG (Course Made Good) at all times.

The antenna was mounted on the top of a pole fixed to the vessel amidships and the echosounder was attached to the base of this pole. The layback diagram in the appendices shows the exact configuration.

The GPS antenna and set, complete with mobile phone receiver, was taken to a reference station provided by Scottish Coal to confirm the correct operation of the geodetic equipment. The results are shown below.

NG3 Ref position:	E 312402.457,	N 691246.962
GPS position:	E 312401.630,	N 691246.777

It was found that the mobile telephone would only communicate with the GPS receiver when they were within 50cm of each other and this communication was shown on the GPS display. Subsequent operation, particularly at the north-western corner showed that there was a ‘hole’ in the telephone coverage and as a result data from that area should be treated with care. Fortunately, the lack of coverage area was relatively small, probably only 100m by 100m and the remainder of the loch would appear to have accurate positions at all times.

3 Narrative

The vessel selected for this project was a Buster'™ outboard launch, some 6 metres long, with partially covered accommodation at the bow where it was intended to place the electronic equipment. This meant that in heavy rain with wind from astern the equipment would be unprotected from water ingress, whilst in the same conditions with a reverse heading little or no water could interfere with the electronics.

3.1 DAY 1 OPERATIONS

The BGS team arrived at the jetty at the loch at 0800 on Monday 23rd March. The survey equipment was packed inside a transit van. The vessel was on a towing trailer and required launching before mobilisation could start.

Scottish Coal had removed the debris from the slipway area, allowing a relatively smooth deployment of the boat into the loch, at which point it was taken out for brief trials to ensure that the transit to the loch had not resulted in any damage.

During this period the DGPS set, including mobile telephone, was taken to two of the reference positions provided by Scottish Coal. This was to confirm that the positions derived from the system were in agreement with the accepted survey datum for the project and that the result, while stationary, showed a relatively small variation in both X and Y coordinates.

The next 3 hours were taken up by installing the survey equipment on the vessel in such a way as to optimise the trim for survey while ensuring that there was maximum protection from the elements, particularly for the HV power supply. The boomer was deployed in the water behind the vessel, there not being any intention to take it onboard as was usual with such equipment.

The first part of the afternoon was taken up with running the navigation program, data recording system and firing the boomer while still tied to the jetty. These trials lasted till around 1500 when it was decided to run some test lines to adjust the tow configuration and 'shakedown' the layout.

For two hours a number of lines were run without any usable data being acquired. This was because there was an earth fault, untraceable at that time, which kept making both the navigation program and HV power unit reset at unpredictable intervals. Most of the trials were confined to east/west lines, these giving the longest opportunities for adjustment. Finally at 1730 the vessel was tied up at the jetty and the team left the loch for accommodation nearby.

For overnight security a landrover and watchman were stationed at the jetty car park. The vessel itself was tied off between two adjacent piers, some two metres from either, to ensure that easy access was not possible without some considerable effort. The laptops and data acquisition equipment were taken back to the hotel for the night to enable data printout. In the event these precautions proved successful and no external interference occurred.



3 State of weather/water on Day 1 (mob – 23/03/09 – 1500hrs)

3.2 DAY 2 OPERATIONS

After arrival at the jetty on the second day the vessel was retrieved to its normal tied up location. The next hour was spent in fitting earth cables and ensuring that the electrical connections could provide least disruption to the operation. These efforts were later found to be successful as the unpredictable ‘trips’ and resets no longer occurred.

After casting off the vessel proceeded to the Western end of the loch to run the first line heading East down the centre of the loch. We had an outline of the loch plotted on the navigation display; however, it had not been possible to obtain charts compatible with the software and this gave the clearest run to collect data without meeting depth constraints.

Initially a variety of settings were tried for the HV power unit, eventually settling on 200Joules at the high frequency setting to enhance resolution.

The line sequence was as follows:

- Lines 6, 7, 8 and 9 running east-west along the centre of the loch
- Lines 10 through 15 were run north – South using the proposed line sequence, missing out alternate lines, culminating at the Eastern end of the loch.
- Line 16 heading west along the northern shores of the loch.
- Line 17 heading east along northern shore of loch
- Line 18 heading west along southern shore of loch
- Lines 19 through 24 ‘filling in’ north/south lines missed out during morning session.
- Line 25 being a repeat of line 18 along southern shore of loch

At this point the Westerly wind increased in strength and it started to rain, forcing water onto the equipment on all headings except those between SW and NW. This effectively ruled out most of the lines for rerun and made line-keeping almost impossible due to the windage of the vessel.

After some minutes trying to ensure minimal water ingress to the covered area it was decided to abandon operations for the day and head for the jetty. At this point all the proposed lines had been run at least once and all the East-West lines run more than once.

On return to the jetty the vessel was again moored off between the two piers and the computer equipment removed to the hotel to allow printing of the seismic data onto thermal film.

3.3 DAY 3 DEMOBILISATION

Following study of the weather forecast for the rest of the week it was concluded that the wind strength would preclude all operations for at least a week. The printed data profiles seemed to cover the required area and the data collecting part of the operation was terminated.

After arrival at the jetty and a brief meeting with Neil Gray the demobilisation was started. This culminated with the vessel being returned to its trailer and all being ready for return to Edinburgh by midday.

Appendix 1 Daily Summary Loch Fitty STB Survey

Date: 23/03/09 JD: 82

Time	
0810	Arrive Loch Fitty car park. Commence mobilisation on ASCK vessel 'Tuppence'.
0930	Check Reference Station NG3, provided by Scottish Coal.
	Ref position: E 312402.457, N 691246.962 GPS position: E 312401.630, N 691246.777
1230	HVPSU tests OK, GPS tests OK, CODA tests OK.
1510	Cast off heading for North side of loch.
1610	QINSy resetting without know cause. CSP resetting without known cause.
1617	SOL1 Fix 22 Heading East. CSP 200J HI
1620	QINSy tripped and reset.
1630	EOL1 Fix 24
1632	SOL2 Fix 25 Heading West
1639	QINSy tripped and reset.EOL2
1644	SOL3 Fix 22
1647	EOL3 Fix 24
1649	CSP 200 J LO
1652	SOL4 Fix 25
1653	CSP tripped and reset.
1700	QINSy tripped and reset. EOL4 Fix 29
1708	SOL5 Fix 30
1713	EOL5 Fix 32

Total km of completed lines:

	Today (hours)	Total (hours)
Setting up (and demobilising)	7	7
On Line	0.6	0.6
Steaming	1.2	1.2
Weather/Vessel Downtime	0	0
Equipment Downtime	0.5	0.5
Total	9.3	9.3

Daily Summary Log 2009_02 Loch Fitty STB Survey

Date: 24/03/09 JD: 83

Time	
0805	Arrive Loch Fitty car park.
0915	All setup after installation of proper earthing wires in attempt to cure resetting of previous day. QINSy run for 10 minutes.
0940	Cast off CSP set to **200J LO**
0957	SOL 6 Fix 40 Heading East. Running length of loch from Western end. CODA file 240309.095426.cod
1010	EOL6 Fix 47
1014	SOL 7 Fix 48. Heading West. CODA file 240309.101343.cod
1028	EOL 7 Fix 55. Change CSP to **200J HI**
1032	SOL 8 Fix 57. Heading East. CODA file 240309.103113.cod
1045	EOL 8 Fix 64
1048	SOL 9 Fix 65 Heading West CODA file 240309.104819.cod
1100	EOL 9 Fix 72. Change CSP to **200J LO.**
1107	SOL 10 Fix 73. Heading South. CODA file 240309.110639.cod
1109	Vessel speed change
1112	EOL 10 Fix 76
1117	SOL 11 Fix 77. Heading North. CODA file 240309.111700.cod
1122	CSP trip. Interlock fault. Reset CSP. Data loss 5 seconds.
1122	EOL 11 Fix 80. Change CSP to **200J HI**.
1125	SOL 12 Fix 81. Heading South. CODA file 240309.112500.cod
1130	EOL 12 Fix 84.
1132	SOL 13 Fix 85. Heading North. CODA file 240309.113314.cod
1137	EOL 13 Fix 88.
1140	SOL 14 Fix 89. Heading South. CODA file 240309.113952.cod
1144	EOL 14 Fix 92.
1148	SOL 15 Fix 93. Heading North. CODA file 240309.114708.cod
1151	EOL 15 Fix 95.
1154	Vessel strikes submerged fence post.
1154	SOL 16 Fix 96. Heading West. CODA file 240309.115246.cod
1208	EOL 16 Fix 104.
1210	Hydrophone inboard. Proceeding to dock for lunch.
1310	PC clock on QINSy Laptop reset to UTC. (Note – up till now this clock had been 10 seconds fast.)

Daily Summary Log 2009_02 Loch Fitty STB Survey

Date: 24/03/09 (continued) JD: 83

Time	
1315	Cast off. Proceeding to rerun line 16 as line 17 with opposite heading.
1325	SOL 17 Fix 105. Heading East. CODA file 240309.132345.cod
1328	Hydrophone tow and buoyancy adjusted.
1330	CSP tripped. Reset. Load fault. No known cause. DGPS correction signal lost.
1332	DGPS signal returns.
1337	EOL 17 Fix 112.
1342	SOL 18 Fix 113. Heading West. CODA file 240309.134126.cod
1354	EOL 18 Fix 120
1356	SOL 19 Fix 121. Heading North. CODA file 240309.135617.cod
1359	EOL 19 Fix 123
1402	SOL 20 Fix 124. Heading South. CODA file 240309.140143.cod
1406	EOL 20 Fix 127.
1411	SOL 21 Fix 129. Heading North. CODA file 240309.140905.cod
1415	EOL 21 Fix 131.
1419	SOL 22 Fix 132. Heading South. CODA file 240309.141909.cod
1423	EOL 22 Fix 134.
1427	SOL 23 Fix 135. Heading North. CODA file 240309.1426298.cod
1431	EOL 23 Fix 138.
1434	SOL 24 Fix 139. Heading South. CODA file 240309.143345.cod
1437	EOL 24 Fix 141.
1441	SOL 25 Fix 142. Heading West. CODA file 240309.144106.cod
1453	EOL 25 Fix 149.
1458	Cease operation due to driving rain and high wind.
1510	Tied up at jetty.
1600	Return to B&B to create data printouts and write up daily logs.

Total km of completed lines:

	Today (hours	Total (hours)
Setting up (and demobilising)	0	7
On Line	2.4	3.0
Steaming	5.6	6.8
Weather/Vessel Downtime	0	0
Equipment Downtime	0	0.5
Total	8.0	17.3

Daily Summary Log 2009_02 Loch Fitty STB Survey

Date: 25/03/09 JD: 84

Time	
0810	Depart B&B for loch.
0815	Arrive Loch Fitty. Meeting Neil Gray. Decision to demobilise equipment as weather forecast is poor.
1030	Van loaded. Commence removing vessel to towing trailer.
1200	Depart Loch Fitty.
1300	Arrive Loanhead.

Total km of completed lines:

	Today (hours	Total (hours)
Setting up (and demobilising)	5.0	12
On Line	0	3.0
Steaming	0	6.8
Weather/Vessel Downtime	0	0
Equipment Downtime	0	0.5
Total	5.0	22.3

Appendix 2 Seismic Log

BGS Marine Operations Seismic Tape Log CODA DA200			British Geological Survey NATURAL ENVIRONMENT RESEARCH COUNCIL						
Project: 2009/02			**Area: Loch Fitty**			**Sheet: 1 of 2**			
Recording Format: CODA			**Client: Scottish Coal**			**HDD**			
CH	**Source**	**Type**	**Power**	**Sample Freq (Hz)**	**Samples per Shot**	**Sweep (msec)**	**Firing Rate (sec)**	**Hydro-phone**	**Filter HP & Anti-alias**
1	**STB**	**AA300**	**200J HI/LO**	**10**	**2000**	**200**	**0.3**	**EG&G 265**	**458-4588Hz**
Date	**Time GMT**	**Line No:**	**Ping No:**	**Media**	**File No**	**File name**		**Comments**	
24/04/09	0907	6		HDD	1	240309.095426.cod		Sol 6 Fix 40 **200J LO**. Heading East	
	1010	6		HDD	1			EOL6 Fix 47	
	1014	7		HDD	2	240309.101343.cod		SOL 7 Fix 48. Heading West	
	1028	7		HDD	2			EOL 7 Fix 55	
	1032	8		HDD	3	240309.103113.cod		SOL 8 Fix 57 **200J HI.** Heading East	
	1045	8		HDD	3			EOL 8 Fix 64	
	1048	9		HDD	4	240309.104819.cod		SOL 9 Fix 65. Heading West	
	1100	9		HDD	4			EOL 9 Fix 72	
	1107	10		HDD	5	240309.110638.cod		SOL 10 Fix 73. **200J LO** Heading South	
	1109	10		HDD	5			Bangbox trip out. Vessel speed changes.	
	1112	10		HDD	5			EOL 10 Fix 76	
	1117	11		HDD	6	240309.111700.cod		SOL 11 fix 77. Heading North	
	1122	11		HDD	6			EOL 11 Fix 80	
	1125	12		HDD	7	240309.112500.cod		SOL 12 Fix 81. **200J HI.** Heading South.	
	1130	12		HDD	7			EOL 12 Fix 84.	
	1132	13		HDD	8	240309.113314.cod		SOL 13 Fix 85. Heading North	
	1137	13		HDD	8			EOL 13 Fix 88	
	1140	14		HDD	9	240309.113952.cod		SOL 14 Fix 89. Heading South	
	1144	14		HDD	9			EOL 14 Fix 92	
	1148	15		HDD	10	240309.114708.cod		SOL 15 Fix 93. Heading North	
	1151	15		HDD	10			EOL 15 Fix 95	
	1154	16		HDD	11	240309.15246.cod		SOL 16 Fix 96. Heading West	
	1208	16		HDD	11			EOL 16 Fix 104	
	1310			HDD				QINSy Nav PC clock reset by 10 seconds. T	

BGS Marine Operations Seismic Tape Log CODA DA200

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

Project: 2009/02			**Area: Loch Fitty**			**Sheet: 2 of 2**			
Recording Format: CODA			**Client: Scottish Coal**			**HDD**			
CH	**Source**	**Type**	**Power**	**Sample Freq (Hz)**	**Samples per Shot**	**Sweep (msec)**	**Firing Rate (sec)**	**Hydro-phone**	**Filter HP & Anti-alias**
1	**STB**	**AA300**	**200J HI**	**10**	**2000**	**200**	**0.3**	**EG&G 265**	**458-4588Hz**
Date	**Time GMT**	**Line No:**	**Ping No:**	**Media**	**File No**	**File name**		**Comments**	
24/03/09	1325	17		HDD	12	240309.132345.cod		SOL 17 Fix 105. 200J HI Heading East	
	1328	17		HDD	12			Hydrophone tow adjusted.	
	1330	17		HDD	12			Bangbox trip out. Reset.	
	1332	17		HDD	12			Short DGPS signal dropout.	
	1337	17		HDD	12			EOL 17 Fix 112	
	1342	18		HDD	13	240309.134126.cod		SOL 18 Fix 113. Heading West	
	1354	18		HDD	13			EOL 187 Fix 120	
	1356	19		HDD	14	240309.135617.cod		SOL 19 Fix 121. Heading North	
	1359	19		HDD	14			EOL 10 Fix 123	
	1402	20		HDD	15	240309.140143.cod		SOL 20 Fix 124. Heading South	
	1406	20		HDD	15			EOL 20 Fix 127	
	1411	21		HDD	16	240309.140905.cod		SOL 21 Fix 129. Heading North	
	1415	21		HDD	16			EOL 21 Fix 131	
	1419	22		HDD	17	240309.141909.cod		SOL 21 Fix 132. Heading South	
	1423	22		HDD	17			EOL 22 Fix 134	
	1427	23		HDD	18	240309.142629.cod		SOL 23 Fix 135. Heading North	
	1431	23		HDD	18			EOL 23 Fix 138	
	1434	24		HDD	19	240309.143345.cod		SOL 24 Fix 139. Heading South	
	1437	24		HDD	19			EOL 24 Fix 141	
	1441	25		HDD	20	240309.144106.cod		SOL 25 Fix 142. Heading West	
	1453	25		HDD	20			EOL 25 fix 149	