

EPs 103,104,127,128

**SOUTHERN GEORGINA BASIN
NORTHERN TERRITORY
AUSTRALIA**

AMY 2D SEISMIC SURVEY



FINAL OPERATIONS REPORT

**Prepared by Seismic Placements International
For Petrofrontier (Australia) and Statoil Australia
December, 2013**

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Appendix 3	Terrex Spatial Survey Report
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ENCLOSURES

1. Amy 2D Seismic Survey Topographic Map
2. Amy 2D Seismic Survey Reclamation photographs
3. Amy 2D Seismic Survey line KML Files
4. Amy 2D Seismic Survey Field Support data – Observers Logs, XPS files

ATTACHMENTS

1. Six field tapes
2. One hard drive of processed and reprocessed data.

1. INTRODUCTION

The Amy 2D Seismic Survey was conducted during July and August 2013 in EPs 103, 104, 127, 128. Permittees for EP 103 and 104 are Petrofrontier (Australia) and Statoil Australia. Permittees for EPs 127 and 128 are Petrofrontier (Australia), Statoil Australia and Baraka Energy. Petrofrontier (Australia) was Operator for the seismic operations. Statoil Australia assumed operatorship of the EPs on 1st September 2013 and supervised the data processing.

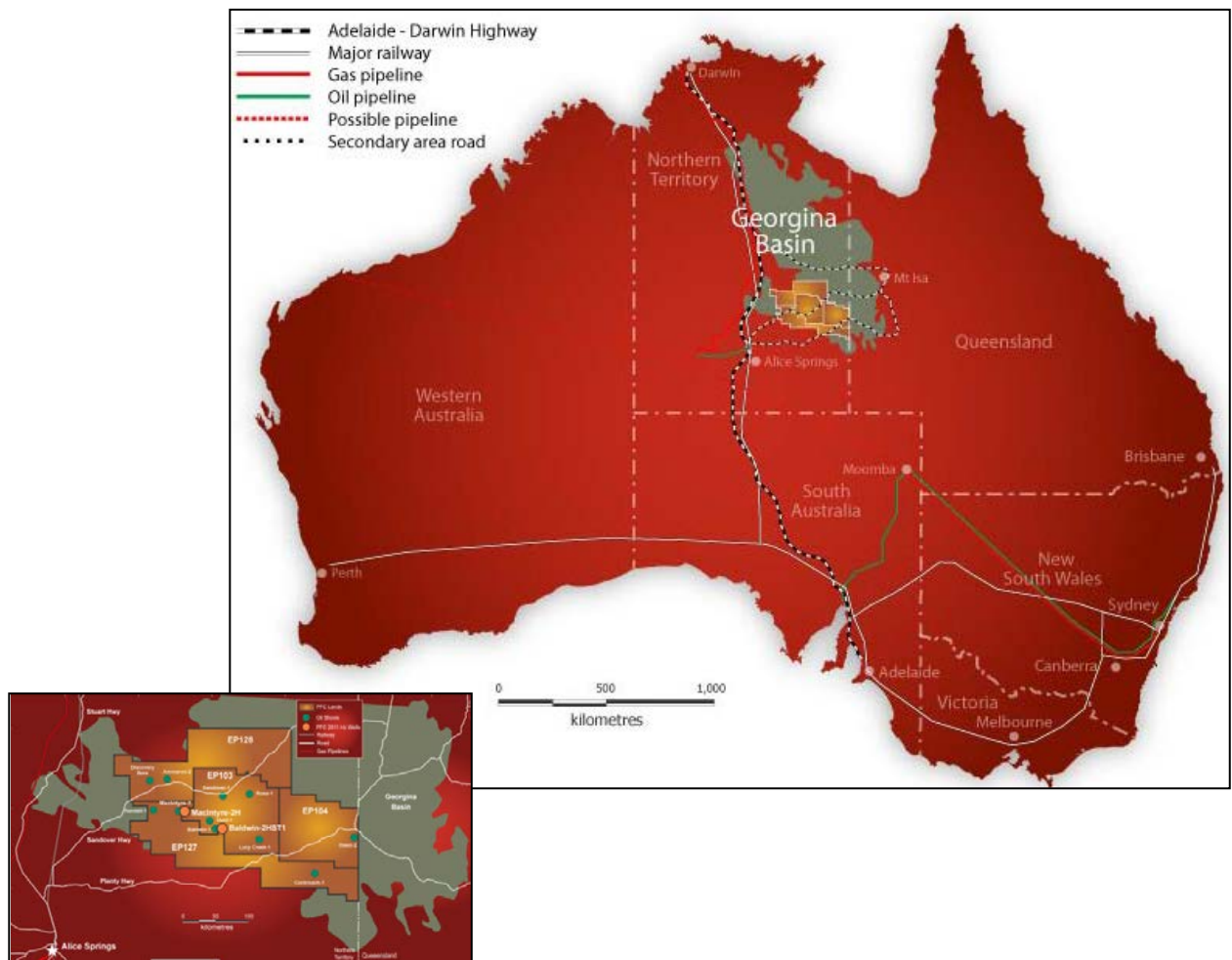
The survey consisted of 6 regional 2D lines totaling 304 line kilometres. The survey area is located approximately 400 km north-east of Alice Springs and falls within the Pastoral Leases Marqua, Tarlton Downs, Manners Creek, Argadargada, Lake Nash, Georgina Downs and Annitowa.

The aim of the Amy Seismic Survey was to gain regional information on the distribution and depth of target formations across areas of the four EPs where there is no seismic coverage. The data was acquired to locate well sites for future regional drilling programs. The seismic survey also enabled permit commitments to be met.

Terrex Pty Ltd was contracted to conduct the survey. Terrex engaged the services of its wholly owned subsidiaries Terrex Contracting (for line clearing and reclamation work), Terrex Spatial (for surveying activities) and Terrex Seismic for data recording. Line preparation commenced on July 3, 2013, and recording commenced on July 21, 2013. Recording was completed on August 25 and Terrex was fully demobilised from the area on August 27, 2013.

The Operator Field Supervisor for the entire survey was Pat Mee of Bruce Beer and Associates.

The seismic data was processed by Dayboro Geophysical Queensland; Dayboro also reprocessed two vintage lines across EPs 103 and 104.



**Figure 1: Location Plan EPs 103, 104, 127,128
Southern Georgina Basin
Northern Territory**

Acquisition

Survey: Amy 2D Seismic Survey

Lines - in order of recording	Start date – end date	Start Sta.	End Sta.	Length (km)
PFC-12-107 from SE to NW	22 July – 30 July 2013	8086	1008	70.78
PFC-12-103 from S to N	31 July – 4 August 2013	938	5083	41.45
PFC-12-104 from NE to SW	4 August – 7 August 2103	5011	1000	40.11
PFC-12-102 from NE to SW	10 August – 17 August 2013	9670	896	87.74
PFC-12-101 from E to W	19 August – 24 August 2013	11093	5554	55.39
PFC-12-108 from S to N	24 August – 25 August 2013	1060	1941	8.81
		TOTAL		
		: 304.28		

Table 1: Seismic Acquisition

Processing and Reprocessing

Survey: Amy 2D Seismic Survey

Line Name	Start	End	Length (km)
PFC12-107	100	13769	68.345
PFC12-103	100	8251	40.755
PFC12-104	100	8110	40.05
PFC12-102	100	11178	55.39
PFC12-101	100	17667	87.835
PFC12-108	100	1875	8.875
GBE10-18	100	14316	71.08
GBE10-05	100	12182	60.41
TEX09-02	100	5741	28.205
TOTAL:			460.945

Table 2: 2013Seismic processing and reprocessing CDP data

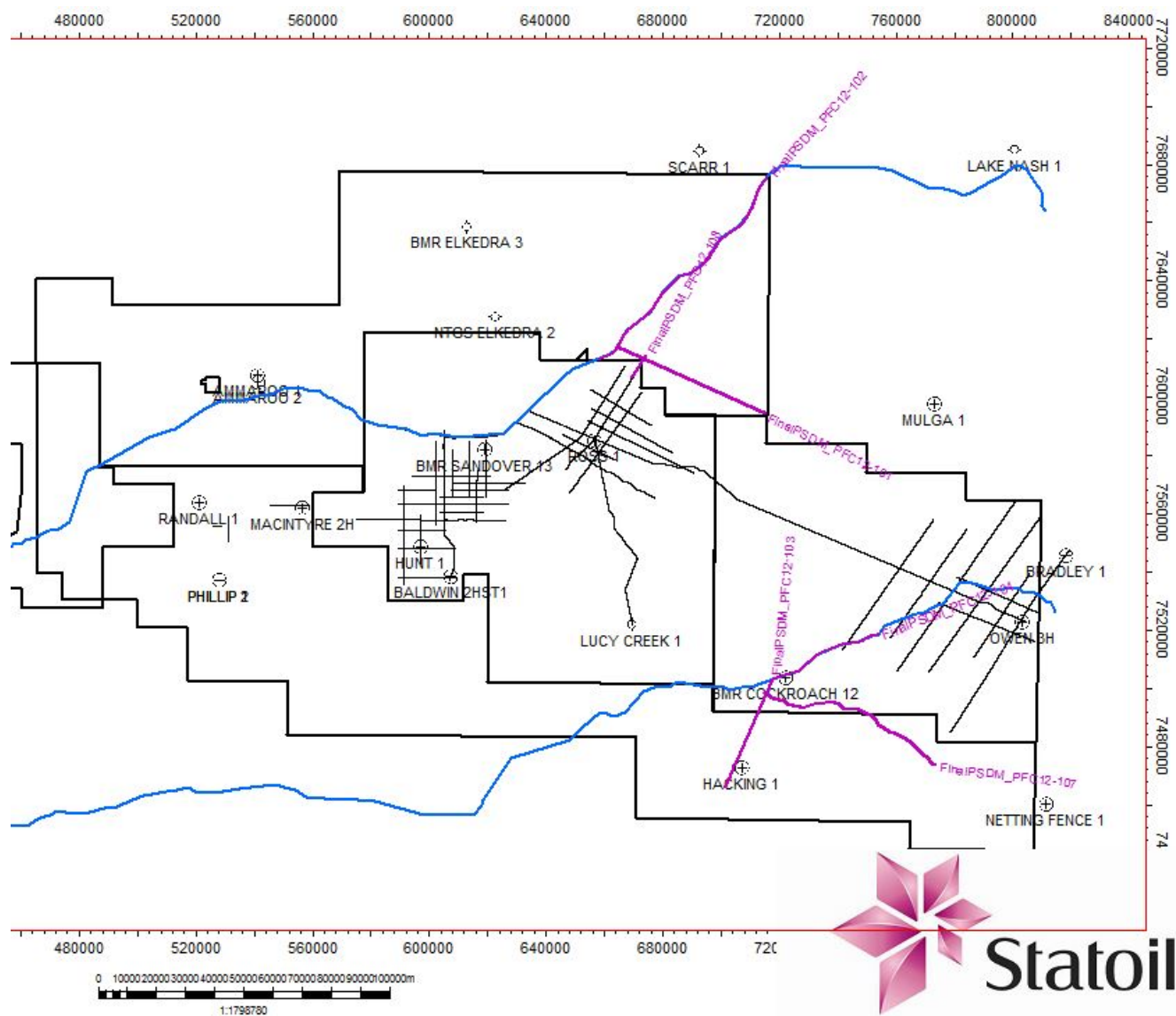


Figure 2: Amy 2D Seismic Survey

2. SURVEY OBJECTIVES

Seismic surveys conducted in EPs 103 and 104 in 2009, 2010 and 2011 were mainly concentrated around earlier identified and drilled structural highs to further define closures for additional testing by the drill. Prior to the Amy survey, no seismic had been recorded in the eastern portions of EPs 127 and 128.

The Amy 2D Seismic Survey was designed with the following objectives:

- provide regional information on the distribution of the basal Arthur Creek Formation and Thornton Limestone unconventional targets away from the existing seismic coverage,
- tie with the earlier seismic surveys conducted in EPs 103 and 104,
- provide suitable quality data for locating exploratory wells in areas not yet accessed by the drill in EPs 127 and 128,
- minimise environmental impact by utilising existing roads and tracks where possible,
- meet Work Program commitments in EPs 127 and 128.

3. HYDROCARBON TARGETS

The primary exploration target in the Permit areas is an unconventional oil play in low porosity organic rich shales and carbonates of the basal Arthur Creek Formation (including the “Hot Shale”), and the immediately underlying dolostones of the Thornton Limestone (Hay Creek Formation). It is considered that stimulation will be required if hydrocarbons are to flow from these tight rocks.

Unconventional hydrocarbon targets are generally not structurally controlled. Because structural definition is not important, initial assessment does not require a grid based seismic program. The target formations are generally flat lying and not folded. Structuring is fault controlled. These characteristics enable initial seismic evaluation of a large area using regional seismic lines with minimal ties.

The seismic data will be interpreted by mapping the important and easily map able reflector at the top Thornton Limestone which will enable identification of targets for a subsequent regional drilling program planned for 2014.

4. PLANNING METHODOLOGY

4.1 Line Selection and Program Approval

The Amy seismic program was originally approved by the Department of Resources on 10 September 2012 for completion in the same calendar year. It then consisted of 8 lines totaling 401 line kilometres. The survey was deferred to 2013 and a revised 385 km 7 line program was approved by the Department of Mines and Energy on 27 June, 2013. Contractor mobilisation difficulties significantly delayed the planned survey start date and contractor and client end date limitations resulted in the survey being shortened to 6 lines totaling 304.28 km. The kilometres deleted were those of least importance to the survey objectives and their deletion did not in any way compromise the surveys primary objectives.

4.2 Line Planning

The two main areas without existing seismic coverage and the principal focus of the survey are well separated requiring a 450km remobilisation. Line numbering was allocated early in 2012 when the survey was planned to be recorded in the same year. Because approvals had already been granted, line numbering prefix “PFC-12” was not changed although recording occurred in 2013.

Marqua Area

The Marqua survey area is located in the southeast of the Permits and was designed to enable selection of a well site in EP 127 and tie to the 2010 EP 104 seismic grid. 152 km were recorded in this area (rounded up to whole numbers). 92 km were recorded in the southeast of EP 104 and 60 km in the eastern portion of EP 127. The lines covered portions of Pastoral Stations Marqua, Manners Creek and Tarlton Downs. All but 41 km were recorded along existing roads and tracks to minimise environmental impact, line clearing and line rehabilitation. Line PFC-12-104 was located along the Plenty Highway and access was restricted to the cleared verge to meet Department of Transport requirements and to minimise environmental impact. Central Lands Council Clearance Certificate requirements also limited access to the Plenty Highway road reserve. These restrictions limited the tie at the intersection of Lines PFC-12-104 and PFC-12-103. Other minor revisions to the line locations were also made after Cultural Clearance.

Argadargada Area

The Argadargada survey area is located in the northeast of the Permits area and was designed to enable selection of well sites in the unexplored eastern portion of EP 128 and to tie to the pre-existing 2010/2011 EP 103 seismic grid. Of the 152 km recorded in the area, 147 km were recorded in EP 128 and 5 km recorded in EP 103. Line PFC-12-102 was located along the cleared verge of the

Sandover Highway to minimise environmental impact, line clearing and line rehabilitation. Here, also access to the road reserve was restricted by Department of Transport requirements which resulted in a limited tie at the intersection with line PFC-12-101. The lines covered portions of Pastoral Stations Argadargada, Lake Nash, Georgina Downs and Annitowa.

Marqua Area Campsite Selection

Access difficulties favoured a single campsite for each of the two areas. For the Marqua area a campsite was selected at a disused airstrip close to the intersection of the Marqua Road and the Plenty Highway on Manners Creek Station. This location was central to the intersection of the three lines and was ideal for access to the Plenty Highway. There was the environmental benefit of no clearing required on an old airstrip. The lack of alternative access routes resulted in long travel times on the long regional lines.

Argadargada Area Campsite Selection

The Argadargada area is approximately 450kms by road via Boulia in Queensland, from the Marqua Area; a two day mobilisation. A single campsite was selected here also. Landholder objections to the use of station roads and their concern of the possibility of weed introduction, resulted in a campsite being selected adjacent to the Sandover Highway road reserve, on Annitowa Station immediately adjacent to the Annitowa/Argadargada boundary fence. This was at the intersection of the two main seismic lines PFC-12-101 and PFC-12-102. This location enabled non-line vehicles to be isolated from Argadargada Station, thus reducing the number of certified wash-downs.

4.3 Environmental

Low Ecological Services was engaged to prepare an Environmental Impact Assessment and make recommendations for best environmental practices. An Environmental Management Plan was then developed for the survey. The "Petrofrontier Environmental Management Plan Amy Seismic Survey Revision 1A" was submitted to Department of Mines and Energy on June 15, 2013.

Environmental impact was minimised by locating as many lines as possible on already cleared road verges and along existing station tracks. This enabled 65% of line km to require no clearing.

A GPS navigation/guidance system was included in the contractor specifications to assist line deviation around terrain irregularities and trees.

A line restoration program was designed to meet the objectives of the Environmental plan. Restoration was planned to commence immediately following the recording crew on each line.

At survey start-up induction, contractors and field personnel were presented with the Environmental Management Plan and were instructed in procedures to minimize environmental impact. These were conveyed through line clearing crew and recording crew inductions by Low Ecology ecologists and Petrofrontier representatives.

During the survey Low Ecology conducted field inspections on two occasions. Low Ecology also inspected line vehicles for evidence of weed seeds following each set of wash-down procedures.

An environmental audit is planned for 2014 after some rain has provided the opportunity for regrowth and seed germination.

4.4 Parameter Selection

No experimental program was conducted. Parameters for the survey were chosen by comparison of parameters used in previous seismic surveys in the region. From an interpretation perspective it was decided that the 2010 (single sweep 10m VPs) and 2011 data (2 sweep 20m VPs) were of the same quality. 2010 parameters were selected for the Amy survey based on superior recording rate.

5. CONSULTATION

All landholders and stakeholders were issued an NOIE (Notice of Intended Entry) prior to commencement of the survey.

Line PFC12-104 was designed to follow along the verge of the Plenty Highway, and line PFC12-102 also went along verge of the Sandover Highway. Traffic control for the lines along side of the roads was provided by Alice Traffic Management Pty Ltd.

Sacred Site Clearance Surveys were conducted through the Central Lands Council and completed by the relevant traditional land owners. Sacred Site Clearance Certificates 2012-077 (Marqua area), and C2012-078 (Sandover area), were issued prior to commencement of seismic operations. Archaeologist Tim Hill prepared an Archeological Assessment and inspected the survey area prior to the commencement of the 2013 survey and did not identify any significant archaeological sites.

The Sacred Site Clearance Certificates provided access corridors along the proposed seismic lines. Specific restrictions were made on some lines and these were fed into the Sacred Site Avoidance documentation provided to the surveyors and lines preparation contractors.

6. TERRAIN AND LINE CLEARING

6.1 Terrain

The terrain in the Marqua area is generally undulating and presented little risk of erosion. Sections of the planned southwestern end of line PFC-12-103 were located on moderate slopes. These terrain obstacles were avoided by placing detours in the line. An incised drainage channel was detoured by vehicles and arrays were hand carried to avoid future erosion. The terrain in the Argadargada area is very flat with no significant drainage channels requiring any detours.



Photograph 1: Moderate slopes in the SW of Marqua area



Photograph 2: Typical flat terrain of the Argadargada area

6.2 Line Clearing

The Terrex line clearing and surveying crews were given a heritage, environmental and safety induction by Low Ecology ecologists prior to commencement of operations.

Line clearing was performed by Terrex Contracting and commenced on July 6 and finished July 29, 2013. The Terrex Contracting bulldozer, support vehicle and camp were then demobilised. The Terrex Contracting grader moved onto line restoration work.

Terrex line clearing equipment was thoroughly washed down prior to entering the exploration area and again prior to entering Argadargada station. Washed down equipment was inspected for the presence of any seeds by an independent Low Ecology weed specialist.

Environmentally sensitive line construction methods were used to carefully comply with the recommendations set out in the EMP. The lines were deviated around trees and the minor terrain irregularities. Bypasses were constructed around the few creek crossings and geophone cables were hand carried across

these. The sparse vegetation enabled the bulldozer to clear line “Blade-up”, mostly just walking the line, leaving small shrubs to be cleared and stockpiled by the grader for redistribution during line restoration. This method avoided the production of significant windrows.



Photograph 3: Blade Up Technique for the line preparation



Photograph 4: Dozer with Grader following up

7. SURVEYING

Surveying commenced on July 5 and finished on August 18, 2013.

Surveying was carried out by Terrex Spatial using a real-time kinematic (RTK) surveying technique. This method enabled both position and elevation coordinates to be acquired in real-time and on the appropriate datum.

The line placement, station pegging, and surveying was also carried out by Terrex Spatial.

The survey reference system was based on Geocentric Datum of Australia 1994 (GDA94). Final rectangular co-ordinates were based on the Map Grid of Australia 1994 (MGA 94) and elevations have been reduced to the Australian Height Datum (AHD71). The survey area was in MGA Zone 53 with central meridian 135° E.

A complete list of personnel and equipment is contained within the Terrex Spatial Report (Appendix 3).

8. HEALTH AND SAFETY AND ENVIRONMENT (HSE)

A Commencement of Operations Meeting was held on the 27th of June 2013 at PetroFrontiers Adelaide office. PetroFrontier, Terrex senior management and field supervisors attended. At this meeting it was decided to utilise the Terrex Health, Safety and Environmental Management System but incorporating the requirements and objectives of PetroFrontier particularly pertaining to Environmental, Cultural Heritage, and Land holders requirements.

All personnel were required to have an Environmental Induction conducted by the Low Ecological Services, and a PetroFrontier Operational Induction, conducted by PetroFrontiers Field Representative, in addition to the Terrex HSE and Site Specific inductions conducted by the Terrex HSE advisor. At the PetroFrontier Operational Induction, all crew members were given a PetroFrontier Operational Procedures requirement sheet to read and sign, so there was no misunderstanding concerning how each crew member was to conduct themselves during the survey. Crew compliance was good and no reportable incidents were recorded during the period of the survey.

An independent HSE audit on behalf of PetroFrontier, was conducted on the crew on the 22nd and 23rd of June. The auditor's report showed there were no major problems with the HSE processes and procedures and way the field operations were being conducted.

Daily tool-box meetings were conducted by the Terrex field managers and HSE Manager. Prior to the tool box meetings all personnel on site were required to undergo a mandatory Alcohol Breath Test supervised by the HSE Manager.

The Terrex Seismic crew included a properly qualified paramedic with a 4WD ambulance. The paramedic and ambulance accompanied the line crew on line in the field.

A more detailed HSE report is included in the Bird-dog Report (Appendix 1) and the HSE statistics for the survey can be found in the Terrex Seismic Final Report (Appendix 2)

9. DATA ACQUISITION

Seismic data acquisition was carried out by Terrex Seismic using a self-contained mobile trailer camp.



Photograph 5: Terrex Seismic Camp (from the air)

Recording commenced on July 21 and completed on August 25 and the crew demobilised from the survey area on August 27.

Terrex Seismic Ltd.'s, Crew #405 was contracted to collect the seismic data on an hourly rate basis. A total of 304.28 km of seismic data were recorded over 6 lines, at a receiver group interval of 10m and source group interval of 20m with 400 live trace recording.

Seismic data was acquired using a Sercel 428 Telemetric Recording System, 400 "live" channels was utilized. A total of 930 channels of cables and 1600 strings geophones were available for field deployment, utilising one string of 6 Sensor SM4 10 hz geophones per station, comprising of 465 cables, each with 2 x FDU's (Field Digitizing Units) and 800 (2x6) strings of geophones.

Source energy was provided by three Hemi-50 50,000 lbs. 6x6 truck mounted vibrators with a fourth off line as a spare.



Photograph 6: Terrex Seismic Vibrators on line 104 (Plenty Highway)

Recording parameters are detailed below.

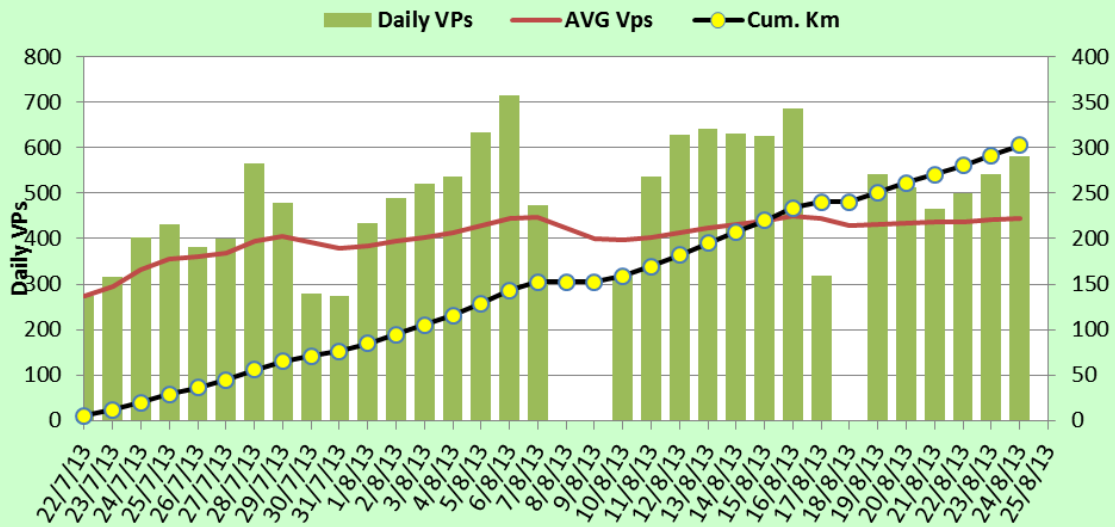
A complete list of personnel and equipment is contained in the Terrex Seismic Operations Report see (Appendix 2).

RECORDING PARAMETERS

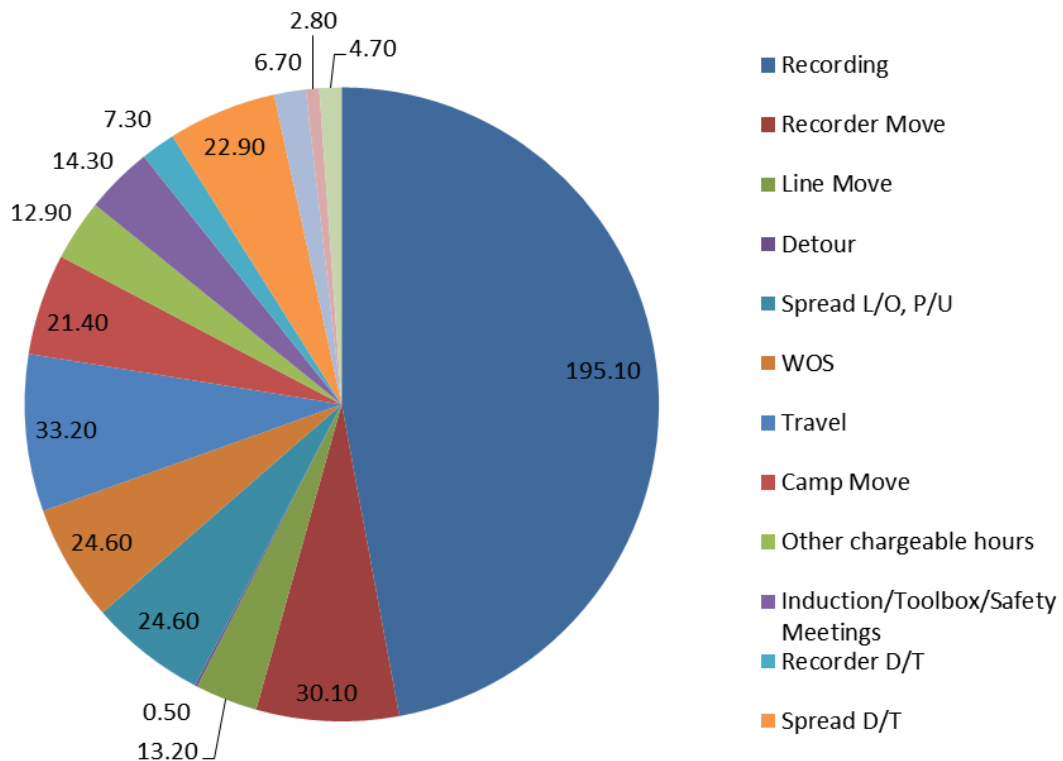
Survey: Amy 2D Seismic Survey

Instrumentation	
Instruments	Sercel 428XL
No. Channels	400 live channels
Tape Drives	IBM Ultrium LT02 (dual drive – 200 Gbyte per tape)
Tape Format	Tape Format : SEG-D Revision 1 8058IEEE Demultiplexed, Noise edited correlated summed 3 sec record
Filters	Hi cut 200 Hz, (0.8 Nyquist - Linear) Lo cut: Out
Sample Rate	2 ms
Record Length	3 sec (2x6 sec sweep, 3 sec listen)
RTC	Yes
Correlation Type	Zero Phase
Stack	Single sweep
Source Data	
Vibrators	3 x IVI Hemi 50's on Paystar 6x6 trucks plus one spare
Electronics	Pelton Advance III, VibePro
Sweep Frequency	Mono-sweep, 5-80 Hz
Sweep Length	6 seconds
No. Sweeps	2 Standing
VP Interval	20 metres
Vibrator Array	3 vibs in line, 12.5m pad to pad standing. No move-up. Centred between stations.
Sweep Amplitude Taper	100% (none)
Drive Level	80% varied by amplitude control function
End Tapers (cosine) (s)	0.1s
Phase Locking Type	Ground Force
Amplitude Control	Peak to Peak
Receivers	
Receiver Group Interval	10 metres
Number of live traces	400
Spread	Split, 1995m – 5m – 0 – 5m – 1995m
Geophones	Sensor SM4 10 Hz
Array	6 in-line, centred on station, 1.67m spacing
Connection	Series (1x6)
Multiplicity	100 fold

Recording Production by Terrex Seismic on the Amy 2D seismic survey



Accumulative Recording Time Breakdown



Recording production averaged 8.405 kilometres per day which is similar to previous surveys done in the same PELs. However, as the pie chart depicting the total hours for each parameter shows actual percentage recording time of the total day averages at only 47% of the total time spent in the field. Eight per cent of the total time was taken up with travel, and seven per cent of the total time was for recorder move ups.

Waiting on Spread (six per cent), spread lay-out and pick up (start and end of job) six per cent and spread down time at no charge was also six per cent were the other major contributors to total time taken for recording.

10. RESTORATION

A comprehensive restoration program was undertaken following recording on each seismic line. This included grading the landowner track used on Marqua for line PFC12-107. The restoration operations were undertaken by Terrex Contracting using their grader. Restoration commenced on the 27th July and was completed on August 27th, 2013.

Line restoration methods included careful grading to remove wheel ruts and grade in any minor windrows to accurately reproduce the original soil profile, redistribute seeds and prevent subsequent erosion. Understory vegetation which had been graded off the line and stockpiled during line clearing, was redistributed back across the line. Diversion barriers were installed on the few gentle slopes encountered during line clearing to prevent erosion during subsequent rain events.

Similar procedures were employed to rehabilitate the camp sites.

Appendix 6 contains example images taken prior to and after rehabilitation. The Bird Dog Report (**Error! Reference source not found.**) has been written by PetroFrontier Bird Dog, Pat Mee. It describes in more detail, the restoration processes used.

11. CONCLUSIONS AND RECOMMENDATIONS

Line access (or the lack of access) was probably the most time limiting constraint of the survey. Hanging lines that are from fifty to seventy kilometres long do

incur a financial penalty for the lease operator with the line being the only access, both in the travel time charged by the contractors and in the restoration required after the crew has completed recording. As mentioned earlier the terrain in the Amy 2D prospect is particularly fragile and being so makes it difficult to maintain a light footprint.

For future work consideration should be given to the possible access to the lines, to lighten the load on the seismic line itself. This would obviously be determined by the geophysical objectives, and landowner requirements, but it should be included in the design strategy of the survey.

It would appear from this survey and the previous surveys that the actual recording time spent per day has not exceeded 47% of the time spent by the crew in the field. This underlines the lack of available access in the prospect area.

In areas where line access was difficult or restricted, requiring long travel times, efficient cost effective use was made of helicopters to move crew, cable and geophone strings.

Delays to the arrival of the recording crew resulted in an excessive time gap between line clearing and recording. This allowed significant cattle disturbance to line pegs, requiring significant line re-pegging.

12. DATA PROCESSING

12.1 Survey Processing

With the change in Operator for the 4 P permits, Statoil supervised the data processing. Processing of the Amy 2D data and older line processing was performed by Dayboro, Brisbane, Queensland. Dayboro satisfactorily processed the 2011 Emma (Ross Infill) seismic data recorded in the same permit area.

Line lengths processed and reprocessed are shown in Table 2: 2013 Seismic processing and reprocessing CDP data.

Reference to the final processing flow chart and parameters are covered in detail in Dayboro's processing report (**Error! Reference source not found.**).

The Processing Flow is set out below. The flow was determined following completion of a full suite of tests on data from line PFC-12-107 by Dayboro with Statoil input.

At each stage of processing QC displays were analysed. Final processed data was carefully QCed by Statoil's geophysicist.

Process	Parameters
Reformat	
Trace Edit/Polarity Reversal	
Geometry Application	Crooked Line
First Break Picking	
Refraction Statics Calculation	
Refraction Statics Application	
Spherical Divergence Correction	$V^2T^{0.7}$
SQUELCH	Adaptive Noise Attenuation
	Pass 1 : 3-8-22-29Hz
	Pass 2 : 16-24-65-90Hz
QUASH	Adaptive Linear Noise Attenuation
	Model: FK +/-2.5ms/tr
	Adaptive Subtraction: Monk - 400ms Gate
Deconvolution	Surface Consistent
	Offset Design Window Start Design Window End
	450m 250ms 1250ms
	1800m 500ms 1500ms
	Offset Apply Window Start Apply Window End
	All 0ms Tmax
	Gap Length Window 16ms
	Operator Length Window 80ms
AGC ***	500ms
First Pass Velocity Analysis	1000m Interval
First Pass Residual Statics	
Second Pass Velocity Analysis	500m Interval
Second Pass Residual Statics	
PSTM Velocity Analysis	500m Interval
Kirchhoff Pre-Stack Time Migration	Half Aperture: 3000m – Maximum Angle 70 Degrees
	Offsets -2040m to 2040m @ 60m
NMO Inverse	Remove Final Migration Velocity
Final Velocity Analysis	500m Interval
NMO	Apply Final Velocity
AGC	500ms
Stack	Stretch Mute 60%
FX Running Mix	Dip Max: 20 – Ntraces: 3
Band Pass Filter	0-1000ms 8-15-75-90Hz
	1000-2000ms 8-15-80-95Hz
	2000-Tmax 8-15-65-85Hz
Trace Balance	Full Trace
Output SEGY	

Kirchhoff Pre-Stack Depth Migration	Half Aperture: 3000m – Maximum Angle 70 Degrees
	Offsets -2040m to 2040m @ 60m
Scale To Time	
NMO Inverse	Remove Final Migration Velocity
Final Velocity Analysis	500m Interval
NMO	Apply Final Velocity
AGC	500ms
Stack	Stretch Mute 60%
AGC	500ms
FX Running Mix	Dip Max: 20 – Ntraces: 3
Band Pass Filter	0-1000ms 8-15-75-90Hz
	1000-2000ms 8-15-80-95Hz
	2000-Tmax 8-15-65-85Hz
Scale To Depth	
Output SEGY	

12.2 Reprocessing

To enable consistent interpretation Dayboro Geophysical reprocessed 3 old lines (GBE-10-18, GBE-10-05 and TEX-09-02) using the 2013 Amy parameters.

12.3 Seismic datum

The datum chosen was 400m ASL to be consistent with previous seismic survey data.

12.4 Statics

No new upholes were recorded and no previous upholes were found in the vicinity. Refraction statics were calculated from first break picks and the near surface data inverted to model near surface velocities.

12.5 Seismic Data Quality

Seismic data quality is highly variable. Local weathering conditions affected quality in some areas. Fractured areas also exhibited poor data quality.