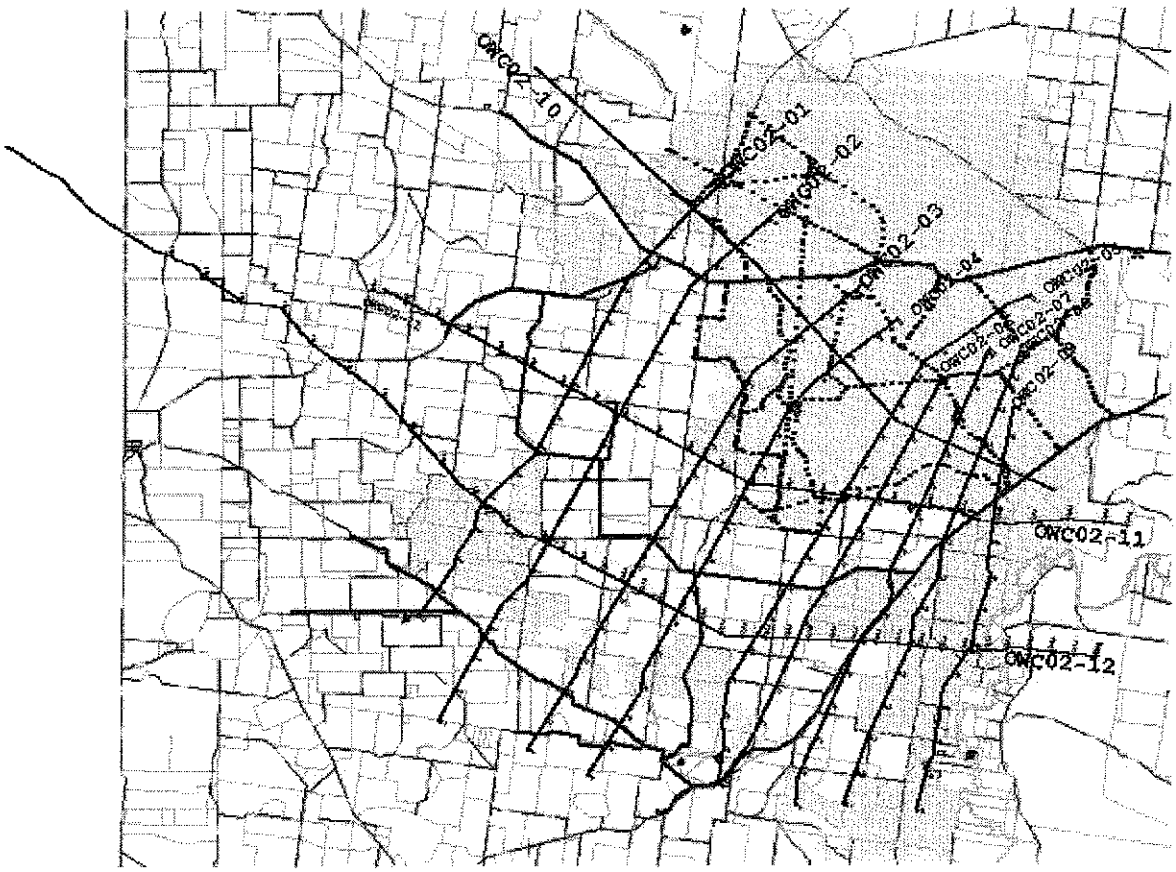
SURVEY OPERATIONS

END OF CONTRACT REPORT

WEST CASTERTON 2D

SANTOS LIMITED

VICTORIA



FINAL SURVEY REPORT

For

SANTOS LIMITED

PEP 160

WEST CASTERTON 2D SEISMIC SURVEY

LINES

OWC02-01
OWC02-02
OWC02-03
OWC02-04
OWC02-05
OWC02-06
OWC02-07
OWC02-08
OWC02-09
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OWC02-11
OWC02-12

MARCH / MAY 2002

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1.0 INTRODUCTION

WesternGeco was contracted by Santos Limited to undertake the West Casterton 2D survey. The prospect is situated west of Casterton near the Victoria and South Australian border in Victoria's Otway Basin. This area is part of Petroleum Exploration Permit PEP 160 belonging to Santos Limited (hereafter referred to as Santos).

The terrain in this area is generally flat, open sheep and cattle grazing land, with areas of pine and blue gum plantations. The northern area is covered by State Forest and is generally of a higher elevation. Small pockets of native scrub and State Forest exist throughout the area.

One ranging crew was sent to the West Casterton area in advance of the survey crew to start the ranging in the forest areas for the hydro-axe. The ranging of lines commenced on the 8th March. Surveying line fieldwork commenced on 16th March 2002 and was completed on 8th April 2002. A total of 210.90 kilometres was surveyed and ranged.

The survey work was accomplished using Real Time Kinematic GPS (RTK) methods and conventional trig levelling methods. A GPS backpacking crew was used to survey through areas of remnant native vegetation and to survey any vibrator offsets.

2.0 LINE SUMMARY

The survey of West Casterton 2D consisted of 12 lines totalling 210.9 kilometres. The station interval for the survey was 20.0m except for line OWC02-12, which had a station interval of 25m. The lines were positioned with the "crooked line" processing technique for processing being a criterion. Thus the lines wandered along the general route chosen.

The individual line details are listed below.

Line	Start	End	Stn Int.	Total
OWC02-01	200	976	20	15.52
OWC02-02	200	1068	20	17.36
OWC02-03	199	1012	20	16.26
OWC02-04	200	980	20	15.60
OWC02-05	236	1080	20	16.88
OWC02-06	199	840	20	12.82
OWC02-07	196	900	20	14.04
OCW02-08	196	880	20	13.68
OCW02-09	189	780	20	11.82
OCW02-10	200	1154	20	19.08
OCW02-11	214	1334	20	22.40
OCW02-12	176	1592	25	35.40
			Total	210.86

3.0 PERSONNEL AND EQUIPMENT

3.1 PERSONNEL

The WesternGeco survey crew consisted of twelve people, of whom generally nine were in crew at any one time. The following is a list of personnel utilized during the survey:

Name	Duties
Charlie Johnson	Senior Surveyor
Scot Townsend	Ranging
Dave Black	Ranging
Jens Tolsdorf	Survey
Jay Argent	Survey
Denis O'Sullivan	Survey
Haydn Kreicbergs	Survey
Ian Seeto	Survey
Gerard Mackenzie	GPS Operator
Matt Skinner	GPS Operator
Dan Kool	GPS Operator
Peter Simpson	Utility
Trent Davies	Utility
Andrew Gleeson	Utility

3.2 EQUIPMENT

The following equipment was used during the survey:

Ranging	2 Toyota Landcruiser Ute
	2 Trimble NT300 GPS receivers
	2 VHF Crew radio
	2 UHF radio (Survey communications)
	1 Toshiba Notebook computer
Survey/Chaining	3 Toyota Landcruiser utes
	1 Toyota Landcruiser Wagon
	4 Trimble 4000 SSi GPS receiver
	2 Trimble 4700 GPS receivers
	2 TSC1 Survey controllers
	3 TDC1 Survey controllers
	5 Beech Base station radio/modem
	6 Beech Portable radio/modems
	1 Leica Total Station
	2 VHF Crew radios
	5 UHF radios
	1 Desktop computer
	2 Dell Laptop Computer
	1 Canon S4500 printer
	Trimble Processing software
	GPSeismic Processing software
	Survey consumables

4.0 LINE PREPARATION

Line preparation and permitting was contracted to Exploration Field Services. Two fencing crews and two slashers were used during the survey. Each of the fencing crews consisted of two persons. A small fire tender accompanied each slasher.

Ian Wyatt (EFS) supervised the line preparation crews and liaised with the survey and recording crews. He also handled the permitting, keeping the landholders informed of the progress of the survey and when the line preparation, survey crews and recording crew would be entering onto their land.

Two WesternGeco ranging crews were deployed throughout the prospect to position and mark out the lines. Each ranging crew had a Toyota landcruiser fitted with Trimble NT300 GPS/display unit and a handheld Garmin GPS unit. The rangers used a combination of design coordinates and topographic maps to scout and bend line to avoid obstacles and fit the lines to the surrounding terrain.

The lines were ranged and bent in a manner sensitive to landholder requirements and environmental considerations. Once the final location of a line was decided and flagged, the fencing crews installed gates and the tractor-mounted slasher mowed pastures of long grass. The ranging crews, using handheld GPS units and compasses, flagged State Forest areas and areas requiring hand clearing prior to line preparation crews.

Sections of lines through pine forests and State Forest native bushland were prepared using a Hydro-Ax. Peter C Roberts of Millicent, South Australia, supplied the hydro-axe. This unit consisted of a tractor with a heavy-duty hydraulic slasher blade mounted on an arm forward of the tractor. A 2m wide track suitable for the line vehicles was cleared through the bushland. A "Feller-Buncher" was used to clear rows of pines in plantation areas before the Hydro-Ax slashed the remaining undergrowth. During a period when the Hyrdro-Ax was down, a tractor-mounted slasher was used in the native vegetation areas. This proved unsuccessful. The Hydro-Ax was required re-clear the line to make it trafficable by vehicles.

Vegetation, on road and lane easements, was hand cleared by a fencing crew using brush cutters and chain saws.

5.0 SURVEYING METHODS

5.1 SURVEY DATUMS

GPS field survey data was collected in World Geodetic System 1984 (WGS84) datum. It was then down loaded into GPSeismic software (by Dynamic Survey Solutions) for conversion to the Australian datum. WGS84 coordinates were converted to the Geocentric Datum of Australia 1994 (GDA94) and output in Map Grid of Australia Zone 54 coordinates. Ellipsoidal heights were converted to the Australian Height Datum (AHD) using the OSU91A geoid separation model.

The following parameters define the World Geodetic System 1984 datum:

Datum	World Geodetic System 1984 (WGS84)
Ellipsoid	WGS84
Semi-Major Axis	6 378 137.0
Inverse Flattening	298.257223563
Unit of Measure	International Metre

The following parameters define the Geocentric Datum of Australia 1994:

Datum	Geocentric Datum of Australia 1994 (GDA94)
Ellipsoid	Geodetic Reference System 1980 (GRS80)
Semi-Major Axis	6 378 137.0
Inverse Flattening	298.257222101
Unit of Measure	International Metre

For all intents and purposes GDA94 is the same as WGS84 so no transformations were applied.

The following parameters define the Map Grid of Australia 1994 - Zone 54:

Projection:	Universal Transverse Mercator
Latitude of origin:	0°
Central Meridian (CM):	141° E
Scale Factor at CM:	0.9996
False Easting:	500 000
False Northing:	10 000 000
Unit of Measure:	International Metre

5.2 SURVEY METHODS

The 'real time' kinematic (RTK) method, the static GPS surveying method and conventional trigonometric levelling methods were used during to survey the prospect. The static method was used for establishing control and surveying new base positions. The survey crew used the RTK and conventional trigonometric levelling method for line chaining / surveying.

The **'real time' kinematic (RTK)** method uses a radio and modem connected to a GPS receiver on a known base point. The base radio broadcasts raw GPS data measured at the base and the base position directly to a radio and modem connected to a roving GPS receiver. Thus the roving receiver can calculate it's own position to within a few centimetres, eliminating time-consuming post-processing. Position data in WGS 84 format was collected in Trimble TSC1 and TDC1 data collectors and downloaded into GPSeismic software where datum transformations and geoid separations were applied. The data was then edited and QC checked.

The **static** method involves setting up a receiver to log data on a known point then logging data on unknown points with a roving receiver for periods upwards of 15 minutes depending on the length of the baseline and satellite geometry. This enables the change in geometry of the satellite positions to be measured and by post-processing the data an accurate position can be determined. RTK base stations were surveyed using the static method for positioning.

Conventional trigonometric levelling was used to survey between GPS points through heavily timbered areas. This method involves using a total station (electronic theodolite) to survey the position and height of a point. This method was used in areas of the pine forests where no satellite coverage was available. Prior to the conventional crew commencing work a GPS survey was done to establish coordinate and height control approximately every 50 stations through the forest, where an open area could be found for better satellite coverage.

5.3 SURVEY CONTROL

The datum for the West Casterton 2D survey was trig survey marker PM125 under the Corndale fire tower. The Geocentric Datum of Australia 1994 coordinates and AHD height for these sites are:

Station	East	North	Elevation	Remarks
PM 125	525236.887	5840325.286	127.5	PSM 85903

Ties to old Permanent Markers are listed below:

Station	Line	Delta E.	Delta N.	Delta Ht.
PM200	OCM00-02	1.47	-1.45	-0.65
PM200	OCM00-03	2.54	-1.26	0.36
PM200	OCM00-05	2.36	-1.17	0.40
PM237	OL94-07b	2.03	-0.66	0.15
PM985+15	OA92-03	-0.75	-0.17	0.05
PM236+5	OK96-09	1.89	-0.68	0.05
PM283+07	OL94-07a	2.05	1.31	-0.38
PM332+07	OL 94-02	1.98	-0.71	-0.08
PM335+03	OL94-07	2.48	0.19	-0.15

Old Permanent Markers Coordinates tied:

Station	Tie line	Easting	Northing	Elev.
PM200	OCM00-02	517772.01	5838288.19	72.75
PM200	OCM00-03	518013.86	5837316.37	71.04
PM200	OCM00-05	520262.73	5836202.63	73.70
PM237	OL94-07b	521657.32	5838103.64	76.05
PM985+15	OA92-03	506367.98	5830630.88	65.74
PM236+5	OK96-09	521270.52	5835126.10	70.25
PM283+07	OL94-07a	522213.01	5838520.80	85.88
PM332+07	OL 94-02	506546.17	5837604.97	67.88
PM335+03	OL94-07	522905.12	5838855.97	85.45

5.5 DATA PROCESSING AND QUALITY CONTROL

Survey data collected in the field was processed in different ways depending on which survey method was used.

Static points were processed using Trimble Geomatics Office software. This produced data in WGS84 format. This data then had the geoid separation applied using the OSU91A model. The data was then set to GPSeismic for editing and QC checks.

For 'real time' kinematic (RTK) data, as the field data was collected in WGS84 format, it was downloaded into GPSeismic software where datum transformations, geoid separations were applied to obtain Map Grid of Australia 1994 (MGA94) Zone 54 coordinates and AHD heights. QC checks were run and reviewed to ensure all data was within specifications. The data was then exported to a text file for sending to Santos and for archiving.

The enhanced QC capabilities of GPSeismic allow for many checks, some of which are listed below:

- The GPS base coordinate and elevation download is checked against the correct data.
- Checks on PDOP, HDOP and VDOP for each point recorded.
- Checks on initialisations and unit variance.
- Compute delta x, y and z for 'check' shots onto other stations.
- Check for duplicate stations and gaps.
- Checks for stations out of specifications.
- Checks on GPS status at time of recording.
- Checks the distance and azimuth between stations
- Check elevations at intersection between lines

5.6 PERMANENT MARKERS

The surveyors placed three Permanent Markers at appropriate points around the prospect.. Where possible the PM was placed close to fences to avoid disturbance by livestock or agricultural activities. These markers consist of a steel fencing post with steel dumpy at the base and an aluminium tag, with the line name, station number and any comments inscribed upon it.

A listing of Permanent Marker information is included as Appendix A of this report.

5.8 TRACE DIAGRAMS AND MAPS

The chaining crew prepared line trace sketches showing details of Permanent Markers, line intersections, crew access, hazards and any other features of importance to the recording crew. The original copy of these was passed on to the recording crew. A prospect map was drafted with actual design location of the lines roads, tracks, forest areas, fences, gates and other relevant information and passed onto the recording crew.

6.0 HEALTH, SAFETY AND ENVIRONMENT

The landscape on the West Casterton 2D was, for the most part, flat farm lands with scatters of small native reserves To the east of the prospect was the Limestone Creek catchment area that required a major detour. Northern part of the prospect mainly consisted of the Drajurk Native Reserves. Distributed throughout the prospect were numerous Pine and Bluegum plantations.

Line preparation was carried out in accordance with the environmental code of practice, as set out by Santos.

As a result of a high emphasis on being placed on safety by WesternGeco, there were no lost time incidents on the survey crew during the prospect. WesternGeco safety policies were adhered to and regular safety meetings were held to discuss relevant safety and environmental matters. Daily "toolbox" meetings were held to discuss current issues concerning safety, the prospect and operations.

All WesternGeco vehicles were fitted with fire extinguishers, Driveright monitors and first aid kits. In addition, some WesternGeco personnel hold Senior First-Aid certificates. The Driveright vehicle monitoring devices assist in controlling vehicle speeds and driver behaviour.

All WesternGeco personnel carried out their duties in an environmentally aware manner. All rubbish generated in the field was returned to camp for proper disposal.

7.0 CONCLUSION

The survey of Casterton commenced with very little lead-time over the recording crew. This allowed for very little time to fix problem areas and the resultant rush placed personnel under stress and most cases line traces had little or no QC checking. The line preparation of the West Casterton 2D was conducted in an efficient manner in the open grazing lands. Problems were encountered and production slowed in the State Forest areas due to poor satellite coverage. In pine and bluegum plantation this coverage was further reduced to nil by the dense foliage. To overcome the lack of coverage the lines were hand chained in these areas and conventionally surveyed. This is very slow

Due to machinery breakdown and long down periods for repairs other methods were employed to maintain expected productive. These methods were inadequate and required cleaning up with the Hydro-axe when operational. Upon the return of the Hydro-axe some line required re-chaining as pegs and pinflags were destroyed.

Due to permitting and environmental constrains some lines were bent to follow firebreaks, tracks and fence lines. This forced some of the bends in to be greater than 15 degrees. Due to these reasons, sections on line OWC02-12 required vibrator offsets stations placed by survey.

All safety guidelines were complied with, and as a result no accidents or lost time injuries occurred.

Respectfully submitted

C. M. Johnson
Senior Surveyor
WesternGeco

APPENDIX A

LIST OF PERMANENT MARKERS

Permanent Markers established during the West Casterton 2D survey.

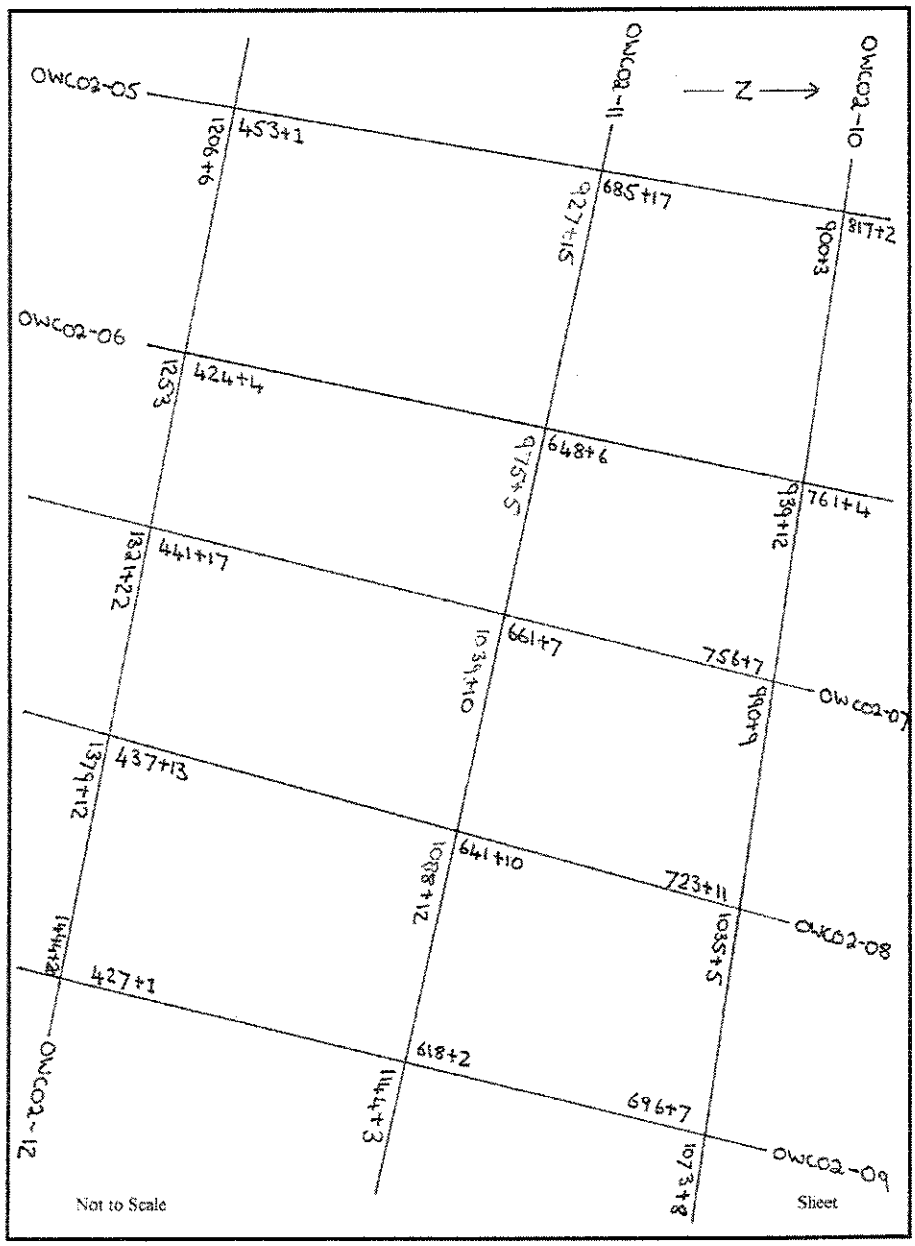
Station	Easting	Northing	Elev.	Line
PM277+14	508915.99	5837041.13	64.28	OWC02-4
PM323+06	518271.95	5829234.89	66.98	OWC02-12
PM440+17	511512.11	5826887.70	66.90	OWC02-11

APPENDIX B

INTERSECTION DIAGRAMS

Area : WEST CASTERTON

Date : March / April 2002



Area : WEST CASTERTON

Date : March / April 2002