Dynamic Satellite Surveys

05066

Final Operations Report
on the

2005 Spring Gully 2D Seismic Survey

for

Origin Energy

January - February 2006

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INTRODUCTION

The following report covers the **2005 Spring Gully 2D Seismic Survey**, performed by **Dynamic Satellite Surveys Pty Ltd** (DSS) whilst contracted to **Origin Energy Ltd** (Origin Energy).

The survey operation was located at Spring Gully, approximately 80kms north-east of Roma, Queensland.

A total of eight (8) 2D seismic lines totalling **78.660 kilometres**, were surveyed at 15m station intervals. The job was completed between 12th January and 2nd February, 2006.

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INSTRUMENTATION AND PERSONNEL

2.1 Personnel and Logistics

DSS personnel involved in the survey were as follows.

Person	Qualification	Tasks
Ben Allsopp	Bachelor of Surveying, Curtin University	Surveying, Processing and Reporting

Personnel and equipment logistics were supported by the DSS Yeppoon office.

Survey operations were based from the Spring Gully Construction camp located in the survey area.

2.2 Equipment

Equipment provided by DSS and used on this project:

	Description	Qty
Vehicles	Toyota Landcruiser Trayback	1
GPS receivers	NovAtel RT2 c/w VHF Telemetry	3
Computers	Dell Inspiron 5100	1
	GRiD 386 Field PCs	1
	Fujitsu XP Tablets	1
Software	GravNav / GravNet GPS post-processing - Waypoint Consultancy	Ver 7.50
	Nav05 Field software - DSS	Ver 3.23
	MIB Windows - DSS	Ver 6.10
	TransIt 2000 - DSS	Ver 5.0
	REM processing software	Ver 2.0
Printer	Canon iP1000 Inkjet	1
Survey Instruments	Rapid Elevation Meter - DSS	1
Miscellaneous	Necessary standard surveying equipment	
	Sundry office and transport equipment	
	Field and Office Consumables	

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SURVEY REFERENCE SYSTEMS

3.1 Geodetic Datum

This project was based on the Geocentric Datum of Australia 1994 (GDA94), which is based on the Geodetic Reference System 1980 (GRS80) model defined by the following parameters:

Datum:	GDA94(Geocentric Datum of Australia 1994)
Spheroid:	GRS80
Reference Frame:	ITRF92 (International Terrestrial Reference Frame)
Semi-Major Axis Length:	6 378 137.0
Inverse Flattening:	298.257222101
The Unit of Measure:	International Metre

3.2 Map Projection

Final rectangular coordinates were based on the Map Grid of Australia 1994 (MGA94). Parameters for this projection are as follows:

Projection:	Universal Transverse Mercator (MGA Zone 55)
Latitude of Origin:	0°
Central Meridian (CM):	147° E
Scale Factor at CM:	0.9996
False Easting:	500 000
False Northing:	10 000 000
The Unit of Measure:	International Metre

3.3 Height Datum

All elevations obtained relative to GDA94 have been reduced to the Australian Height Datum (AHD) using the AUSGEOID98 Geoid - Spheroid separation model to determine the geoid-ellipsoid separation (N) for the particular area.

GPS observations are made on the GDA94 datum. The height associated with this datum is an ellipsoidal height (h). The Australian Height Datum (AHD), the height datum associated with MGA94, is an orthometric height which is measured as the height above mean sea level, or the geoid (H).

The function that defines the relationship between the ellipsoid and orthometric heights is:

$$\mathbf{H = h - N}$$

Or

AHD = GDA94 - (Geoid / Ellipsoid Separation)

The value for the geoid/spheroid separation is interpolated from a national model called Ausgeoid98.

AUSGEOID98 is the third in a series of national geoid models produced for Australia by the Australian Surveying and Land Information Group (AUSLIG). The geoid-ellipsoid data is prepared for the Australian region from:

- EGM96 Global Geopotential Model;
- 1996 Australian Gravity DataBase, from the Australian Geological Survey Organisation (AGSO);
- AUSLIG / AGSO GEODATA nine-second digital elevation model;
- Satellite altimeter - derived free air gravity anomalies offshore;
- Theories, techniques and software developed by Associate Professor Will Featherstone, Curtin University of Technology[1].

AUSGEOID98 N values were interpolated using the GrafNet Version 7.50 software, distributed by Waypoint Consulting Inc.

[1] Johnston, G.M., Featherstone, W.E. (1998) AUSGEOID98: A New Gravimetric Model for Australia

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SURVEY CONTROL

The survey datum for this project was SG02, a new survey base established using AUSPOS. AUSPOS is Geoscience Australia's on-line processing system for dual frequency static GPS bases. It requires about 4 hours of 30 second GPS data for a successful computation.

SG02 has the following MGA94 (zone 55) AUSPOS coordinates.

Station	Easting (MGA)	Northing (MGA)	Height (AHD)
SG02	702318.240	7140111.810	351.020

A total of ten new control stations were installed as part of the control network for the project. AUSPOS observations were made at stations SG01 and SG10 as checks on the control network.

All new control stations and survey miscloses are listed in **Appendix A: Survey Control and Ties**.

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MONUMENTATION

All lines were pegged at a 15 metre station interval. Wooden pegs were placed at every station and were numbered on both sides of the peg at every even numbered station.

Ten permanent markers were placed throughout the project area and were used as GPS base stations. Permanent markers consist of a 1650mm steel star picket driven to give 1.2m above ground, and tagged with an aluminium plate stating project and station number.

The permanent markers (survey base stations) are listed at **Appendix A - Survey Control and Ties**.

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METHOD OF SURVEY

6.1 Line Ranging

The lines ran along existing tracks, fence lines and cleared lines, environmental and heritage interest permitting. Any required ranging was completed by Aztex Pty Ltd before or during DSS commencing surveying on the lines.

6.2 Manual Chaining

Lines requiring manual chaining were completed by the DSS Surveyor. Line trace diagrams were completed in the field for each line, and later digitally edited.

Manual chaining requires a graduated (at 15m intervals) chain to be dragged behind the survey vehicle. The surveyor drove the vehicle forward 10 stations, conditions permitting, walked back down the line checking the spacing at the last station. The surveyor then returned towards the vehicle, installing the intermediate stations.

6.3 Surveying

DSS utilise Global Positioning Systems (GPS) in three different tasks being static observations, kinematic observations and real-time observation methods. All three methods utilise phase data received from US Navy NAVSTAR Satellites to provide three-dimensional positioning.

For establishing survey control, the static observation method was used to propagate survey control throughout the area at a high level of accuracy (usually in the order of 10mm ± 2ppm). This method involves setting up a GPS unit on a known point and other GPS units at new points, then simultaneously recording phase data. A control network was observed between all the survey base stations and post processing of the data was done using Waypoint Consulting's GRAFNET software.

Due to thick tree coverage in parts of the survey area, the kinematic method of survey was used to determine horizontal positions along each seismic line in those parts to the metre accuracy. This enables a chaining check to be completed on each line to ensure no stations have been missed or added.

The kinematic method involved a GPS unit being set up on a known survey position (base station) and a remote GPS unit mounted on the survey vehicle. Logging GPS data every 5 seconds, the vehicle was driven adjacent to the manually installed survey stations, and observations were made for about 30 seconds. This was repeated along the line, observing changes in direction on certain stations.

This data was post-processed using Waypoint Consulting's GRAFNAV software.

The dual frequency real-time kinematic (RT2) survey method was used in the more open areas of the survey. RT2 enables both position and elevation coordinates to be acquired in real-time and on the appropriate datum.

One receiver was set up as a base station at a known location (eg SG01), while another receiver was used as a remote rover. This method cuts out the need for manual chaining as the rover GPS is used to guide the surveyor to the peg locations, the pegs are placed on the ground and the coordinates are surveyed in real-time. Due to the winding nature of the lines, radial pegging was used.

NovAtel dual frequency real-time kinematic can achieve accuracies of better than +/- 0.05m in position and elevation, depending on base line length. The expected precision for locating pegged positions is better than 0.20 metres in both position and elevation relative to the base station used and is generally better than 0.10 metres.

Initialisation of the RT2 rover GPS usually takes as little as 2-3 minutes, although this is greatly dependant on satellite geometry, availability, and base line length.

Checks and ties were examined in real-time operation to assess coordinate integrity.

The field data was edited into line files and examined for quality control.

6.4 Rapid Elevation Meter (REM)

Elevations along the seismic lines were surveyed using DSS' Rapid Elevation Metre (REM).

This instrument consists of a digital-quartz barometer, which models atmospheric conditions during a certain time period of survey observations.

Setting the known Australian Height Datum (mean sea level) height into the REM at a known location allows the surveyor to progress along the seismic line, observing intermediate stations before closing to another known elevation station. These sections are completed a second time, such that a standard deviation of the data can be computed.

Any points which lie outside 0.3m are flagged, and a third observation is completed if necessary.

Typically, each run lasts only fifteen minutes, thus allowing for minimal change in atmospheric conditions over a short period of time.

6.5 GPS Processing and Quality Control

All data is downloaded to the office computer each evening.

Quality of the satellite data is monitored by careful examination of the various on-screen quality control statistics produced by the software.

These checks on data integrity are in the form of standard deviation (or sigma) values for Easting, Northing and Height and are generally better than 0.2 metres.

The survey data is checked using DSS' Mib Windows software. Any position which falls outside a specified distance or azimuth tolerance is flagged for further investigation and re-recorded if necessary.

Numerous checks on pre-recorded marks were observed during each day's survey. These observations confirmed the integrity of the GPS base receiver and the placed markers.

Profile plots were examined to identify any height anomalies.

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DATA PRESENTATION

All line files were checked and finalised before the survey crew demobilised from the project area.

All final data was in UTM grid coordinate format on the MGA94 datum on the GDA94 reference spheroid. All elevations were on the Australian Height Datum (AHD71).

Files produced were:

SG06-XX.uka	Line data in UKOOA format.
SG06-XX.seg	Line data in SEGP1 format.
SG06-XX.PDF	Digitial mud maps for all lines.
Intersec.crd	All new line intersections in .crd format

Final data was handed to Lindsay Horn on the 3rd of February 2006.

All files are backed up on digital disks in the Yeppoon office for future reference.

No hard copy data was provided.

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SAFETY

DSS are aware of safety conditions concerning all exploration seismic surveys. The DSS *"Quality Policy Statement"* and *"Health, Safety and Environment Policy"* were adhered to at all times.

The vehicle was fitted with a UHF radio, CDMA mobile phone, shovel, fire extinguisher, first-aid kit, vehicle recovery equipment, and weekly vehicle maintenance check lists were completed.

UHF radio contact was available between the surveyor and line preparation crew. Regular contact was made throughout each day between crews to ensure safe operations.

Weekly safety meetings with the main crew (Terrex Seismic) were conducted at the camp. These meetings highlighted any safety concerns personnel encountered during the day and ensured everyone was informed about planned lines and progress.

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OPERATIONAL ASPECTS

The project was completed in 22 days, giving an average daily production of about 3.57 kms but it should be noted the last 4 days were spent locating upholes on old lines for reprocessing.

Most lines followed existing tracks or roads throughout the area. There were a few lines which traversed across paddocks. The terrain consisted of tall tree coverage and deep valleys between hills thus requiring manual chaining of lines with kinematic GPS and REM techniques used for surveying the pegged positions.

Poor satellite geometry meant there were effectively three hours of GPS down-time in the middle of each day.

Line trace diagrams and access maps were provided to the Terrex crew before their commencement of each line to aid in line traversing.

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CONCLUSIONS AND RECOMMENDATIONS

Under ideal conditions, lines with a 15m station interval may easily be chained and surveyed with one person. In Spring Gully, however, the terrain which consisted of thick, tall tree coverage and deep valleys between hills, meant that a lot of manual chaining and REM survey was required. In the hot conditions, this was an unreasonable work load for one person.

This was exacerbated by poor satellite geometry which, under normal circumstances, may only cause 15-30 minutes of trouble in a day but here was more like three hours in the middle of the day. During this period real-time techniques could not even be used in sparsely tree-covered areas. Because line clearing was only just ahead of surveying, the surveyor couldn't skip to another more open line. It was also not possible to skip ahead of the line clearing crew. These sections ended up being manually chained due to pressure from the lack of lead time on the seismic crew.

This form of survey generates more office work, partly due to the manual chaining and also having to update trace diagrams and access mud maps every night for the crew to use the next day because they were so close. Because no line pointing, as such, was being done, access routes had to be investigated and mapped on a daily basis, for updating access maps for the crew each evening, taking away from time spent pegging. Time spent placing control was also considerable because of access time spent travelling from existing control around to new locations.

The work load was such that little requests, put together with other little requests became too much too handle for a single Surveyor and we had to make do with what could be accomplished in the time available.

The process of driving the survey vehicle forward 150 metres (dragging the graduated chain), the surveyor walking back this distance installing the wooden pegs at each station, and then walking back to the survey vehicle was very inefficient.

If there had been sufficient lead by the line clearing crew, the production levels achieved by DSS could have easily been double by employing a survey offsider. This was stated in DSS' original tender submission and was also contained in the signed agreement between DSS and Origin Energy for the Spring Gully prospect.

It is strongly recommended that on future projects that line clearing commences at least one week before survey and that survey has at least a one week lead over the main crew. It is also recommended that two surveyors, or a surveyor with an offsider are used for future, similar projects. This would make the whole survey operation less stressful, run more smoothly, allow trace diagrams and access to be completed ahead of the main crew, reducing fatigue. Thus making a much safer, quicker and more efficient operation for all parties involved.

Signed,

Ben Allsopp

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APPENDICES

Survey Control and Ties

Survey Control and Ties

All values are Map Grid of Australia 1994 (MGA94 Zone 55)
and Australian Height Datum 1971 (AHD71)
using the AusGeoid98 N Value Model

Control Datum

Station	Easting (MGA)	Northing (MGA)	AHD
SG02	702318.240	7140111.810	351.020

Bases Established During Survey

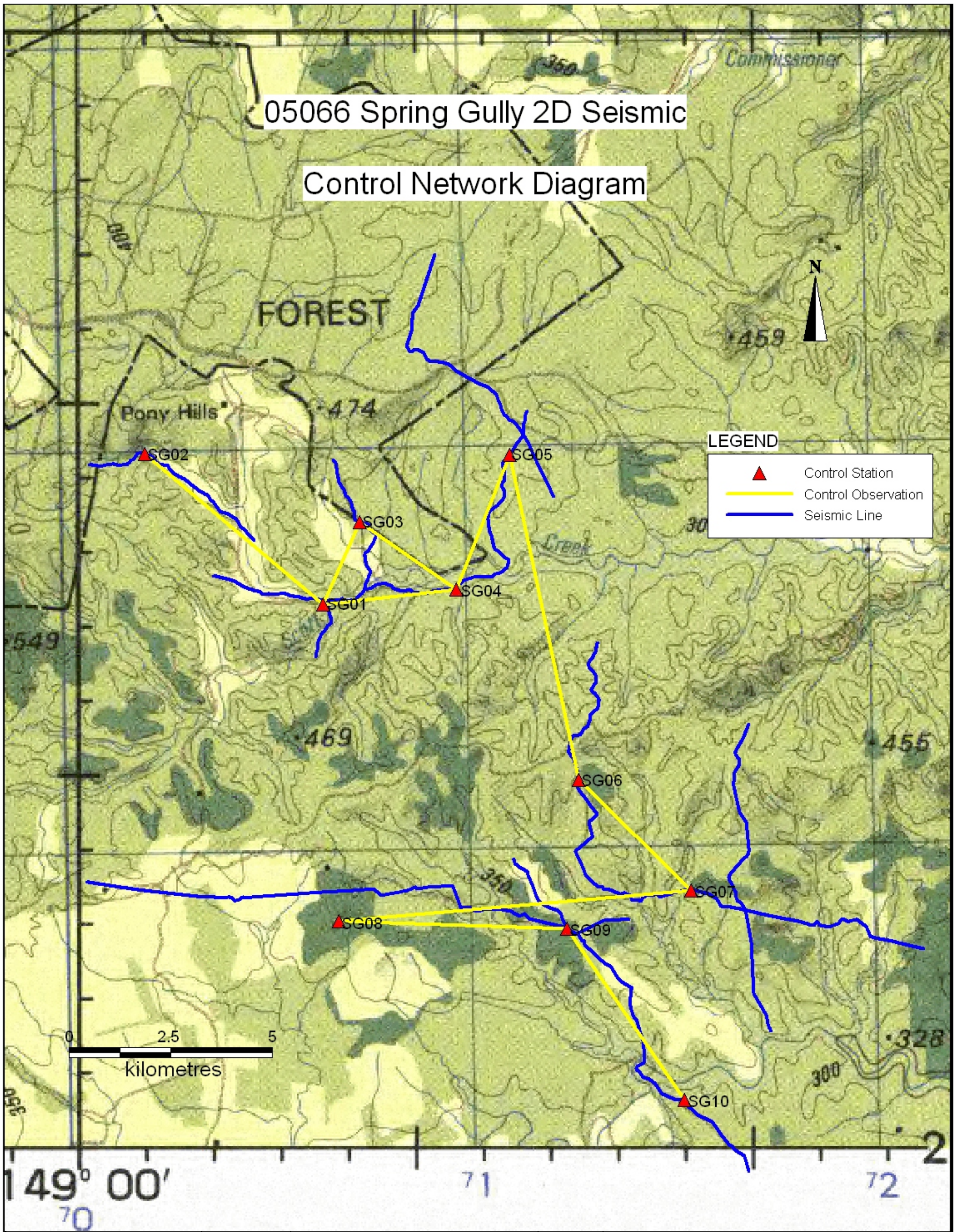
Station	Easting (MGA)	Northing (MGA)	AHD
SG01	706639.95	7136315.28	317.25
SG03	707591.92	7138338.59	332.99
SG04	709937.35	7136628.26	301.32
SG05	711306.59	7139969.89	388.57
SG06	712866.43	7131829.60	415.29
SG07	715604.63	7129043.61	400.21
SG08	706912.23	7128407.86	391.44
SG09	712518.17	7128131.18	391.67
SG10	715351.93	7123826.25	330.27

Survey Checks

Station	Easting (MGA)	Northing (MGA)	AHD71	Comments
SG01	706639.91	7136315.27	317.33	AUSPOS
SG01	706639.95	7136315.28	317.25	Observed
	0.04	0.01	-0.08	

Station	Easting (MGA)	Northing (MGA)	AHD71	Comments
SG10	715351.88	7123826.26	330.31	AUSPOS
SG10	715351.93	7123826.25	330.27	Observed
	0.05	-0.01	-0.04	

Network Diagram



Dynamic Satellite Surveys ABN 16 008 210 348	Quality Endorsed Company ISO 9001:2000 QEC 10046 SAI Global	Dynamic Satellite Surveys Pty Ltd PO Box 713 YEPPOON QLD 4703 Ph: 07 4939 2866 Fax: 07 4939 2867 Email: yeppoon@dss.com.au Web: www.dss.com.au	Scale: 1:120000 Drawn: LPB File: 05066control.tif Rev: 0.0 Date: 28/02/06	**Origin Energy** **Spring Gully 2D**

Permanent Markers

Permanent Marker Listing

Coordinates are Map Grid of Australia 1994 (MGA Zone 55) and AHD71.

Station	Easting (MGA)	Northing (MGA)	AHD
SG01	706639.95	7136315.28	317.25
SG02	702318.24	7140111.81	351.02
SG03	707591.92	7138338.59	332.99
SG04	709937.35	7136628.26	301.32
SG05	711306.59	7139969.89	388.57
SG06	712866.43	7131829.60	415.29
SG07	715604.63	7129043.61	400.21
SG08	706912.23	7128407.86	391.44
SG09	712518.17	7128131.18	391.67
SG10	715351.93	7123826.25	330.27

Line Length Summary

Line Length Summary
2005 Spring Gully 2D Seismic Survey

Station Interval = 15 m

Line	SOL Station	EOL Station	Line km
OSG06-01	100	638	8.070
OSG06-02	103	441	5.070
OSG06-03	87	331	3.660
OSG06-03	332	922	8.850
OSG06-04	113	1009	13.440
OSG06-05	100	1037	14.055
OSG06-06	104	528	6.360
OSG06-07	100	825	10.875
OSG06-08	102	654	8.280
		TOTAL =	**78.660**

Line Intersection Listing

Line Intersection Listing

Coordinates are Map Grid of Australia 1994 (MGA Zone 55) and AHD71

Line and Stn No.	Line and Stn No.	Easting	Northing	Height
OSG06-01/524+05	OSG06-03/881+09	711655.9	7140449.9	374.03
OSG06-03/357+05	OSG06-06/271+10	707654.1	7136635.7	307.12
OSG06-08/447+04	OSG06-04/893+08	716930.3	7128519.3	392.83

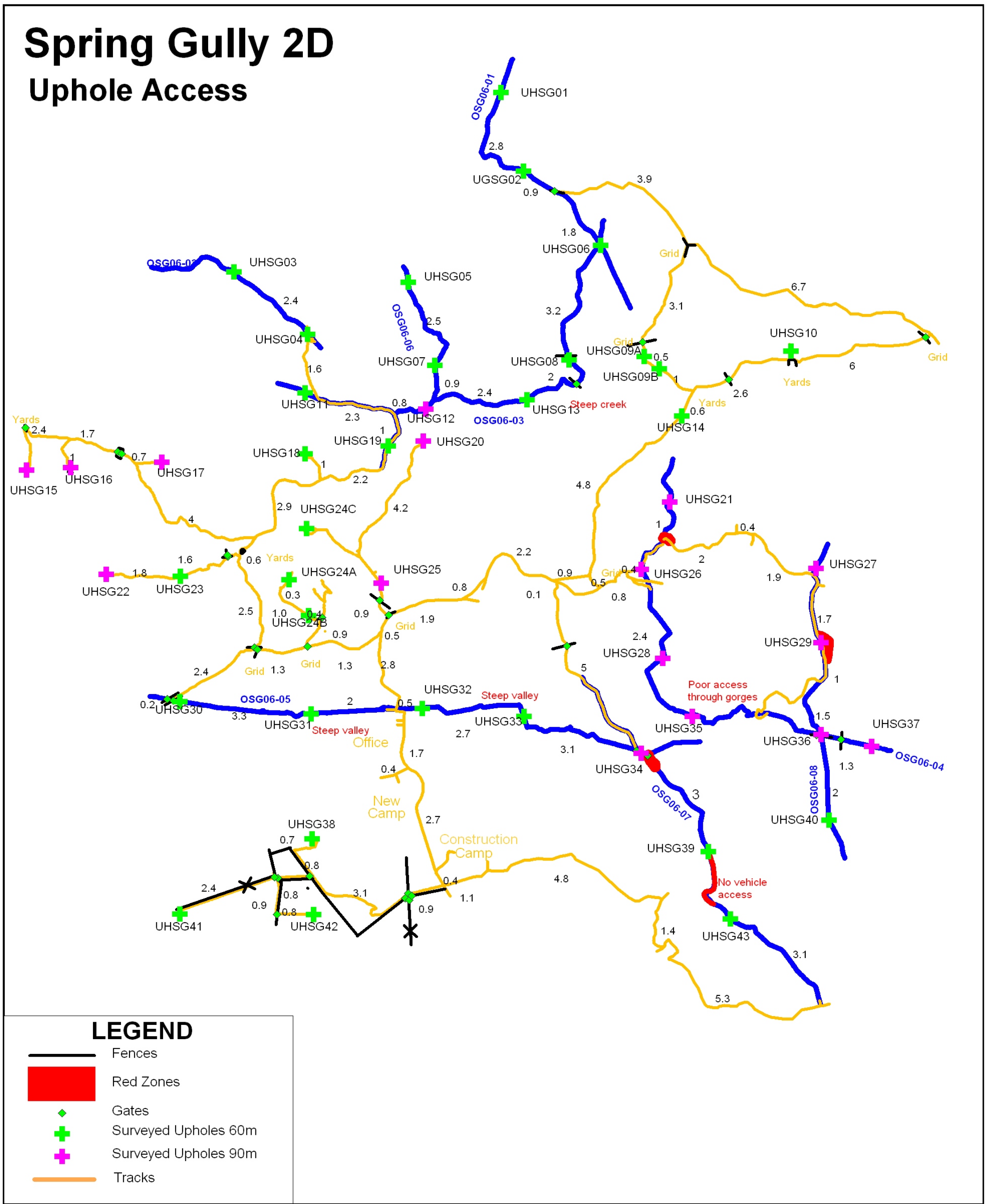
Upholes Listing and Map

Surveyed Upholes Listing

Coordinates are Map Grid of Australia 1994 (MGA Zone 55) and AHD71

(Depths provided by Origin Energy 24 February, 2006)

Uphole #	Easting	Northing	Elevation	Depth (m)
UHSG01	709274.7	7144157.1	344.4	60
UGSG02	709817.1	7142247.1	407.7	60
UHSG03	702897.6	7139789.3	341.1	60
UHSG04	704659.5	7138270.9	321.9	60
UHSG05	707056.5	7139531.9	351.6	60
UHSG06	711653.8	7140439.5	372.5	60
UHSG07	707696.3	7137510.0	309.0	60
UHSG08	710898.0	7137649.5	326.7	60
UHSG09A	712693.4	7137730.2	310.9	60
UHSG09B	713054.7	7137429.4	291.5	60
UHSG10	716202.9	7137864.7	288.8	60
UHSG11	704600.7	7136847.3	320.9	60
UHSG12	707483.4	7136456.1	304.7	90
UHSG13	709897.6	7136675.4	299.4	60
UHSG14	713589.8	7136284.5	295.8	60
UHSG15	697941.6	7134966.2	399.2	90
UHSG16	698994.1	7135025.3	467.7	90
UHSG17	701177.5	7135158.4	457.3	90
UHSG18	704596.8	7135359.3	340.6	60
UHSG19	706586.2	7135556.4	309.9	60
UHSG20	707414.9	7135667.7	422.0	90
UHSG21	713309.7	7134195.3	417.8	90
UHSG22	699847.8	7132436.1	429.8	90
UHSG23	701618.1	7132380.0	379.3	60
UHSG24A	704209.4	7132300.8	413.4	60
UHSG24B	704676.0	7131424.1	431.0	60
UHSG24C	704632.6	7133545.7	442.2	60
UHSG25	706411.6	7132216.9	446.9	90
UHSG26	712629.6	7132551.5	418.1	90
UHSG27	716797.0	7132574.9	427.3	90
UHSG28	713135.3	7130380.2	415.2	90
UHSG29	716915.1	7130770.2	387.9	90
UHSG30	701604.0	7129334.6	398.8	60
UHSG31	704737.5	7129037.6	379.0	60
UHSG32	707399.1	7129169.7	397.6	60
UHSG33	709822.2	7128968.2	386.1	60
UHSG34	712624.2	7128073.5	389.7	90
UHSG35	713840.1	7128968.6	360.0	90
UHSG36	716916.8	7128526.3	392.4	90
UHSG37	718122.9	7128237.9	348.7	90
UHSG38	704763.5	7125993.8	335.4	60
UHSG39	714228.4	7125681.1	355.5	60
UHSG40	717108.7	7126448.7	347.5	60
UHSG41	701601.2	7124160.3	348.5	60
UHSG42	704805.1	7124156.5	328.5	60
UHSG43	714757.1	7124041.6	323.8	60



Dynamic Satellite Surveys ABN 16 008 210 348	Quality Endorsed Company ISO 9001 QEC 10046 SAI Global	Dynamic Satellite Surveys Pty Ltd PO Box 713 YEPPOON QLD 4703 Ph: 07 4939 2866 Fax: 07 4939 2867 Email: yeppoon@dss.com.au Web: www.dss.com.au	Scale	1:150 000	**Origin Energy**
			Drawn	DW	
			File	Upholes.wor	
			Rev:	2.0	**Spring Gully 2D**
			Date	27-02-06	

Photographs


Scenic Valleys

Deep Bull Dust Between Trees

Tree-filled Valleys

Backpack GPS

Chronological Summary

Chronological Summary

DATE	OPERATIONS
Jan 12	Travelled from Miles to Roma. Spring Gully Inductions. Returned to Miles.
Jan 14	Travelled from Miles to Roma. Vehicle wash down and inspection. Travelled from Roma to Spring Gully. Started scouting lines and setting up base stations.
	Daily Chaining Total: 0.000 km
Jan 15	Weekly safety meeting. Completed pegging OSG06-02. Started control for OSG06-06. Mapped access from lines to construction camp
	Daily Surveying Total: 5.070 km
Jan 16	Started control for OSG06-03. Started pegging OSG06-06.
	Daily Surveying Total: 4.230 km
Jan 17	Completed pegging OSG06-06. Started pegging OSG06-03, progress stopped until grader could clear lines.
	Daily Surveying Total: 3.585 km
Jan 18	Continued pegging OSG-03.
	Daily Surveying Total: 5.775 km
Jan 19	Completed pegging OSG06-03. Started pegging OSG06-0.
	Daily Surveying Total: 7.020 km

Chronological Summary

DATE	OPERATIONS
Jan 20	Manually chained 5 km along OSG06-01.
	Daily Surveying Total: 5.250 km
Jan 21	REM 6 km of OSSG06-01completeing line Transfer control from the northern area to southern area around OSG06-04. Started pegging OSG06-04.
	Daily Surveying Total: 3.945 km
Jan 22	Weekly safety meeting. Continued pegging southern end of OSG06-04, 1 km chaining. Continued pegging north once pipeline access was cleared.
	Daily Surveying Total: 6.195 km
Jan 23	REM OSG06-04, 2.4km. Chaining OSG06-04, 1.95km of gorge country. Continued pegging OSG06-04.
	Daily Surveying Total: 4.230 km
Jan 24	Continued pegging OSG06-04. Started pegging OSG06-08.
	Daily Surveying Total: 7.665 km
Jan 25	Chained last section of OSG06-08. Started pegging OSG06-05, had to stop to sort out access through well 57.
	Daily Surveying Total: 5.670 km

Chronological Summary

DATE	OPERATIONS
Jan 26	Finished REM on OSG06-08. Completed pegging OSG06-05.
	Daily Surveying Total: 5.685 km
Jan 27	Continued pegging OSG06-05. Started pegging OSG06-07. Finished REM on OSG06-04
	Daily Surveying Total: 9.780 km
Jan 28	Established control for the southern end of OSG06-07. Started hand carry section of OSG06-07. Pegged from hand carry section to end of line on OSG06-07.
	Daily Surveying Total: 3.825 km
Jan 29	Weekly safety meeting. Completed hand carry section of OSG06-07. Extended OSG06-07 south to fenceline.
	Daily Surveying Total: 0.735 km
Jan 30	Static survey of nine old line upholes.
Jan 31	Continued static survey of an additional eight old line upholes.
Feb 01	Standby waiting for pipeline to be located and final uphole location.
Feb 02	Completed pipeline pickup and placed final uphole. Travelled to Westmar 2D.

Line Trace Diagrams