Dynamic Satellite Surveys

04056

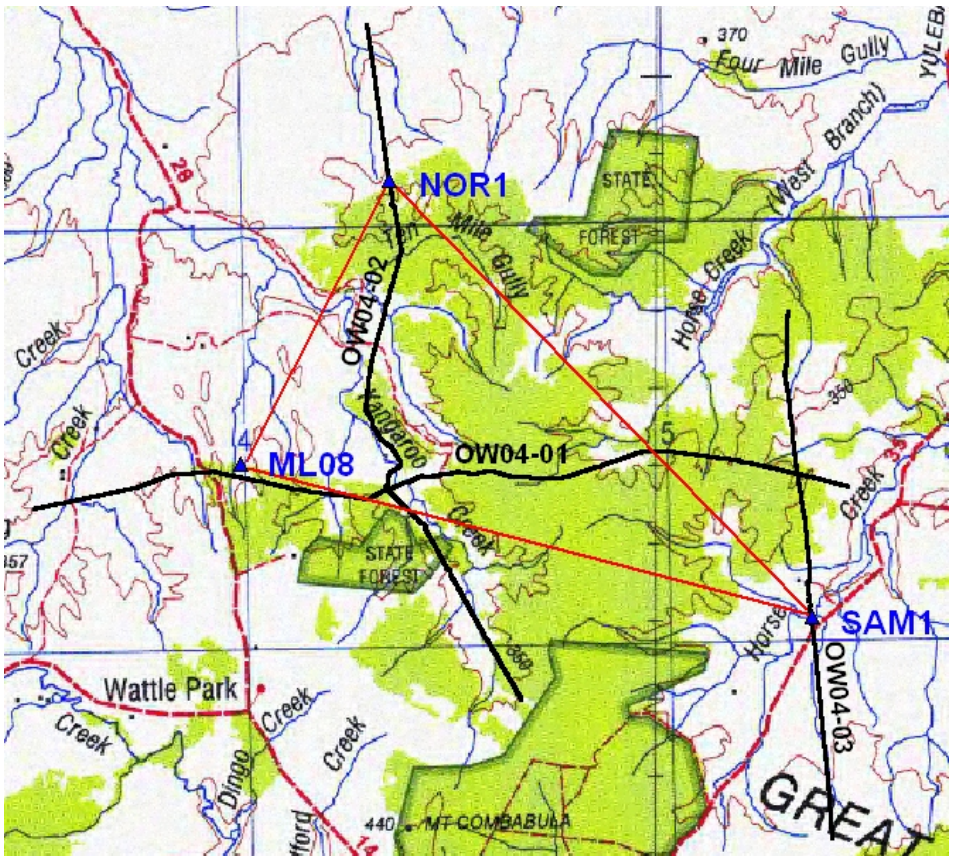
Final Operations Report
on the

2004 COMBABULA 2D Seismic Survey

for

ORIGIN ENERGY CSG LIMITED

August 2004



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1

INTRODUCTION

The following report covers the **2004 Combabula 2D Seismic Survey**, undertaken by **Dynamic Satellite Surveys Pty Ltd** (DSS) for **Origin Energy CSG Limited**.

The survey was located approximately 30km north of Yuleba in Queensland.

The survey operation was within **ATP 606P** and consisted of three lines totalling **50.625** kilometres at a station interval of 12.5 metres.

Survey production varied from 3.34 to 7.23 kilometres per day with the average for the job being over 5 kilometres per day.

The survey operations were completed in two stages with the initial heritage clearance conducted between the 13th and 19th of July and the survey pegging conducted between the 9th and 21st of August.

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INSTRUMENTATION AND PERSONNEL

2.1 Personnel and Logistics

DSS personnel involved in the survey were as follows.

Mark Lefebvre - Bachelor of Applied Science (Surveying)
Samantha Lilleboe - Field Assistant

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

Survey operations were based at the Overlander Homestead Motel in Roma during the heritage clearance, and the Mandalay Motel in Roma for the survey pegging stage.

2.2 Equipment

Equipment provided by DSS and used on this project.

	Description	Qty
Vehicles	Toyota Landcruiser Trayback - Hired	1
GPS receivers	NovAtel RT2 c/w VHF Telemetry	3
	NovAtel RT20	2
	Garmin 72	1
Computers	Dell Inspiron 5000	1
	GRiD 386 Field PCs	5
Software	GravNav / GravNet GPS post-processing - Waypoint Consultancy	1
	Nav98 field software - DSS	Ver4.0
	Nav98 Dozer field software - DSS	Ver4.0
	MIB2003 for Windows - DSS	Ver4.1.1
	TransIt 2000 - DSS	Ver2.04
Printer	Canon I60 Printer	1
Miscellaneous	Necessary standard surveying equipment	
	Sundry office and transport equipment	
	Field and Office Consumables	

3

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:

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 6.03 software, distributed by Waypoint Consulting Inc.

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

4

SURVEY CONTROL

As no existing control could be found in the area, an initial control point (ML08) was installed a few hundred metres north of station 400 on Line OW04-01 and GPS data was recorded for a period of approximately 10 hours.

This data was then submitted via the internet to the Geoscience[2] Australia website and final coordinates are computed (using a variety of computational methods) in GDA94 and are sent to the user.

These standard deviations of these AUSPOS values are quoted to be better than 0.020m for X,Y and Z. Static GPS observations to two other marks in the network NOR1 and SAM1 were also observed and an AUSPOS position also obtained for NOR1.

The misclose to NOR1 was as follows :

MGA94 and AHD71

Station	Easting	Northing	Height	Comments
NOR1	744126.492	7101463.136	374.102	Network observed/computed
NOR1	744126.468	7101463.120	374.170	AUSPOS
Diff	0.024	0.016	-0.068	

This is an excellent result and the misclose in height is more than acceptable considering GPS observations were used.

[2] Geoscience Australias AUSPOS at www.ga.gov.au/bin/gps/pl

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MONUMENTATION

All lines were pegged at a 12.5 metre station interval. Wooden pegs were placed at every station and were numbered on both sides of the peg at every even station.

Three permanent markers were placed on the prospect.

ML08 - 200m north of Station 400 on Line OW04-01.
NOR2 - At the intersection of OW04-02 and the southern boundary of “Norwood”.
SAM1 - At the intersection of Line OW04–03 and the northern boundary fence of the road reserve of Potters Flat Road.

Permanent markers consisted of a 1.80m steel star picket driven into the ground leaving approximately 1.60m above ground, and tagged with an aluminium plate stating the line number, station number and control station name and number.

The permanent markers are listed at **Appendix C - Permanent Markers**.

6

METHOD OF SURVEY

6.1 Line Ranging

All lines were cleared by Aztex Earthmoving contractors. The equipment supplied to perform the clearing was two Caterpillar bulldozers (D7 and D6) and a Caterpillar 12G Grader with some lines being slashed by a tractor.

The operators were experienced in preparation of seismic lines with regard to environmental issues and GPS guidance techniques.

A Novatel RT20 GPS receiver was mounted on the D6 dozer to supply real time positions when cutting the seismic lines and the D7 followed behind the D6 further clearing the line of sticks and other unwanted material. The coordinates of start, end and any bend points (obtained by the initial Heritage clearance survey) were uploaded into the GPS unit and each line had a separate waypoint file.

The operator had no problems using the system and only a small amount of time was lost due to earthing problems/power overload on the D6. No time was lost due to GPS equipment down time during the seismic pegging program.

The DSS Surveyor ensured operators were aware of the existence of any culturally significant sites and all designated sites, such as gullies and eroded areas that had been previously identified, were avoided.

Several additional areas to avoid were identified during the line clearing by the Origin representative and additional bends were inserted by him to avoid these areas.

Unfortunately the surveyor was not informed or consulted regarding these additional bends and this caused some problems as the pegging approached these areas.

6.2 Surveying and Chaining

The lines were surveyed using DSS' RT2 real-time kinematic surveying technique.

RT2 enables both position and elevation coordinates to be acquired in real-time and on the appropriate datum.

The survey method utilised phase data received from US Navy NAVSTAR Satellites to provide three-dimensional positioning. One receiver was set up as a base station at a known location while the other receiver was used as remote rover.

To obtain real-time capabilities, VHF telemetry is required between the base and the remote GPS receiver. Numerous remote receivers can be used at any given time with any base station.

NovAtel real-time kinematic methods can achieve accuracies of better than +/-0.10m in position and elevation, depending on base line length. The expected precision for locating pegged positions is better than 0.2 metres and is generally better than 0.15 metres.

Initialisation of the RT2 rover GPS usually takes less than 60 seconds, although this is greatly dependant on satellite geometry, availability and base line length.

No delays were experienced due to poor satellite visibility or geometry.

6.3 GPS Processing and Quality Control

When using RT20, all data is recorded internally in GRiD palmtop data loggers and 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.

Any recording of positions when the standard deviation values are in excess of 0.05m is highlighted to the surveyor at the time of recording, and the GPS may be re-initialised until a more accurate solution is calculated.

Any position which falls outside the required tolerances is flagged for further investigation and re-recording if necessary.

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

The coordinates are then checked by determining point to point direction and distance. Profile plots are examined to identify any height anomalies.

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DATA PRESENTATION

All line files were checked and finalised shortly after the survey was completed.

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

Files produced were:

OW04-XX.UKA	Line coordinate data in UKOOA format.
OW04-XX.SEG	Line coordinate data in SEGP1 format.

The Final Data was transferred by Sam Coniglio from a USB drive at the Origin office in Surat on the 27th of August 2004.

Sam Coniglio, in his capacity as an Origin representative, thanked Mark for the prompt response in preparing the data.

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

UHF radio contact was always available between the surveyor and with the line clearing contractors and other members of the crew. Regular contact was made throughout each day to ensure that the safety of personnel was monitored.

Morning toolbox meetings highlighted any safety concerns which personnel encountered during the previous day and ensured everyone was informed about the activities planned for that day.

Line trace diagrams were prepared as the pegging progressed and copies were passed on to Bill Foster who in turn passed them on to the recording crew. They can be seen in **Appendix H - Line Trace Diagrams**.

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CONCLUSIONS AND RECOMMENDATIONS

The project ran well with no major problems.

One small problem, and this was briefly mentioned earlier, was that additional bends were placed by the Origin Energy environmental representative without any knowledge of, or consultation with the surveyor. The fact that the Origin representative had limited knowledge of seismic operations added to this dilemma as very sharp bends were inserted into the seismic lines. This meant that some heritage clearance needed to be re-performed and, in some cases, some lines required re-dozing to avoid these sharp bends.

In some cases DSS surveyors prefer to have all bends surveyed before commencing pegging because if the bends are known, as well as the start and end of line, the line can be pegged in what is known as “constant” mode. This means that, as all bends are predetermined, any portion of the line can be pegged at any time. This is particularly useful when parts of lines are to be cleared later or where vegetation prohibits the use of GPS. It was intended to use this method of chaining as all bends had been surveyed previously during the Heritage clearance.

However, as additional bends were introduced, I found that I was sometimes getting a station interval longer than the desired interval of 12.5m. The largest difference from 12.5 metres is 1.6m and this was an isolated case where the line bends at a very sharp angle.

During the survey, as I became aware that bends were being inserted, I decided to revert to pegging in what is known as “radial” mode where each subsequent peg is exactly 12.5m from the previous peg no matter what the angle of deviation is from the peg.

This method of chaining was changed from station 995 onwards on Line OW04-01 and continued for the rest of the job.

A greater proportion of time could have been spent on field survey duties had the travel time to and from the job been reduced. While staying in Roma, the average time spent travelling to and from the job per day was two hours. It was the client representative's intention to have the crew stay in the one place and this prevented the crew staying anywhere else but the town of Roma.

A Satellite image of the prospect was obtained by Origin Energy for mapping and other purposes but unfortunately this image was not made available to DSS.

This would have been helpful after the initial Heritage clearance stage when most of the bend points were surveyed and, if the lines were able to be plotted on the satellite image, this would have highlighted sharp bends and any areas that needed further survey before the line clearing commenced.

There were no upholes required on this project and no ties were made to old PMs as none were found.

There were no safety incidents on the project.

Signed,

Mark Lefebvre

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APPENDICES

Survey Control, Miscloses and Ties

Survey Control, Miscloses and Ties

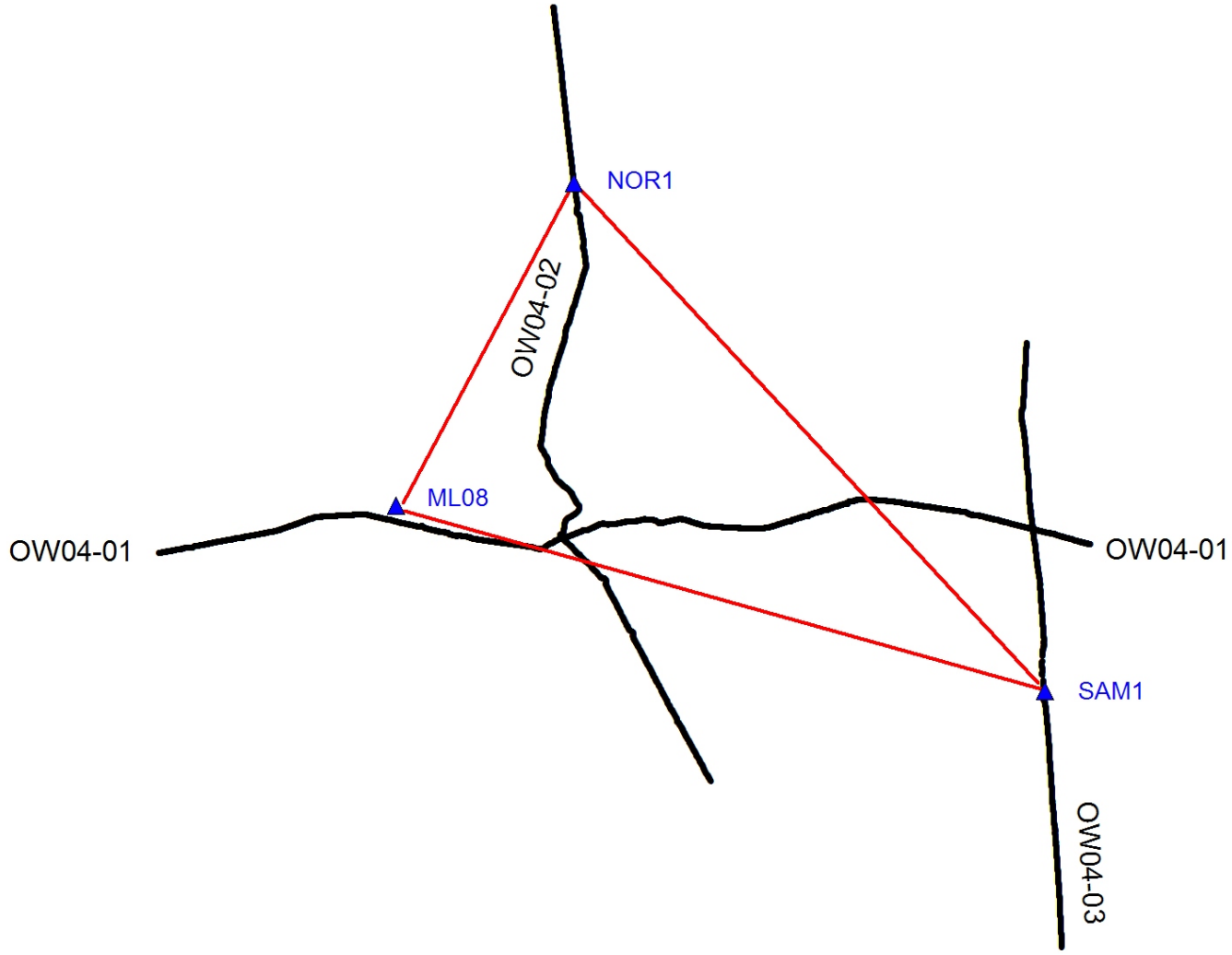
Coordinates are Map Grid of Australia 1994 (MGA Zone 55) and AHD71

Station	Easting	Northing	Height
ML08	740487.995	7094739.326	365.481
NOR1	744126.492	7101463.136	374.102
SAM1	754019.559	7090878.772	310.719

Station	Easting	Northing	Height	Comments
NOR1	744126.492	7101463.136	374.102	Network observed/computed
NOR1	744126.468	7101463.120	374.170	AUSPOS
Diff	0.024	0.016	-0.068	

Network Diagram

CONTROL NETWORK AND PLOT OF LINES
COMBABULA 2D SEISMIC SURVEY AUGUST 2004



Permanent Markers

Permanent Marker Listing

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

Combabula 2D Seismic Survey 2004

Line Number	Stn	Easting	Northing	Elevation	Comments
OW04-01	400	740488.00	7094739.33	365.48	ML08
OW04-02	339	744202.29	7101494.16	370.56	NOR2
OW04-03	680	754019.56	7090878.77	310.72	SAM1

Line Length Summary

Line Length Summary

2004 Combabula Seismic Survey

Station Interval = 12.5 m

Line	SOL Station	EOL Station	Line Km's
OW04-01	100	1700	20.000
OW04-02	44	1478	17.925
OW04-03	92	1108	12.700
		TOTAL	**50.625kms**

Intersection Listing

Line Intersection Listing

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

Line / Station	Line / Station	Easting	Northing	Height
OW04-01 /790+9	OW04-02 /990+8	743956.84	7094078.26	323.31
OW04-01 /1600+3	OW04-03 /405+1	753776.98	7094274.17	337.77

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INTERSECTION DIAGRAM

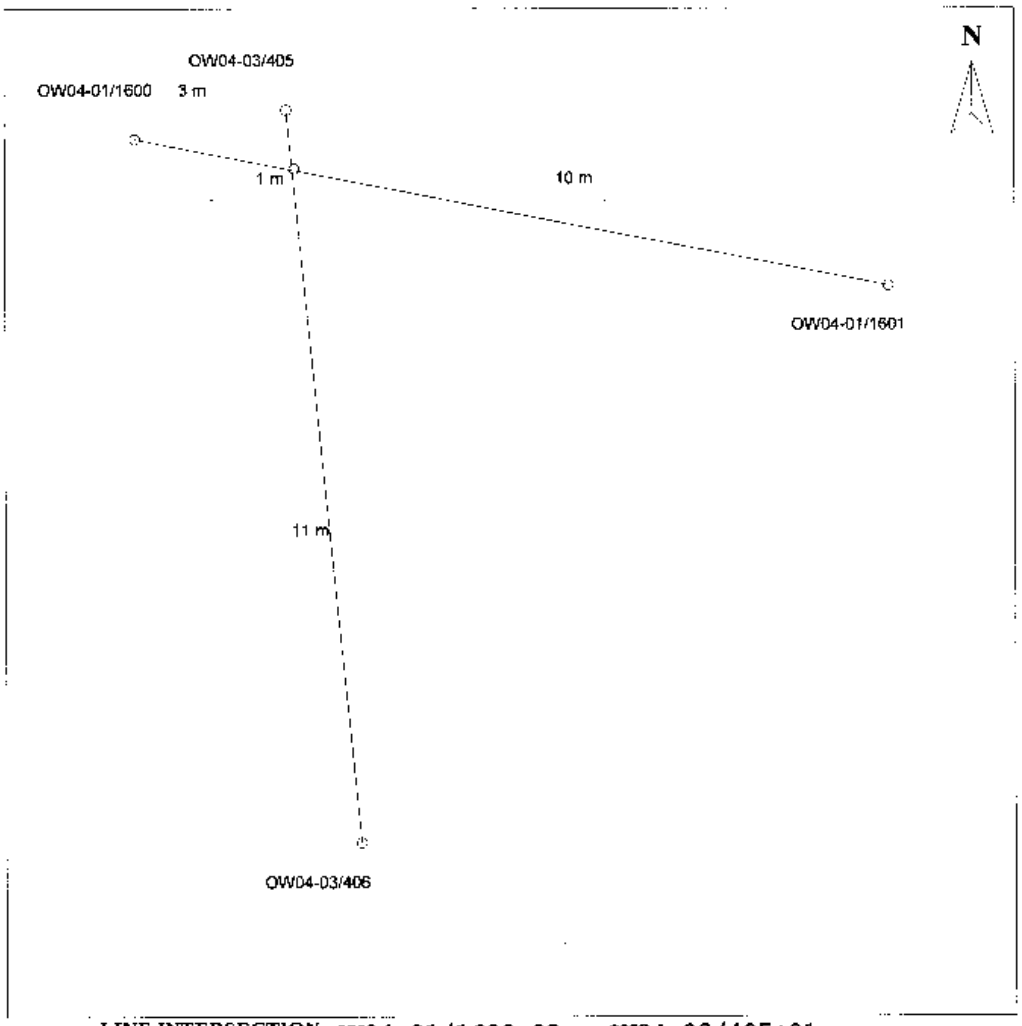
DSS-FF-14
REV 4.0
May 1998

PROJECT / JOB #: 04056 CLIENT: ORIGIN ENERGY DATE: 08/04

INTERSECTION LINES: OW04-01 / OW04-03

AREA: Combabula 2D PROJECTION: MGA Zone 55

STATION INTERVAL: 12.5 DATUM: GDA94 AHD



LINE INTERSECTION: OW04-01/1600+03 = OW04-03/405+01

Easting	753776.98	RL1 =	337.81
Northing	7094274.17	RL2 =	337.74
RL	337.77	MEAN:	337.77

Dynamic Satellite Surveys

INTERSECTION DIAGRAM

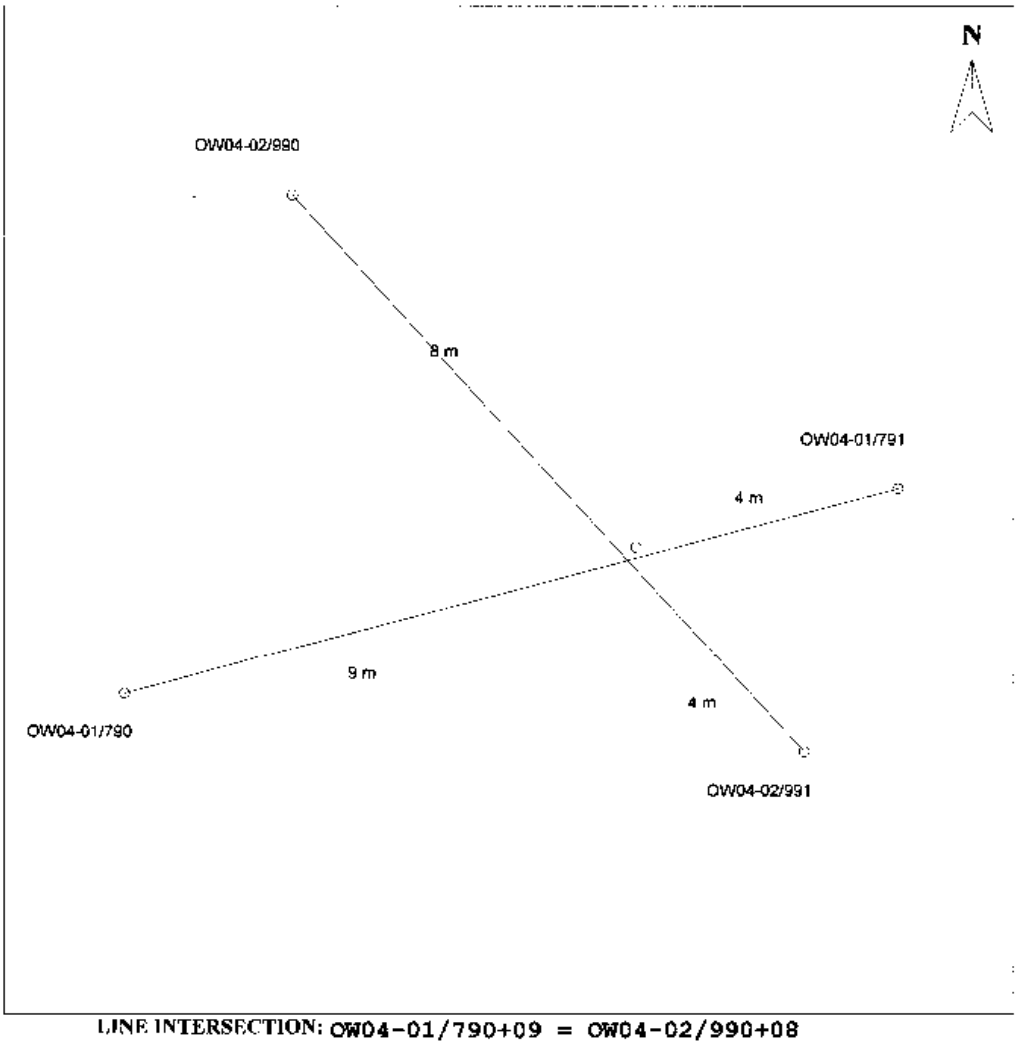
DSS-FF-14
REV 4.0
May 1998

PROJECT / JOB #: 04056 CLIENT: ORIGIN ENERGY DATE: 08/04

INTERSECTION LINES: OW04-01 / OW04-02

AREA: Combabula 2D PROJECTION: MGA Zone 55

STATION INTERVAL: 12.5 DATUM: GDA94 AHD



LINE INTERSECTION: OW04-01/790+09 = OW04-02/990+08

Easting	743956.84	RL1 =	323.31
Northing	7094078.26	RL2 =	323.32
RL	323.31	MEAN:	323.31

Photographs

Line 02, Norwood boundary looking North

Line 02, Norwood boundary looking South

Line 02

Base ML08

Chronological Summary

Chronological Summary

DATE	OPERATIONS
13th July	Mark met Sam Coniglio at Origin's office in Surat to be briefed and also download emails awaiting from Lindsay Horn. Met Lindsay Horn at Yuleba at 0915hrs and met with landholders and commenced reconnoitre of prospect.
14-19th July	Heritage clearance completed. Monitors present with Mark and Lindsay were Bevan McCarthy and Francis Ulataufonua. Mark demobs to Surat.
9th August	Mark mobilises from Surat to Roma. Samantha (pegging assistant) arrives from Yeppoon. Site specific induction at Origin office in Surat. Commence line clearing.
10th August	Three new bases installed and control observed for all bases.
11th August	Pegging commenced after grader arrived from Roma.
18th August	Line clearing completed.
20th August	Pegging completed and additional control installed and observed.
21st August	Check line data with Bill Foster and finalise Daily Reports and Line Trace diagrams with Bill Foster. Samantha demobs to Yeppoon.
27th August	Check line data and prepare final data. Final data copied from USB drive by Sam Coniglio at Surat office.
31st August	Prepare final report.
15th September	Completed Final report.

Line Trace Diagrams

Dynamic Satellite Surveys

TRACE DIAGRAM

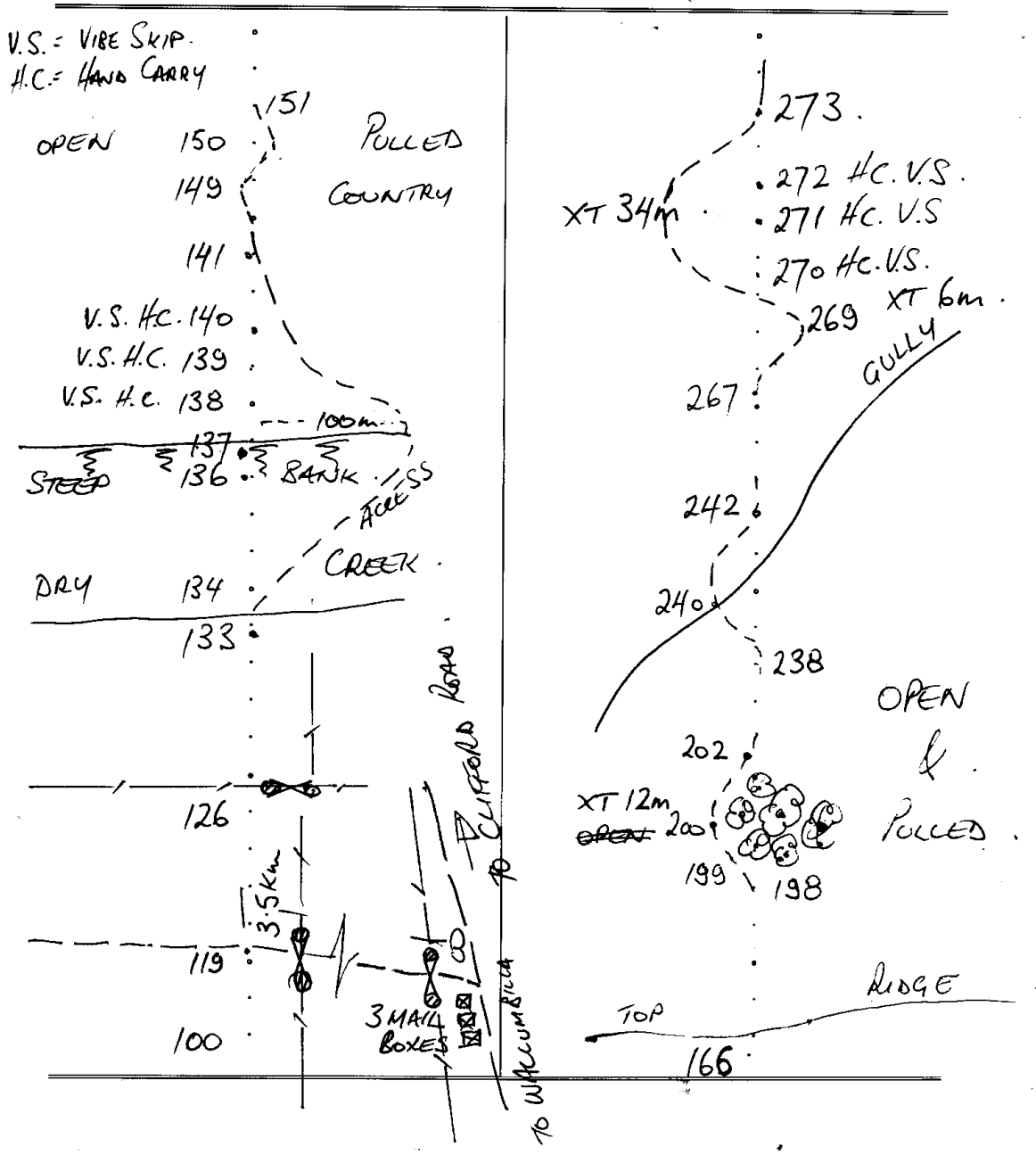
DSS-FF-07
REV 7.0
e 2001

LINE: OW04-01

PROJECT/JOB #: 04056 ORIGIN.

PAGE 1 OF 8 AREA COMBABULA STN INTERVAL 12.5 INTERVAL:

FROM STN 100 TO STN 273. SHOOTING DIRECTION: TO:



TRACE DIAGRAM

Dynamic Satellite Surveys

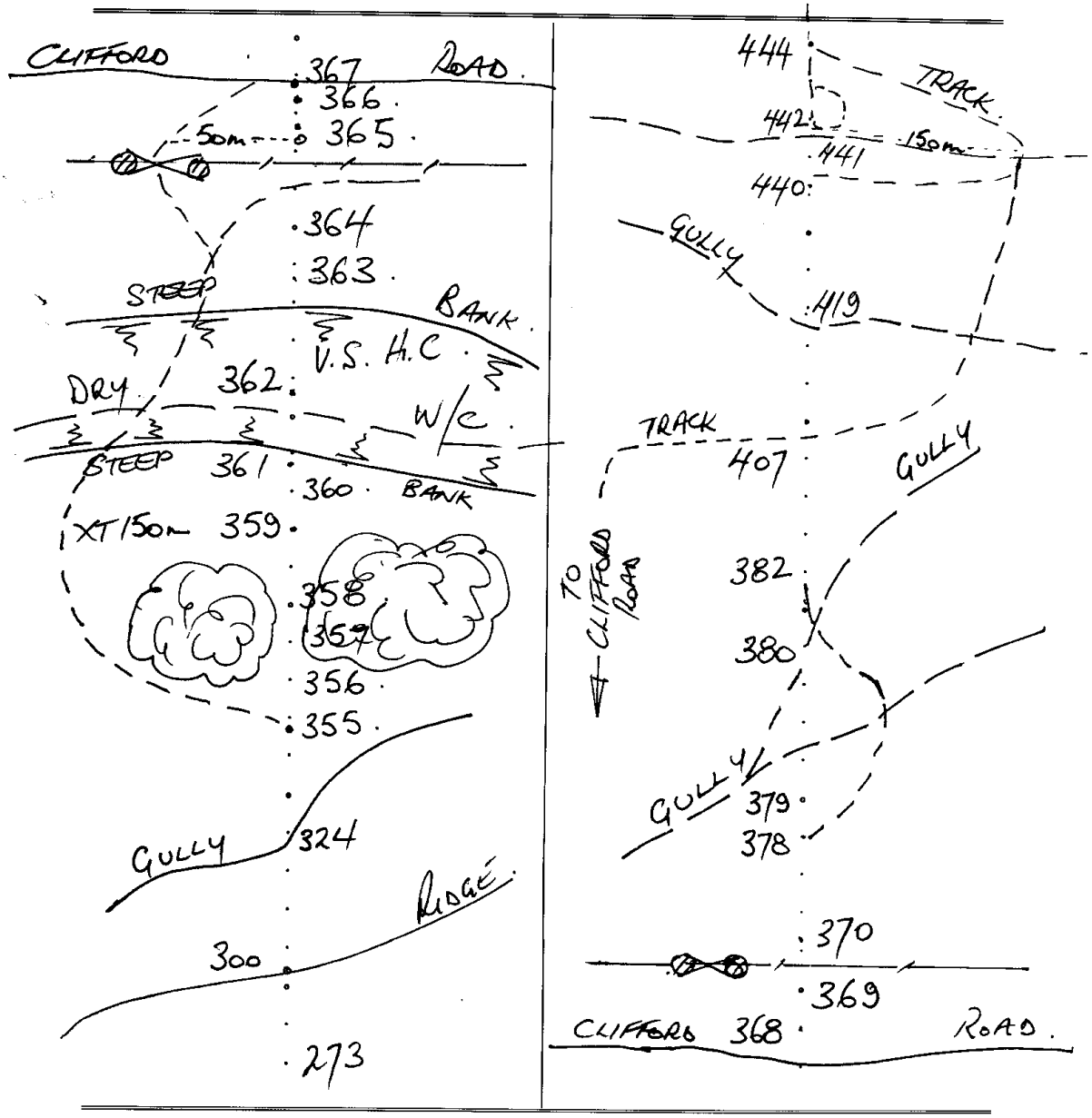
DSS-FF-07
REV 7.0
June 2001

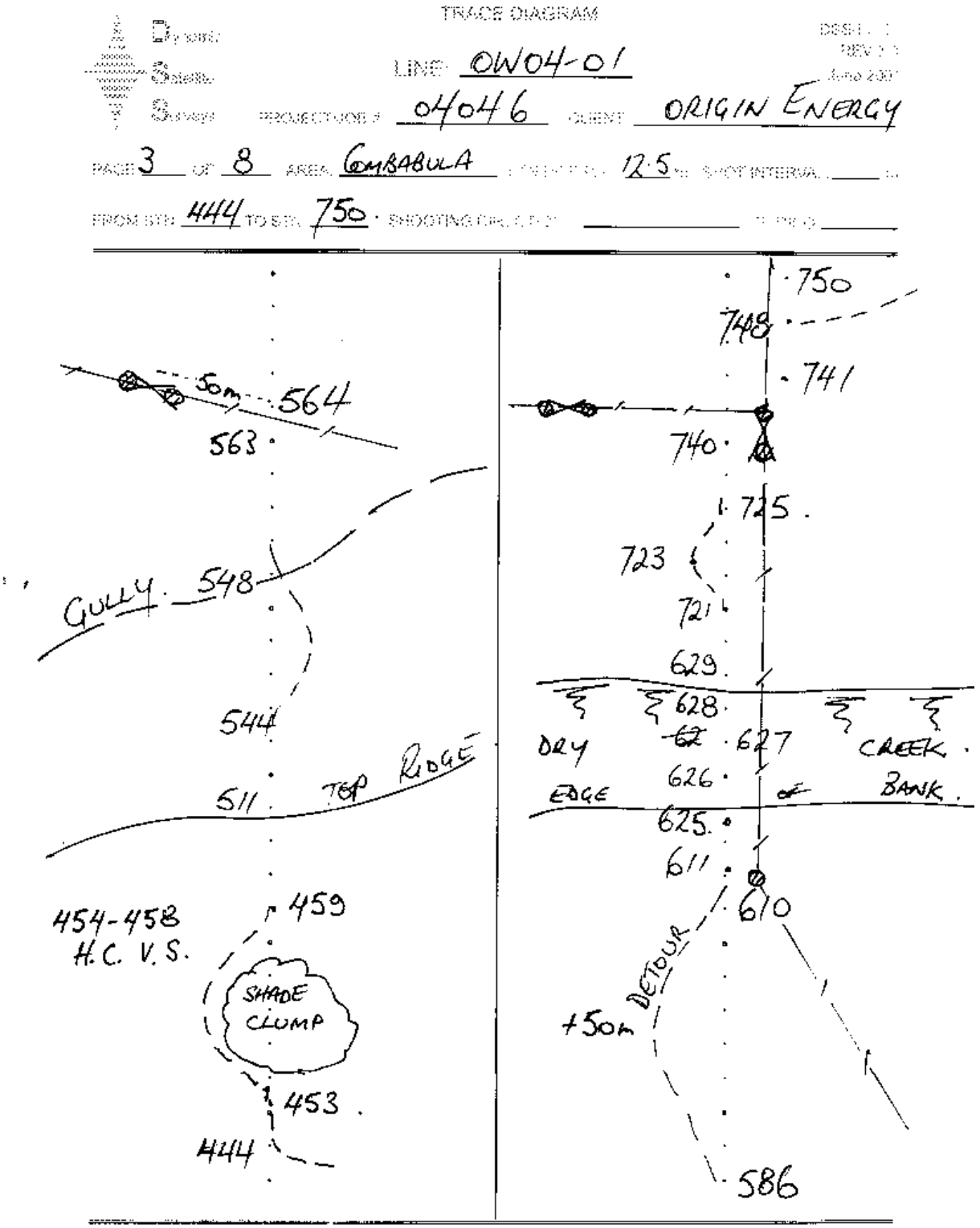
LINE: OW04-01.

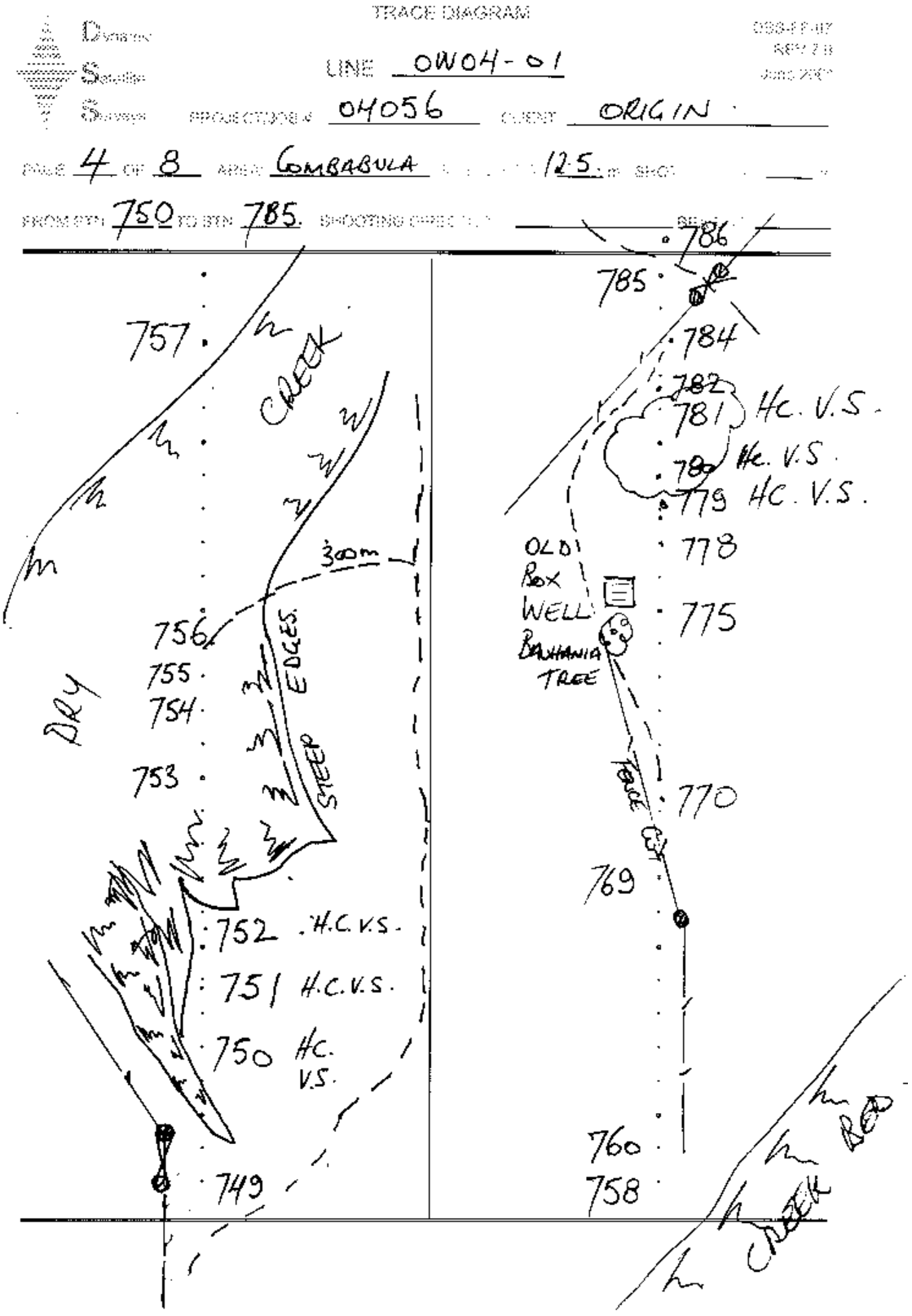
PROJECT/JOB # 04056 CLIENT ORIGIN.

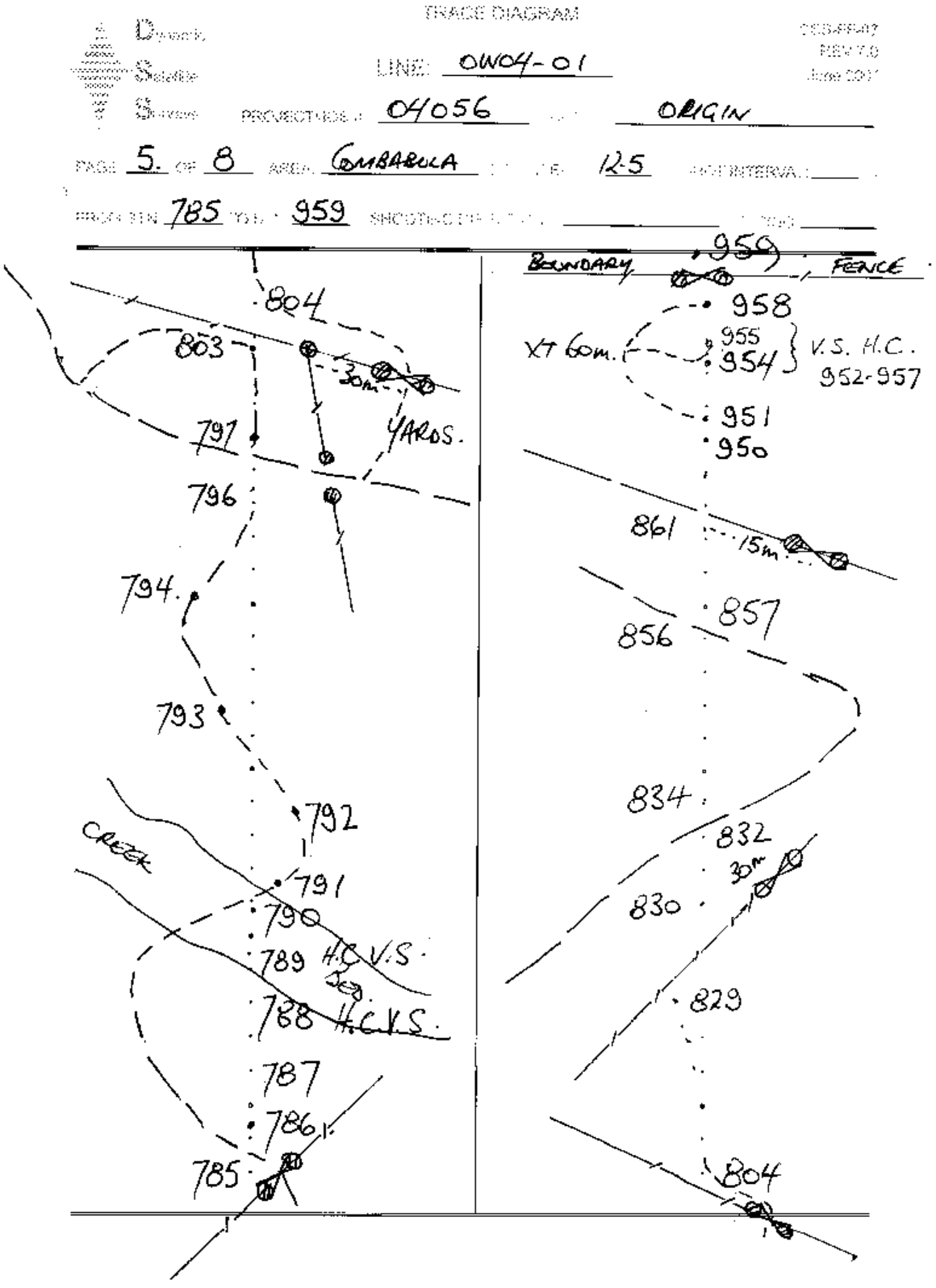
PAGE 2 OF 8 AREA: COMBABULA STN INTVL 12.5 m SHOT INTERVAL ____ m

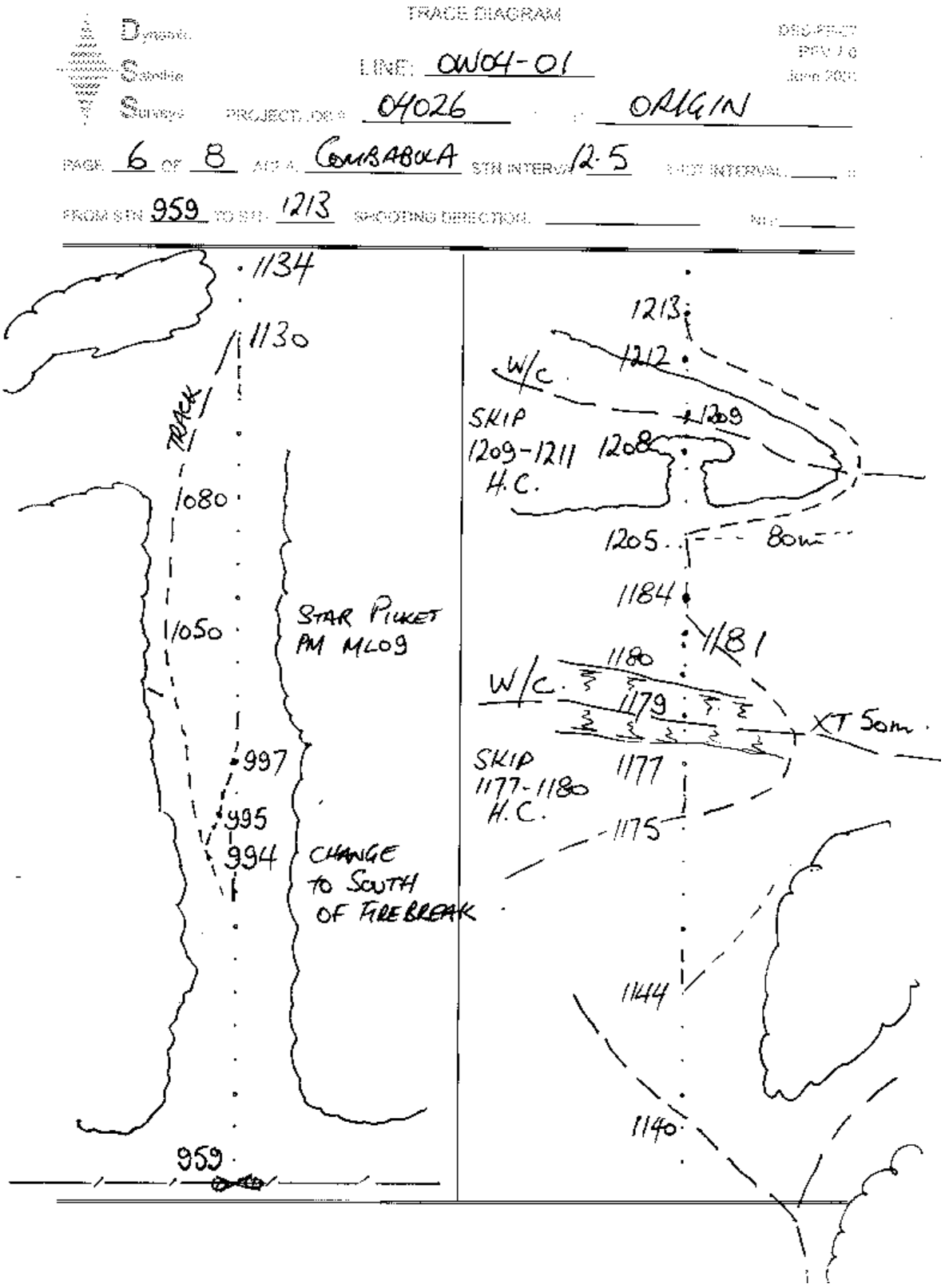
FROM STN 273 TO STN 444 SHOOTING DIRECTION: _____ BEARING: _____











Dynamic Satellite Surveys

TRACE DIAGRAM

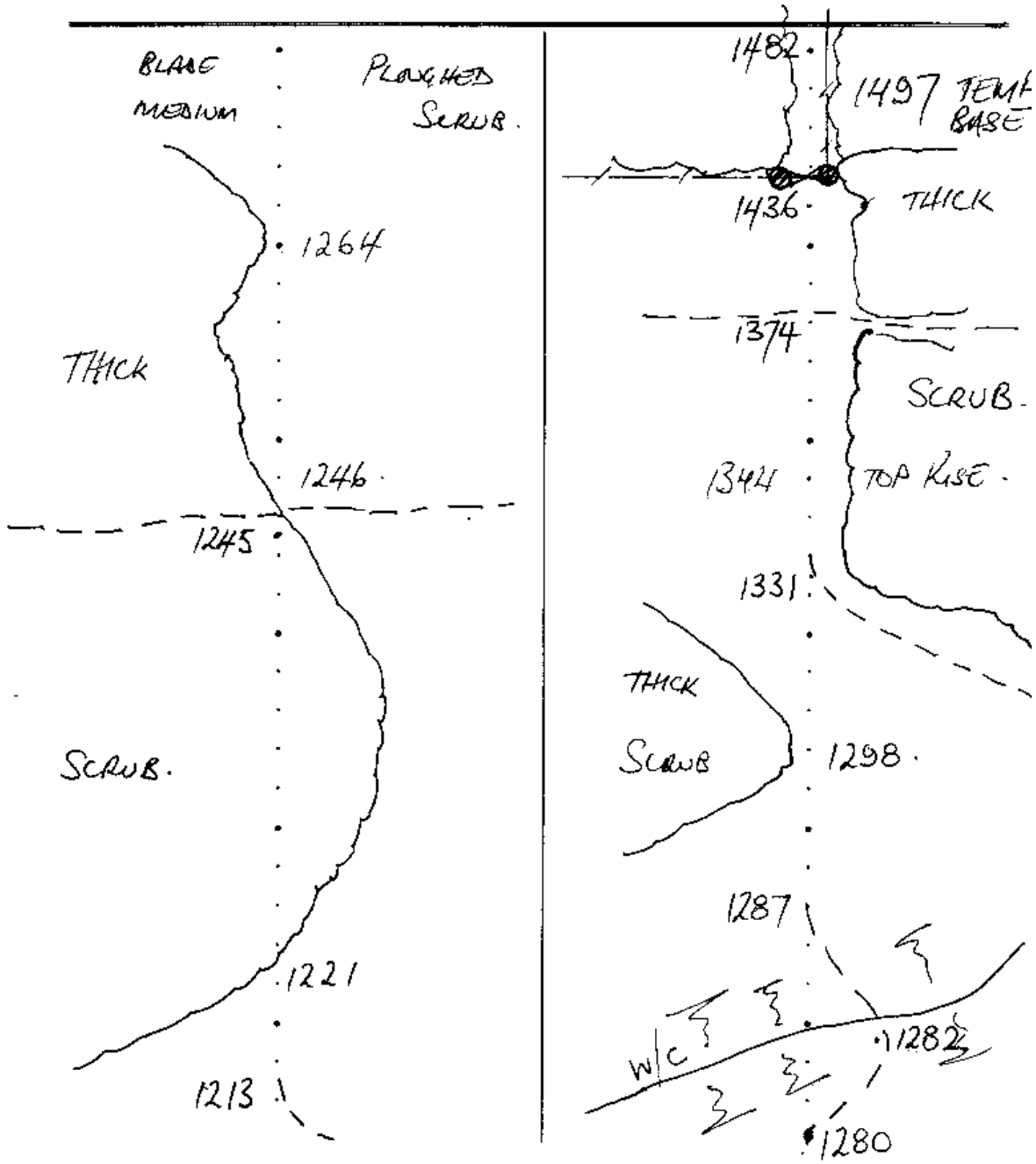
DSS-FF-07
REV 7.0
June 2001

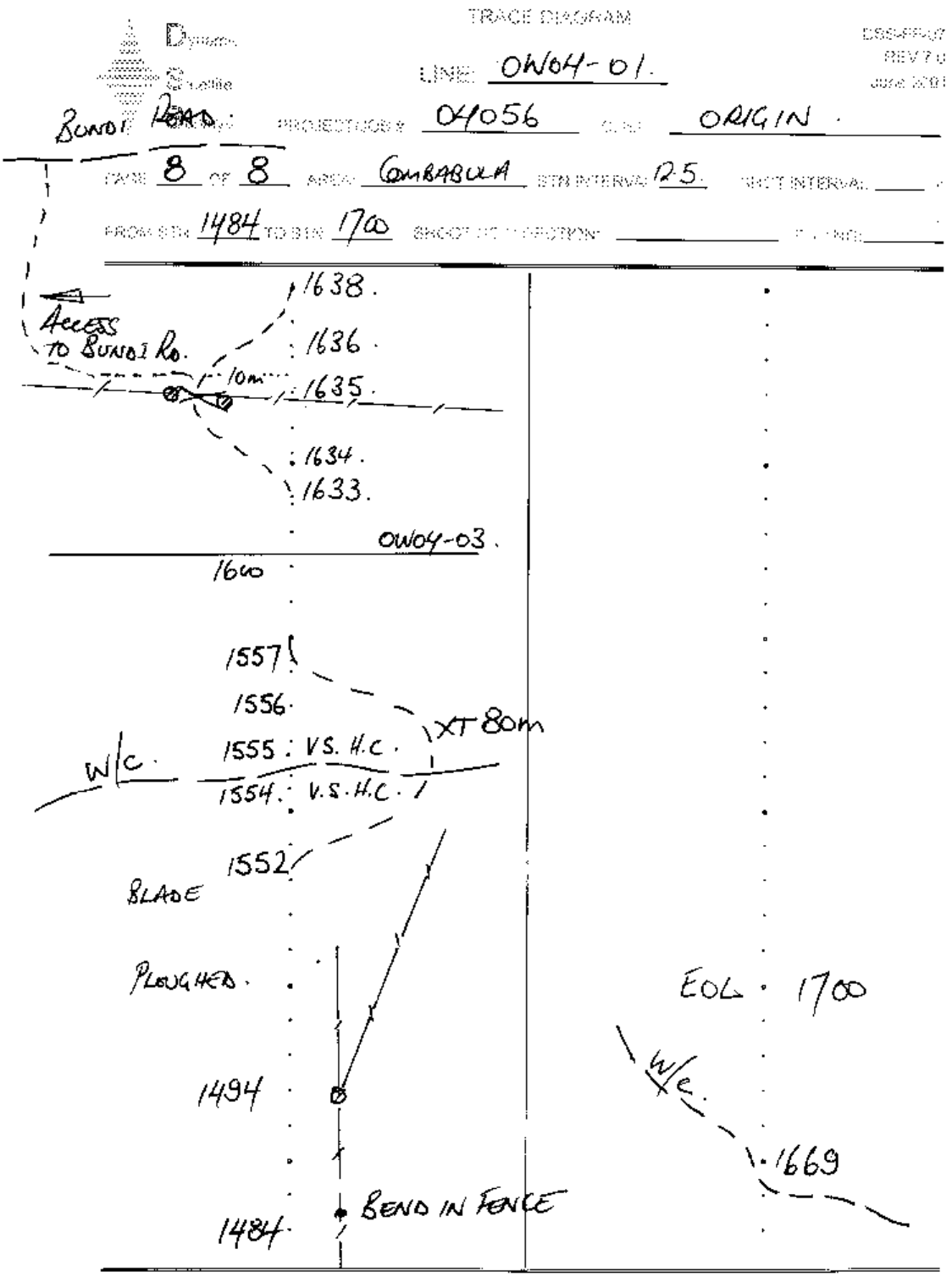
LINE: OW04-01

PROJECT/JOB # 04026 CLIENT ORIGIN

PAGE 7 OF 8 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 1213 TO STN 1482 SHOOTING DIRECTION: _____ BEARING: ____°





Dynamic Satellite Surveys

TRACE DIAGRAM

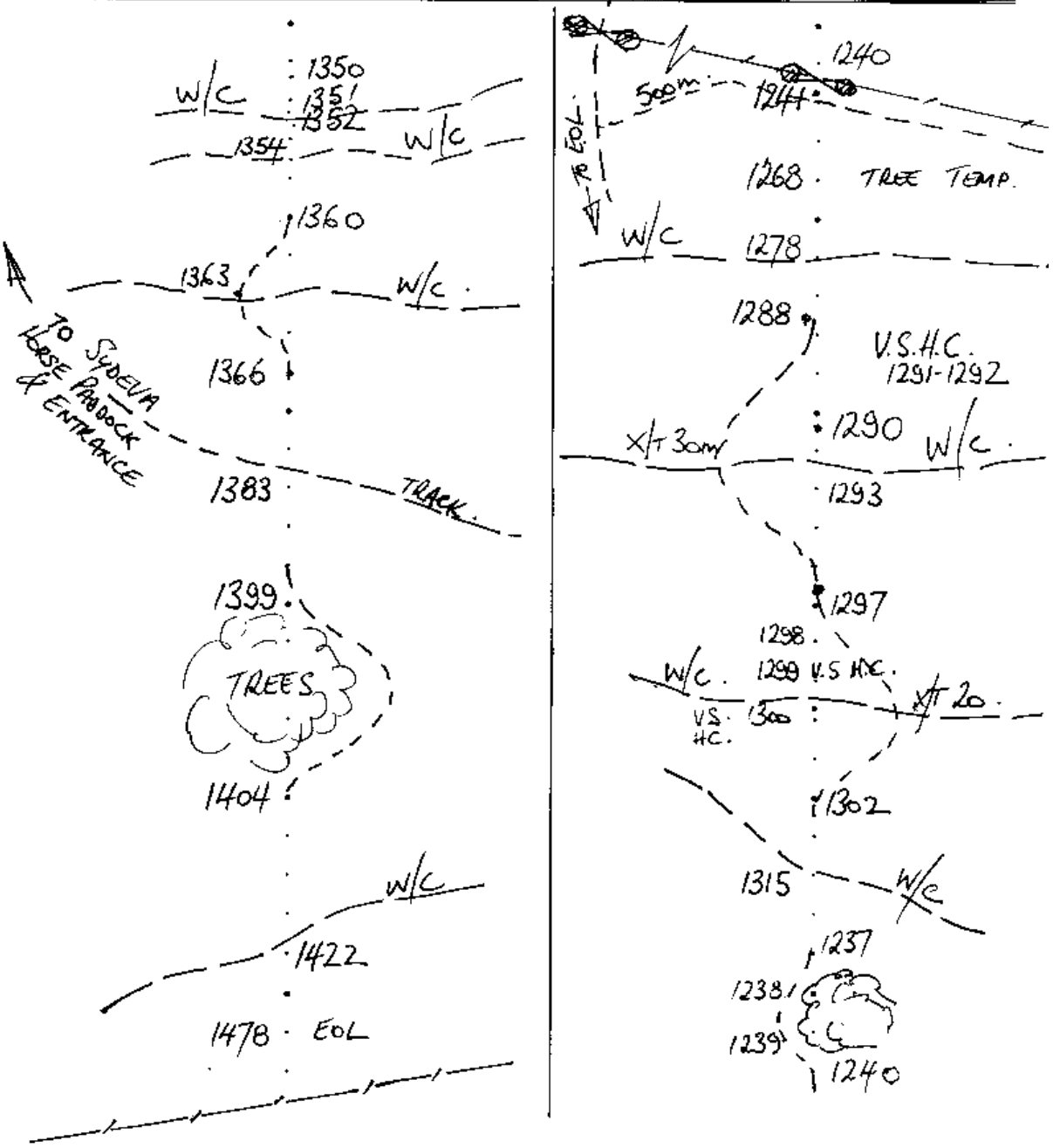
DSS-FF-07
REV 7.0
June 2001

LINE: OW04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 1 OF 6 AREA: COMBABULA STN INTERVAL: 2.5 m SHOT INTERVAL: ____ m

FROM STN 1478 TO STN 1240 SHOOTING DIRECTION: ____ BEARING: ____°



Dynamic Satellite Surveys

TRACE DIAGRAM

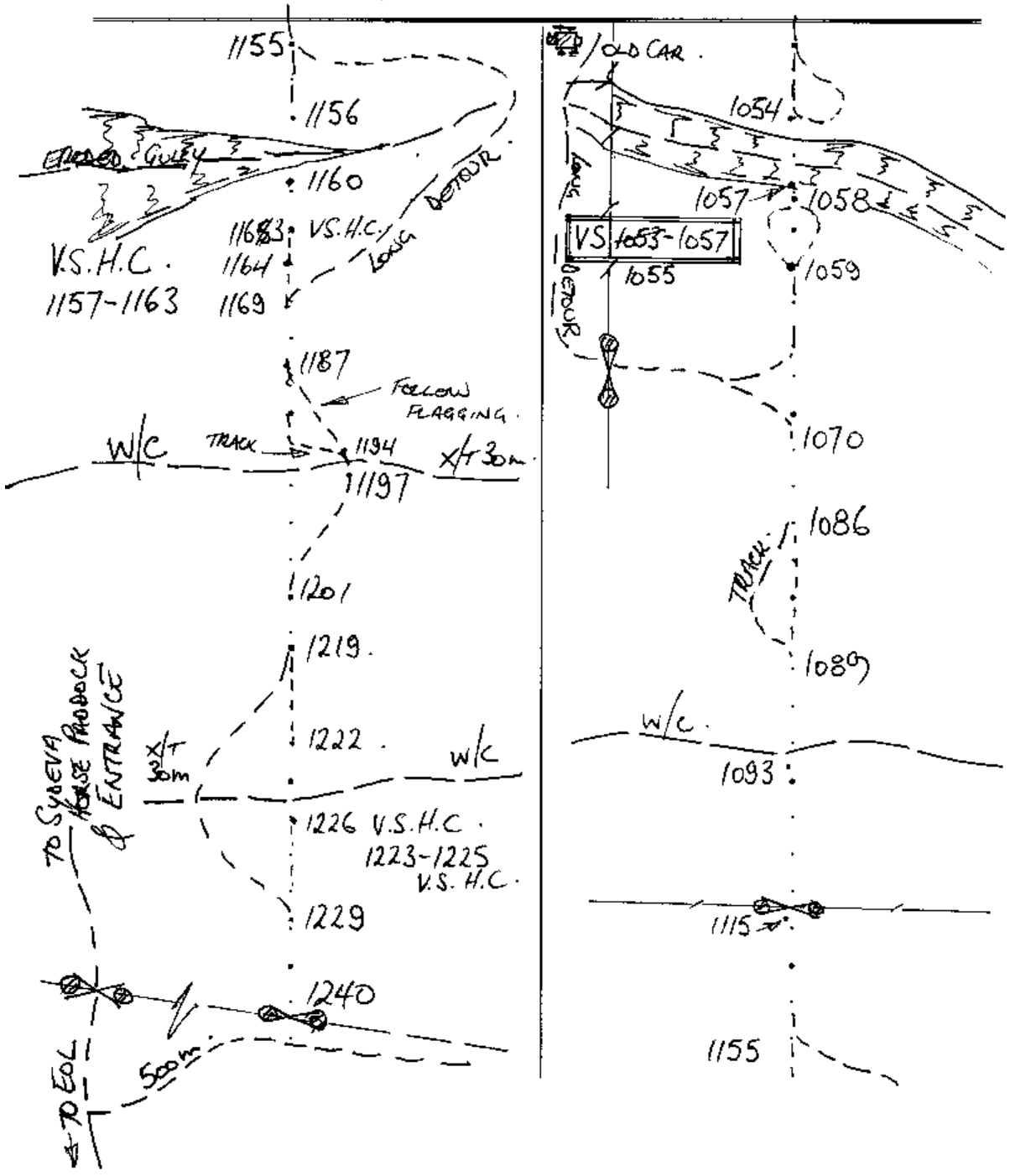
DSS-FF-07
REV 7.0
June 2001

LINE: OW04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 2 OF 6 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 1240 TO STN 1054 SHOOTING DIRECTION: _____ BEARING: ____°



Dynamic Satellite Surveys

TRACE DIAGRAM

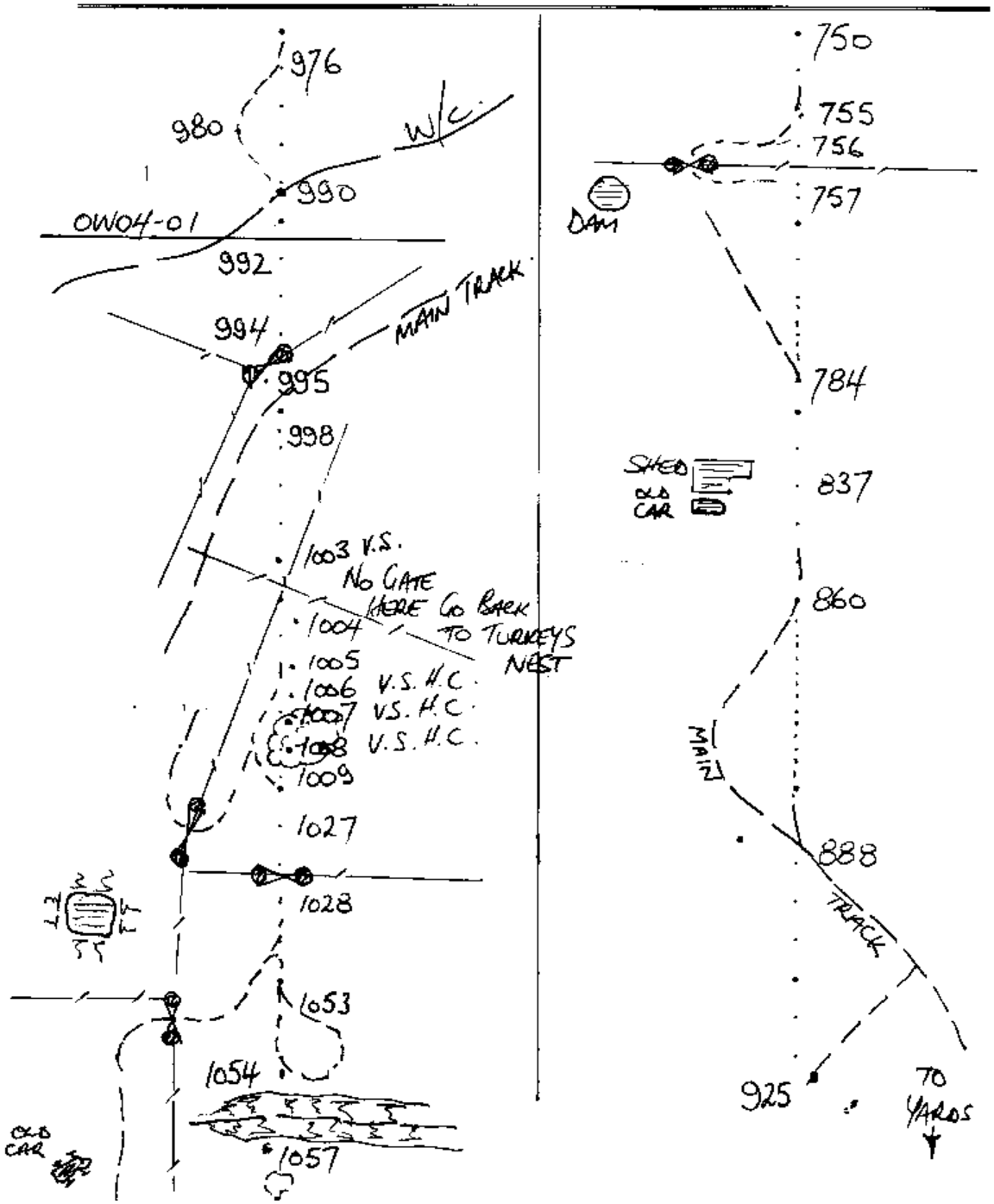
DSS-FF-07
REV 7.0
June 2001

LINE: OW04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 3 OF 6 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 1054 TO STN 750 SHOOTING DIRECTION: _____ BEARING: ____°



Dynamic Satellite Surveys

TRACE DIAGRAM

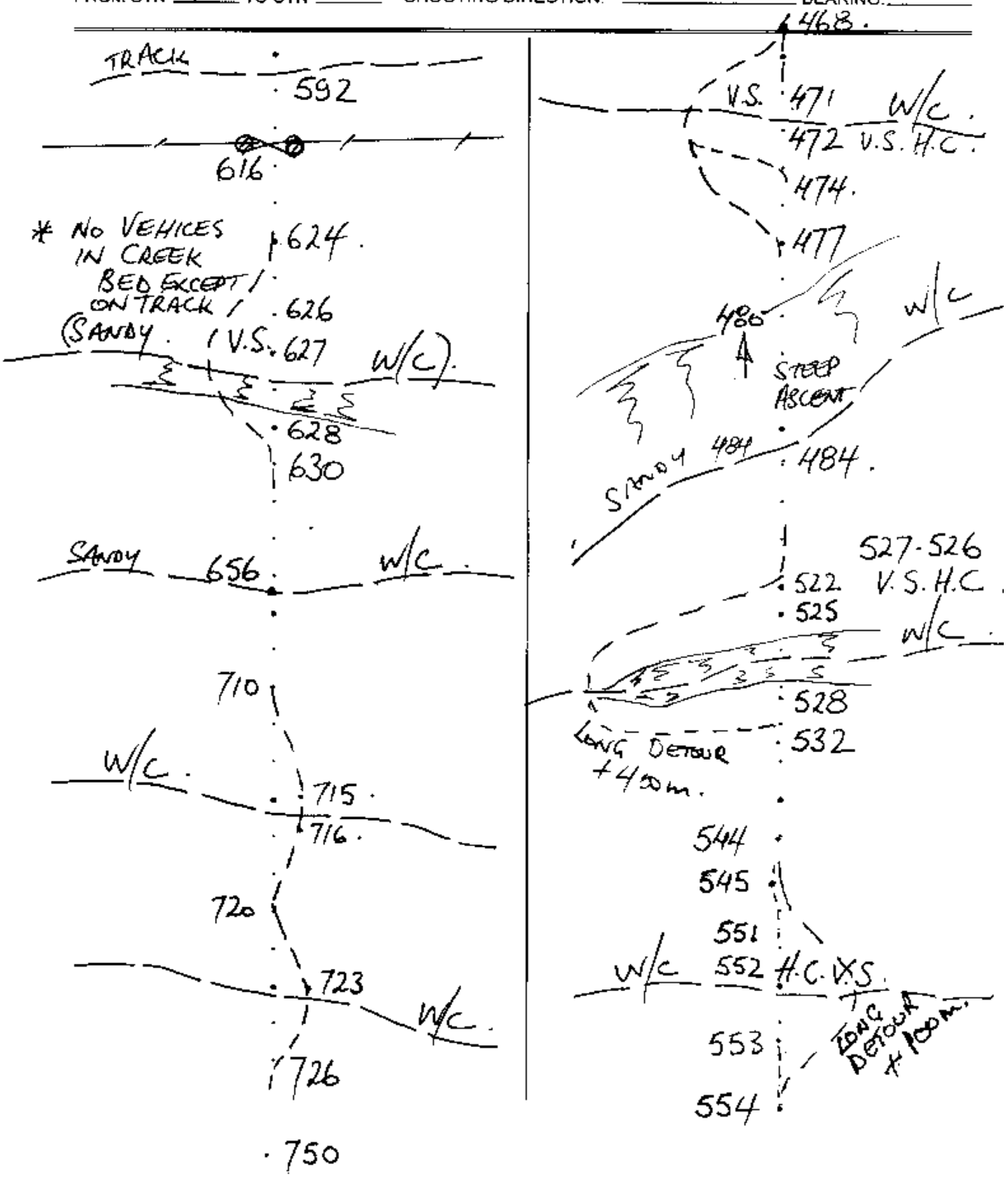
DSS-FF-07
REV 7.0
June 2001

LINE: 0W04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 4 OF 6 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 750 TO STN 468 SHOOTING DIRECTION: _____ BEARING: ____°



Dynamic Satellite Surveys

TRACE DIAGRAM

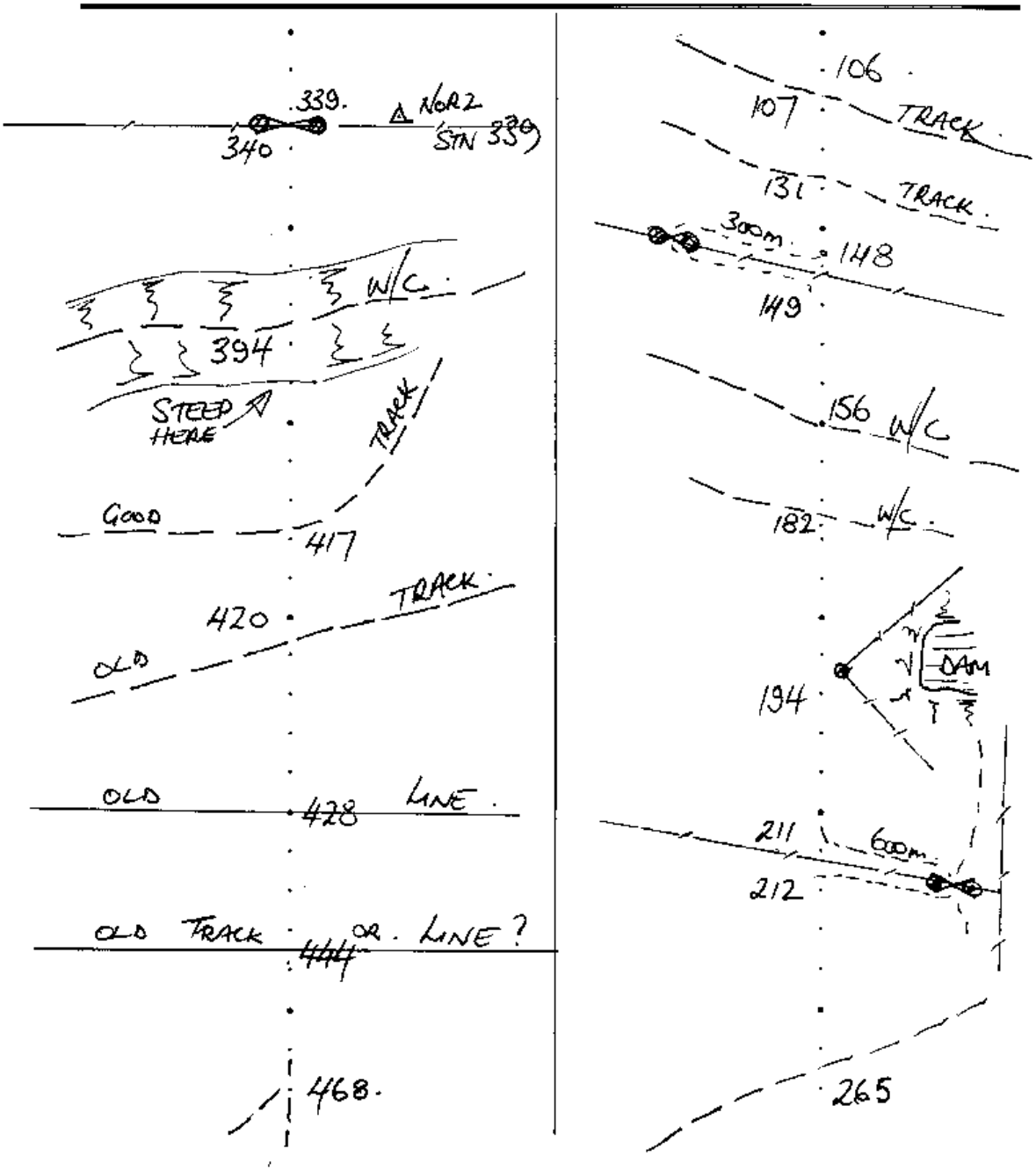
DSS-FF-07
REV 7.0
June 2001

LINE: 0W04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 5 OF 6 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 468 TO STN 106 SHOOTING DIRECTION: _____ BEARING: ____°



Dynamic Satellite Surveys

TRACE DIAGRAM

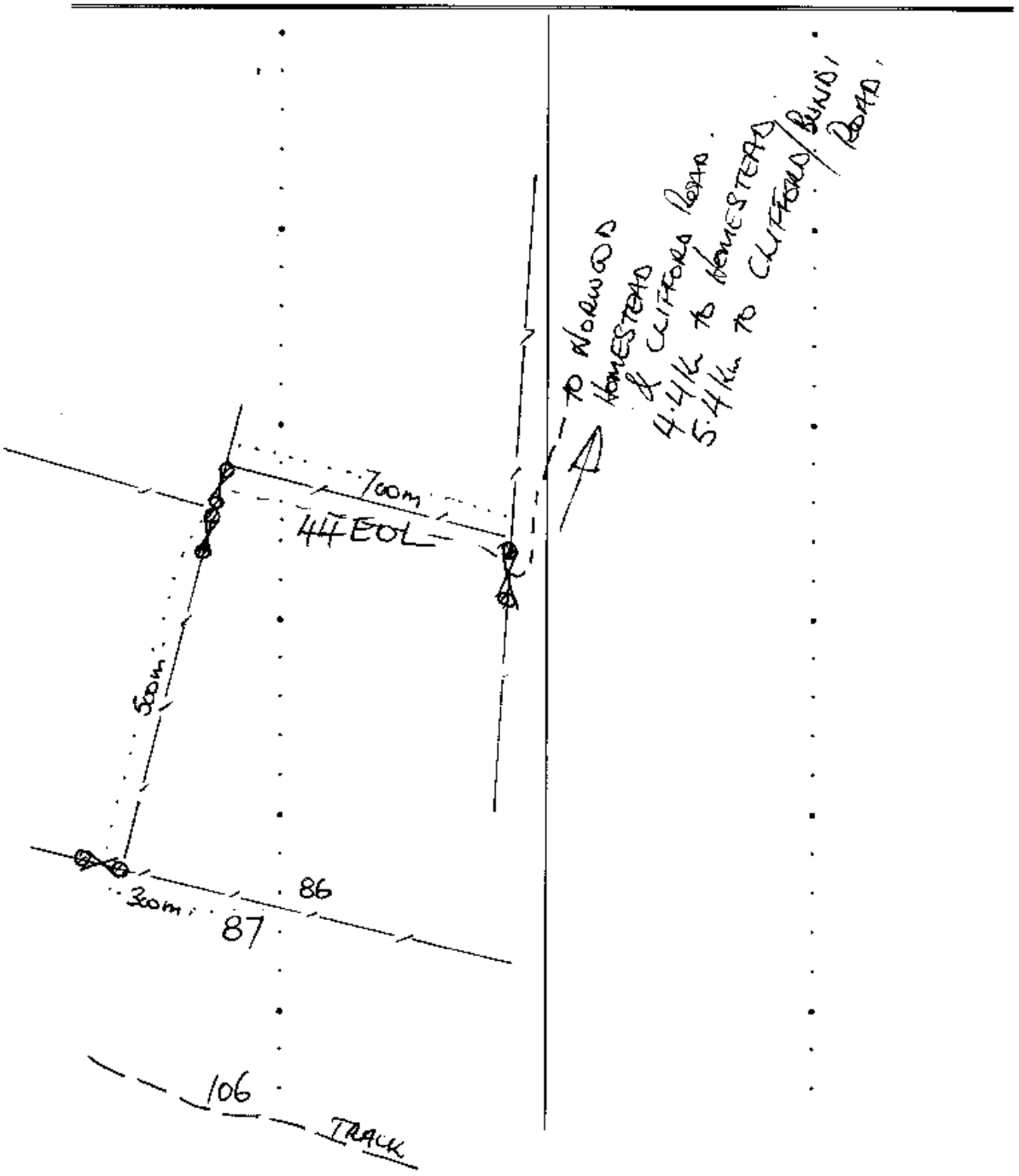
DSS-FF-07
REV 7.0
June 2001

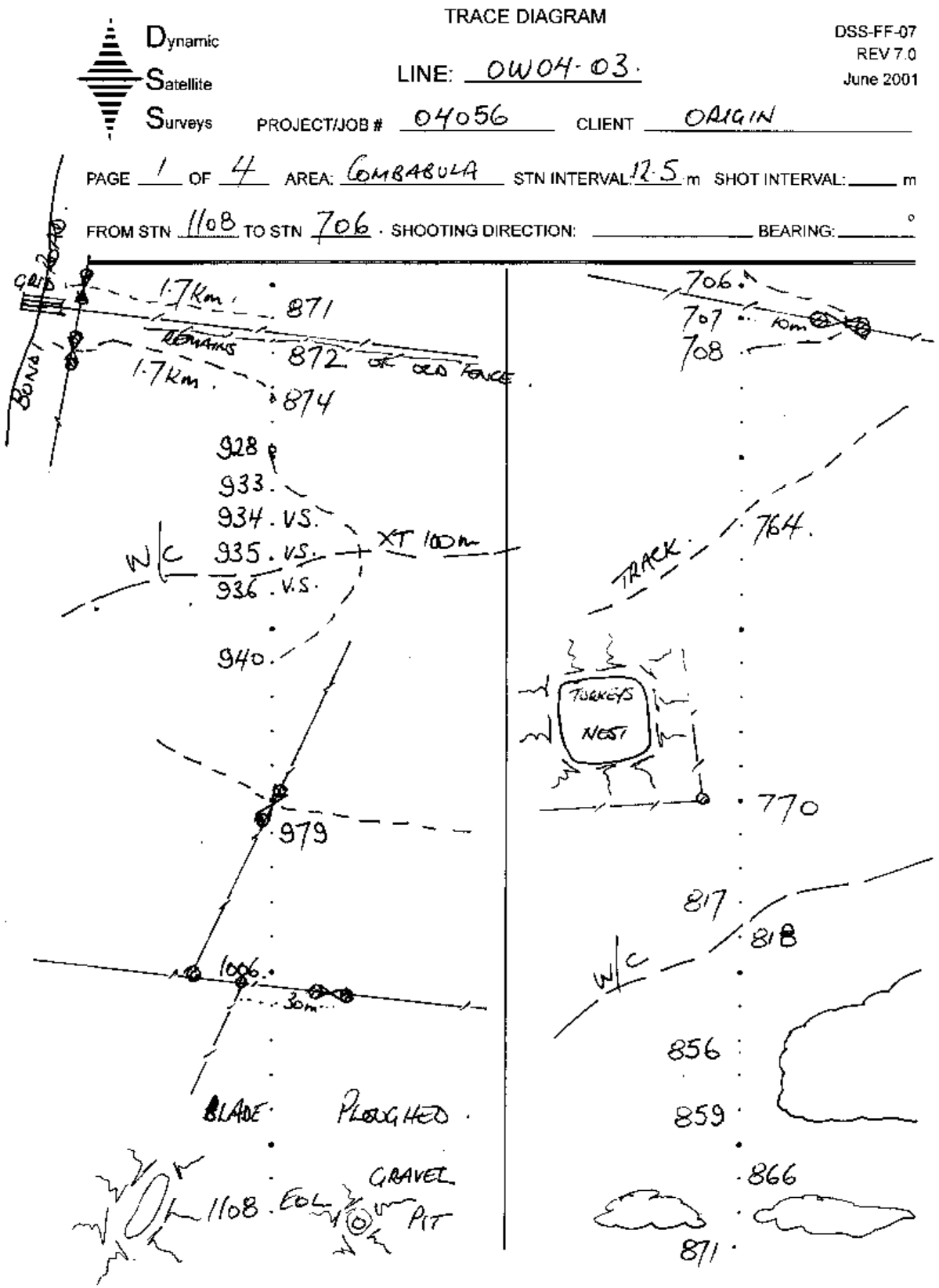
LINE: ~~040~~ 0W04-02

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 6 OF 6 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 106 TO STN 44 SHOOTING DIRECTION: ____ BEARING: ____ °





Dynamic Satellite Surveys

TRACE DIAGRAM

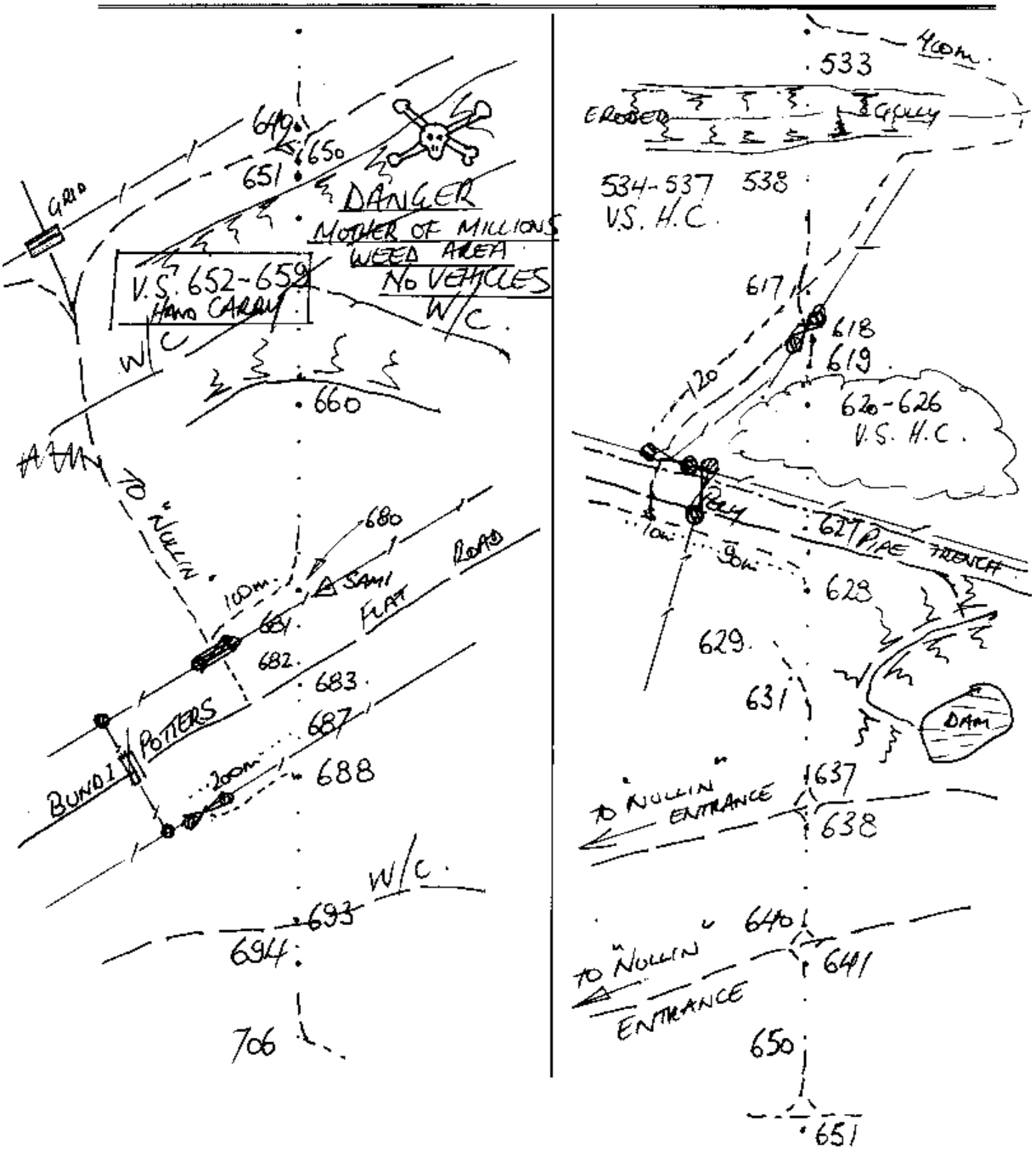
DSS-FF-07
REV 7.0
June 2001

LINE: OW04-03

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 2 OF 4 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 706 TO STN 533 SHOOTING DIRECTION: ____ BEARING: ____ °



Dynamic Satellite Surveys

TRACE DIAGRAM

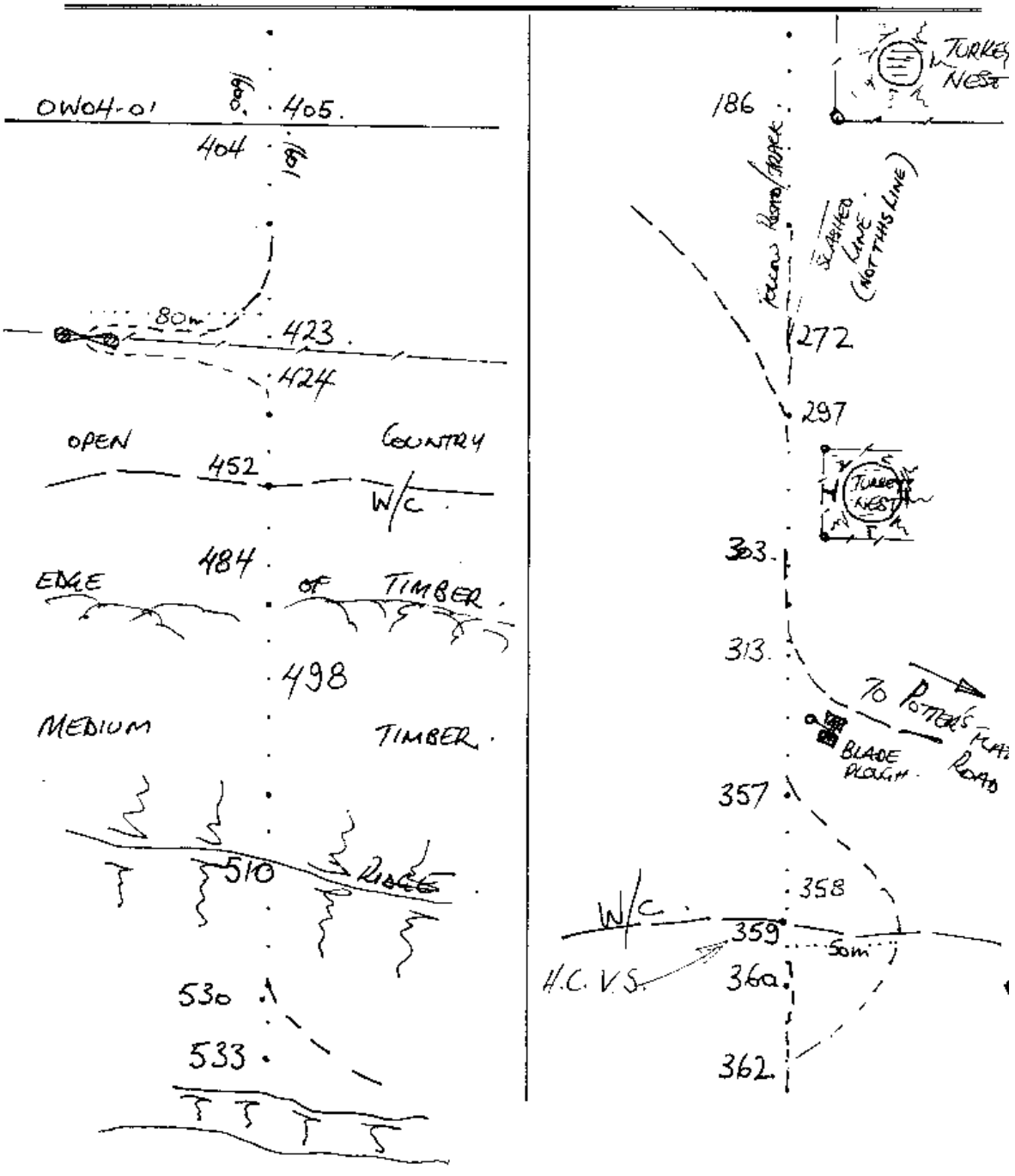
DSS-FF-07
REV 7.0
June 2001

LINE: OW04-03

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 3 OF 4 AREA: COMBABULA STN INTERVAL 12.5 m SHOT INTERVAL: ____ m

FROM STN 533 TO STN 186 SHOOTING DIRECTION: _____ BEARING: ____°



TRACE DIAGRAM

Dynamic Satellite Surveys

DSS-FF-07
REV 7.0
June 2001

LINE: OW04-03.

PROJECT/JOB # 04056 CLIENT ORIGIN

PAGE 4 OF 4 AREA: COMBABULA STN INTERVAL: 12.5 m SHOT INTERVAL: ____ m

FROM STN 186 TO STN 92 SHOOTING DIRECTION _____ BEARING: ____°