GROSVENOR 1782

REPORT ON THE 2005 FIELDWORK SEASON

By
Nikolay Mavrodinov – Chief Archaeologist

SUMMARY

Since the inception of the *Grosvenor* project in 1999, the application of adequate survey techniques and accurate measurements to process special information has been of paramount importance. Given the high energy environment in which the site is located, mostly through trial and error, it was discovered that a grid of datum points inserted into rock on the seabed was the most durable and accurate solution. Any excavation which took place in the gully was related to this grid and in this way spatial relationships on the site started to come to the foreground. Although the exact position of all the datum points relative to each other was well known, the grid itself was not measured in to any terrestrial points with established co-ordinates. This presented problems because, although the datum points were constructed in such a way that they could withstand the adverse conditions underwater, they could not be expected to last forever. The potential loss of datum points would make their re-establishing difficult and could lead to loss of important information. In addition, the grid, prominent underwater site features and the excavated portions of the site could not be incorporated into a coherent site map.

The primary objective of the 2005 fieldwork season was to rectify this situation by measuring the underwater grid to known terrestrial points with a Total Station. This method can deliver sub centimeter accuracy and is widely used on maritime archaeological excavations. The technique, however, requires ideal sea conditions to allow for measurements to be taken. A total of one week at the beginning of September was spent on the site to complete the work. Unfortunately, the prevalent for this time of the year bad weather did not abate and the sea was too rough to facilitate the survey.

Nevertheless, having the Total Station on the site presented an opportunity to take accurate measurements on land. All the important terrestrial features around the gully were surveyed. This information, together with handheld GPS measurements taken previously by Argo on several underwater features in the gully, was used to construct detailed digital maps. These maps are based on a co-ordinate grid system and highlight important spatial information. In future, prior to any excavation taking place on the site, the underwater grid will have to be surveyed in and the information will have to be incorporated into the established format.

CONTENTS

INTRODUCTION

2005 saw the completion of another fieldwork season on the *Grosvenor* site. The primary objective was to address an issue which has remained unresolved during previous fieldwork seasons – the creation of an accurate site map.

During the 1999, 2000 and 2001 fieldwork seasons a grid of datum points was established on the seabed. Twenty six datum points made of corrosion resistant metal were labeled and inserted into rock via technology used in rock climbing. It was felt that the minimal size of the individual datum points, the materials used and the fact that they were well secured onto the rock surface would contribute to their endurance in what is a very high energy underwater environment. The exact positions of all datum points were measured relative to each other and an underwater survey and recording grid was established. Subsequently all the artifacts recovered from the site were measured to at least three datum points to maintain adequate spatial control.

During the 1999 fieldwork season three benchmark points were established on the shore around the gully. These were constructed from iron rods and were also inserted and cemented into the rock. In 2000 their exact positions were recorded with the use of DGPS with stated accuracy of 20cm. These benchmark points were to form an integral part of the overall site map. The positions of all key terrestrial features of the site such as the shell midden, old steam crane, tunnel and old ruin were to be measured from these benchmarks. More importantly, the grid of underwater datum points could be measured with adequate accuracy to the benchmarks and a set of co-ordinates could be assigned to each datum point. It was felt by the archaeologists that sub 50cm accuracy should be aimed for while surveying the underwater grid. All this information would ultimately translate into digital site maps with GIS capability.

An established method of producing survey grade site maps on terrestrial and underwater archaeological sites is through the use of professional survey equipment such as a Total Station. This instrument employs a laser beam to establish accurate (<1cm) distances and elevation between points. Personnel of two is required to operate the Total Station – one person at the instrument taking measurements and one with a reflective prism at the points to be measured. The prism serves as a mirror reflecting the laser back to the instrument.

An obvious drawback of using a Total Station on a maritime archaeological site is the fact that the reflective prism has to be taken to the water by a diver and positioned on top of the points to be measured. While in most instances it is the depth of the site which presents a limitation, in the case of the *Grosvenor* depth is not an issue being between 3.5 and 7m. The prism pole can easily be extended to hold the actual prism above the water level for measurements to take place. However, the location of the site in the surf zone means that perfectly flat sea conditions are needed to accomplish the task.

In July 2005 Steven and Paul Valentine from Argo spent several weeks at the *Grosvenor* site. They succeeded in recording several important underwater and terrestrial site features through the use of a handheld GPS. Subsequent to this, in early September 2005, a team of five people including the chief archaeologist and

representatives of Argo, Tyroon and Octopus spent a total of one week on the site with the intention of surveying the underwater grid and other site features. For this purpose a Total Station was hired from the department of Geomatics at the University of Cape Town.

Several years spent on the site in the past have shown that the prevalent weather and sea conditions tend be favorable for fieldwork between March and July and progressively deteriorate during August – September. Unfortunately this year was no exception and during the week spent on the site the sea conditions were too rough to allow for the completion of the underwater grid survey. No diving could take place, which also meant that the present condition of the underwater grid could not be assessed. However, the opportunity of having the team on the site with a Total Station was put to full use and a number of important tasks were completed.

- The Total Station was used to measure the distances and elevation of numerous important terrestrial features in relation to the already established benchmark points.
- A digital map of several underwater features such as cannons was produced with the aid of a handheld GPS.
- A digital map of the gully outline during spring low tide was produced with the aid of a handheld GPS.
- All the above information was incorporated into a general digital site map.
- All the datum points established during previous seasons were plotted on a theoretical X-Y grid and a digital map was produced.

It is hoped that in future a survey of the datum point grid can take place and it will successfully be incorporated into the overall site map.

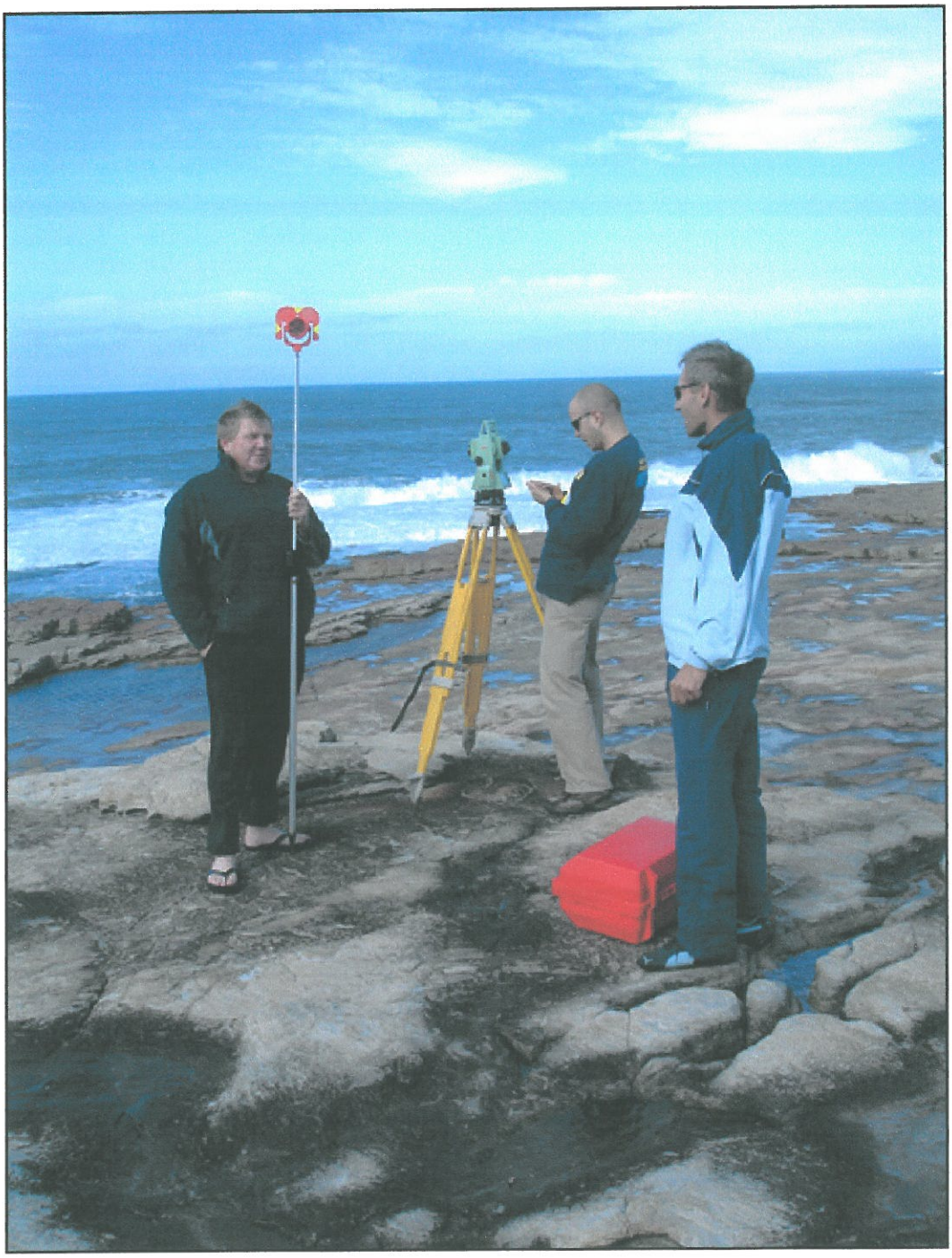
BENCHMARK POINTS

The three benchmark points established in 1999 were accurately surveyed in 2000 with DGPS by Racal Survey (see appendices). Subsequent disputes between CEIC (now Tyroon) and Racal regarding the quality of the work produced by Racal prompted the chief archaeologist to verify the benchmark co-ordinates supplied by Racal. This was done with a 12 Channel Garmin 182C GPS instrument. The results indicated that the original measurements were accurate and, since DGPS has greater (<20cm) accuracy than GPS, these were taken into consideration when taking further measurements and producing the overall site map. The readings are as follows:

	Co-ordinates in WGS84 – decimal minutes	
	South	**East**
Southern Benchmark (S)	31°22.401911'	29°54.852280'
Central Benchmark (C)	31°22.385639'	29°54.872021'
Northern Benchmark (N)	31°22.375280'	29°54.891960'

TOTAL STATION MEASUREMENTS

Once the accurate co-ordinates of the benchmark points were verified, the Total Station was used to perform distance and elevation measurements to a number of terrestrial site features (see appendices).



Setting up the Total Station before the survey

Firstly the Total Station was used to establish exact distances and elevation between the three benchmark points. With the instrument positioned on the Southern Benchmark readings were taken to the Central and Northern Benchmarks. Next, the instrument was positioned on the Central Benchmark and readings were again taken to the Southern and Northern Benchmarks for cross-check purposes. Then readings were taken to the tunnel, old steam crane and the top of the midden in front of the old cottage (see appendices).

Following this, the instrument was positioned on top of the shell midden and readings were taken to the Southern Benchmark and two white painted survey points in front and east of the old cottage (see appendices).

EDGE OF GULLY AT SPRING LOW TIDE

For the purposes of producing a comprehensive map of the *Grosvenor* site it was felt that a fairly accurate contour of the gully had to be established. It was originally intended to achieve this with the Total Station. The prism could be placed on a series of points along the waters edge and the readings could be plotted onto a map. The problem once again arose from the rough seas prevalent during this time of the year. It takes the instrument approximately 2-3 seconds to take a measurement. A diver wearing a wetsuit aiming to get the prism as close to the water as possible runs the risk of being washed away by wave action as the instrument is taking a measurement. In this context it was decided that the use of the Total Station in this instance would be dangerous and instead a handheld Garmin GPS was used to take the measurements.

This instrument takes less than a second to take a measurement. Also, its portability and the fact that it logs all data instantly means that the person taking measurements could time his readings with periods of minimal wave action and concentrate on hazards and safety. It was felt that the inferior accuracy of GPS (2-3m) compared to a Total Station (<1cm) would still be adequate for a general site map.

A total of 29 points were measured along the edge of the gully during spring low tide. The contour of the gully between measured points was extrapolated (see appendices).

UNDERWATER SITE FEATURES

In July 2005 Steven and Paul Valentine from Argo spent several weeks at the *Grosvenor* site. Their prime objective was to survey some known underwater features in the gully. They succeeded in taking readings of a number of cannons present on the site. This was done once again with a Garmin handheld GPS. In this instance all objects were buoyed, a diver was positioned on the water surface above the object to be measured and took a reading with the instrument.

A total of six cannons were surveyed this way (see appendices). Although this method can not attain survey grade accuracy, the exercise was still particularly valuable, because it provided the first set of co-ordinates for objects underwater. Measurements were also taken along the edge of the gully and on some terrestrial features such as the steam crane, old ruin, tunnel, etc.

GENERAL SITE MAP

All of the above data, together with co-ordinate data from a 2002 magnetometer survey conducted on the site by Argo, was imported into mapping software which in turn helped produce a set of comprehensive digital site maps of the gully and its surrounding features (see appendices). These maps are constructed on a co-ordinate grid system (WGS84, UTM) and provide important spatial analysis capability. In addition, they undoubtedly will aid any future fieldwork on the site.

DATUM POINT GRID

As mentioned previously the intended survey of the underwater datum point grid could not take place due to adverse sea conditions. Nevertheless, the opportunity was used to digitize the grid which up to this point had only been plotted on paper. All previously taken measurements of individual datum points were imported into mapping software and a digital layout of the grid was produced on a theoretical X-Y axis (see appendices). This offers the ability to attain much greater accuracy when plotting excavated sections of the site. A digital format of the grid also dramatically improves on the ease with which spatial relations between artifacts and excavated sections can be analyzed and manipulated.

RECOMMENDATIONS

- Before any future field work takes place on the site, the condition of the underwater grid has to be assessed and any datum points which have disappeared or are deteriorating will have to be re-established. A more durable labeling system will have to be applied.
- At least four datum points, preferably at opposite ends of the grid, have to be surveyed with a Total Station in relation to the terrestrial benchmarks. In order to complete the task at least a month has to be put aside to allow for down time and adverse sea conditions.
- The data has to be processed according to the established digital format and incorporated into the overall site map.

CONCLUSION

Several important tasks were completed during the 2005 fieldwork season. A general digital site map was created through the use of Total Station and GPS. This exercise will undoubtedly prove very helpful during future excavation and analysis. In addition, the grid of underwater datum points was digitized and a comprehensive reference map was produced. Unfortunately due to adverse weather and time constraints the grid itself could not be surveyed with the Total Station. It is hoped that in the near future this important task will be completed and the information will be incorporated into the overall site map.

APPENDICES

Total Station Measurements on Gully Benchmarks and other features - 2005

Instrument: Leica TCR407

H° - Horizontal Angle

V° - Vertical Angle

HP – Height of Prism

HS – Height of Station

Dm – Distance in meters

S – Southern Benchmark

C – Central Benchmark

N – Northern Benchmark

Station on Southern Benchmark (S)

HP – 2m **HS** – 1.48m

	C	N
H°	0°	5°36'23''
V°	92°37'10''	91°53'15''
Dm	42.37	79.478
Height (meters)	-2.46	-3.14

Station on Central Benchmark (C)

HP – 2m **HS** – 1.5m

	S	N
H°	0°	191°54'16''
V°	86°05'36''	90°23'56''
Dm	42.321	37.467
Height (meters)	2.38	-0.76

	Tunnel	Old Steam Crane
H°	186°55'48''	104°59'41''
V°	88°32'58''	82°17'42''
Dm	102.005	51.882
Height (meters)	2.08	6.46

	Top of Midden
H°	49°26'47''
V°	79°34'10''
Dm	50.095
Height (meters)	8.57

Station on top of Midden

HP – 2m **HS** – 1.33m

	S	Benchmark 1 (front of house)	Benchmark 2 (East of house)
H°	0°	143°42'03''	236°15'08''
V°	98°22'39''	91°19'30''	91°45'52''
Dm	39.307	38.278	66.718
Height (meters)	-6.4	-1.56	-2.72

Racal DGPS co-ordinates 2000 Season

	Co-ordinates in meters – Lo 29° Clark 1880		Co-ordinates in WGS84 – decimal minutes	
	x	y	South	East
Southern Benchmark (S)	3472438.5	-87002.3	31°22.401911'	29°54.852280'
Central Benchmark (C)	3472408.5	-87033.6	31°22.385639'	29°54.872021'
Northern Benchmark (N)	3472390.0	-87065.8	31°22.375280'	29°54.891960'

DGPS: 12 channel VBS system model 2100
Accuracy: 20cm

GPS co-ordinates 2005 Survey

	Co-ordinates – WGS84 UTM		Co-ordinates – WGS84 decimal minutes	
	x	y	South	East
Southern Benchmark (S)	35J 0777171	6525345	31°22.402'	29°54.852'
Central Benchmark (C)	35J 0777203	6525375	31°22.387'	29°54.871'
Northern Benchmark (N)	35J 0777234	6525392	31°22.377'	29°54.890'

GPS: Garmin 182C 12 channel
8 satellites were read for each measurement
Stated Accuracy: 4m
DOP: 1m

Co-ordinates of features in and around the gully measured with handheld GPS – Argo 2005

Projection: WGS84, UTM, July 2005
Accuracy: 2 – 3m

Feature	X	Y	Comments
Cannon	777238	6525331	
Cannon	777235	6525339	
Cannon	777231	6525346	
Two cannon together	777243	6525348	
Cannon	777253	6525347	
Outside cannon	777241	6525236	Magnetometer reading 2002
Anchor	777258	6525251	Magnetometer reading 2002
Ruin	777293	6525509	
Tunnel	777287	6525439	
Steam crane	777181	6525418	

Gully outline during spring low tide - 2005

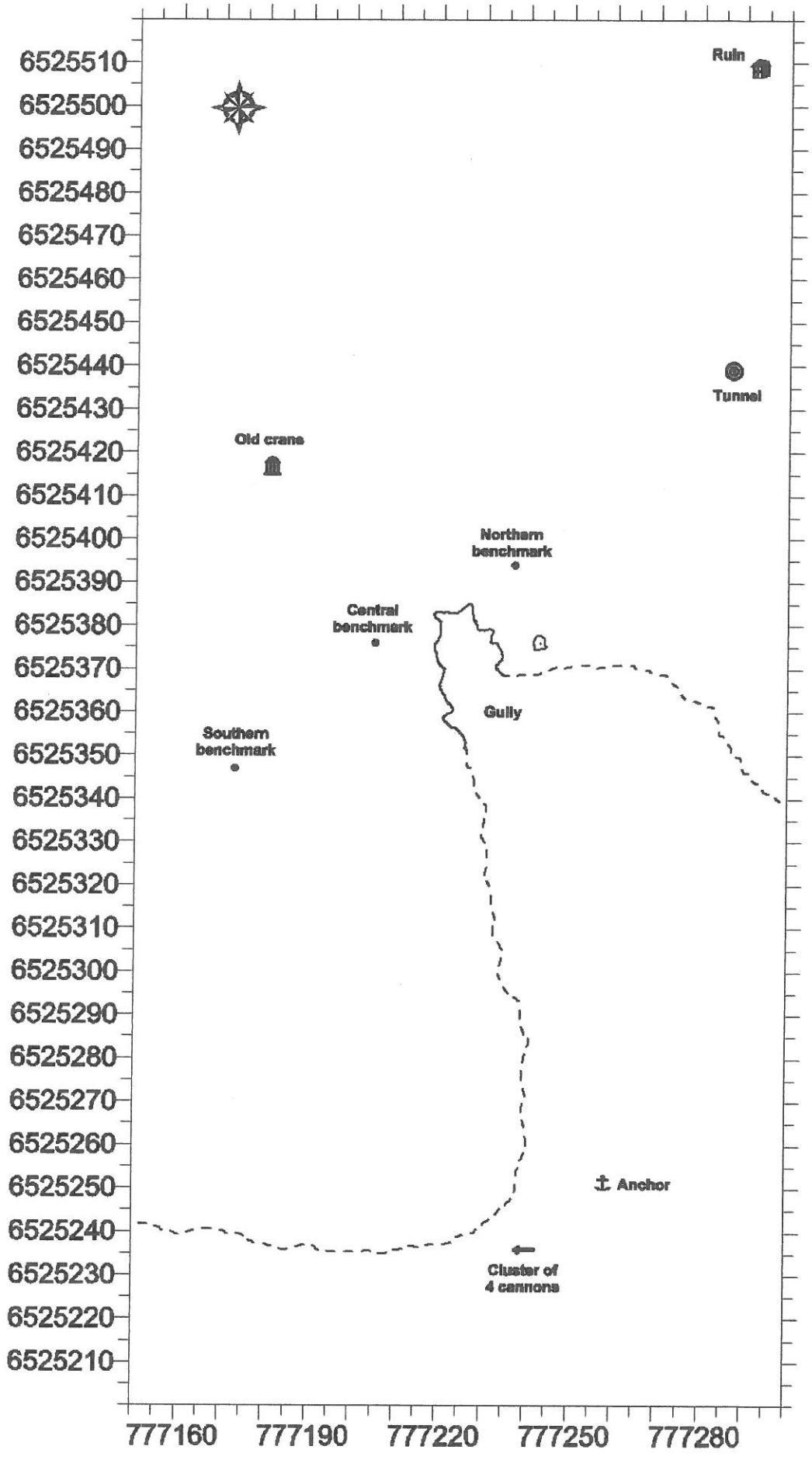
Garmin GPS II Plus Handheld (02-09-2005)
Projection: WGS84, UTM
Accuracy: 2 – 3m

	X	Y
Point		
1	0777234	6525369
2	0777233	6525370
3	0777232	6525376
4	0777229	6525379
5	0777233	6525371
6	0777234	6525372
7	0777233	6525376
8	0777232	6525379
9	0777230	6525379
10	0777228	6525381
11	0777227	6525385
12	0777222	6525383
13	0777243	6525376
14	0777224	6525383
15	0777221	6525383
16	0777219	6525383
17	0777220	6525381
18	0777219	6525376
19	0777219	6525374
20	0777220	6525371
21	0777221	6525370
22	0777220	6525366
23	0777222	6525362
24	0777221	6525359
25	0777223	6525361
26	0777221	6525364
27	0777225	6525355
28	0777226	6525353
29	0777226	6525352
Central benchmark	0777205	6525376
Northern benchmark	0777237	6525394

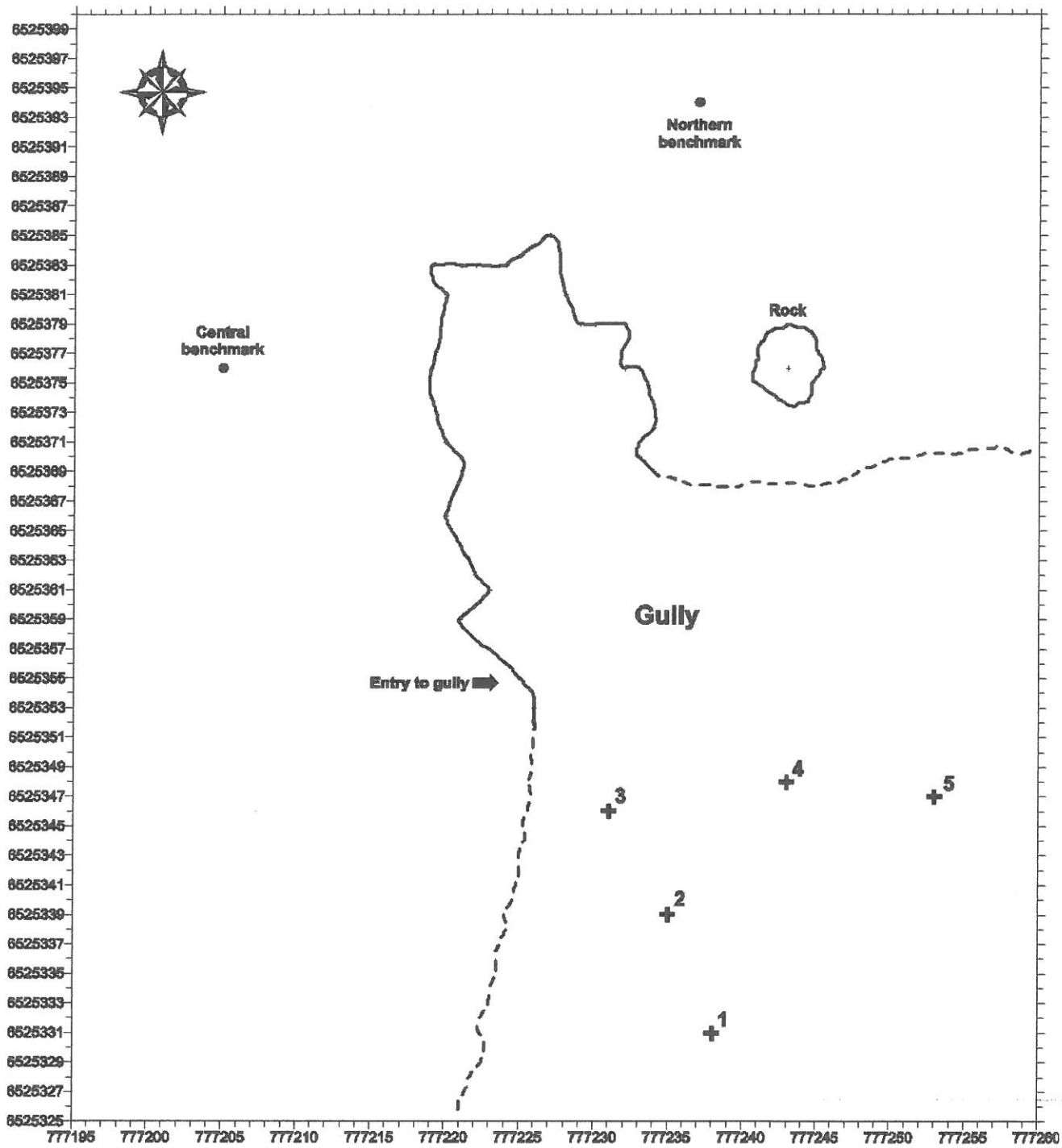
Gully datum points on a theoretical X – Y axis 2005

Measurements in meters

DP No.	X	Y
1	7.41	21.36
2	6.825	19.31
3	6.8	16.61
4	4.9	16.425
5	7.475	23.91
6	4.095	20.575
7	7.625	26.96
8	8.065	12.66
9	7.625	9.95
10	5.325	7.745
11	7.485	26.375
12	7.515	30.665
13	1.96	27.475
14	4.05	29.85
20	8.975	2.085
21	7.525	1.8
22	7.225	2.8
23	8	4.3
24	8.55	5.81
25	8.25	7.2
26	8.07	10.7
27	8.87	3.425
28	8.3	17.5
29	7.375	18.375
30	6.65	21.425
31	7.29	24.85



General site map
2005
WGS84, UTM



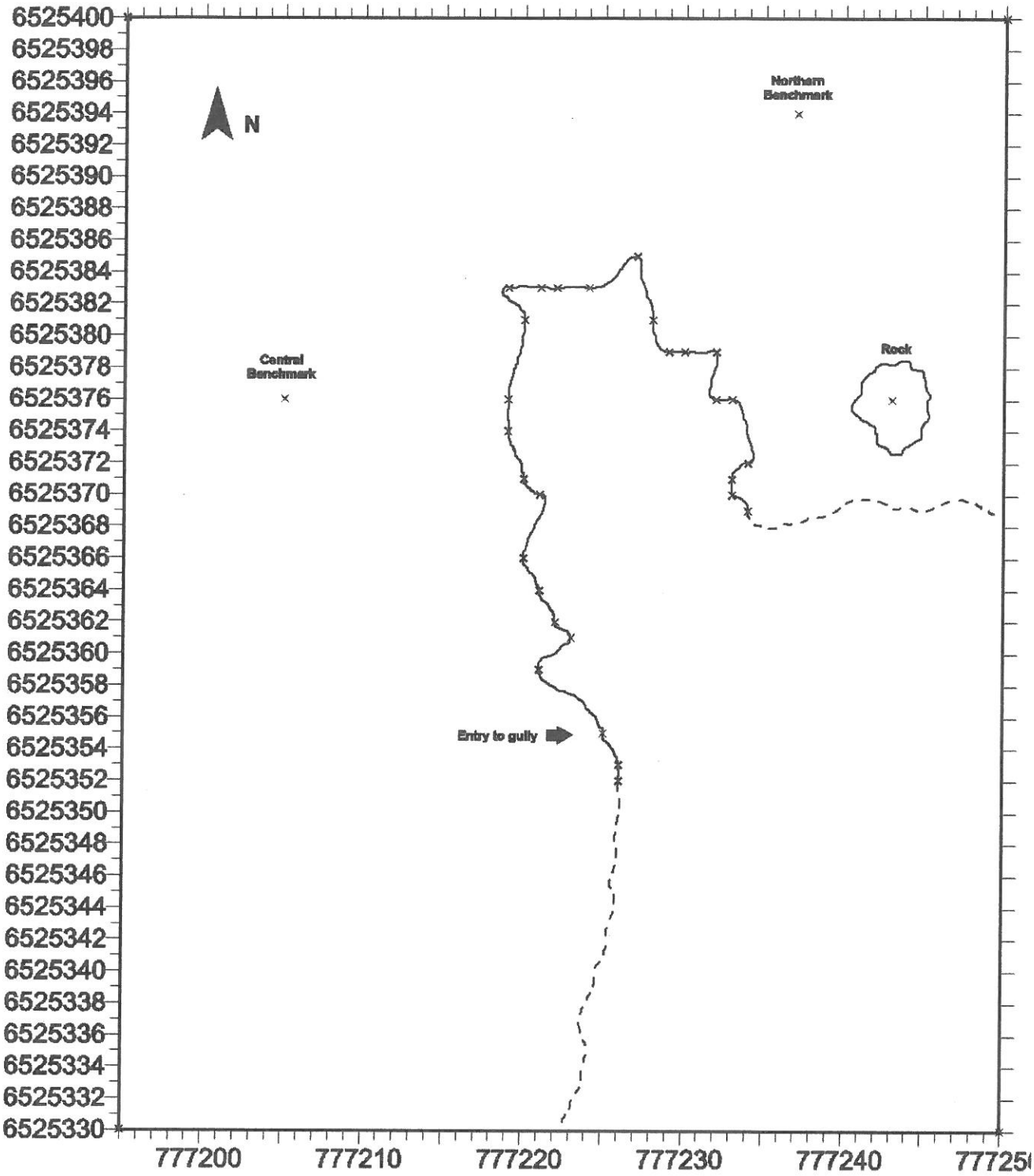
Cannons in the gully
Garmin hand-held GPS
Projection: WGS84, UTM

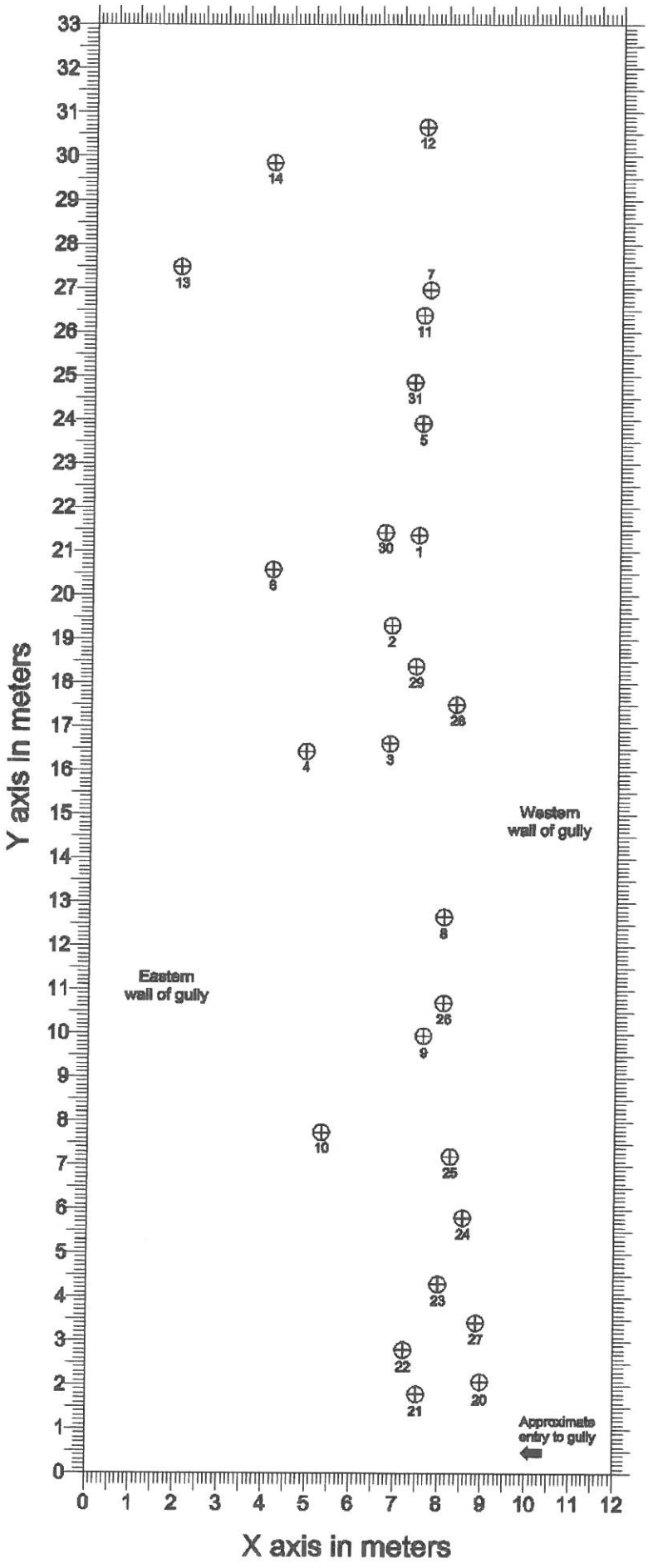
1 - Cannon
2 - Cannon
3 - Cannon
4 - Two cannons together
5 - Cannon

Edge of gully at spring low tide

Theoretical line of underwater ledge

2013/10/16


6525400
6525398
6525396
6525394
6525392
6525390
6525388
6525386
6525384
6525382
6525380
6525378
6525376
6525374
6525372
6525370
6525368
6525366
6525364
6525362
6525360
6525358
6525356
6525354
6525352
6525350
6525348
6525346
6525344
6525342
6525340
6525338
6525336
6525334
6525332
6525330
N
Northern Benchmark
Central Benchmark
Rock
Entry to gully
777200
777210
777220
777230
777240
777250
Edge of gully at spring low tide 02-09-2005
Garmin hand-held GPS
Projection: WGS84, UTM
Measured points with extrapolated edge of shore
Theoretical line of underwater ledge



Map of gully Datum Points on a theoretical X-Y axis