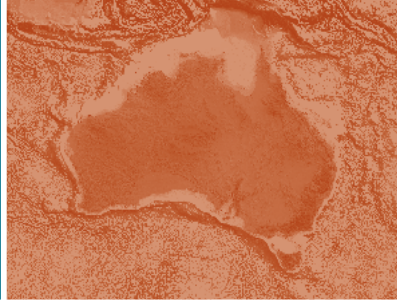




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EDM Height Traversing Levelling Survey Report

Nauru, February 2012

S. J. K. Yates, A. Lal

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Nauru, February 2012

GEOSCIENCE AUSTRALIA
RECORD 2014/22

S. J. K. Yates¹, A. Lal²



Australian Government
Geoscience Australia

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1. National Geospatial Reference Systems, Geospatial and Earth Monitoring Division, Geoscience Australia GPO Box 378 Canberra ACT 2601
 2. Secretariat of the Pacific Community (SPC)

Department of Industry

Minister for Industry: The Hon Ian Macfarlane MP

Parliamentary Secretary: The Hon Bob Baldwin MP

Secretary: Ms Glenys Beauchamp PSM

Geoscience Australia

Chief Executive Officer: Dr Chris Pigram

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1 Introduction

This report outlines the levelling survey completed during the visit to Nauru from 6 to 15 February 2012.

Personnel involved in the survey were Steve Yates, Project Officer, Geoscience Australia and Andrick Lal, Surveyor, Secretariat of the Pacific Community (SPC).

This is the fifth Electronic Distance Measurement (EDM) height traversing levelling survey of the deep bench mark array in Nauru. The previous levelling surveys using this technique were performed in 2005, 2007, 2009 and 2010.

Precise Differential Levelling surveys were performed on nine occasions between 1993 and 2003 by the National Tidal Centre Australia (NTCA) and the survey in 2005 included a comparison between the precise levelling and EDM height traversing techniques. This report contains a comparison between the 2010 and 2012 EDM height traversing results as well as a combined comparison since the first levelling survey.

2 The Survey

The EDM Height Traversing levelling survey was carried out between the 6 deep driven bench marks:

NAU1

NAU2

NAU36

NAU37

NAU38

NAU16

All the deep bench marks were located and found in good order and undisturbed. Included in the survey was the Sea Level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) tide gauge sensor bench mark, NAU15 and the tide gauge benchmark located adjacent to the tide gauge hut, NAU14.

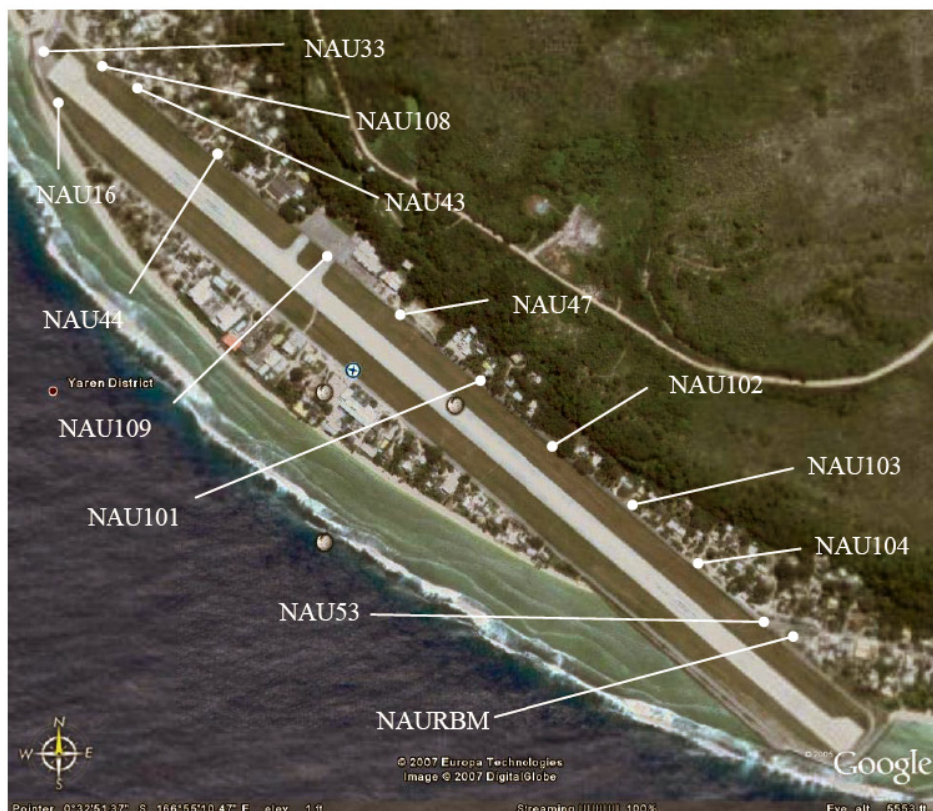
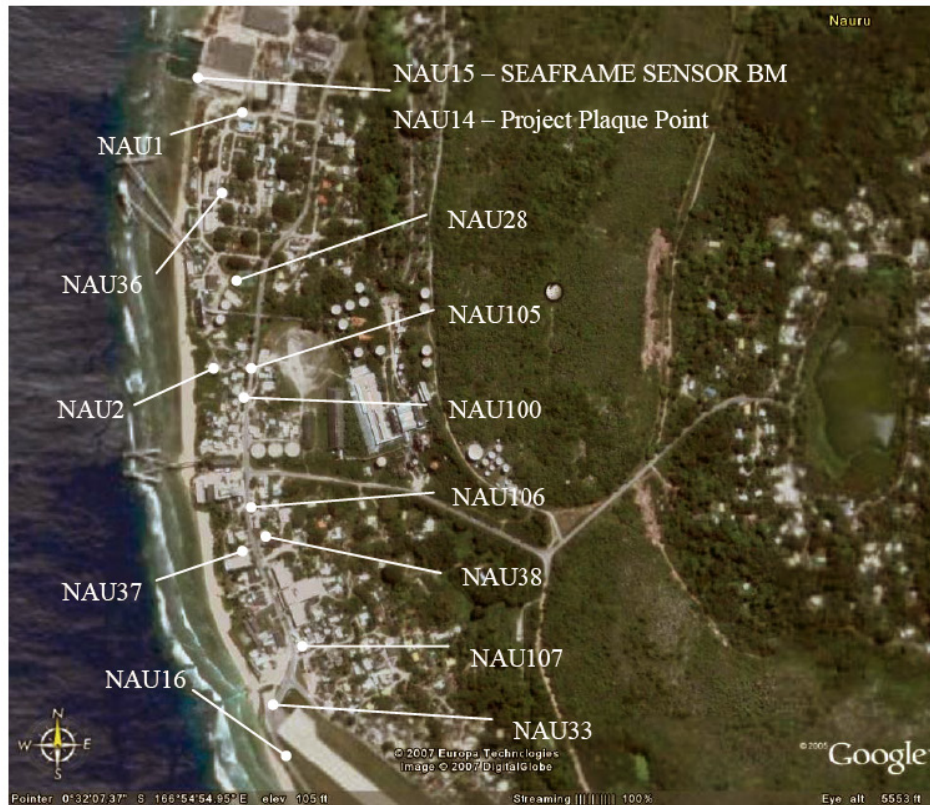
Also included in the survey were temporary holding marks – NAU28, NAU100-109, NAU33, NAU43, NAU44, NAU47, NAU53 as well as the Continuous Global Navigation Satellite System (CGNSS) bench mark NAURBM, the CGNSS reference point NAUR, and the three CGNSS reference marks, RM1, RM2 and RM3.

The EDM height traversing levelling technique was performed to the Class L2A specifications (ICSM, 2002). After reduction an internal precision of $1\text{mm}\sqrt{K}$ or better was achieved, where K is distance in kilometres. This is well within the project specification of $2\text{mm}\sqrt{K}$. A table of results and comparisons and the 2012 reduced levels are detailed later in this report.

All the deep bench marks were located and found in good order and undisturbed.

The EDM height traversing levelling technique was performed to the Class L2A specifications (ICSM, Standards and Practices for Control Surveys). After reduction an internal precision of $1\text{mm}\sqrt{K}$ or better was achieved, where K is distance in kilometres. This is well within the project specification of $2\text{mm}\sqrt{K}$. A table of results and comparisons and the 2012 reduced levels are detailed later in this report.

2.1 Bench Mark Locality Diagram



2.2 The Nauru Datum

The Datum for the survey is the Nauru Island Datum (NID). Reduction of the data has been calculated holding NAU1 fixed at 7.2930 metres, this value was determined by the NTC in 1993 by:

- | | |
|------|--|
| 1993 | Adopting the height of UH 1 as 4.130m NID |
| 1994 | Adopting the 1993 height of U2B as 3.8894m NID |

2.3 Equipment

- Leica total station model TM30 (Serial No: 361441)
- Leica precision prisms GPH1P (2).
- Leica rigid tripod.
- Stainless steel target poles supported by Leica telescopic bi-poles (2).
- Shortened stainless steel target pole for the SEAFRAME sensor BM connection.
- Leica cast iron change plates (2).
- Kestral 4000 pocket weather tracker

2.4 Method

The “Leap-Frog” EDM height traversing technique was employed for the Nauru tide gauge levelling survey. This technique involves setting up a total station (TCA1800L) midway between two target/reflectors (on reflector rods with struts). The targets remain at a particular change point for the back-sight and fore-sight observations. The instrument measures slope distances ($\pm 1\text{mm}$) and vertical angle ($1''$) to derive height differences (between the instrument’s trunnion axis and the reflectors). In support of the slope distance observations, the ambient temperature, pressure and humidity are recorded (Kestral 4000 pocket weather tracker) and input into the instrument to apply the first velocity correction to the observed distances (Rüeger & Brunner, 1982). Four rounds of observations are taken to the back-sight and fore-sight targets from each instrument setup. All levelling runs started and finished with the same reflector and reflector rod, i.e. an even number of setups when the two reflector rod configuration was used. This eliminates any reflector rod zero error. This technique can also be performed using a single set-up / single rod configuration which is particularly useful when levelling between bench marks which are close together e.g. between the CGNSS RMs.

Reduction of the digital data was computed by the Geoscience Australia levelling program “leveling1.exe”. This program computes the height difference between the two reflectors.

2.5 Nauru 2012 Reduced Levels

Table 2.1 Nauru – Reduced levels and heights difference relative to NAU1 from the 2012 survey

Date: 6 – 15 February 2012

Datum: Nauru Island Datum

POINT #	2010 levelled diff. ht.	2010 RL
NAU14	3.4458	3.8481
NAU15	1.2869	6.0052
NAU36	0.0735	7.2190
NAU28	-0.5070	7.7987
NAU2	-0.4930	7.7846
NAU105	-0.4907	7.7824
NAU100	-0.9192	8.2100
NAU106	-0.7550	8.0458
NAU37	-0.4083	7.6988
NAU38	-0.2814	7.5722
NAU107	-0.4891	7.7797
NAU33	-0.1189	7.4094
NAU16	0.5969	6.6935
NAU108	0.4267	6.8638
NAU43	1.3698	5.9197
NAU44	0.7994	6.4896
NAU109	1.5771	5.7107
NAU47	1.4456	5.8421
NAU101	0.9741	6.3134
NAU102	0.9847	6.3031
NAU103	1.6645	5.6225
NAU104	2.0930	5.1937
NAU53	1.8035	5.4825
NAURBM	2.0283	5.2580
*NAUR		6.2063
NAUR	1.0797	6.2133
RM1	2.7406	4.5456
RM2	2.9032	4.3831
RM3	2.8052	4.4810

**The RL of the Reference Point NAUR (ARP) is derived from adding the static height difference of 0.9483 m (NAURBM to NAUR) to the levelled RL of NAURBM.*

2.6 Survey Support

The survey team very much appreciated the assistance from staff of the Lands Department Nauru Office.

Personnel consulted during the visit were:

- Mr. Porthos Bop –Chief Surveyor, Lands Department
- Mr.Wess Tsitsi – Senior Surveyor, Lands Department

The Nauru Lands and Survey Department provided a chainman to assist with the field survey. Both Porthos and Wess have always taken a keen interest in the SPSLCMP and are always supportive with any associated project matters.

2.7 Issues

It is recommended to establish an additional deep driven bench mark approximately midway along the airport road between NAU16 and the CGPS bench mark NAURBM.

Also, the valve boxes for the CGPS reference marks, RM2 and RM3 require replacement.

2.8 Description of Marks – Nauru

NAU1 is the bench mark held fixed with an RL = 7.2930 metres. The height of NAU1 was derived by NTC as described earlier.

Deep driven bench marks:

NAU1, NAU2, NAU36, NAU37, NAU38 and NAU16 are deep driven bench marks.

Other marks:

NAU15 is the SEAFRAME Sensor Bench Mark.

NAU 14 is the Project Plaque point, located adjacent to the tide gauge sensor.

NAURBM is the Reference Bench Mark for the CGPS Pillar.

NAUR is the CGPS mark.

All other points used with the prefix of NAU are temporary holding marks consisting of stainless steel bolts drilled in concrete and glued in situ with epoxy resin.

3 Comparisons

3.1 Comparisons between 2010 and 2012 Surveys

Table 3.1 Nauru EDM Height Traversing Levelling Comparison 2010 - 2012 and Table of Results. NAU 1 - adopted fixed height (NID) 7.29300 m

From	To	Levelled Ht. Diff.	RL 2012	Misclose (mm)	Dist. (km)	1mm/k	RL 2010	Difference (mm) 2012 - 2010
NAU1			7.2930					
NAU14	NAU14	-3.4449	3.8481	0.090	0.109	0.330	3.8472	0.0009
	NAU15	2.1571	6.0052	0.050	0.007	0.084	6.0061	-0.0009
NAU1			7.2930					
NAU36	NAU36	-0.0741	7.2190	0.400	0.186	0.431	7.2195	-0.0005
NAU28	NAU28	0.5798	7.7987	0.400	0.196	0.443	7.8000	-0.0013
NAU2	NAU2	-0.0141	7.7846	0.300	0.167	0.409	7.7860	-0.0014
NAU105	NAU105	-0.0022	7.7824	0.050	0.072	0.268	7.7837	-0.0013
NAU100	NAU100	0.4276	8.2100	-0.200	0.097	0.311	8.2122	-0.0022
NAU106	NAU106	-0.1642	8.0458	0.280	0.200	0.447	8.0480	-0.0022
NAU37	NAU37	-0.3470	7.6988	-0.020	0.118	0.344	7.7013	-0.0025
NAU38	NAU38	-0.1267	7.5722	0.080	0.054	0.232	7.5744	-0.0022
NAU107	NAU107	0.2075	7.7797	0.330	0.200	0.447	7.7821	-0.0024
NAU33	NAU33	-0.3703	7.4094	0.080	0.131	0.361	7.4119	-0.0025
	NAU16	-0.7158	6.6935	-0.110	0.123	0.351	6.6961	-0.0026
NAU33								
NAU108	NAU108	-0.5455	6.8638	0.090	0.178	0.421	6.8663	-0.0025
NAU43	NAU43	-0.9441	5.9197	-0.040	0.177	0.420	5.9232	-0.0035
NAU44	NAU44	0.5699	6.4896	0.110	0.204	0.451	6.4936	-0.0040
NAU109	NAU109	-0.7789	5.7107	-0.060	0.200	0.447	5.7159	-0.0052
NAU47	NAU47	0.1315	5.8421	-0.450	0.199	0.447	5.8474	-0.0053
NAU101	NAU101	0.4713	6.3134	0.090	0.200	0.447	6.3189	-0.0055
NAU102	NAU102	-0.0104	6.3031	0.280	0.199	0.446	6.3083	-0.0052
NAU103	NAU103	-0.6806	5.6225	0.300	0.199	0.447	5.6285	-0.0060
NAU104	NAU104	-0.4288	5.1937	0.010	0.199	0.446	5.2000	-0.0063
NAU53	NAU53	0.2888	5.4825	0.240	0.193	0.439	5.4895	-0.0070
NAURBM	NAURBM	-0.2245	5.2580	0.040	0.074	0.272	5.2647	-0.0067
NAURBM								

From	To	Levelled Ht. Diff.	RL 2012	Misclose (mm)	Dist. (km)	1mm√k	RL 2010	Difference (mm) 2012 - 2010
NAURBM	RM1	-0.7124	4.5456		0.020	0.142	4.5524	-0.0068
NAURBM	RM2	-0.8749	4.3831		0.022	0.148	4.3898	-0.0067
NAURBM	RM3	-0.7769	4.4810		0.024	0.155	4.4878	-0.0068

An internal precision of 1mm √K was achieved for all level bays, the Project Specification is 2mm √K

3.2 Combined Comparisons 1993 to 2012

Table 3.2 Nauru - Comparison of the RL's for Precise Differential Levelling (1993 – 2005) and EDM Height Traversing (2005 - 2012).

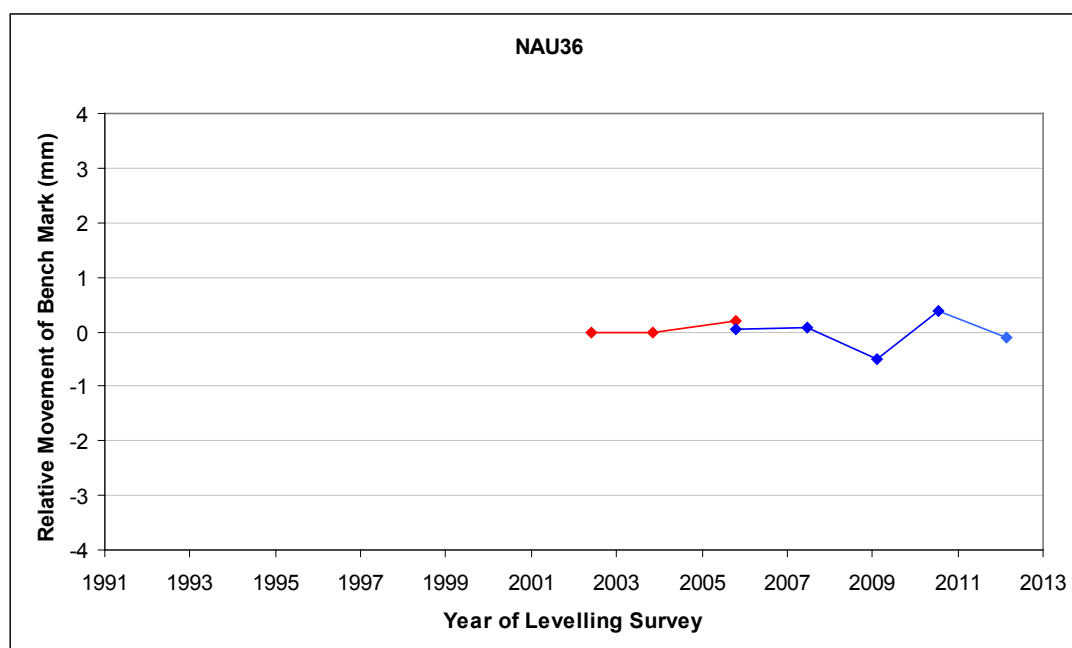
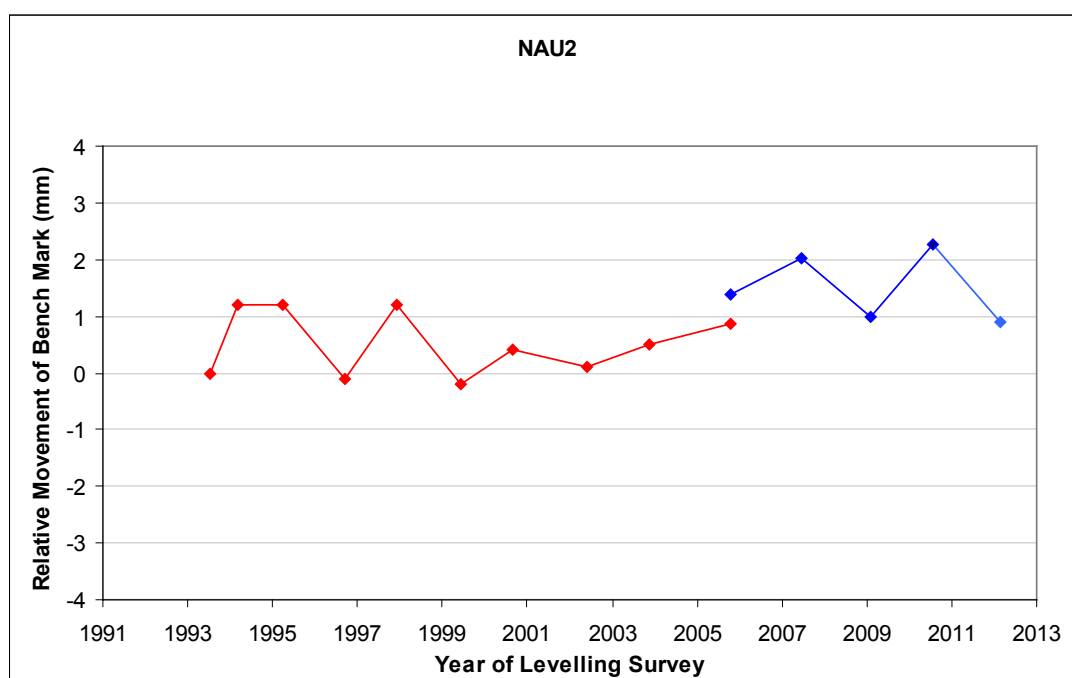
Year	NAU1	NAU2	NAU36	NAU37	NAU38	NAU16	NAURBM	NAU14	NAU15	*NAUR	RM1	RM2	RM3
1993.5	7.2930	7.7837						3.8459	6.0044				
1994.2	7.2930	7.7849				6.6915		3.8462	6.0041				
1995.2	7.2930	7.7849				6.6923		3.8459	6.0038				
1996.7	7.2930	7.7836				6.6923		3.8469	6.0048				
1997.9	7.2930	7.7849				6.6920		3.8462	6.0027				
1999.5	7.2930	7.7835				6.6916		3.8462	6.0032				
2000.6	7.2930	7.7841				6.6920		3.8465	6.0050				
2002.4	7.2930	7.7838	7.2191	7.6977	7.5711	6.6920		3.8464	6.0046				
2003.9	7.2930	7.7842	7.2191	7.6979	7.5714	6.6915	5.2570	3.8472	6.0046		4.5446	4.382	4.4801
2005.8	7.2930	7.7846	7.2193	7.6987	7.5722	6.6934		3.8478	6.0064				
2005.8	7.2930	7.7851	7.2191	7.6994	7.5729	6.6939	5.2613	3.8476	6.0070	6.2096	4.5489	4.3863	4.4843
2007.5	7.2930	7.7857	7.2192	7.6998	7.5731	6.6944	5.2625	3.8479	6.0070	6.2107	4.5499	4.3874	4.4854
2009.1	7.2930	7.7847	7.2186	7.6992	7.5725	6.6935	5.2604	3.8479	6.0073	6.2089	4.5481	4.3854	4.4834
2010.5	7.2930	7.7860	7.2195	7.7013	7.5744	6.6961	5.2647	3.8472	6.0061	6.2133	4.5524	4.3898	4.4878
2012.1	7.2930	7.7846	7.2190	7.6988	7.5722	6.6935	5.2580	3.8481	6.0052	6.2063	4.5456	4.3831	4.4810

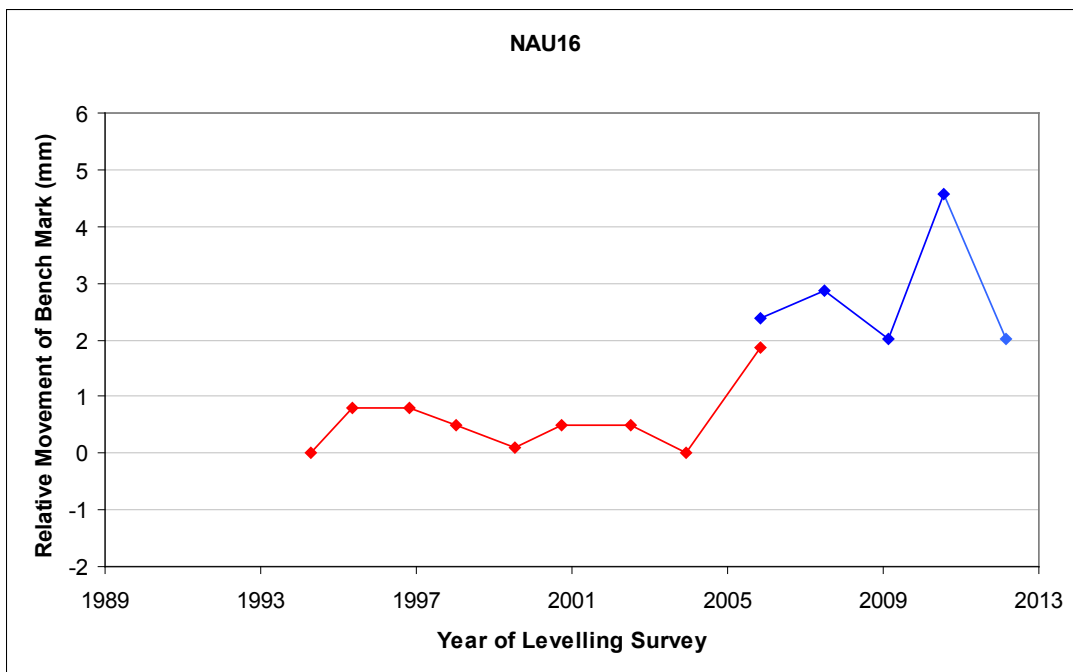
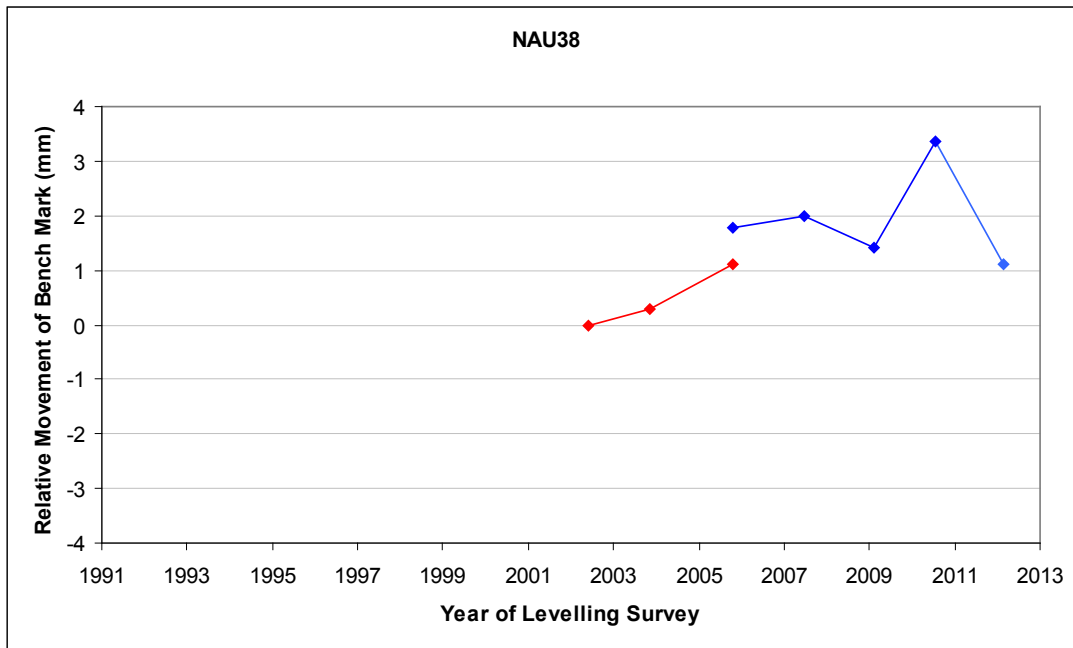
*The RL of the Reference Point NAUR (ARP) is derived from adding the static height difference of 0.9483 m (NAURBM to NAUR) to the levelled RL of NAURBM.

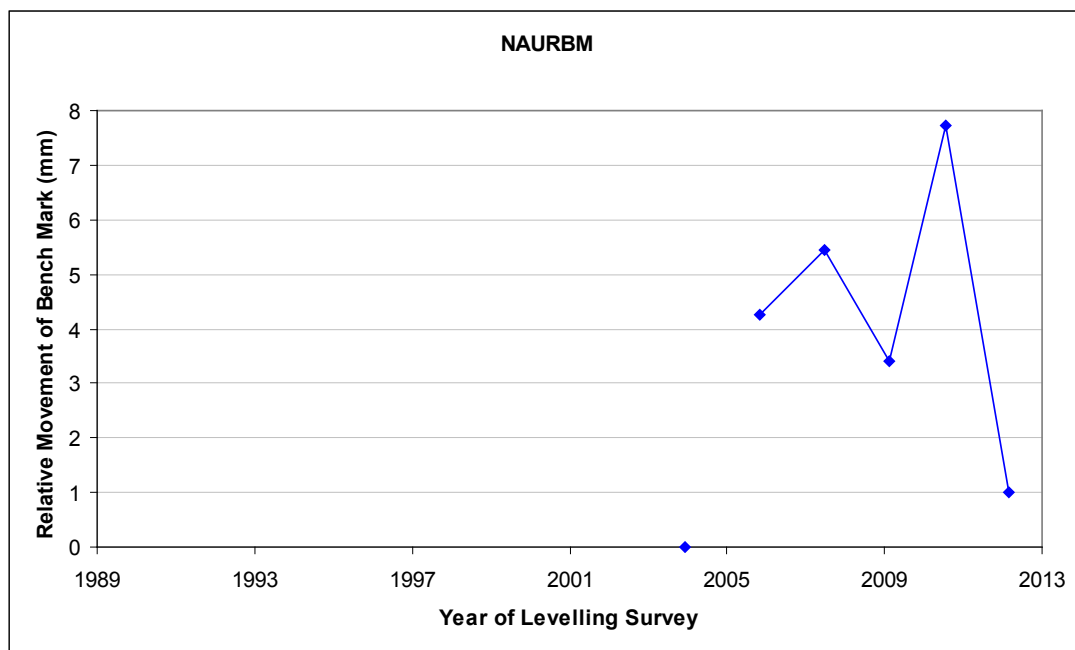
The 2012 RL of NAUR is 6.2063 m

3.3 Time Series of Bench Mark Movement relative to Fixed Deep Bench Mark NAU1

Precise Differential Levelling: 1993 - 2005 ◆ — ◆
EDM Height Traversing: 2005 onwards ◆ — ◆







4 Deep driven Bench Mark Locality Diagrams



SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING PROJECT



Survey Bench Mark Record

Bench Mark Number: NAU1

Original Bench Mark Established by: National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	Date: 11-02-92
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Existing Bench Mark Established by:	Date:
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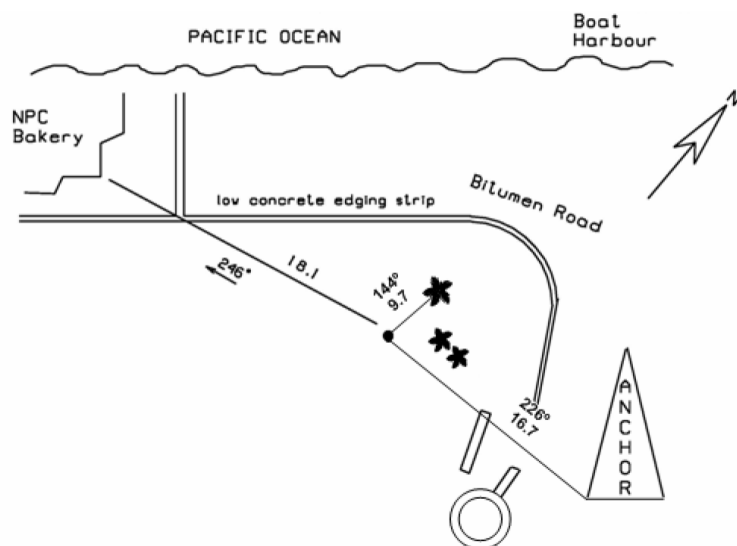
Notes / References: Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.

Country: Nauru Island: Nauru	Atoll: Nauru
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Marking and locality sketch

Bench Mark: 4.3m of 19mm diameter stainless steel capped rod driven to refusal.
Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 1.5m. Top of mark 0.2m below ground level.

Locality sketch: Mark approximately 100m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
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Approved by: Geoscience Australia / SOPAC

Date: November 2006

c:\users\andrick\sps\cmp\localitydiagrams\nauru



**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: NAU2

<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 11-02-92
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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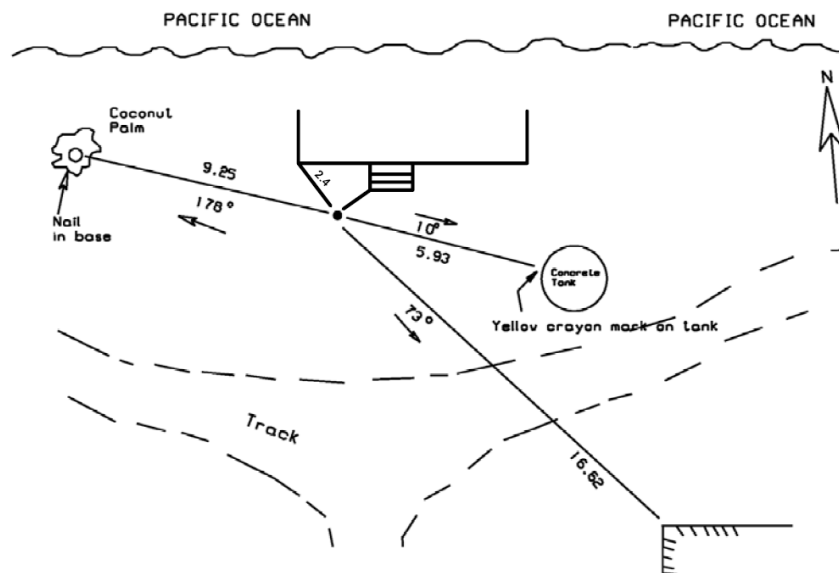
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
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<i>Country:</i> Nauru <i>Island:</i> Nauru	<i>Atoll:</i> Nauru
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Marking and locality sketch

Bench Mark: 4.8m of 19mm diameter stainless steel capped rod driven to refusal.
 Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 1.8m. Top of mark 0.1m below ground level.

Locality sketch: Mark approximately 600m from the tide gauge station.



Not to scale Distances in Metres Magnetic bearings

Approved by: Geoscience Australia / SOPAC	Date: November 2006 c:\users\andrick\spslcmp\localitydiagrams\nauru
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**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: NAU16

<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 25-08-93
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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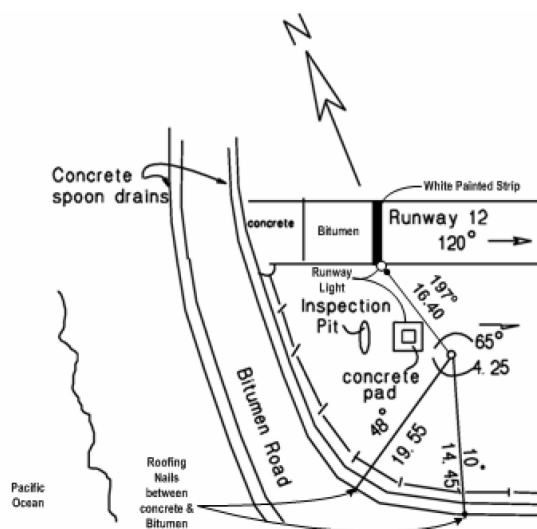
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality for GPS occupation.
--

<i>Country:</i> Nauru <i>Island:</i> Nauru	<i>Atoll:</i> Nauru
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Marking and locality sketch

Bench Mark: 4.3m of 19mm diameter stainless steel capped rod driven to refusal.
 Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 0.5m. Top of mark 0.1m below ground level.

Locality sketch: Mark approximately 1500m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
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Approved by: Geoscience Australia / SOPAC	Date: November 2006 c:\users\landrick\spslcmpl\localitydiagrams\nauru
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**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: NAU36

<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 03-06-02
<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality for GPS occupation.	
<i>Country:</i> Nauru <i>Island:</i> Nauru	<i>Atoll:</i> Nauru
<u>Marking and locality sketch</u> Bench Mark: 4.2m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 0.5m. Top of mark 0.1m below ground level. Locality sketch: Mark approximately 600m from the tide gauge station. The diagram is a schematic locality sketch. It shows a horizontal line representing a 'Road'. Above the road, on the left, is a building labeled 'MIS & AUDIT No. 22'. To the right of the road, there is a 'low concrete wall'. Further right, a 'Walkway' is indicated. A point on the walkway is marked with a dot and labeled '1.0'. To the right of the walkway are two small squares labeled 'Conc. Posts'. At the bottom right of the sketch is a building labeled 'NPC HQ'. A diagonal line with hatching indicates a boundary or feature.	
Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC Date: November 2006 c:\users\andrick\spslcmp\localitydiagrams\nauru	



**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: NAU37

<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 03-06-02
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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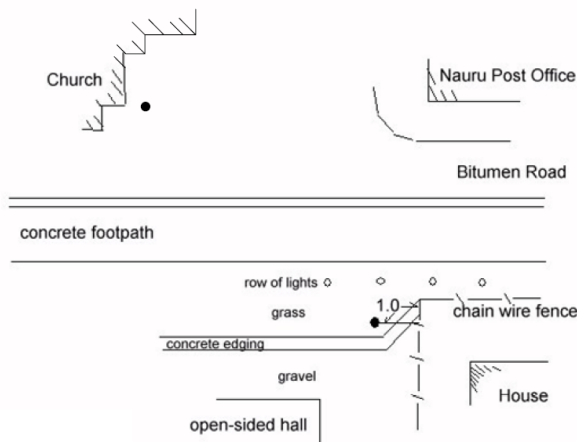
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality for GPS occupation.
--

<i>Country:</i> Nauru <i>Island:</i> Nauru	<i>Atoll:</i> Nauru
---	---------------------

Marking and locality sketch

Bench Mark: 3.3m of 19mm diameter stainless steel capped rod driven to refusal.
 Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 0.5m. Top of mark 0.1m below ground level.

Locality sketch: Mark approximately 1200m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
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Approved by: Geoscience Australia / SOPAC

Date: November 2006

c:\users\andrick\spslcmp\localitydiagrams\nauru



**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: NAU38

<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 03-06-02
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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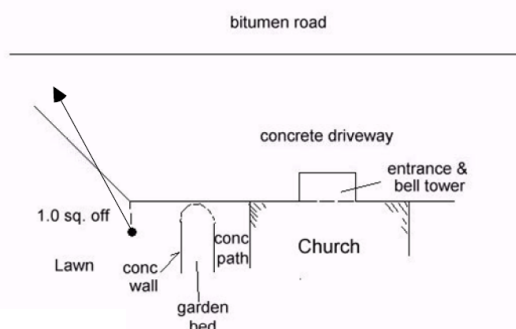
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality for GPS occupation.
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<i>Country:</i> Nauru <i>Island:</i> Nauru	<i>Atoll:</i> Nauru
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Marking and locality sketch

Bench Mark: 3.3m of 19mm diameter stainless steel capped rod driven to refusal.
 Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 0.5m. Top of mark 0.1m below ground level.

Locality sketch: Mark approximately 1200m from the tide gauge station.

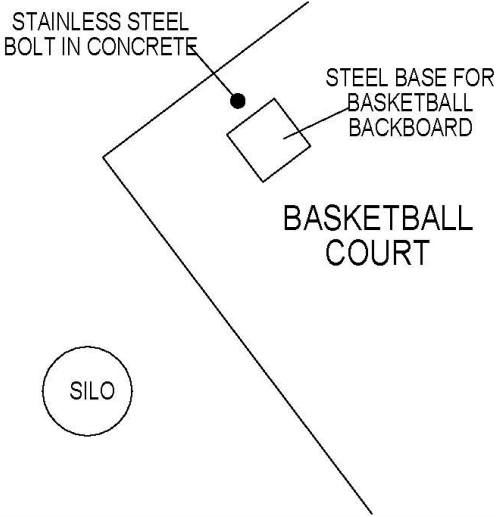
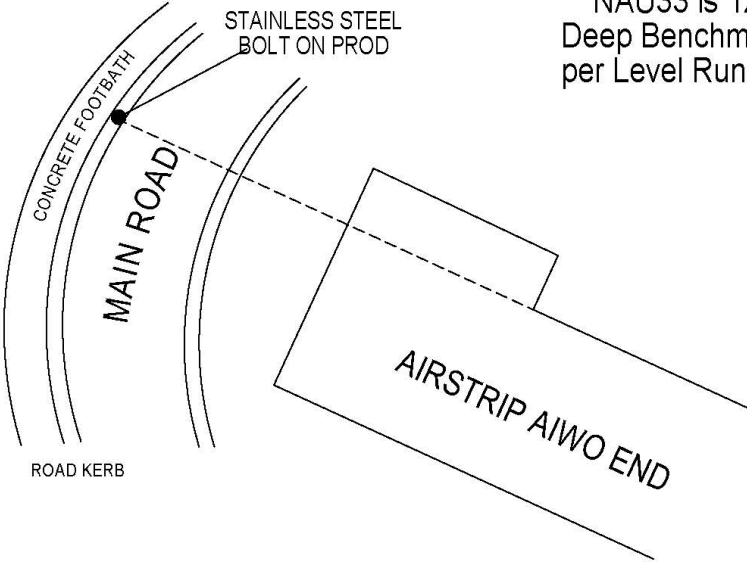


Not to scale	Distances in Metres	Magnetic bearings
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Approved by: Geoscience Australia / SOPAC

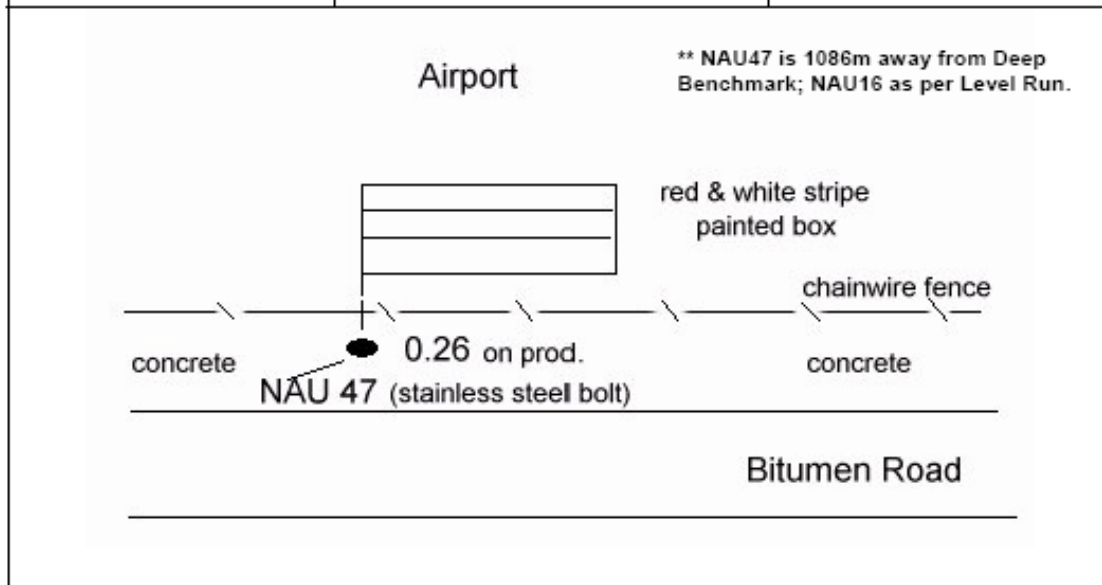
Date: November 2006

c:\users\landrick\spslcmpl\localitydiagrams\nauru

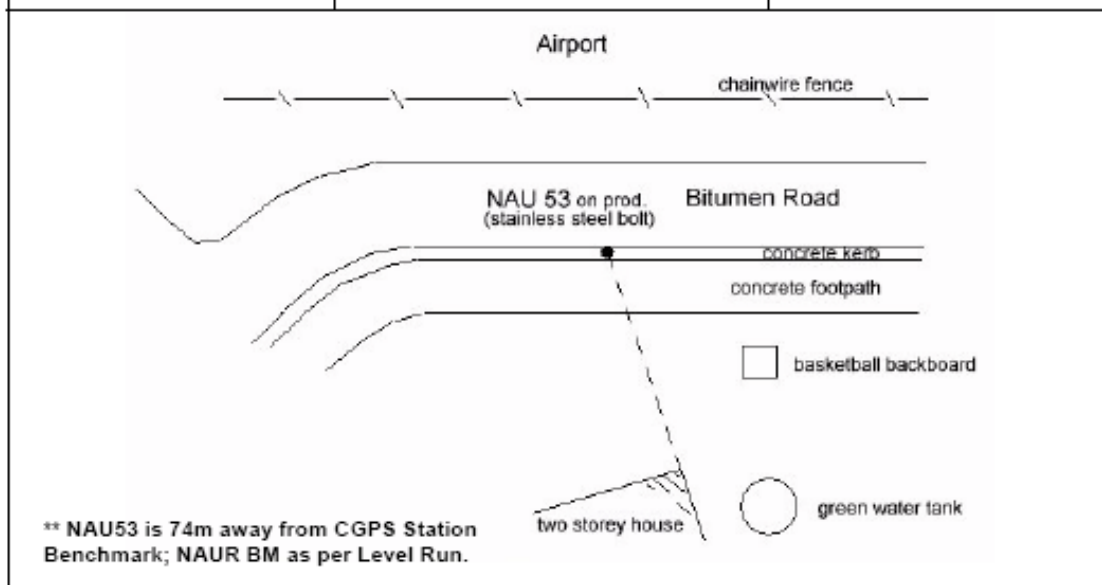
COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 565 POINT NO. NAU 28
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 31-05-02
** NAU28 is 197m away from Deep Benchmark; NAU36 as per Level Run  STAINLESS STEEL BOLT IN CONCRETE STEEL BASE FOR BASKETBALL BACKBOARD BASKETBALL COURT SILO		
COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 570 POINT NO. NAU 33
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 31-05-02
** NAU33 is 129m away from Deep Benchmark; NAU16 as per Level Run  CONCRETE FOOTPATH MAIN ROAD ROAD KERB STAINLESS STEEL BOLT ON ROD AIRSTRIp AIWO END		

COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/ Boe	L. D. P. 752 POINT NO. NAU 43
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 06-11-03
Airport ** NAU43 is 486m away from Deep Benchmark; NAU16 as per Level Run.		
COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/ Boe	L. D. P. 753 POINT NO. NAU 44
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 06-11-03
Airport ** NAU44 is 690m away from Deep Benchmark; NAU16 as per Level Run.		

COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/ Boe	L. D. P. 756 POINT NO. NAU 47
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 06-11-03

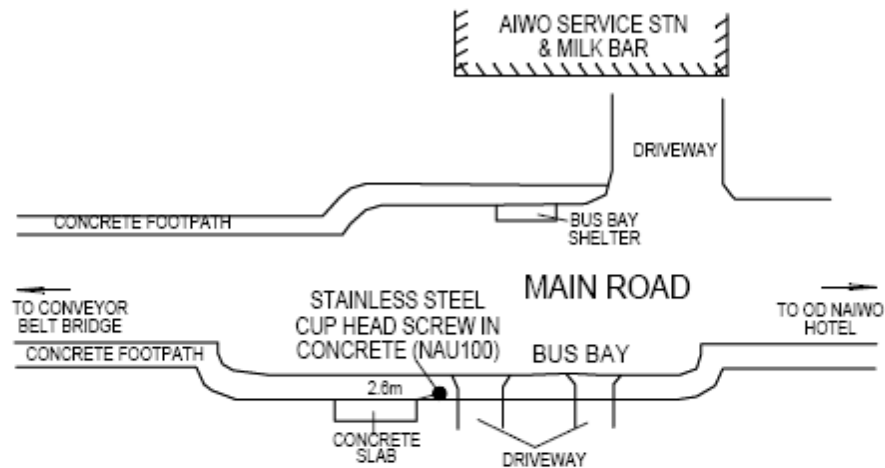


COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/ Boe	L. D. P. 762 POINT NO. NAU 53
PROJECT: SPSLCMP	SURVEYOR: S. Turner	DATE: 06-11-03

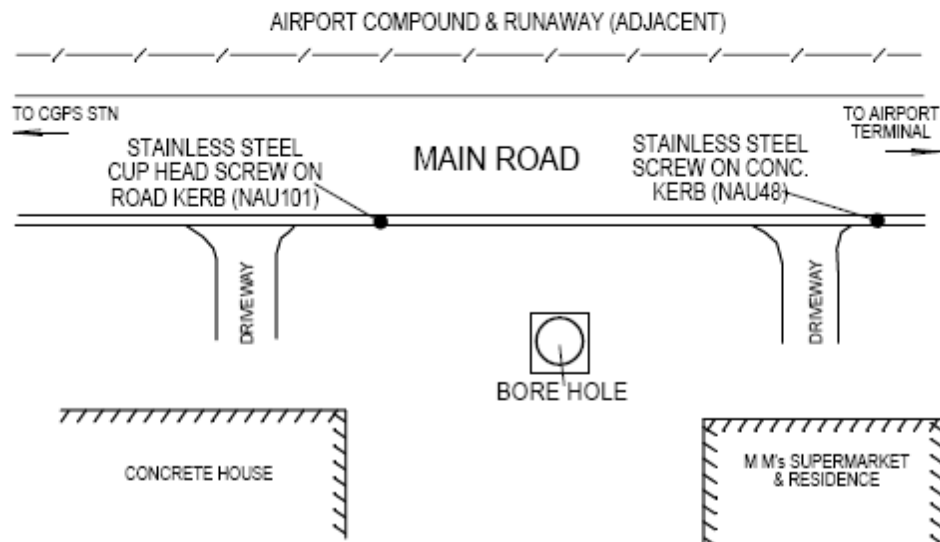


COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 786 POINT NO. NAU 100
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 04-06-07

** NAU100 is 166m away from Deep Benchmark; NAU2 as per Level Run

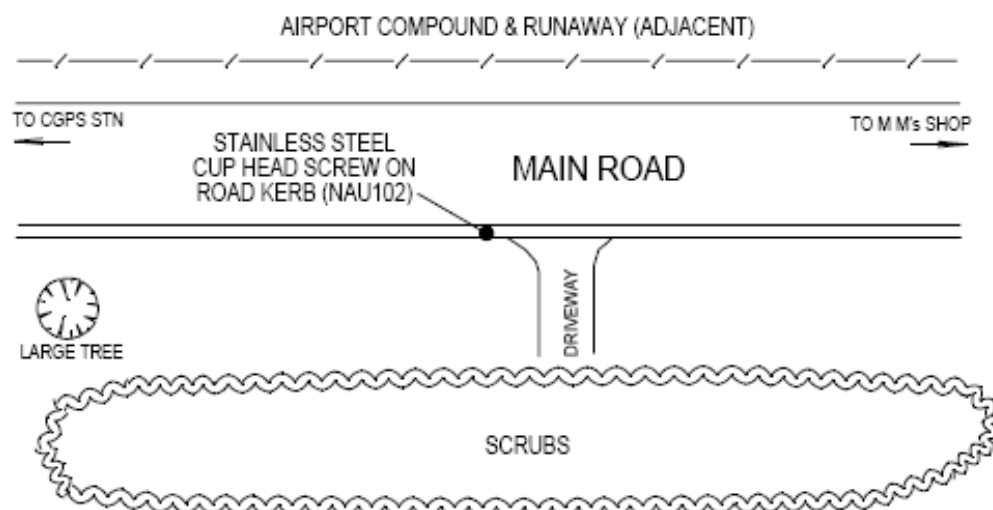


COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 787 POINT NO. NAU 101
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 04-06-07



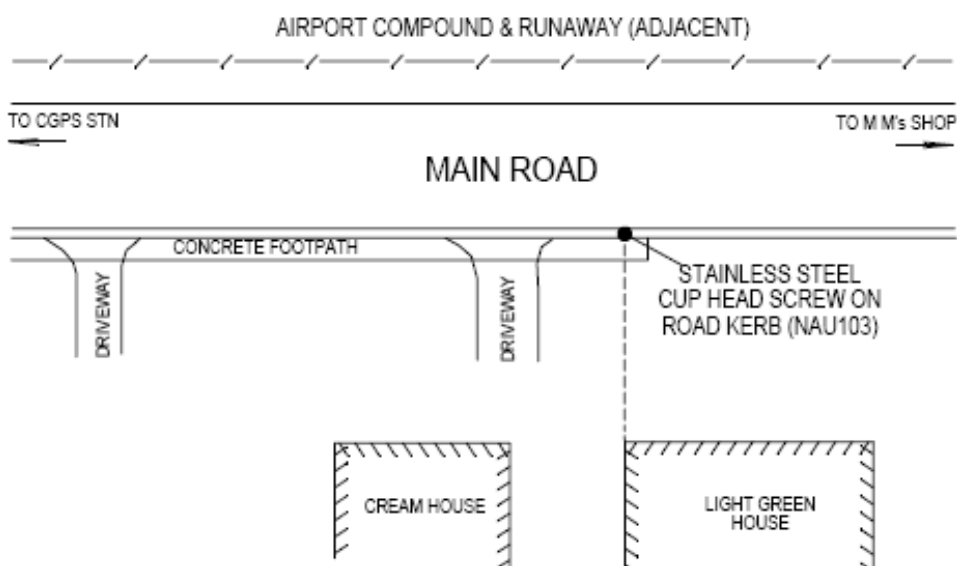
** NAU101 is 1287m away from Deep Benchmark; NAU16 as per Level Run

COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 788 POINT NO. NAU 102
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 04-06-07

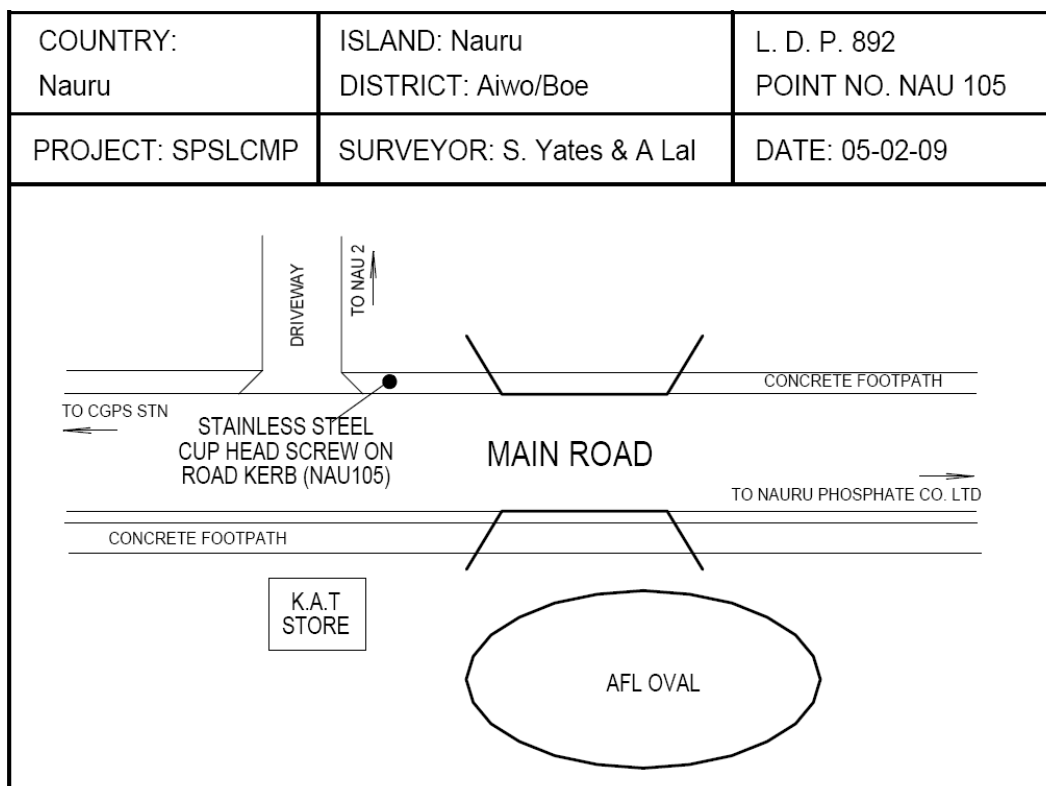
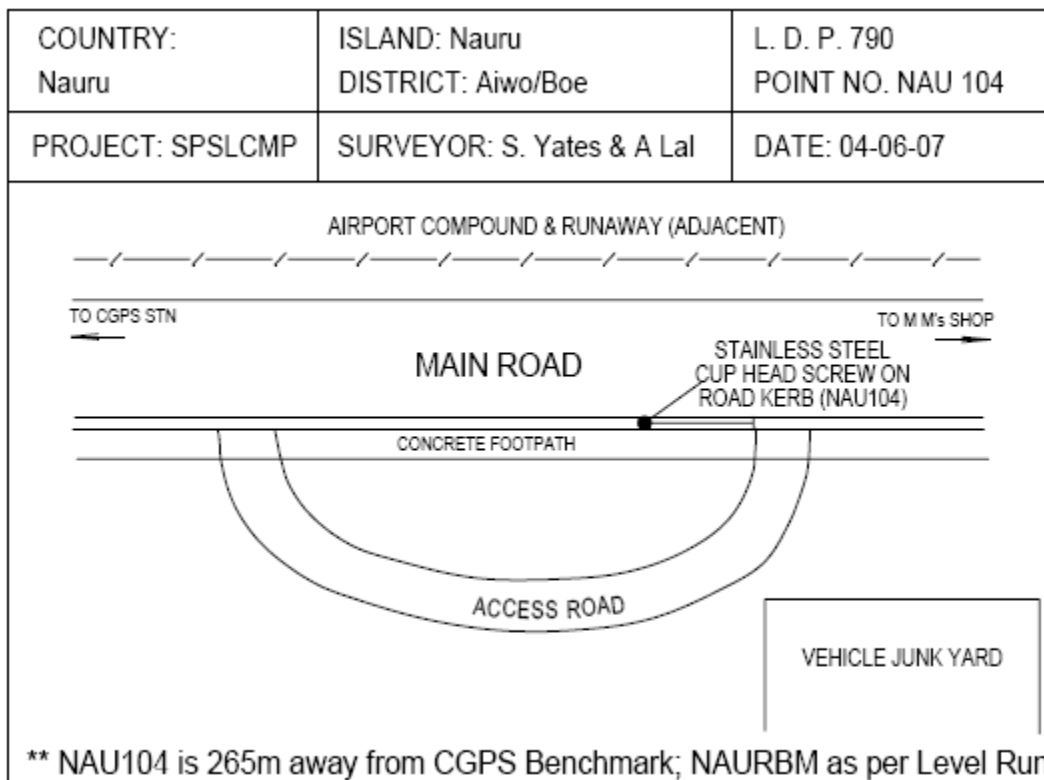


** NAU102 is 1486m away from Deep Benchmark; NAU16 as per Level Run

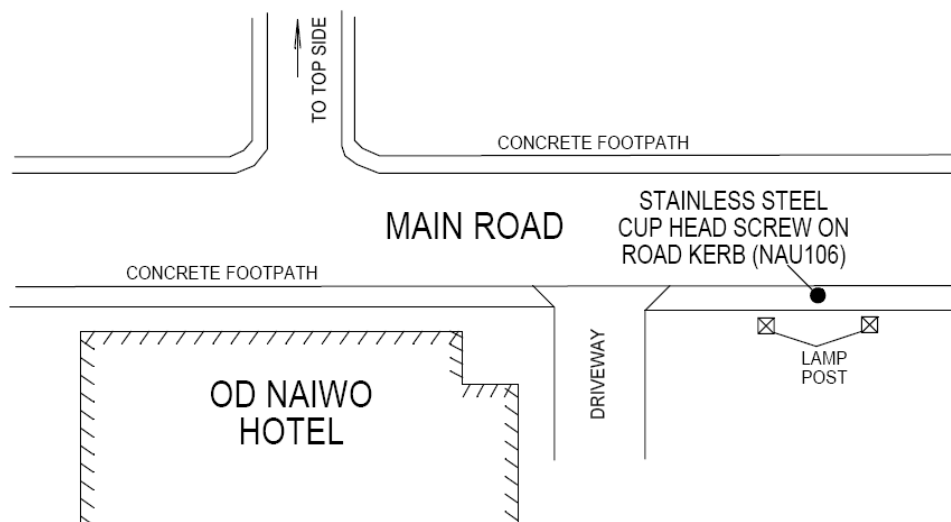
COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 789 POINT NO. NAU 103
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 04-06-07



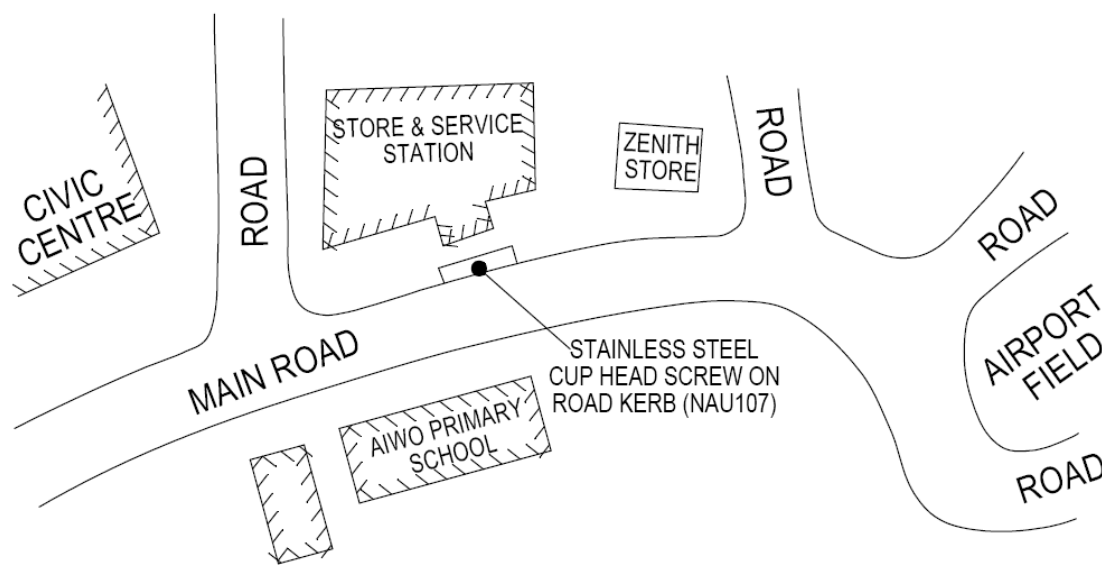
** NAU103 is 1686m away from Deep Benchmark; NAU16 as per Level Run



COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 893 POINT NO. NAU 106
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 05-02-09



COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 894 POINT NO. NAU 107
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 05-02-09



COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 895 POINT NO. NAU 108
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 05-02-09

Diagram description: A horizontal line represents the 'MAIN ROAD'. Above it, a vertical line is labeled 'ROAD'. A 'CONCRETE FOOTPATH' runs horizontally, with a 'STAINLESS STEEL CUP HEAD SCREW ON FOOTPATH (NAU108)' marked on the left side. Below the road, 'RUNAWAY MARKINGS' are shown as a series of vertical lines. The area below the runway is labeled 'AIRPORT RUN-AWAY'. Arrows indicate directions: 'TO CIVIC CENTRE' to the left and 'TO AIRPORT TERMINAL' to the right.

COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 896 POINT NO. NAU 109
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 05-02-09

Diagram description: The top section shows an 'AIRCRAFT PARKING BAY' and an 'AIRPORT TERMINAL'. Below this is the 'MAIN ROAD'. Arrows indicate directions: 'TO CIVIC CENTRE' to the left and 'TO CGPS STATION' to the right. The bottom section shows the 'AIRPORT RUN-AWAY' with 'ENTRY B' and 'ENTRY A' marked. A 'STAINLESS STEEL CUP HEAD SCREW ON BASE OF RUNAWAY LIGHTS (NAU109)' is marked on the runway. A 'RED/WHITE BOX' is also shown on the right side of the runway.

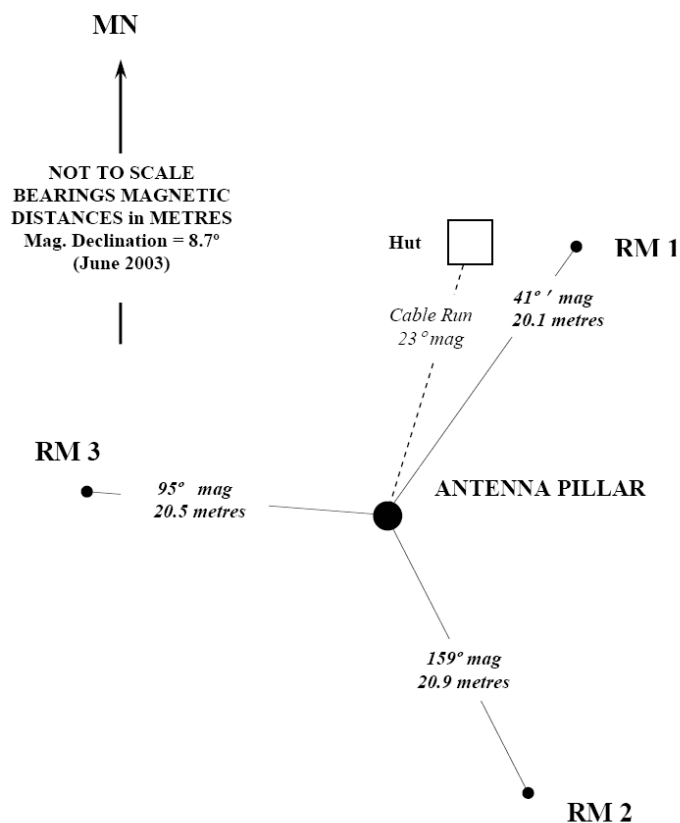
COUNTRY: Nauru	ISLAND: Nauru DISTRICT: Aiwo/Boe	L. D. P. 897 POINT NO. NAU 14 & 15
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 05-02-09

5 NAURBM and NAUR Reference Mark Locality Diagrams

NAURU CGPS Station, Yaren District. – Reference Marks

REFERENCE MARKS

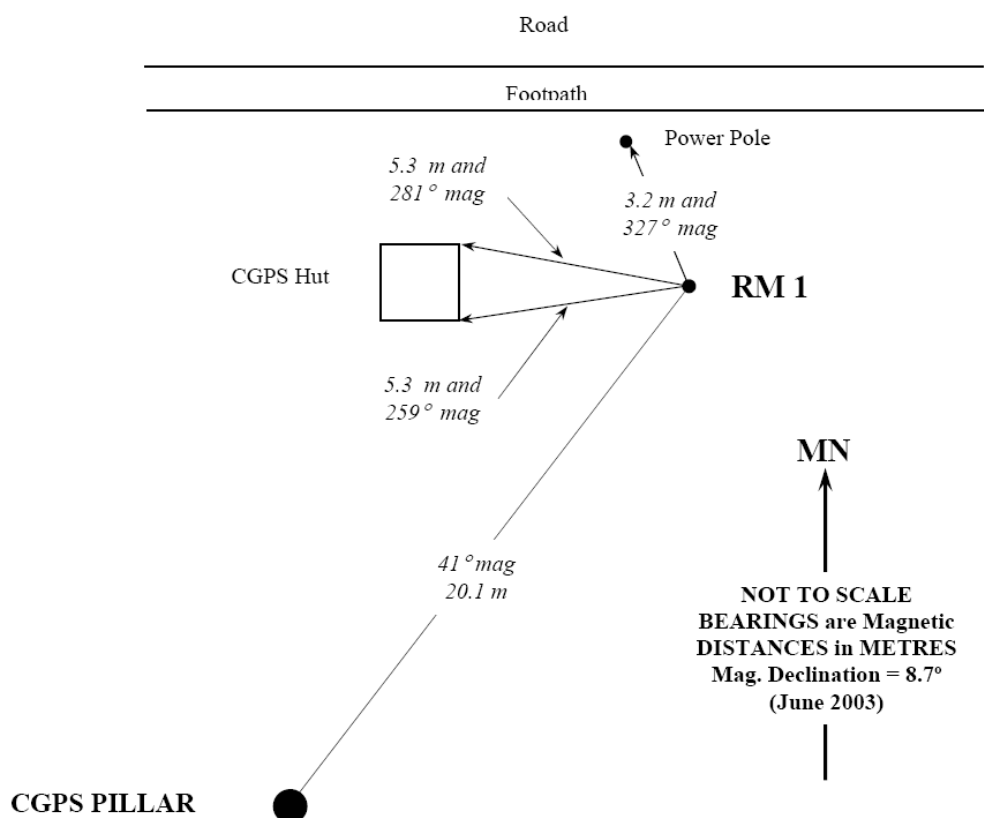
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



NAURU CGPS Station, Yaren District. – RM 1

REFERENCE MARKS

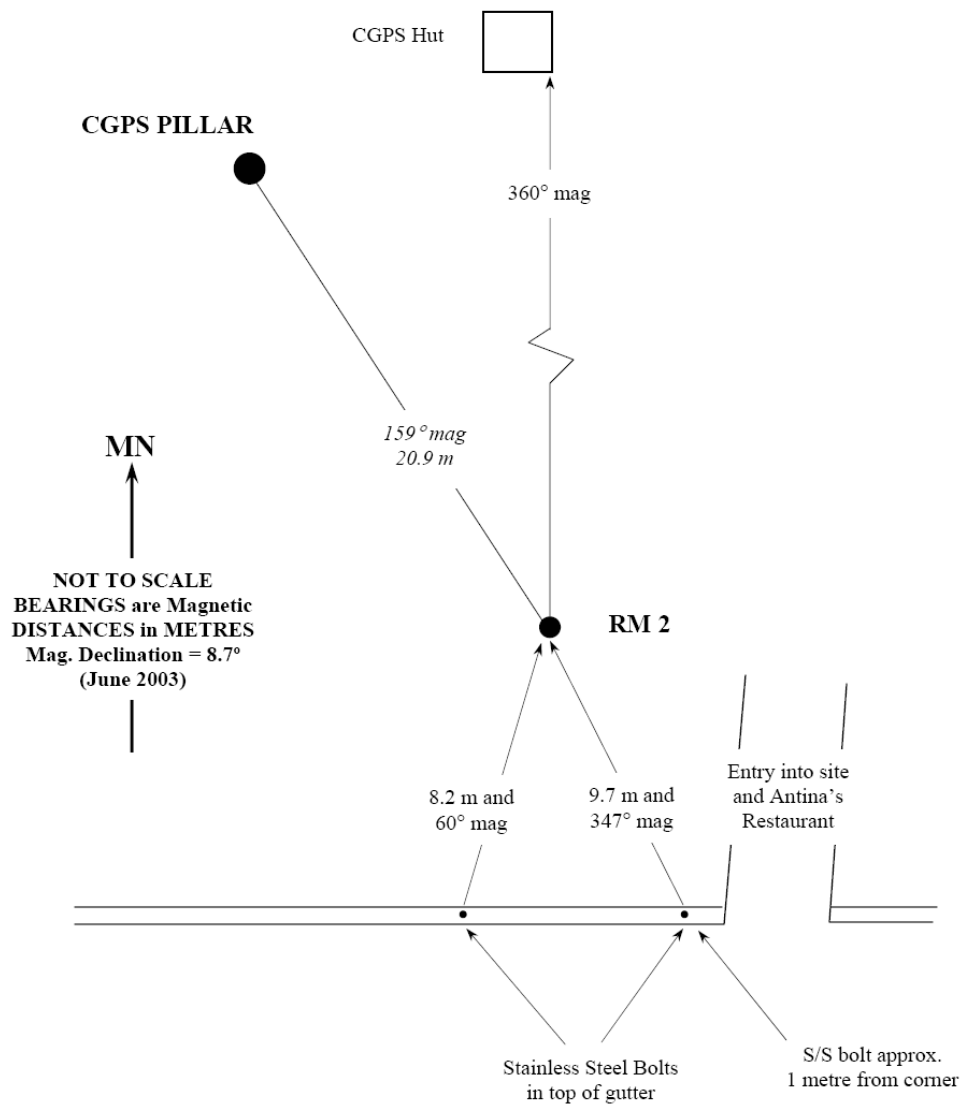
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



NAURU CGPS Station, Yaren District. – RM 2

REFERENCE MARKS

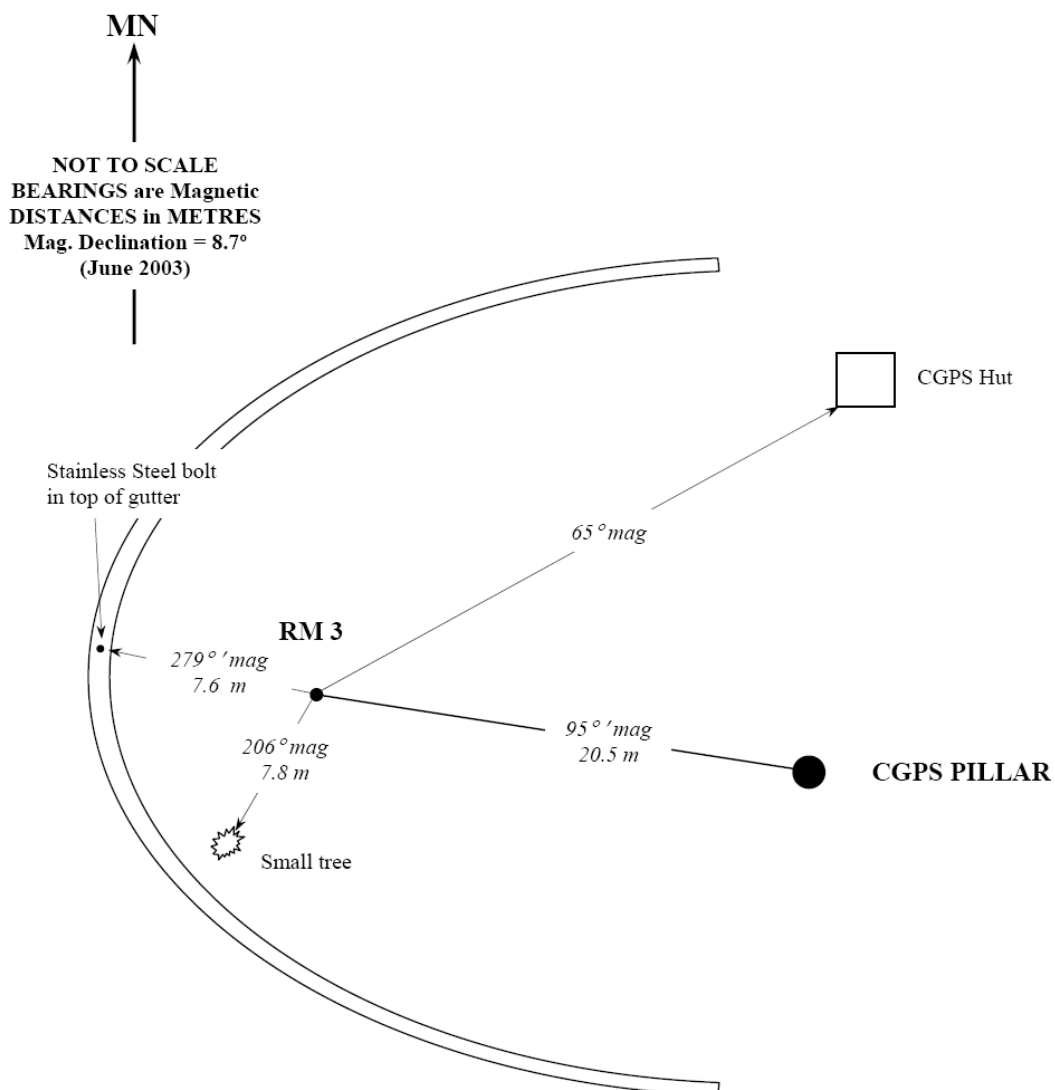
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



NAURU CGPS Station, Yaren District. – RM 3

REFERENCE MARKS

All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



6 References

- Rüeger, J.M. & Brunner, F.K. 1982, 'EDM Height Traversing versus Geodetic Levelling', The Canadian Surveyor, vol. 36, no. 1, pp. 69-87.
- Inter-Government Committee on Surveying and Mapping (ICSM) 2002, Standards and Practices for Control Surveys, SP1, Ver. 1.5, May 2002.