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EDM Height Traversing Levelling Survey Report

Tarawa, Kiribati, August 2013

S. J. K. Yates, A. Lal

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GEOSCIENCE AUSTRALIA
RECORD 2014/18

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Australian Government
Geoscience Australia

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1 Introduction

This report outlines the high precision level survey completed between the Sea Level Fine Resolution Acoustic Measuring Equipment (SEAFRAME) tide gauge and the Continuous Global Navigation Satellite System (CGNSS) Station in Tarawa, Kiribati from 15th – 22nd August 2013.

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

The Electronic Distance Measurement (EDM) Height Traversing levelling technique was employed to observe differences in height between the deep bench mark arrays in Tarawa, which runs approximately 2.2km from the SEAFRAME tide gauge sensor to the CGNSS Station. Previous levelling surveys have been conducted along the route using this technique in 2006, 2007, 2009, 2010 and 2012.

In addition, precise differential levelling surveys were performed along the deep bench mark array from 1992 to 2006 by the National Tidal Centre Australia (NTCA) and the survey in 2006 included a comparison between the precise differential levelling and EDM height traversing techniques. This report contains a comparison between the 2013 and 2012 EDM height traversing results as well as a combined comparison since the first levelling survey in 1992.

2 The Survey

The EDM height traversing levelling survey was carried out between the SEAFRAME tide gauge sensor, CGNSS station and the deep driven bench mark array:

KIR1	– reference deep driven bench mark
KIR2	– deep driven bench mark
KIR3	– deep driven bench mark
KIR46	– deep driven bench mark
KIR47	– deep driven bench mark
KIR49	– deep driven bench mark
KIR12	– SEAFRAME sensor bench mark
KIR13	– SEAFRAME Project plaque bench mark
KIRIBM	– reference bench mark for the GNSS pillar

Also included in the survey were temporary holding marks – KIR39, KIR44, KIR100, KIR101, KIR102, KIR104, KIR105 and KIR106.

The CGNSS Reference Point - KIRI and the three CGNSS Reference Marks – RM1, RM2 and RM3 were also levelled. 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. 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 2013 reduced levels are detailed later in this report.

2.1 Bench Mark Locations – Tarawa



2.2 The Kiribati Datum

The adopted reference point for this survey is KIR1. Reduction of the data was calculated holding KIR 1 fixed at 3.5334 metres relative above the Tide Gauge Zero (TGZ) mark from the University of Hawaii tide gauge.

The original reference point for the 1992 survey was UT8 which had a height of 4.027 m above the Tide Gauge Zero (TGZ) mark from the University of Hawaii tide gauge, however, both the UT8 and the tide gauge no longer exist.

2.3 Equipment

- LEICA total station model TCA2003 and 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 Betio Island 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 Kiribati 2013 Reduced Levels

Table 2.1 Tarawa, Kiribati – Reduced levels 2013 survey

Date: 15 – 22 August 2013

Datum: Tide Gauge Zero

Point ID	Reduced Level 2013	Type
KIR1	3.5334	Stainless Steel Rod in Ground
KIR102	4.0096	Stainless Steel Pin in Concrete
KIR100	3.8317	Stainless Steel Pin in Concrete
KIR39	4.0779	Stainless Steel Pin in Concrete
KIR101	4.1426	Stainless Steel Pin in Concrete
KIR49	4.0224	Stainless Steel Rod in Ground
KIR12	4.2188	Stainless Steel Pin in Concrete
KIR13	4.6316	Stainless Steel Pin
KIR46	3.3801	Stainless Steel Rod in Ground
KIR106	3.8032	Stainless Steel Pin in Concrete
KIR104	3.6795	Stainless Steel Pin in Concrete
KIR2	3.1836	Stainless Steel Rod in Ground
KIR44	3.6198	Stainless Steel Pin in Concrete
KIR47	3.2957	Stainless Steel Rod in Ground
KIR105	3.8308	Stainless Steel Rod in Ground
KIR3	3.5665	Stainless Steel Rod in Ground
*KIRI	5.3576	Pillar Plate (ARP)
KIRIBM	4.4147	Stainless Steel Pillar Pin

Point ID	Reduced Level 2013	Type
KIRIRM1	3.5391	Stainless Steel Rod in Ground
KIRIRM2	3.5017	Stainless Steel Rod in Ground
KIRIRM3	3.5169	Stainless Steel Rod in Ground

**The RL of the Reference Point KIRI (ARP) is derived from adding the static height difference of 0.9429m (KIRIBM to KIRI) to the 2013 levelled RL of KIRIBM.*

2.6 Survey Support

Assistance from Boata Iabeta, Acting Chief Surveyor in Romano Reo's absence, and his survey staff namely, Tiure Toorua and Tentao Takaaio; from the Ministry of Lands was appreciated, they provided great support throughout the survey, including assistance in obtaining customs clearances for the surveying equipment. This is a lengthy process and seems to be becoming more time consuming throughout most countries in the Pacific.

The staff from the Kiribati Weather Office also provided great assistance during the 2013 visit.

2.7 Issues

No issues of any significance were encountered during the 2013 visit.

3 Comparisons

3.1 Comparisons between 2013 and 2012 EDM Surveys

Table 3.1 Results of Tarawa, Kiribati 2013 EDM Height Traversing Comparison 2013 – 2012. KIR1 - adopted fixed height of 3.5334m

From	To	Levelled Ht. Diff.	RL 2013	Misclose (mm)	Dist. (km)	1mm√k	RL 2012	Difference (mm) 2013 - 2012
KIR1			3.5334				3.5334	
KIR102	KIR102	0.4762	4.0096	-0.083	0.051	0.227	4.0097	-0.12
KIR100	KIR100	-0.1779	3.8317	0.086	0.051	0.225	3.8323	-0.65
KIR39	KIR39	0.2463	4.0779	0.398	0.196	0.442	4.0789	-0.99
KIR101	KIR101	0.0647	4.1426	-0.395	0.204	0.452	4.1438	-1.21
KIR49	KIR49	-0.1202	4.0224	-0.367	0.146	0.382	4.0234	-1.04
KIR12	KIR12	0.1965	4.2188	-0.383	0.179	0.423	4.2210	-2.16
	KIR13	0.4127	4.6316	-0.008	0.011	0.105	4.6336	-2.05
KIR102			4.0096					
KIR46	KIR46	-0.6294	3.3801	0.370	0.150	0.387	3.3802	-0.07
KIR106	KIR106	0.4230	3.8032	-0.363	0.142	0.377	3.8038	-0.64
KIR104	KIR104	-0.1236	3.6795	0.010	0.202	0.450	3.6805	-0.97
	KIR2	-0.4960	3.1836	-0.140	0.101	0.318	3.1840	-0.43
KIR104			3.6795					
KIR44	KIR44	-0.0597	3.6198	-0.392	0.188	0.433	3.6212	-1.39
KIR47	KIR47	-0.3241	3.2957	0.220	0.092	0.303	3.2968	-1.06
KIR105	KIR105	0.5350	3.8308	0.117	0.166	0.407	3.8295	1.27
KIR3	KIR3	-0.2642	3.5665	0.257	0.216	0.464	3.5666	-0.07
	KIRIBM	0.8481	4.4147	-0.108	0.070	0.265	4.4145	0.16
			Misclose for all bays levelled =	-0.783	2.166	1.472		
KIRIBM			4.4147					
	RM1	-0.8756	3.5391	-0.092	0.043	0.208	3.5388	0.28
KIRIBM			4.4147					
	RM2	-0.9130	3.5017	0.067	0.050	0.223	3.5016	0.08
KIRIBM			4.4147					
	RM3	-0.8978	3.5169	-0.058	0.031	0.177	3.5169	0.03

All levelling was performed within the project specifications of 2√k

3.2 Combined Comparisons

Examination of the level survey results do not show any significant changes in reduced levels from the 2012 survey. All indications are that no immediate or significant displacement of any of the deep driven bench marks has occurred.

Table 3.2 Tarawa, Kiribati – Deep Bench Mark final RL's for Precise Differential Levelling (1992 - 2005) and EDM Height Traversing (2005 - 2013).

Year	KIR1	KIR2	KIR3	KIR12	KIR13	KIR46	KIR47	KIR49	KIRIBM
1992.96	3.5334	3.1835	3.5657	4.2176	4.6302				
1994.21	3.5334	3.1838	3.5655	4.2187	4.6319				
1995.21	3.5334	3.1845	3.5654	4.2195	4.6331				
1996.71	3.5334	3.1843	3.5654	4.2191	4.6321				
1997.96	3.5334	3.1843	3.5657	4.2196	4.6325				
1999.46	3.5334	3.1844	3.5644	4.2195	4.6324				
2000.63	3.5334	3.1847	3.5658	4.2195	4.6321				
2002.46	3.5334	3.1843	3.5648	4.2191	4.6321	3.3782	3.2948	4.0232	4.4124
2004.46	3.5334	3.1843	3.5653	4.2190	4.6324	3.3788	3.2952	4.0225	4.4130
2006.21	3.5334	3.1839	3.5662	4.2195	4.6328	3.3788	3.2956	4.0226	4.4139

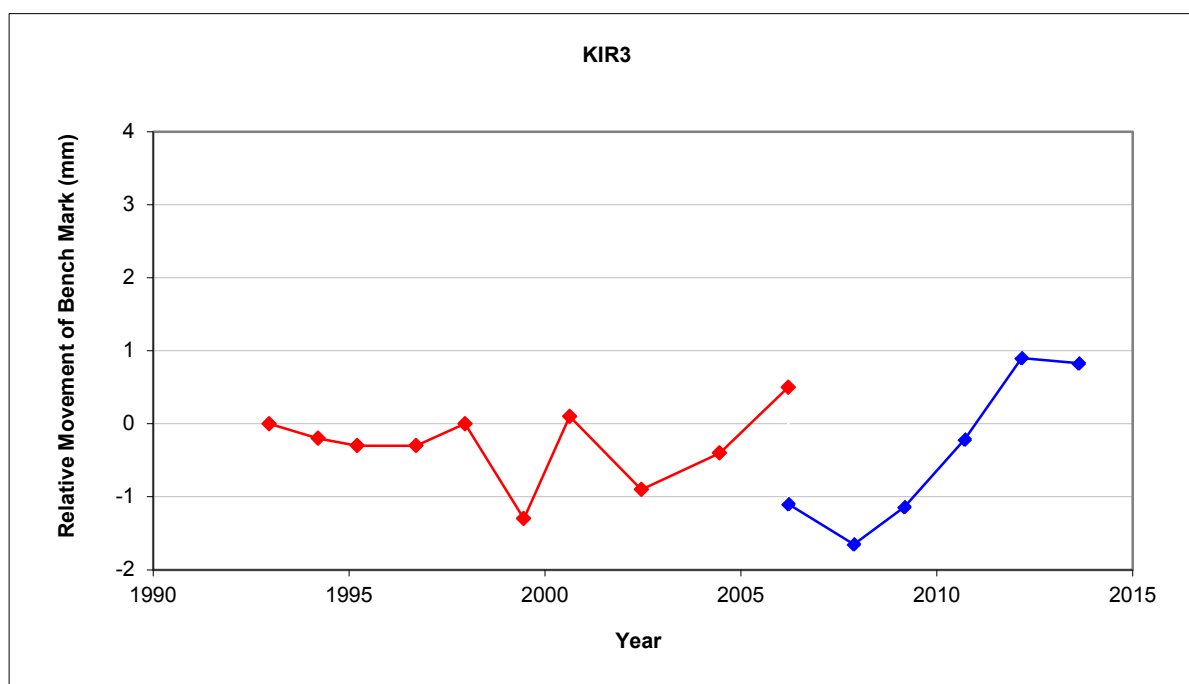
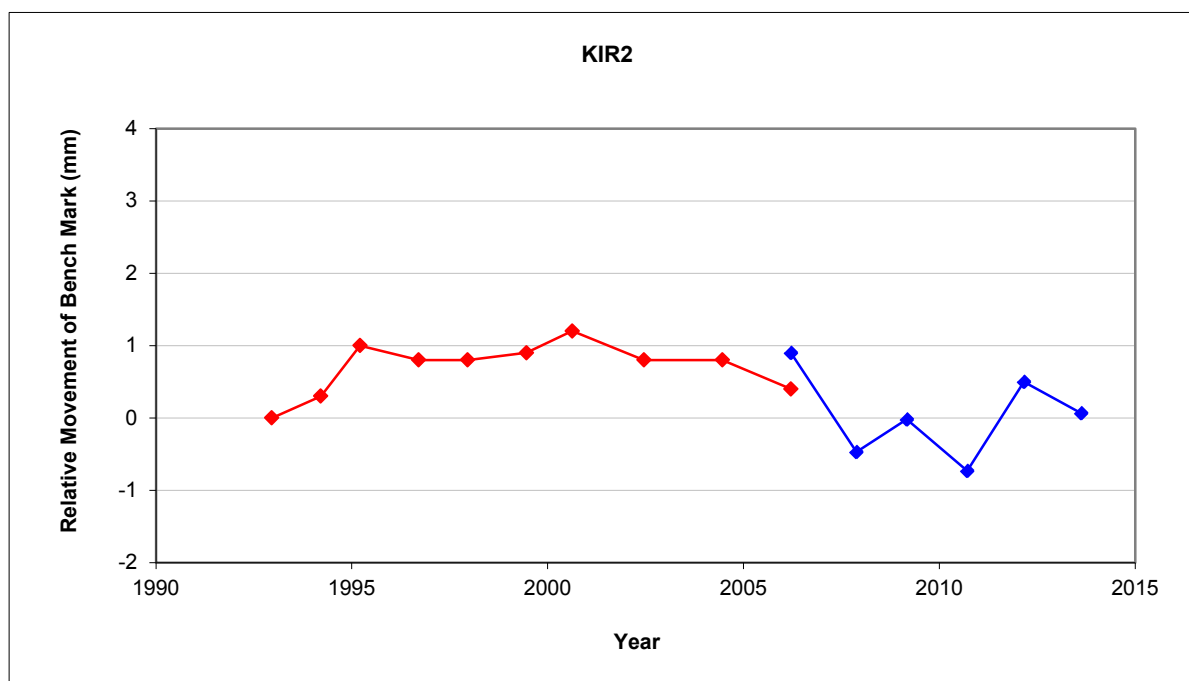
Year	KIR1	KIR2	KIR3	KIR12	KIR13	KIR46	KIR47	KIR49	KIRIBM
2006.21	3.5334	3.1844	3.5646	4.2193	4.6326	3.3794	3.2953	4.0230	4.4124
2007.88	3.5334	3.1830	3.5641	4.2202	4.6308	3.3795	3.2941	4.0230	4.4119
2009.17	3.5334	3.1835	3.5646	4.2199	4.6320	3.3791	3.2951	4.0229	4.4125
2010.71	3.5334	3.1828	3.5655	4.2200	4.6322	3.3794	3.2954	4.0229	4.4134
2012.16	3.5334	3.1840	3.5666	4.2210	4.6336	3.3802	3.2968	4.0234	4.4145
2013.62	3.5334	3.1836	3.5665	4.2188	4.6316	3.3801	3.2957	4.0224	4.4147

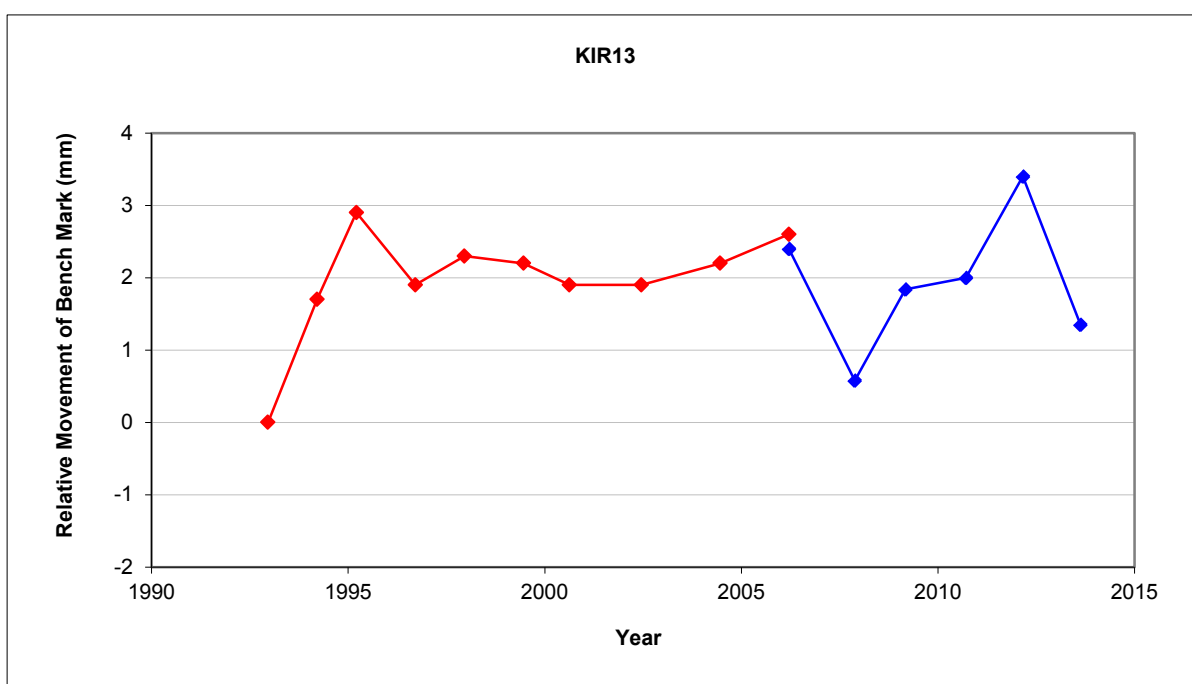
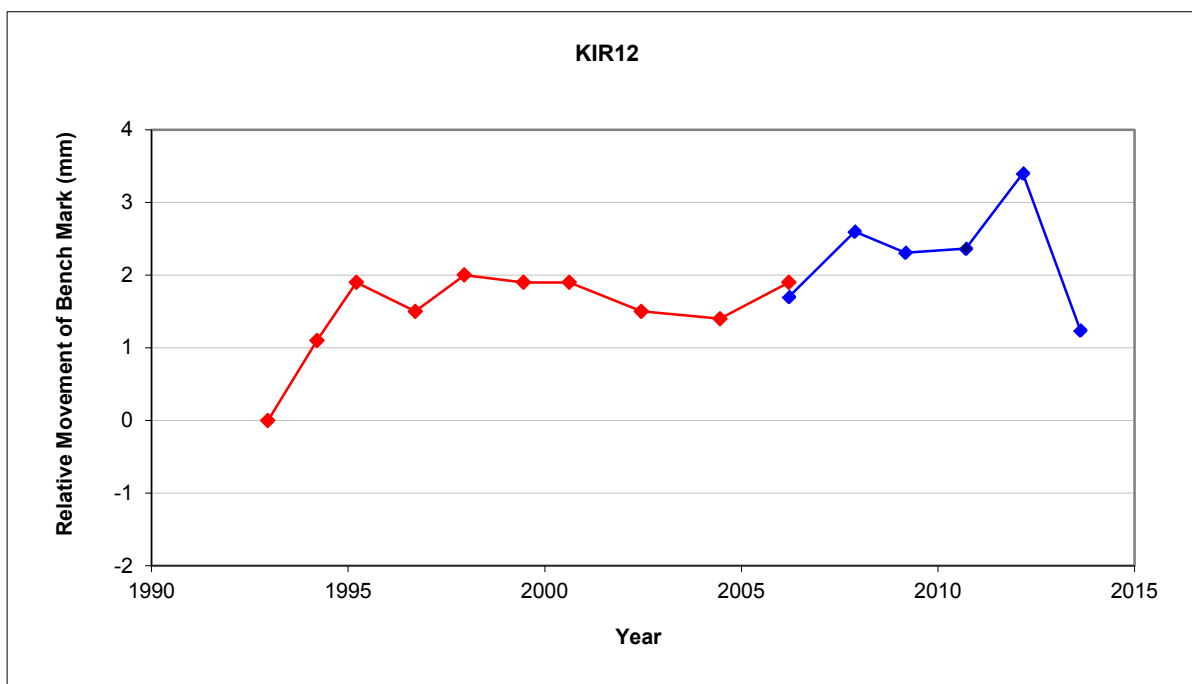
The 2013 RL of KIR1 is 5.3576m

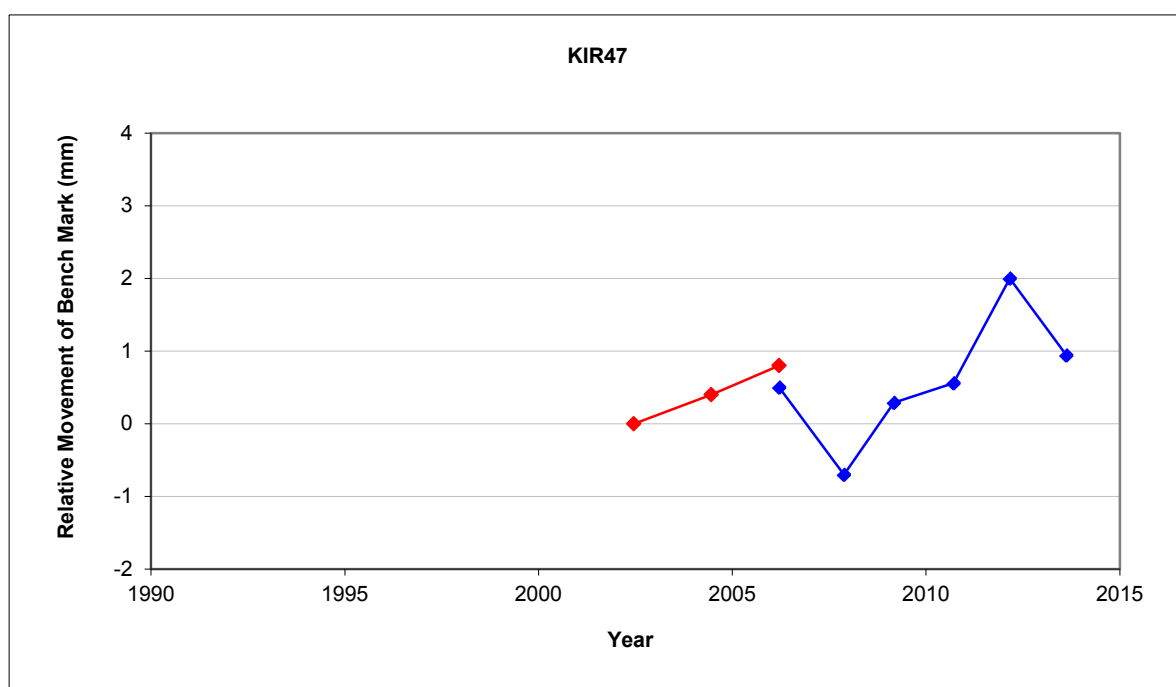
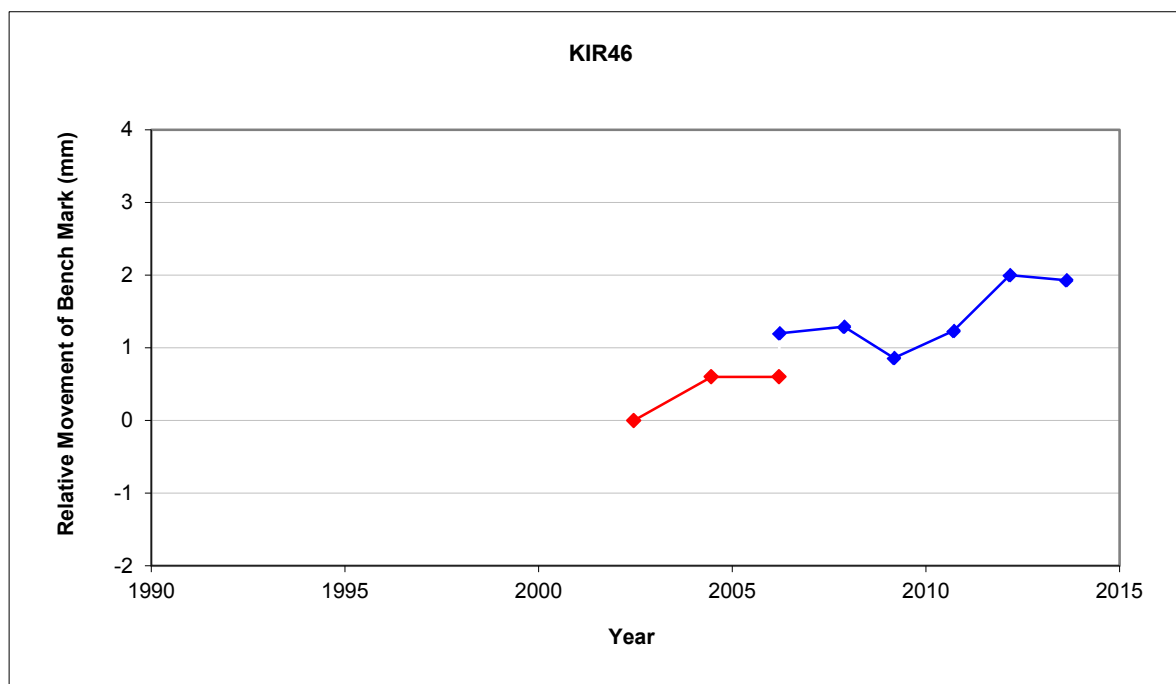
**The RL of the Reference Point KIR1 (ARP) is derived from adding the static height difference of 0.9429m (KIRIBM to KIR1) to the 2013 levelled RL of KIRIBM.*

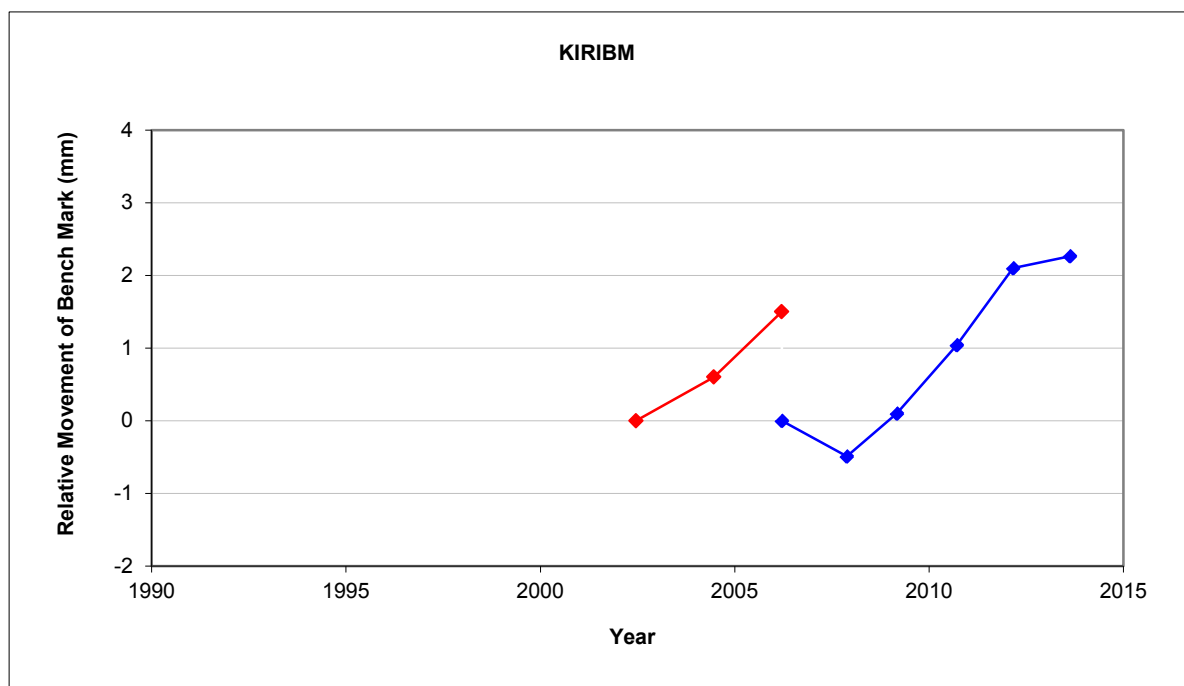
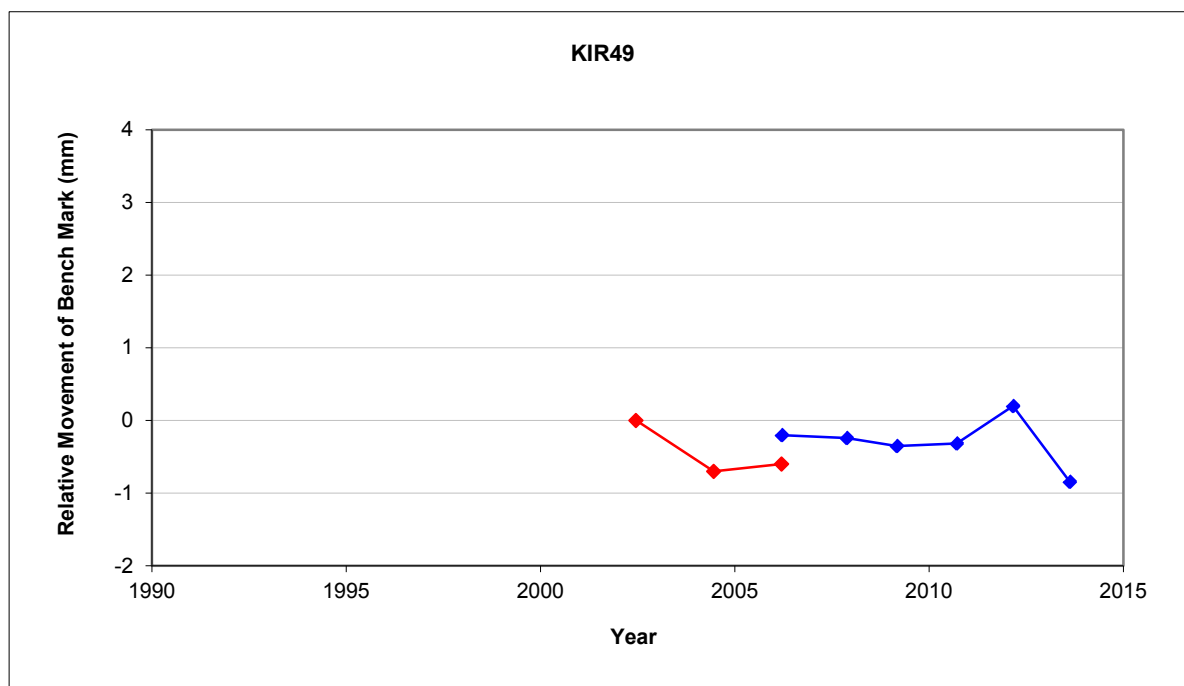
3.3 Time Series of Bench Mark movement relative to Fixed Deep Bench Mark KIR1

Precise Differential Levelling: 1992 - 2005 ◆ — ◆
EDM Height Traversing: 2005 onwards ◆ — ◆









4 Deep Bench Mark Locality Diagrams



SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING PROJECT



Survey Bench Mark Record

Bench Mark Number: KIR1

Original Bench Mark Established by: National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA. *Date:* 28-01-92

Existing Bench Mark Established by: *Date:*

Notes / References: Deep Survey Benchmark
This survey mark is not in a good locality for GPS occupation.

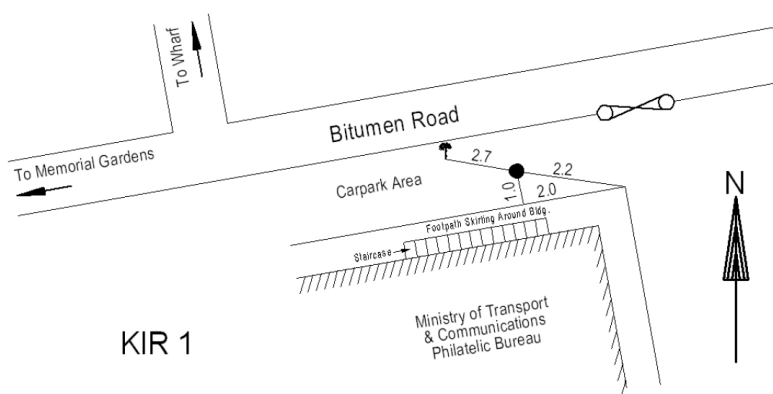
Country: Kiribati
Island: Tarawa

Atoll: Betio

Marking and locality sketch

Bench Mark: 6.2m of 19mm diameter stainless steel capped rod driven to refusal.
Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 1.0m. Top of mark 0.2m below ground level.

Locality sketch: Mark approximately 750m from the tide gauge station.



Not to scale

Distances in Metres

Magnetic bearings

Approved by: Geoscience Australia / SOPAC

Date: April 2006

c:\users\landrick\spslcmpllocalitydiagrams\kiribati



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



Survey Bench Mark Record

Bench Mark Number: KIR2

<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> 28-01-92
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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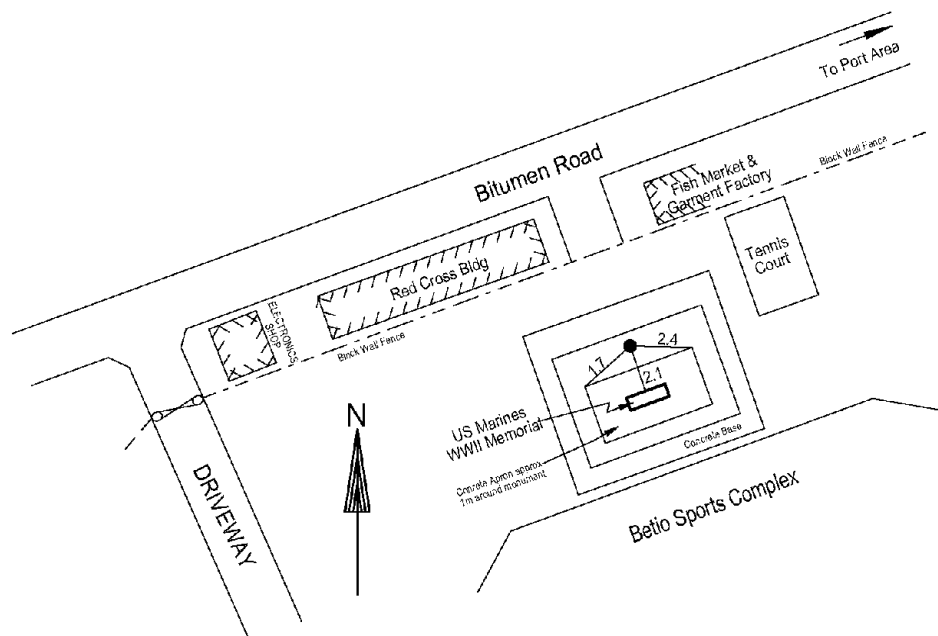
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Kiribati <i>Island:</i> Tarawa	<i>Atoll:</i> Betio
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Marking and locality sketch

Bench Mark: 6.2m of 19mm diameter stainless steel capped rod driven to refusal.
 Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 1.0m. Top of mark 0.3m below ground level.

Locality sketch: Mark approximately 1250m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
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Approved by: Geoscience Australia / SOPAC	Date: Dec 2007 c:\users\andrick\spslcmpl\localitydiagrams\kiribati
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**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: KIR3

<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> 28-01-92
<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.	
<i>Country:</i> Kiribati <i>Island:</i> Tarawa	<i>Atoll:</i> Betio
<u>Marking and locality sketch</u> Bench Mark: 6.2m of 19mm diameter stainless steel capped rod driven to refusal. Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 1.0m. Top of mark 0.2m below ground level. Locality sketch: Mark approximately 2000m from the tide gauge station. The diagram is a locality sketch showing the relative positions of several points. KIR3 is a survey bench mark. RM1, RM2, and RM3 are other marks. A DORIS ANTENNA PILLAR and a CGPS ANTENNA PILLAR are also shown. A HUT (house) is located near RM1. A dashed line represents the 'Fence line along Met. office boundary'. Distances in metres are labeled: 8.2, 2.2, 1.65, 5.2, 12.2, 8.3, 9.1, and 352° 30'. Magnetic bearings are labeled: 212°, 211°, and 145° 30'. A north arrow points upwards.	
Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC	
Date: Dec 2006 c:\users\andrick\spslcmp\localitydiagrams\kiribati	



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



Survey Bench Mark Record

Bench Mark Number: KIR46

<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> 07-06-02
<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> Kiribati <i>Island:</i> Tarawa	<i>City:</i> Betio
<u>Marking and locality sketch</u> Bench Mark: 7.0m 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 1000m from the tide gauge station.	
Not to scale	Distances in Metres
Magnetic bearings	
Approved by: Geoscience Australia / SOPAC	
Date: April 2006 c:\users\andrick\spslcmp\localitydiagrams\kiribati	



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



Survey Bench Mark Record

Bench Mark Number: KIR47

<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> 07-06-02
<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> Kiribati <i>Island:</i> Tarawa	<i>Atoll:</i> Betio
<u>Marking and locality sketch</u> Bench Mark: 7.9m 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 1700m from the tide gauge station. Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC	
Date: April 2006 c:\users\landrick\spslcmpl\localitydiagrams\kiribati	



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



Survey Bench Mark Record

Bench Mark Number: KIR49

<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> 07-06-02
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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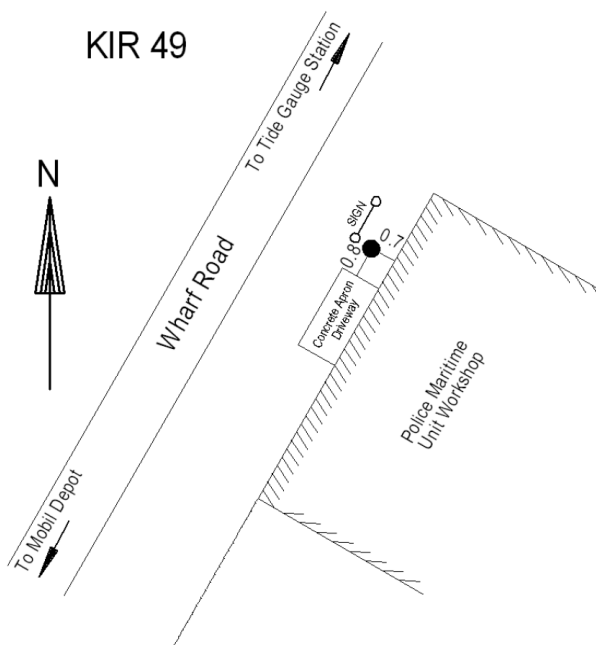
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality for GPS occupation.
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<i>Country:</i> Kiribati <i>Island:</i> Tarawa	<i>Atoll:</i> Betio
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Marking and locality sketch

Bench Mark: 2.5m 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 200m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
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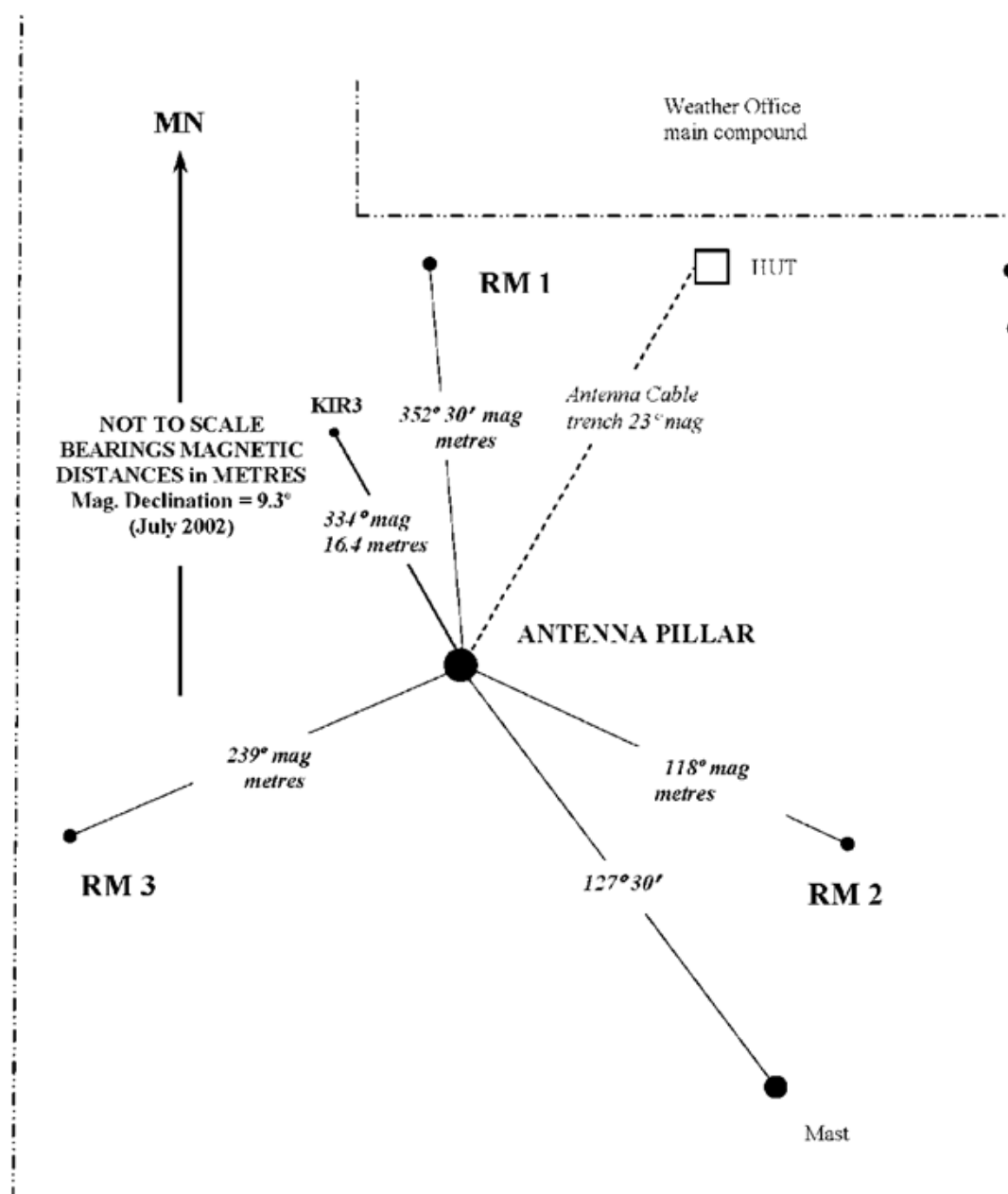
Approved by: Geoscience Australia / SOPAC	Date: April 2006 c:\users\landrick\spslcm\localitydiagrams\kiribati
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5 Reference Mark Locality Diagram

KIRIBATI CGPS Station, Betio Is. – Reference Marks

REFERENCE MARKS

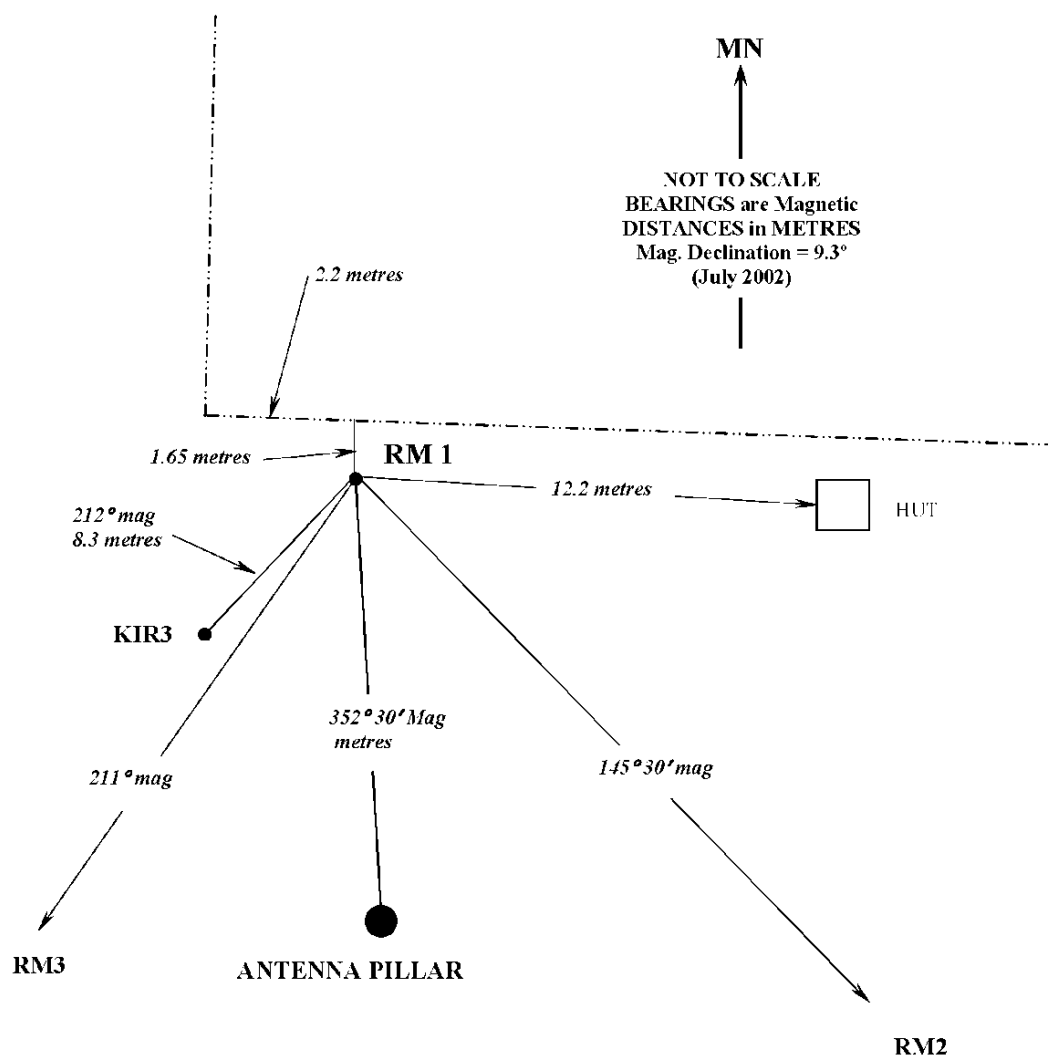
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



KIRIBATI CGPS Station, Betio Is. – RM 1

REFERENCE MARKS

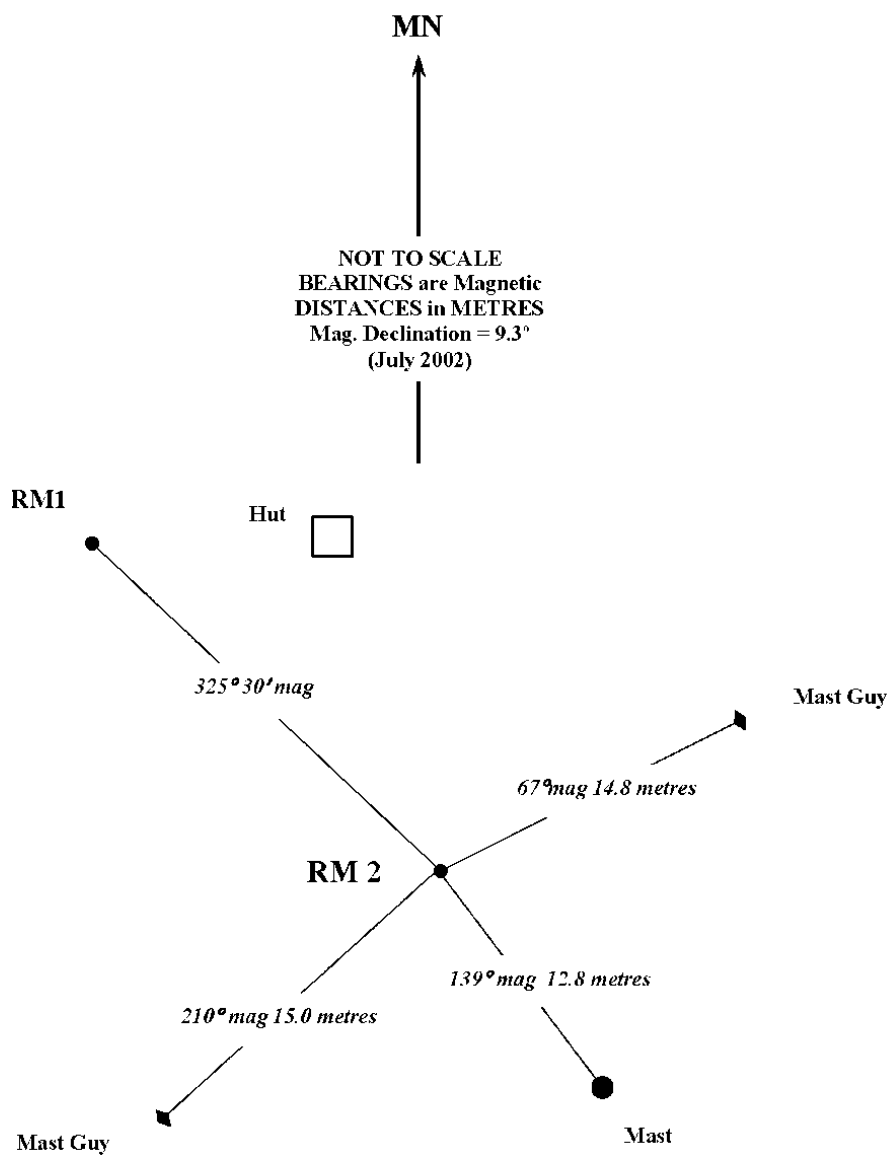
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



KIRIBATI CGPS Station, Betio Is. – RM 2

REFERENCE MARKS

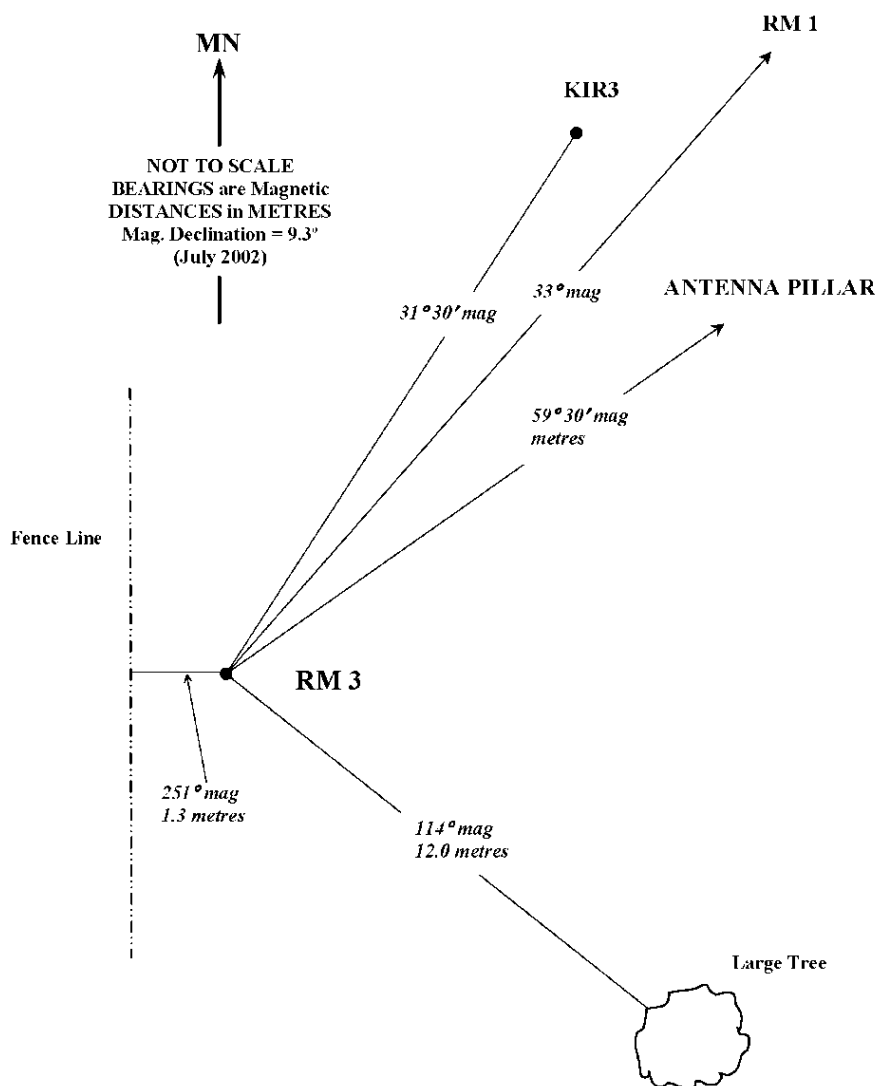
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



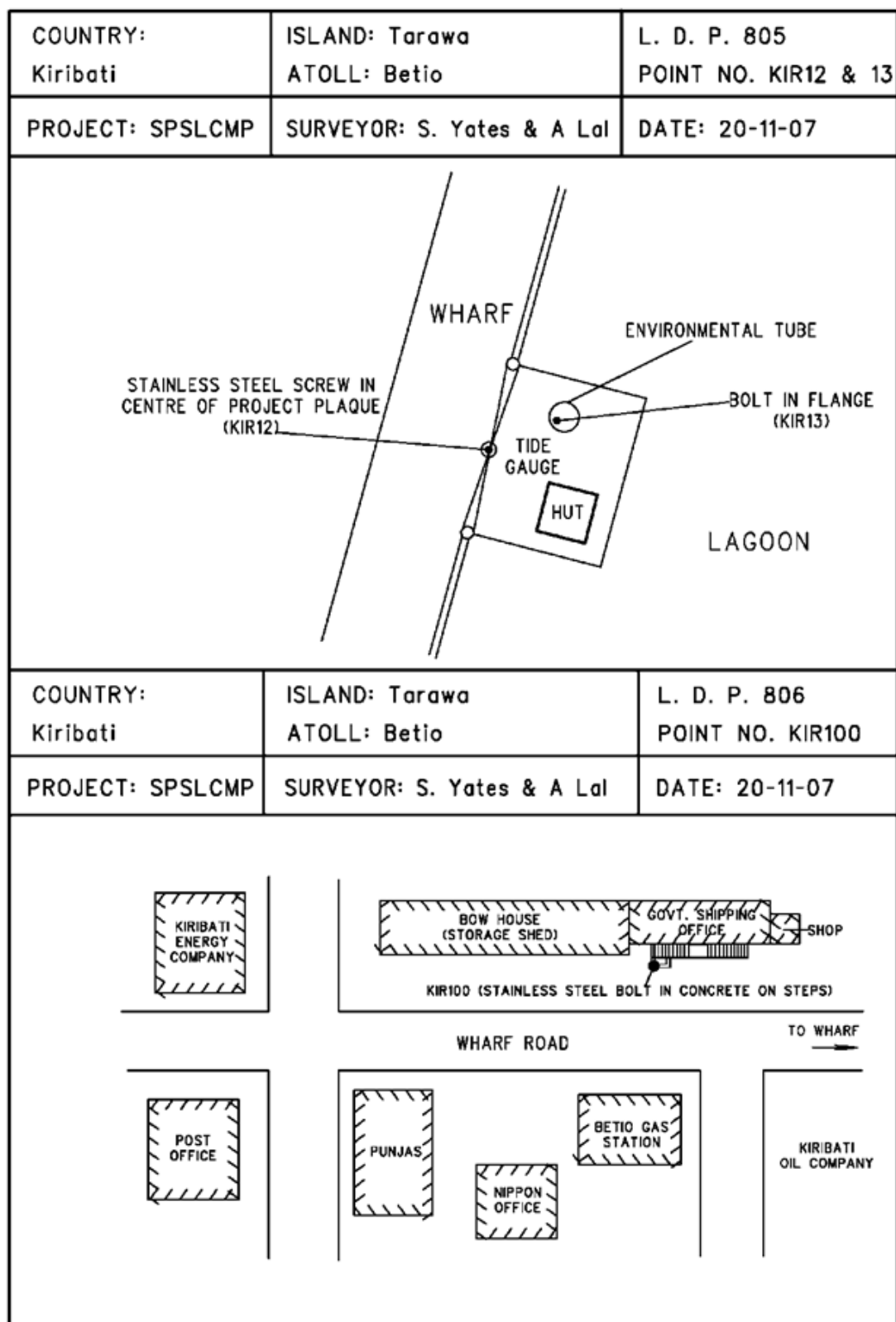
KIRIBATI CGPS Station, Betio Is. – RM 3

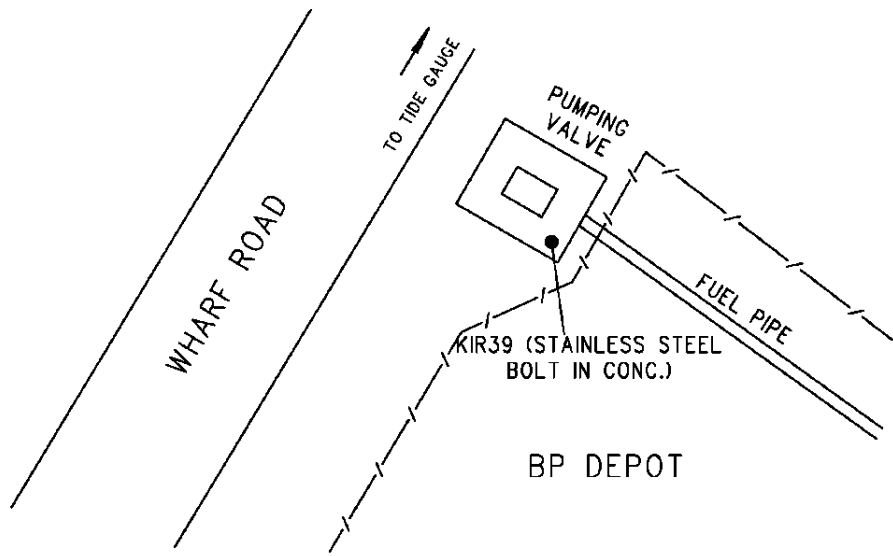
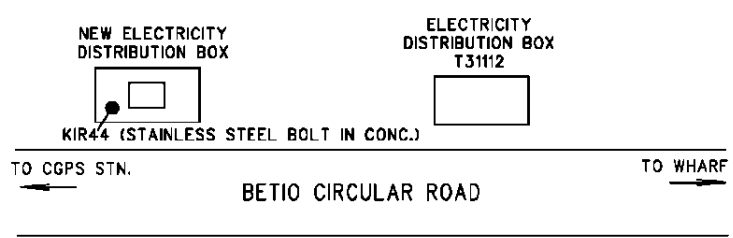
REFERENCE MARKS

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 Temporary Holding Mark Locality Diagrams



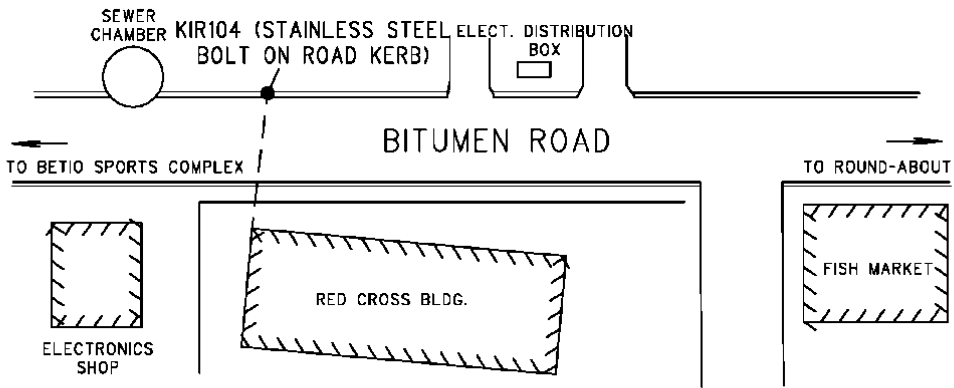
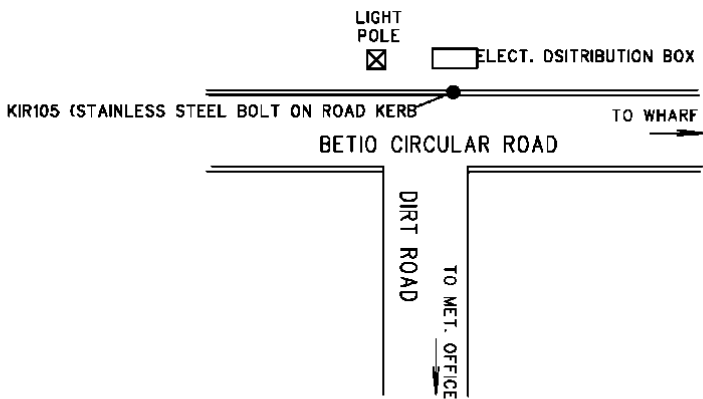
COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 811 POINT NO. KIR39
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07
 The diagram for Point KIR39 shows a section of Wharf Road on the left. To the right of the road is a BP Depot. A line labeled 'TO TIDE GAUGE' with an arrow points towards the top right. A 'PUMPING VALVE' is located near the BP Depot. A 'FUEL PIPE' runs from the depot area towards the right. A point labeled 'KIR39 (STAINLESS STEEL BOLT IN CONC.)' is marked on a dashed line extending from the depot area.		
COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 812 POINT NO. KIR44
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07
 The diagram for Point KIR44 shows a section of Betio Circular Road. On the left side of the road is a 'NEW ELECTRICITY DISTRIBUTION BOX' with a point labeled 'KIR44 (STAINLESS STEEL BOLT IN CONC.)' marked next to it. An arrow points from this point towards the left, labeled 'TO CGPS STN.'. On the right side of the road is an 'ELECTRICITY DISTRIBUTION BOX T31112'. An arrow points from this box towards the right, labeled 'TO WHARF'.		

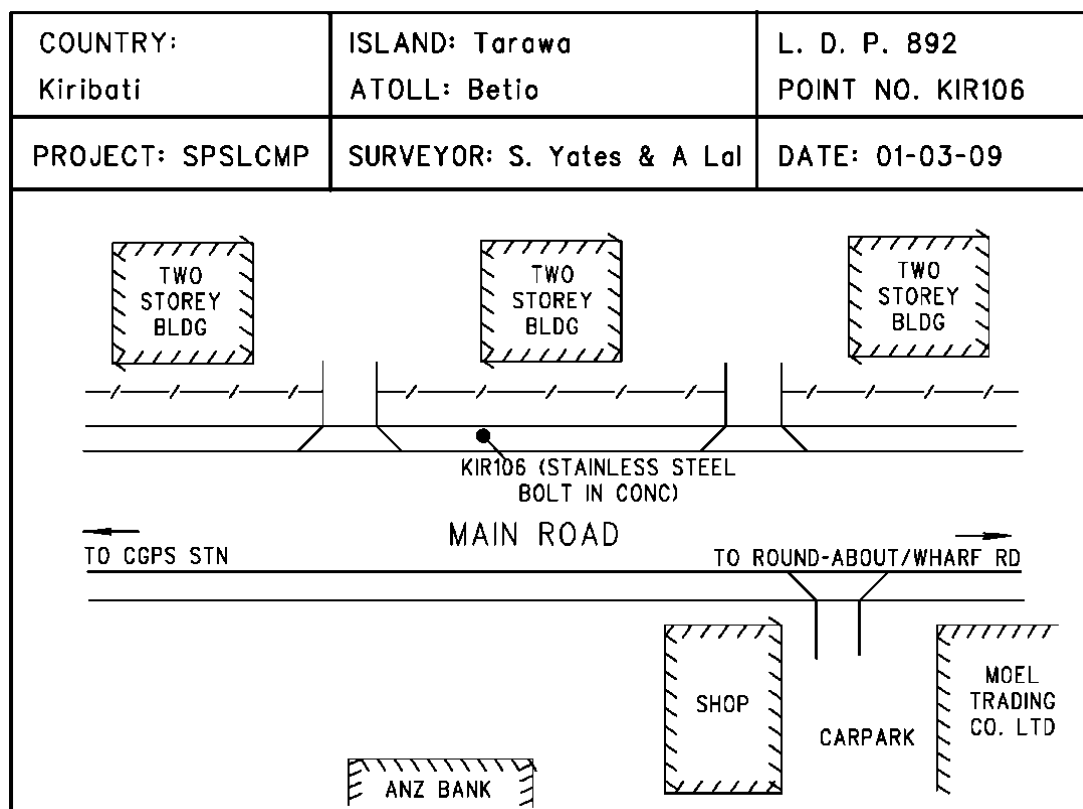
COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 807 POINT NO. KIR101
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07

The diagram for Point KIR101 shows a plan view of a wharf area. A horizontal line represents the 'WHARF ROAD'. To the left of the road, there is a 'CEMENT STEPS RETAINING WALL' indicated by a wavy line. To the right of the road, there is a 'NEW CONCRETE WHARF EXTENSION' shown as a rectangle. A survey point 'KIR101 (STAINLESS STEEL BOLT ON CONCRETE BLOCK)' is marked with a dot on the extension. Arrows at the ends of the road point 'TO POST OFFICE' (left) and 'TO TIDE GAUGE' (right).

COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 808 POINT NO. KIR102
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07

The diagram for Point KIR102 shows a plan view of a wharf area. A horizontal line represents the 'WHARF ROAD'. To the left of the road, there is a 'KIRIBATI ENERGY COMPANY' building. To the right of the road, there is a 'BOW HOUSE (STORAGE SHED)' and a 'KIR102 (STAINLESS STEEL BOLT ON SEWER CHAMBER)' marked with a dot. Below the road, there are several other buildings: 'POST OFFICE', 'PUNJAS', 'NIPPON OFFICE', and 'BETIO GAS STATION'. An arrow at the right end of the road points 'TO WHARF'.

COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 809 POINT NO. KIR104
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07
 Diagram for Point KIR104: A horizontal BITUMEN ROAD. Above the road, from left to right, are a SEWER CHAMBER (circle), KIR104 (STAINLESS STEEL BOLT ON ROAD KERB) (dot), and an ELECT. DISTRIBUTION BOX (rectangle). An arrow points left from the road labeled 'TO BETIO SPORTS COMPLEX'. Another arrow points right from the road labeled 'TO ROUND-ABOUT'. Below the road, three buildings are shown: ELECTRONICS SHOP (square with diagonal lines), RED CROSS BLDG. (rectangle with diagonal lines), and FISH MARKET (rectangle with diagonal lines).		
COUNTRY: Kiribati	ISLAND: Tarawa ATOLL: Betio	L. D. P. 810 POINT NO. KIR105
PROJECT: SPSLCMP	SURVEYOR: S. Yates & A Lal	DATE: 20-11-07
 Diagram for Point KIR105: A T-junction. A horizontal BETIO CIRCULAR ROAD intersects a vertical DIRT ROAD. Above the circular road, from left to right, are a LIGHT POLE (square with an 'X') and an ELECT. DISTRIBUTION BOX (rectangle). KIR105 (STAINLESS STEEL BOLT ON ROAD KERB) is marked at the intersection. An arrow points right from the circular road labeled 'TO WHARF'. An arrow points down from the dirt road labeled 'TO MET. OFFICE'.		



7 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.