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EDM Height Traversing Levelling Survey Report

Lautoka, Fiji Islands, February 2013

S. J. K. Yates, A. Lal

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GEOSCIENCE AUSTRALIA
RECORD 2014/16

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Australian Government
Geoscience Australia

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1 Introduction

This report outlines the levelling survey completed during the visit to Lautoka, Fiji from 17th to 24th February 2013.

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 sixth Electronic Distance Measurement (EDM) height traversing levelling survey of the deep bench mark array in Lautoka, Fiji, which runs approximately 3 km from the tide gauge sensor benchmark (SEAFRAME – Sea Level Fine Resolution Acoustic Measuring Equipment) at the wharf to the continuous GNSS (Global Navigation Satellite System) Station located in the Fiji Sugar Corporation (FSC) Compound. The previous levelling surveys using this technique were performed in 2005, 2007, 2008, 2010 and 2011.

Precise Differential Levelling surveys were performed on eight occasions between 1992 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 technique. This report contains a comparison between the 2011 and 2013 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 five deep driven bench marks and from the CGNSS Station to the SEAFRAME Station:

LAUTBM	– CGNSS Benchmark
FIJ13	– SEAFRAME sensor benchmark
BM3244	– Deep Driven Benchmark
BM3245	– Deep Driven Benchmark
BM3246	– Deep Driven Benchmark
BM3247	– Deep Driven Benchmark
BM3248	– Deep Driven Benchmark

All the deep bench marks were located and found in good order and undisturbed except the primary benchmark BM3243 which, unfortunately is now covered with soil and a statute, making it impossible to recover and rendering it useless. Therefore, the LAUTBM was used as the primary, and fixed, benchmark and will be used as such for future surveys.

Included in the survey was the SEAFRAME tide gauge sensor bench mark, FIJ13 and the survey mark (project plaque) located adjacent to the tide gauge hut, FIJ12.

Also included in the survey were temporary holding marks – FIJ212, FIJ81, FIJ207, FIJ205, FIJ84, FIJ85, FIJ206, FIJ87, FIJ92, FIJ208, FIJ209, FIJ210, FIJ211 and FIJ214 (new mark) as well as the CGNSS bench mark – LAUTBM and the three CGNSS reference marks - RM1, RM2 and RM4 .

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 Fiji Islands Datum

The Datum for the survey is Tide Staff Zero (TSZ). Reduction of the data has been calculated holding LAUTBM (the Reference Bench Mark for the CGNSS Pillar) fixed with a Reduced Level of 31.3403m, this value was determined by the SPSLCMP survey team in July 2011, computed from the previously held fixed bench mark BM3243.

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 Lautoka 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 Lautoka 2013 Reduced Levels

Table 2.1 Lautoka, Fiji – Reduced levels from the 2013 survey

Date: 19th to 24th February 2013

Datum: Tide Staff Zero

Point ID	Reduced Level 2013	Type
LAUTBM	31.3403	Stainless Steel Pillar Pin
*LAUT	32.2955	Pillar Plate (ARP)
FIJ92	26.2538	Stainless Steel Pin in Concrete
BM3247	20.9601	Stainless Steel Rod in Ground
BM3246	7.8256	Stainless Steel Rod in Ground
FIJ87	7.4018	Stainless Steel Pin in Concrete
FIJ206	4.6409	Stainless Steel Pin in Concrete
BM3244	4.1729	Stainless Steel Rod in Ground
FIJ211	4.2342	Stainless Steel Pin in Concrete
FIJ85	3.1427	Stainless Steel Pin in Concrete
FIJ84	3.0463	Stainless Steel Pin in Concrete
FJ210	3.2207	Stainless Steel Pin in Concrete
FJ205	5.3255	Stainless Steel Pin in Concrete
FJ212	3.1492	Stainless Steel Pin in Concrete
FJ81	2.6684	Stainless Steel Pin in Concrete

Point ID	Reduced Level 2013	Type
FJ207	4.1709	Stainless Steel Pin in Concrete
FJ12	4.0713	Project Plaque Stainless Steel Pin
FJ13	4.4458	Stainless Steel Sensor Pin
BM3248	35.2356	Stainless Steel Rod in Ground
FJ208	30.9335	Stainless Steel Pin in Concrete
FJ209	25.0123	Stainless Steel Pin in Concrete
FJ214	16.8872	Masonry Nail in Concrete
BM3245	16.6377	Stainless Steel Rod in Ground

**The RL of the Reference Point LAUT (ARP) is derived from adding the static height difference of 0.9552 m (LAUTBM to LAUT) to the levelled RL of LAUTBM.*

2.6 Survey Support

The survey team very much appreciated the assistance from staff of the Lands Department Lautoka Office, the Lautoka Ports and the Fiji Sugar Corporation.

Personnel consulted during the visit were:

Mr. Litia Navusolo, Divisional Surveyor, Lands Department

Mr. Jekope Tubukalou, Technical Officer – Surveys, Lands Department

Email: jekope.tubikalou@govnet.gov.fj; Phone (679) 9525570/ 6661800

Mr. Atunaisa Ralulu, Technical Officer – Surveys, Lands Department

Email: arobanakadavu@govnet.gov.fj; Phone (679) 9214167/ 6661800

Mr. Emosi Navusolo, Supervisor Administration – Lautoka Ports

Email: emosi@fijiports.com.fj; Phone (679) 9907125/ 6662160

Mr. Viliame Savou, Production Manager – Fiji Sugar Corporation, Lautoka.

Phone (679) 9922006

The Lautoka Lands and Survey Department have always had a keen interest in the SPSLCMP and are always supportive with any associated project matters.

2.7 Issues

A security pass is required in order to access the Lautoka Ports area, where the tide gauge is located. This must be arranged prior to the survey through the Lands Department or SOPAC (SPC) staff. This is also a hard-hat zone. A letter to the Ports Authority for accessibility is necessary prior to the visit.

3 Comparisons

3.1 Comparisons between 2013 and 2011 EDM Surveys

Table 3.1 Lautoka, Fiji EDM Height Traversing Levelling Comparison 2013 – 2011. LAUTBM - adopted fixed height of 31.34031m

From	To	Levelled Ht. Diff.	RL 2013	Misclose (mm)	Dist. (km)	1mm√k	RL 2011	Difference (mm) 2013 - 2011
LAUTBM			31.34031					
FIJ92	FIJ92	-5.086550	26.25376	-0.250	0.0697	0.264	26.25424	-0.48
BM3247	BM3247	-5.293656	20.96010	0.063	0.0932	0.305	20.95991	0.19
BM3246	BM3246	-13.134526	7.82558	-0.325	0.2184	0.467	7.82428	1.30
FIJ87	FIJ87	-0.423735	7.40184	-0.010	0.0809	0.284	7.39929	2.55
FIJ206	FIJ206	-2.760930	4.64091	0.265	0.2251	0.474	4.63804	2.87
	BM3244	-0.468025	4.17289	0.075	0.0362	0.190	4.17025	2.64
FIJ206			4.64091					
FIJ211	FIJ211	-0.406728	4.23419	-0.370	0.0985	0.314	4.23130	2.89
FIJ85	FIJ85	-1.091521	3.14266	-0.278	0.1784	0.422	3.14041	2.25
FIJ84	FIJ84	-0.096325	3.04634	0.230	0.0803	0.283	3.04341	2.93
FIJ210	FIJ210	0.174340	3.22068	0.100	0.0769	0.277	3.21697	3.71
FIJ205	FIJ205	2.104775	5.32545	-0.200	0.1287	0.359	5.32272	2.73
FIJ212	FIJ212	-2.176263	3.14919	0.275	0.1570	0.396	3.14549	3.70
FIJ81	FIJ81	-0.480819	2.66837	-0.363	0.1810	0.425	2.66568	2.69
FIJ207	FIJ207	1.502563	4.17094	-0.325	0.1724	0.415	4.16675	4.19
FIJ12	FIJ12	-0.099686	4.07125	0.238	0.0467	0.216	4.06708	4.17
	FIJ13	0.374515	4.44577	0.010	0.0130	0.114	4.44091	4.86
LAUTBM			31.34031					
BM3248	BM3248	3.895332	35.23564	0.388	0.1670	0.409	35.23661	-0.97
FIJ208	FIJ208	-4.302126	30.93352	-0.175	0.1972	0.444	30.93406	-0.54
FIJ209	FIJ209	-5.921169	25.01235	0.288	0.1909	0.437	25.01221	0.14
FIJ214	FIJ214	-8.125194	16.88715	0.188	0.1204	0.347	New Mark	New Mark
	BM3245	-0.249476	16.63768	0.000	0.2164	0.465	16.63951	-1.83

From	To	Levelled Ht. Diff.	RL 2013	Misclose (mm)	Dist. (km)	1mm√k	RL 2011	Difference (mm) 2013 - 2011
			Misclose for all bays levelled =	-0.177	2.748	1.658		
LAUTBM			31.34031					
	RM1	-2.329155	29.01116	-0.070	0.0443	0.210	29.01115	0.00
LAUTBM			31.34031					
	RM2	-1.00255	30.33776	-0.040	0.0322	0.179	30.33782	-0.06
LAUTBM			31.34031					
	RM4	-0.70364	30.63667	0.000	0.0348	0.186	30.63639	0.28

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

3.2 Combined Comparisons 1992 to 2013

Table.3.2 Lautoka, Fiji - Comparison of the RL's for Precise Differential Levelling (1992 – 2005) and EDM Height Traversing (2005 - 2013).

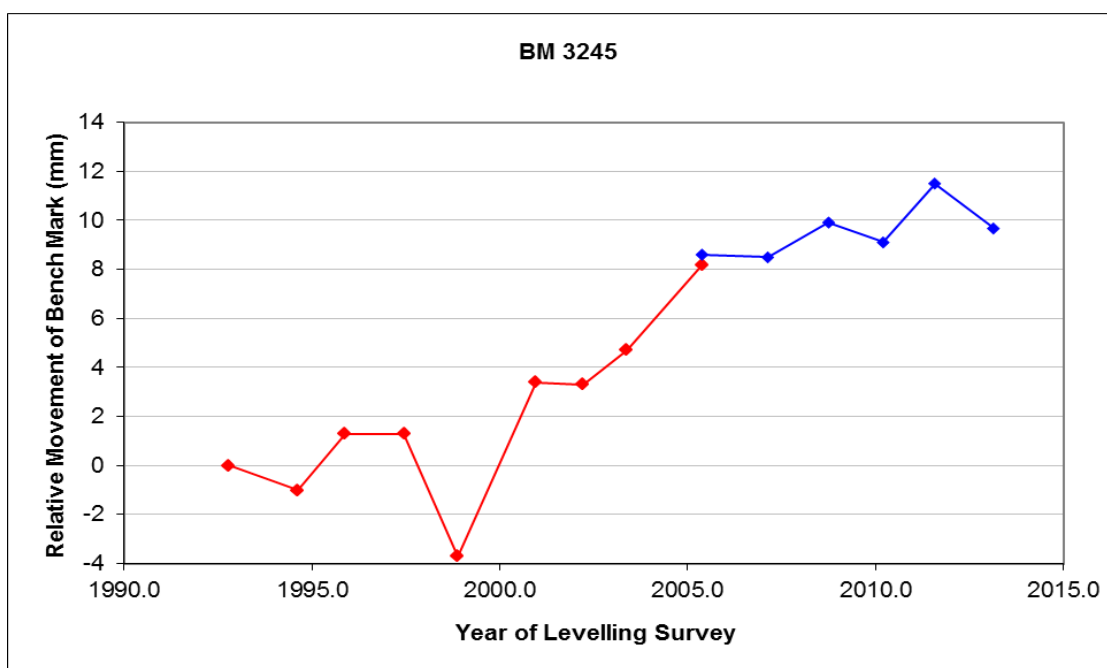
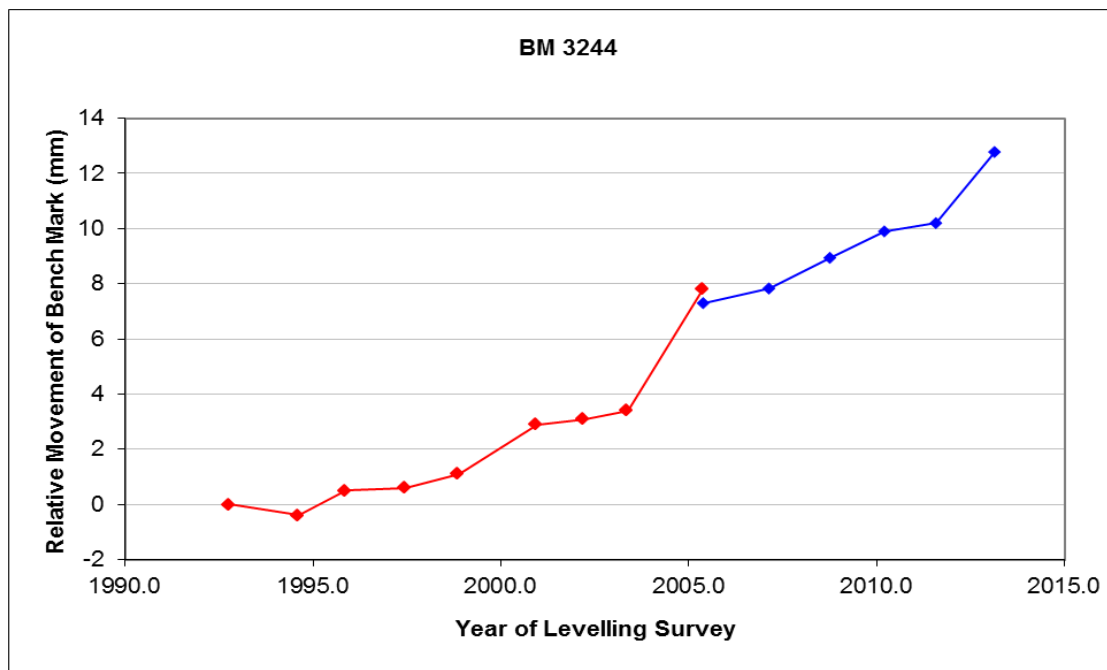
Year	BM 3244	BM 3245	BM 3246	BM 3247	BM 3248	LAUTBM	FIJ 13	FIJ 12
1992.8	4.1601	16.6280					4.4326	4.0591
1994.6	4.1597	16.6270					4.4336	4.0597
1995.9	4.1606	16.6293					4.4345	4.0606
1997.5	4.1607	16.6293					4.4341	4.0608
1998.9	4.1612	16.6243					4.4342	4.0606
2001.0	4.1630	16.6314					4.4352	4.0611
2002.2	4.1632	16.6313	7.8170	20.9526	35.2283	31.3337	4.4348	4.0603
2003.4	4.1635	16.6327	7.8179	20.9533	35.2294	31.3338	4.4368	4.0624
2005.4	4.1679	16.6362	7.8219	20.9571	35.2332	31.3375	4.4396	4.0657

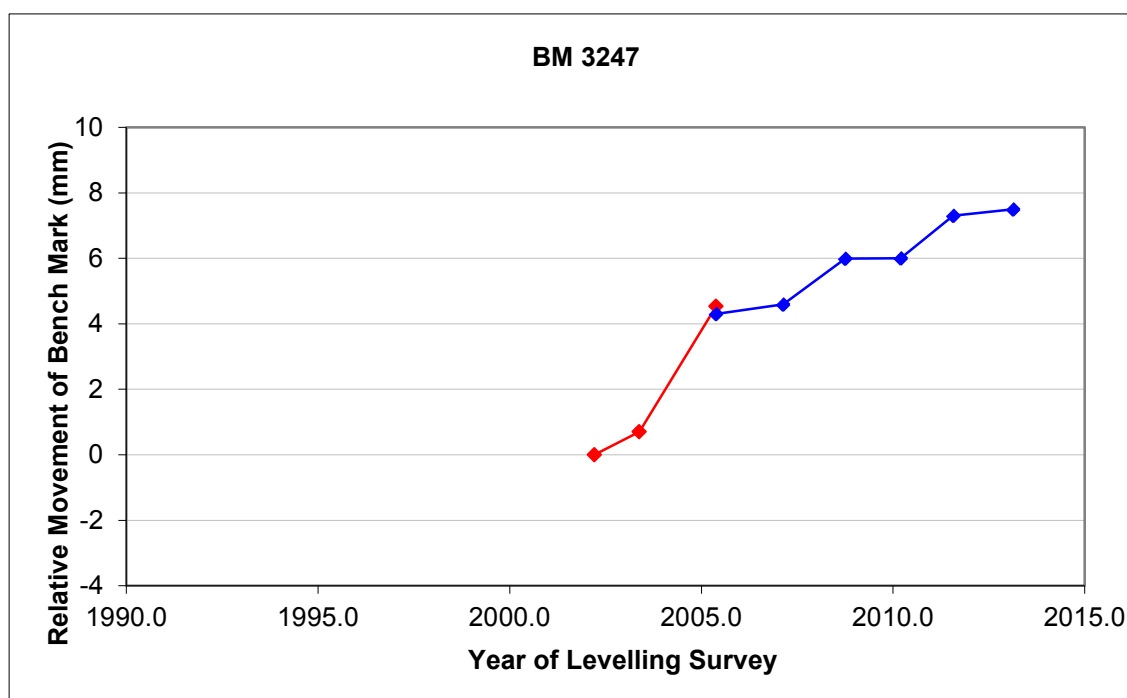
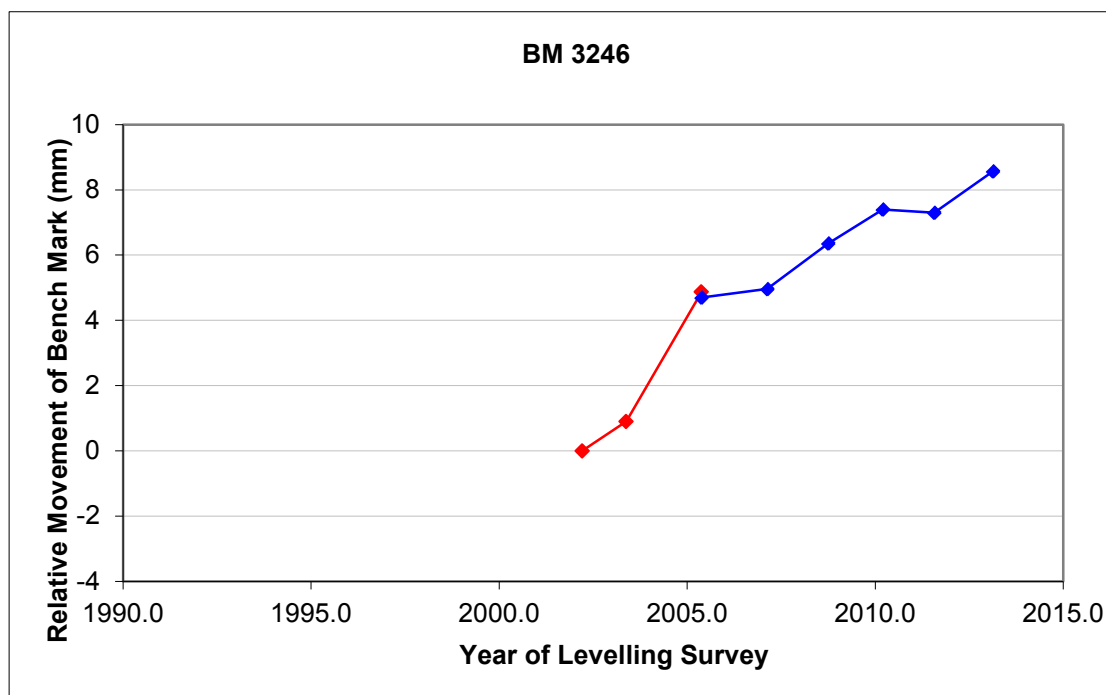
Year	BM 3244	BM 3245	BM 3246	BM 3247	BM 3248	LAUTBM	FIJ 13	FIJ 12
2005.4	4.1674	16.6366	7.8217	20.9569	35.2334	31.3379	4.4395	4.0655
2007.1	4.1679	16.6365	7.8220	20.9572	35.2333	31.3384	4.4413	4.0664
2008.8	4.1690	16.6379	7.8234	20.9586	35.2360	31.3399	4.4416	4.0672
2010.2	4.1700	16.6371	7.8244	20.9586	35.2347	31.3390	4.4426	4.0678
2011.6	4.1703	16.6395	7.8243	20.9599	35.2366	31.3403	4.4409	4.0671
2013.1	4.1729	16.6377	7.8256	20.9601	35.2356	31.3403	4.4458	4.0713

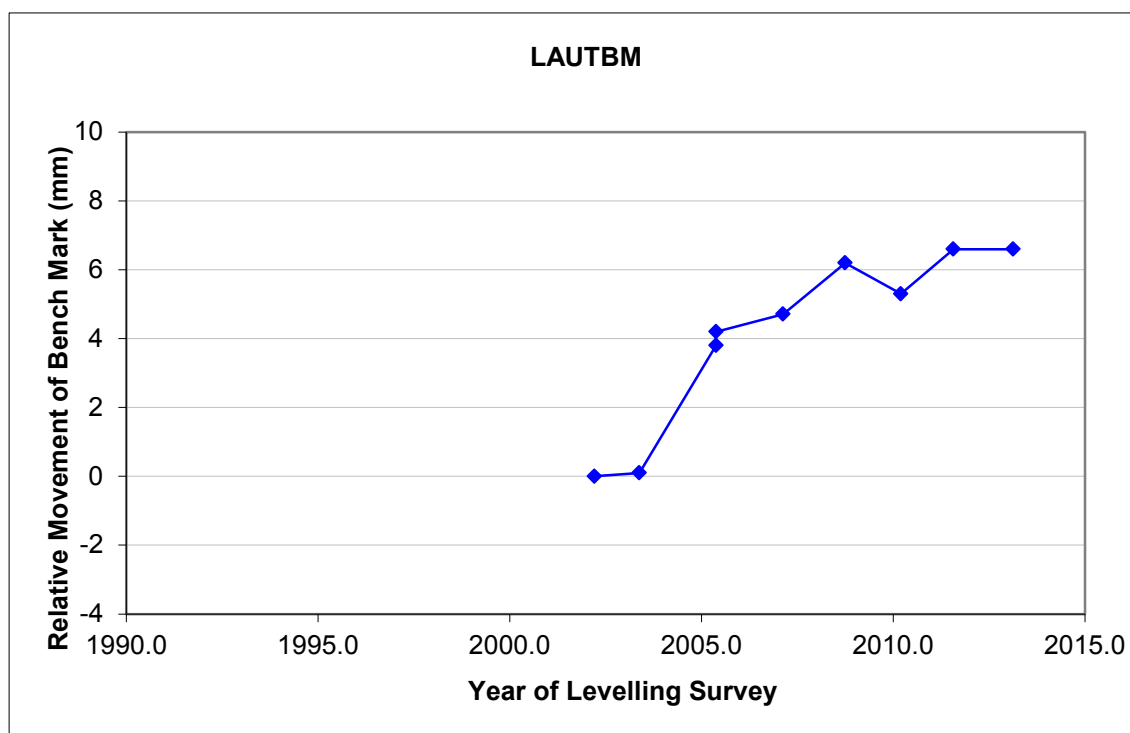
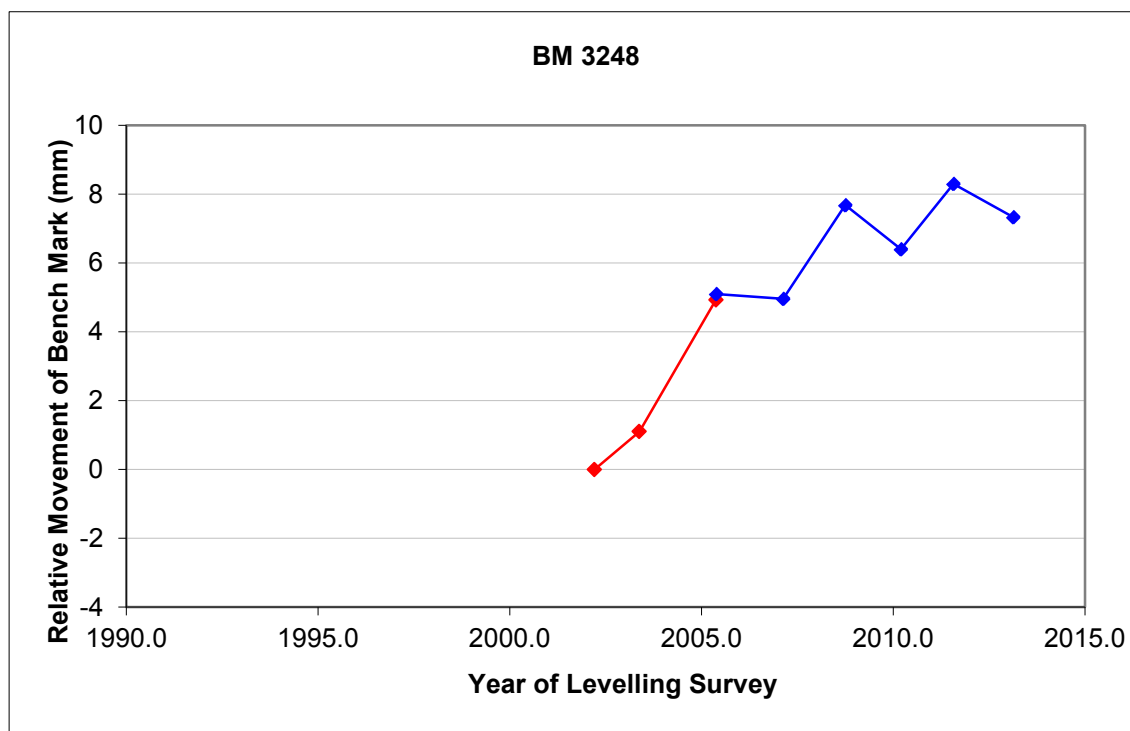
3.3 Time Series of Bench Mark Movement relative to Fixed Deep Bench Mark LAUTBM

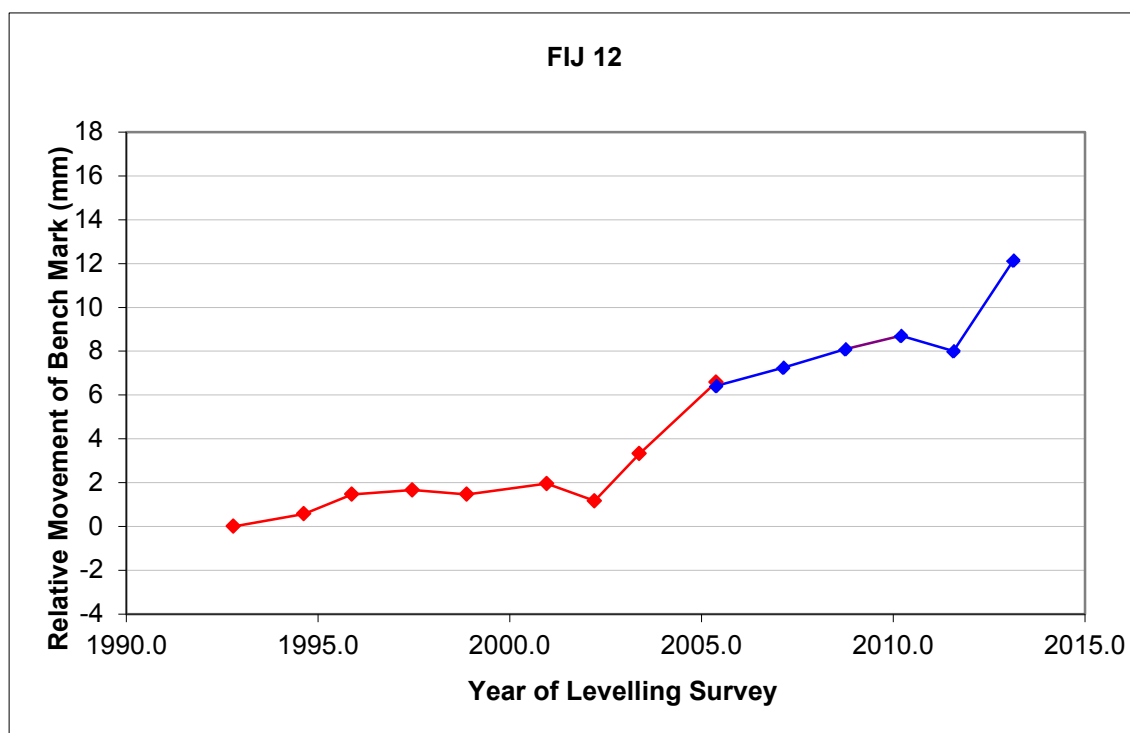
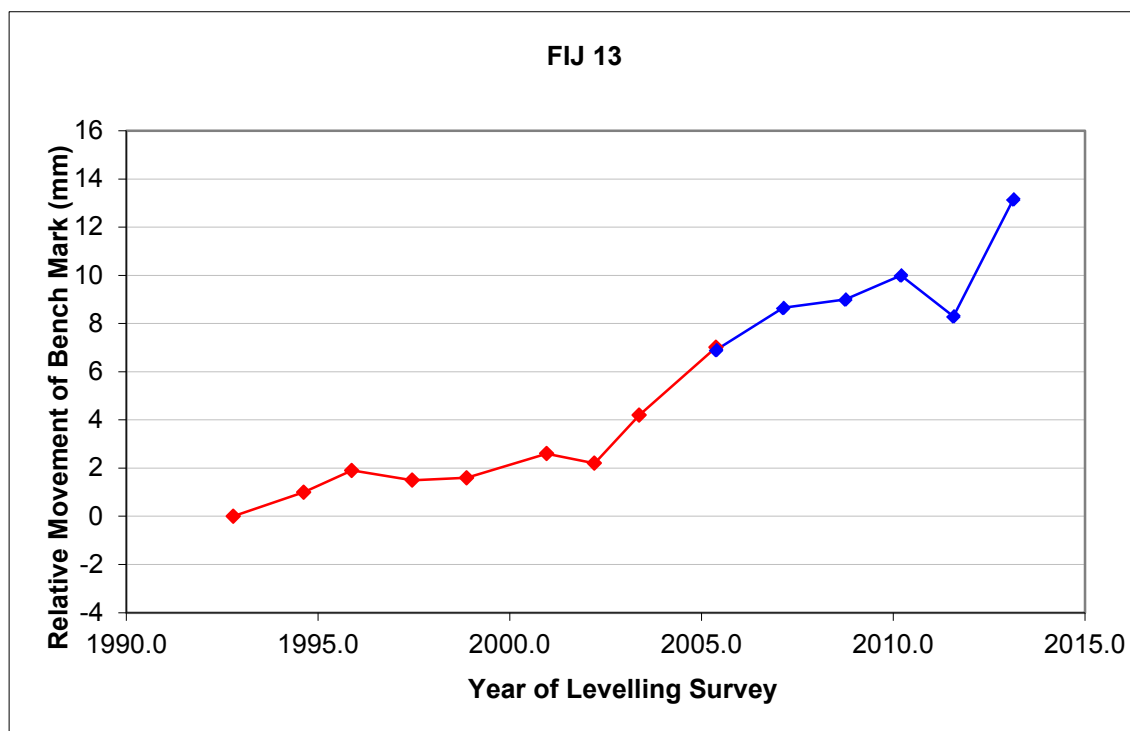
Precise Differential Levelling: 1992 - 2005 ◆ — ◆
EDM Height Traversing: 2005 onwards ◆ — ◆

The survey measured a significant movement on the Tide Gauge in Lautoka (+4.86mm) which indicates instability at the wharf. The deep driven benchmarks have also shown an unexplained movement between +1.3mm to +4.17mm range.









4 Deep Bench Mark Locality Diagrams



SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING PROJECT



Survey Bench Mark Record

Bench Mark Number: BM3243

Original Bench Mark Established by: National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	Date: 16-01-92
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Existing Bench Mark Established by:	Date:
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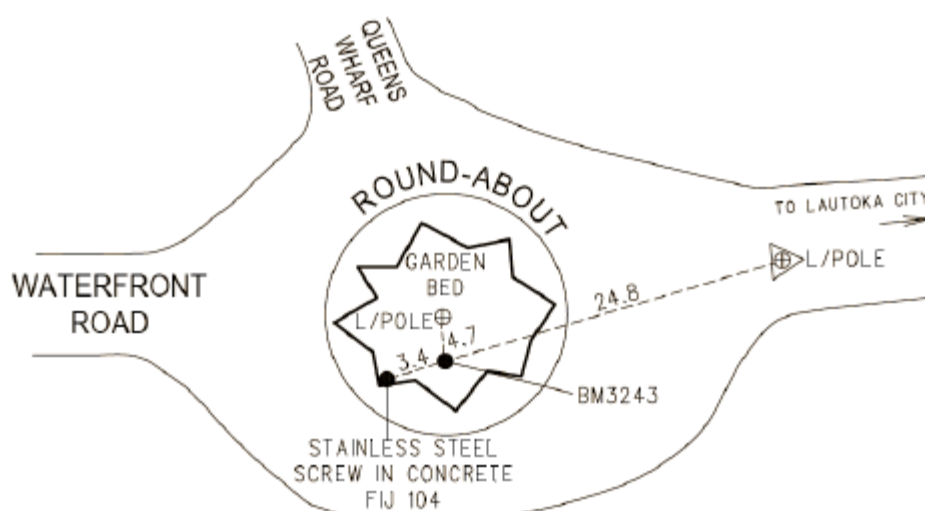
Notes / References: Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.

Country: Fiji Islands Island: Viti Levu	City: Lautoka
--	---------------

Marking and locality sketch

Bench Mark: 8.6m of 19mm diameter stainless steel capped rod driven to refusal.
Rod sheathed with 50mm diameter PVC pipe, filled with bentonite, for 0.75m. Top of mark 0.5m below ground level.

Locality sketch: Mark approximately 400m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
Approved by: Geoscience Australia / SOPAC		Date: April 2007

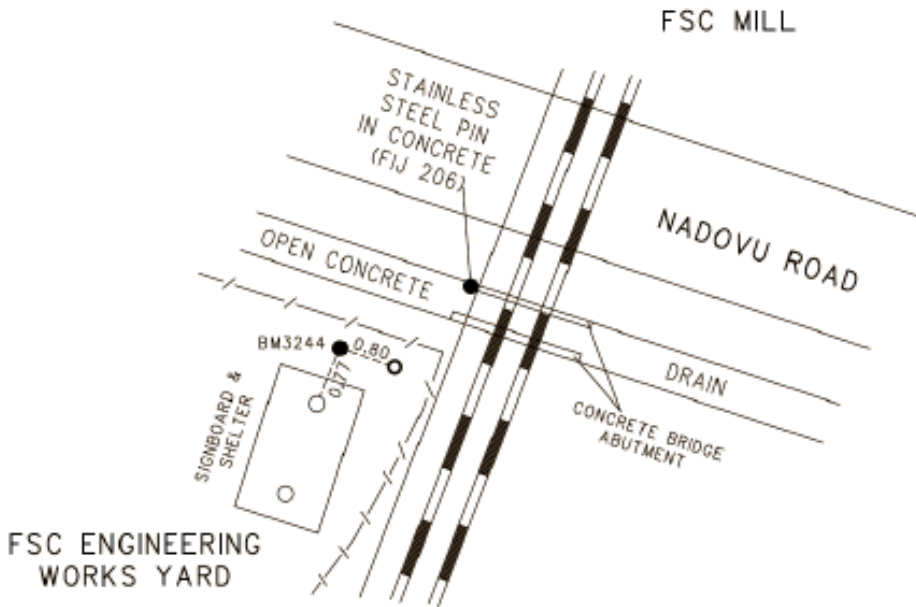


**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: BM3244

<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> 08-02-92
<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> Fiji Islands <i>Island:</i> Viti Levu	<i>City:</i> Lautoka
<u>Marking and locality sketch</u> Bench Mark: 9.8m 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 0.2m below ground level. Locality sketch: Mark approximately 1150m from the tide gauge station. 	
Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC	
Date: April 2007	



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



Survey Bench Mark Record

Bench Mark Number: BM3245

<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> 16-01-92
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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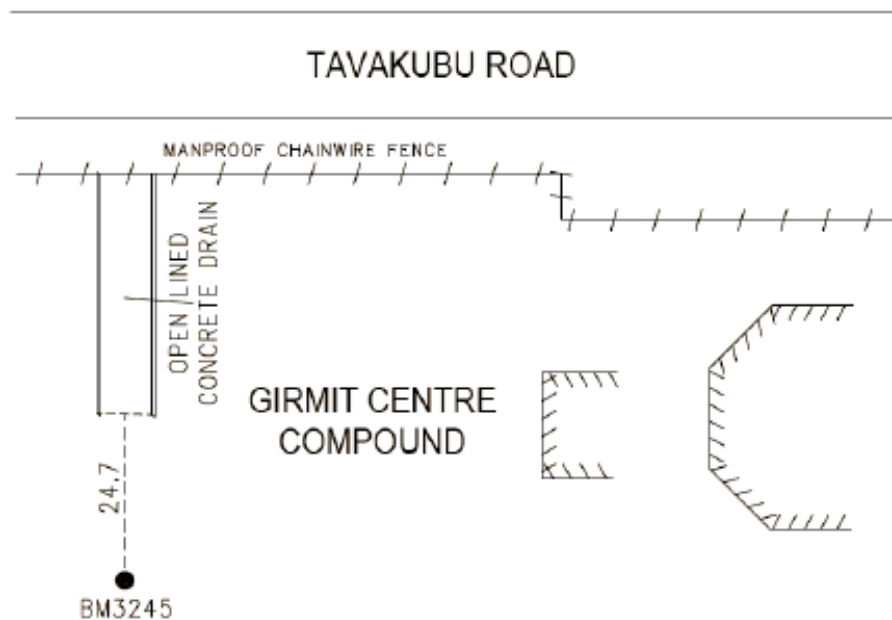
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Fiji Islands <i>Island:</i> Viti Levu	<i>City:</i> Lautoka
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Marking and locality sketch

Bench Mark: 8.6m 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 0.2m below ground level.

Locality sketch: Mark approximately 2300m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
--------------	---------------------	-------------------

Approved by: Geoscience Australia / SOPAC	Date: April 2007
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**SOUTH PACIFIC SEA LEVEL
&
CLIMATE MONITORING PROJECT**



Survey Bench Mark Record

Bench Mark Number: BM3246

<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> 27-02-02
<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> Fiji Islands <i>Island:</i> Viti Levu	<i>City:</i> Lautoka
<u>Marking and locality sketch</u> Bench Mark: 6.9m 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 1600m from the tide gauge station.	
Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC Date: April 2007	



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



Survey Bench Mark Record

Bench Mark Number: BM3247

<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> 27-02-02
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<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
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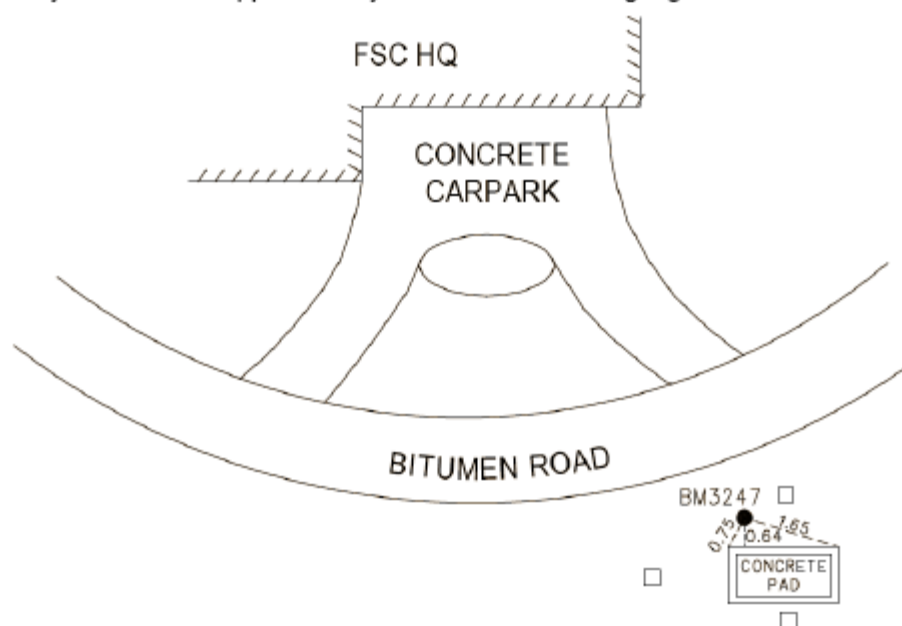
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Fiji Islands <i>Island:</i> Viti Levu	<i>City:</i> Lautoka
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Marking and locality sketch

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 1800m from the tide gauge station.



Not to scale	Distances in Metres	Magnetic bearings
Approved by: Geoscience Australia / SOPAC		Date: April 2007



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



Survey Bench Mark Record

Bench Mark Number: BM3248

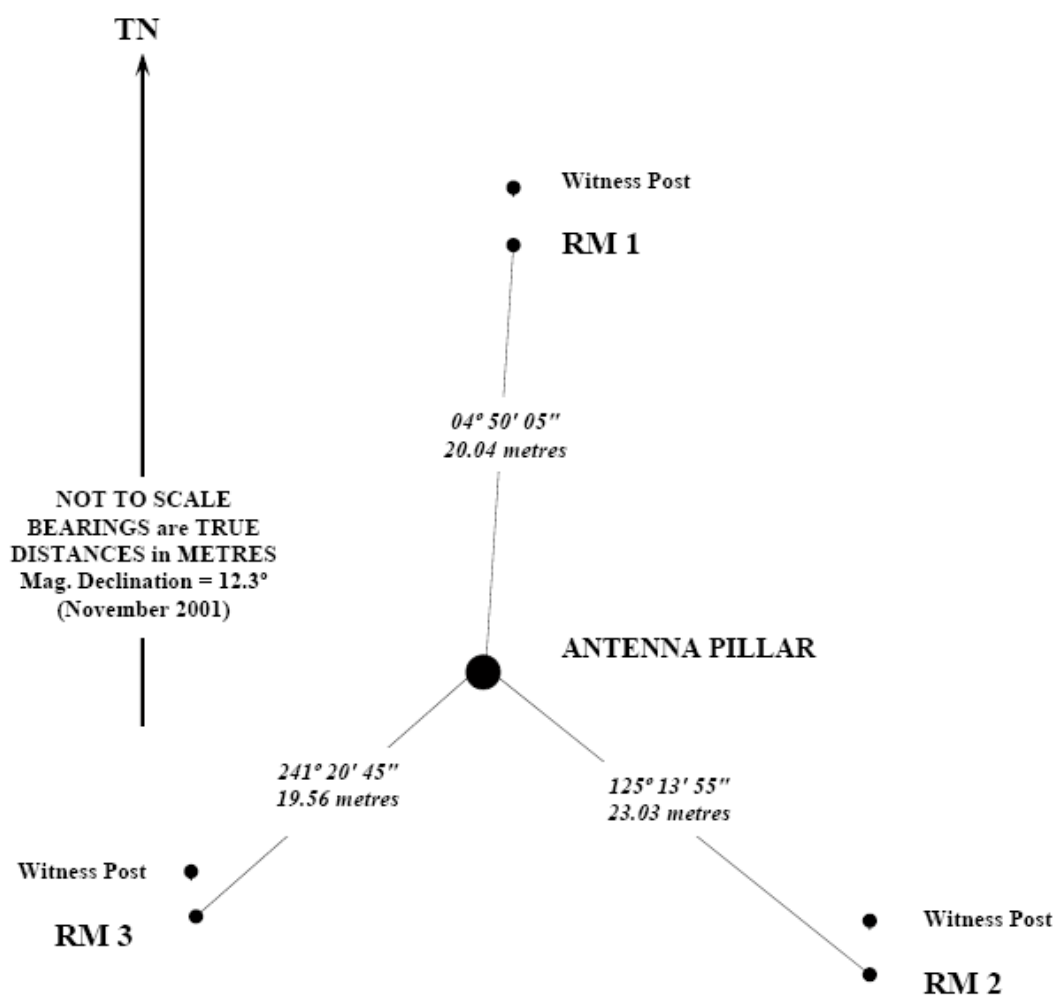
<i>Original Bench Mark Established by:</i> National Tidal Centre Australia, Oceanographic Services, Bureau of Meteorology, 25 College Rd, Kent Town, SA.	<i>Date:</i> 27-02-02
<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is not in a good locality (tree) for GPS occupation.	
<i>Country:</i> Fiji Islands <i>Island:</i> Viti Levu	<i>City:</i> Lautoka
<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 2250m from the tide gauge station and approximately 200m from the CGPS Station. Not to scale Distances in Metres Magnetic bearings	
Approved by: Geoscience Australia / SOPAC	
Date: April 2007	

5 LAUTBM and LAUT Reference Mark Locality Diagrams

FIJI CGPS Station, FSC Lautoka – Reference Marks

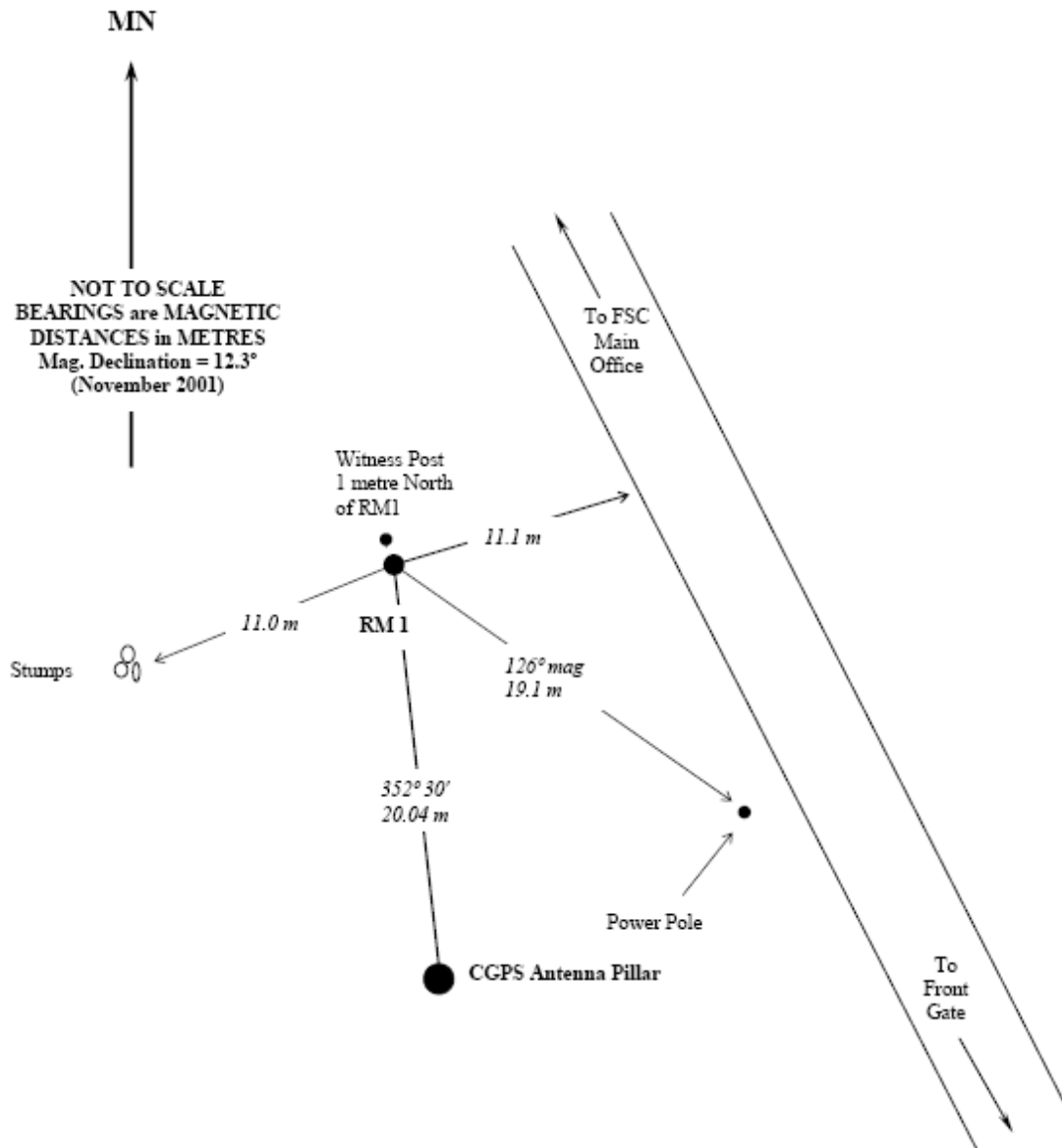
REFERENCE MARKS

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 150 mm below ground level. Treated pine witness posts 150 mm in diameter and 1.4 m high are located 1 metre to the north of each RM.



FIJI CGPS Station, FSC, Lautoka – RM 1 Location Diagram

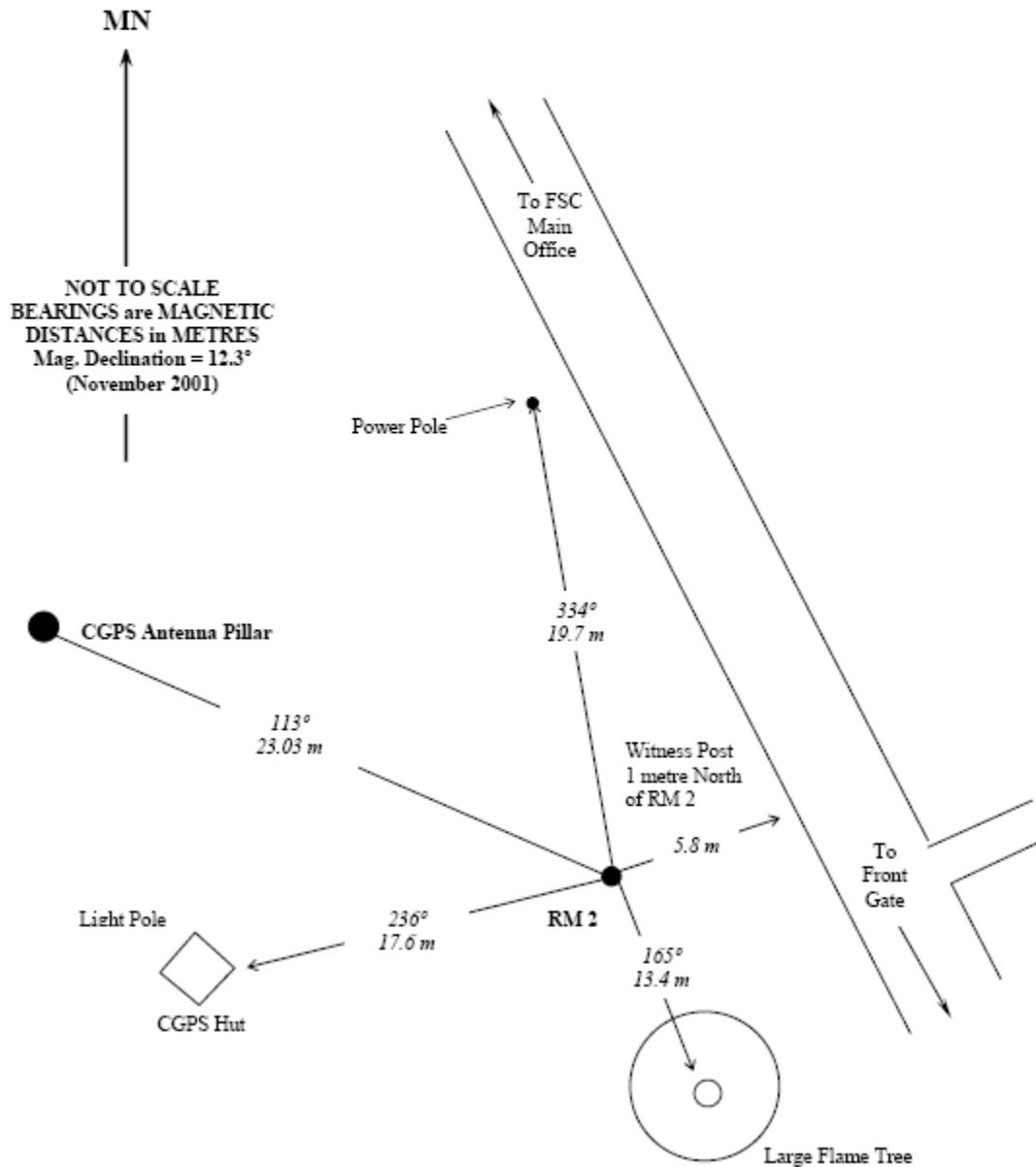
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 150 mm below ground level.
Treated pine witness posts 150 mm in diameter and 1.4 m high are located 1 metre to the north of each RM.



FIJI CGPS Station, FSC, Lautoka – RM 2 Location Diagram

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 150 mm below ground level.

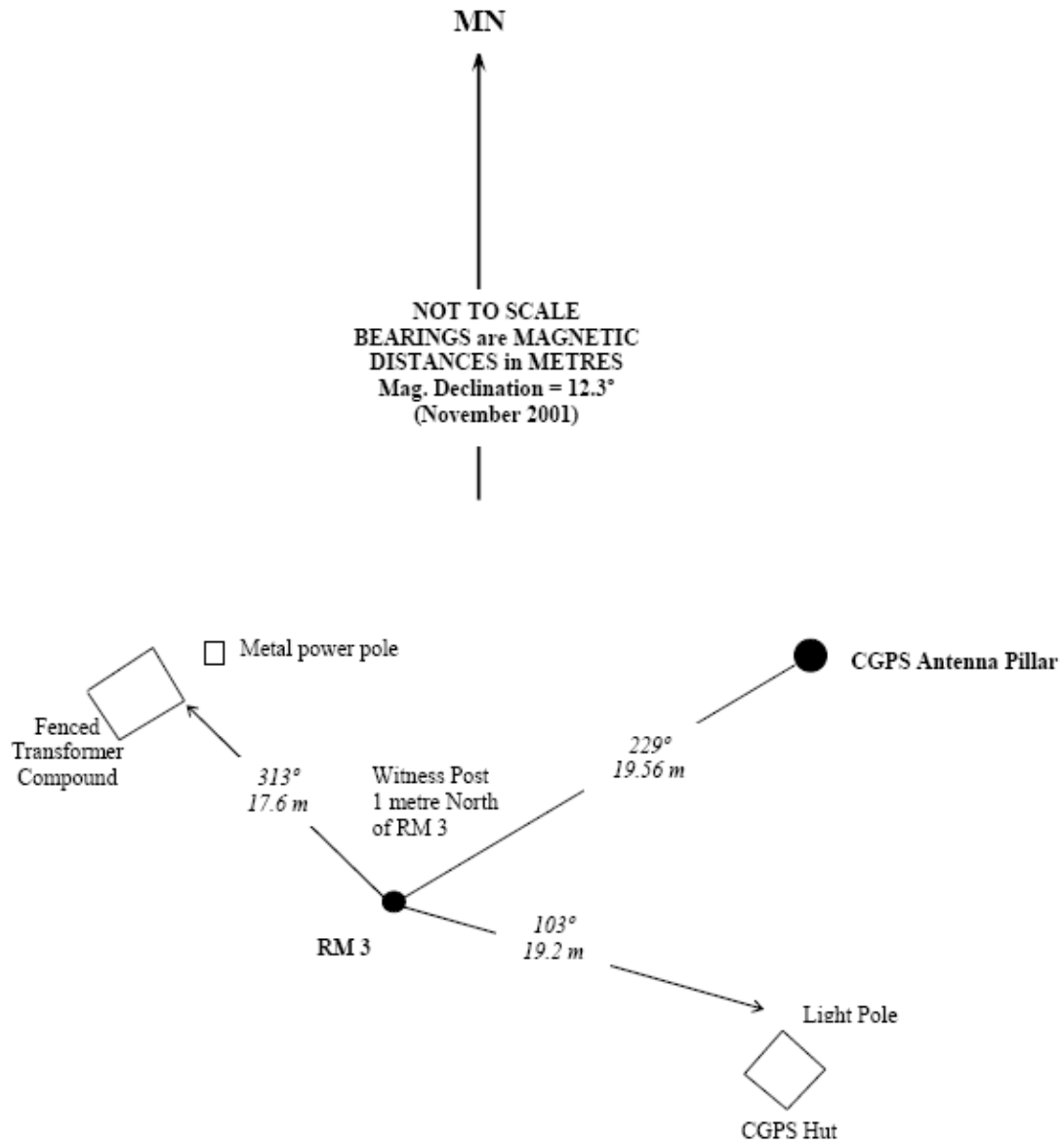
Treated pine witness posts 150 mm in diameter and 1.4 m high are located 1 metre to the north of each RM.



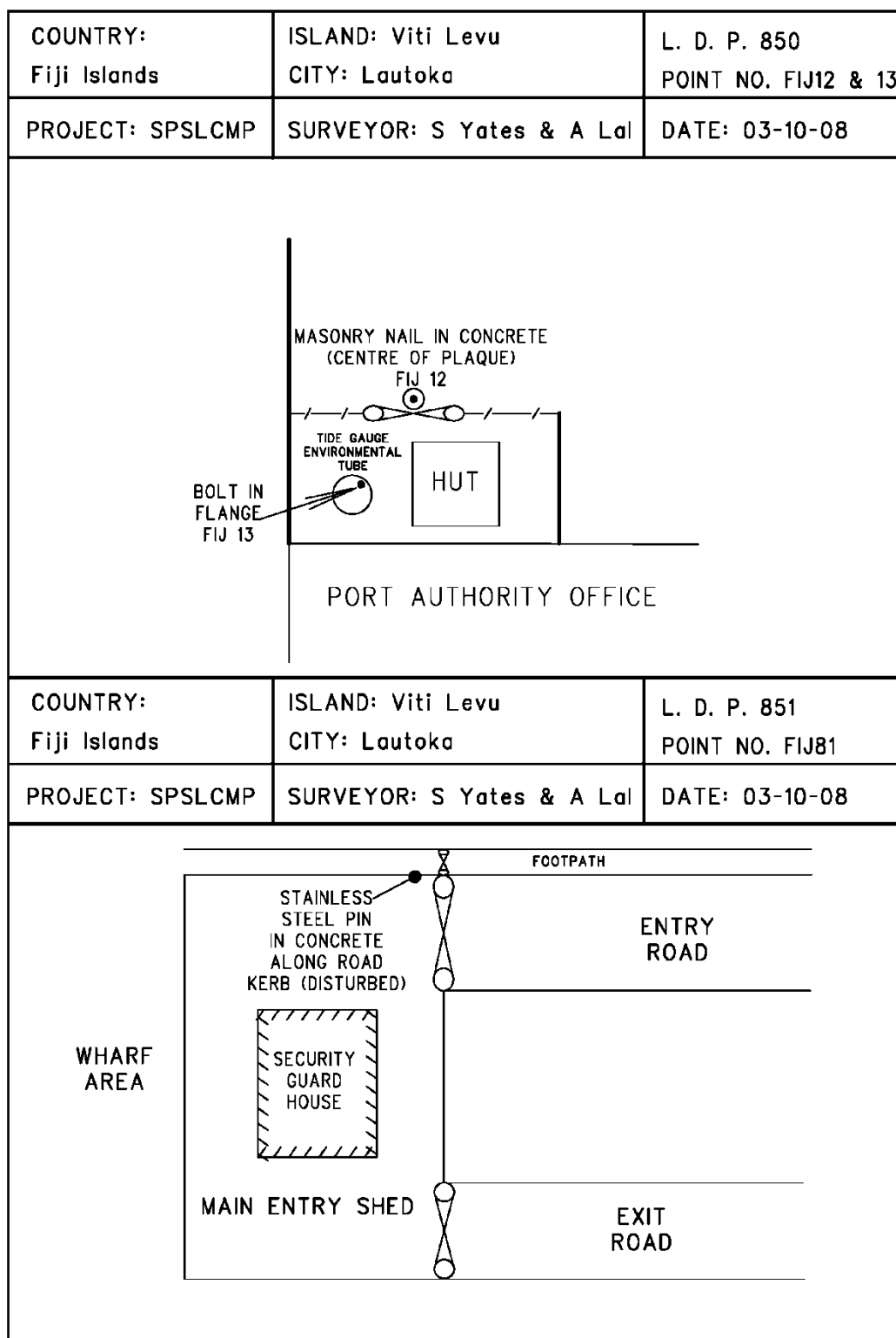
FIJI CGPS Station, FSC, Lautoka – RM 3 Location Diagram

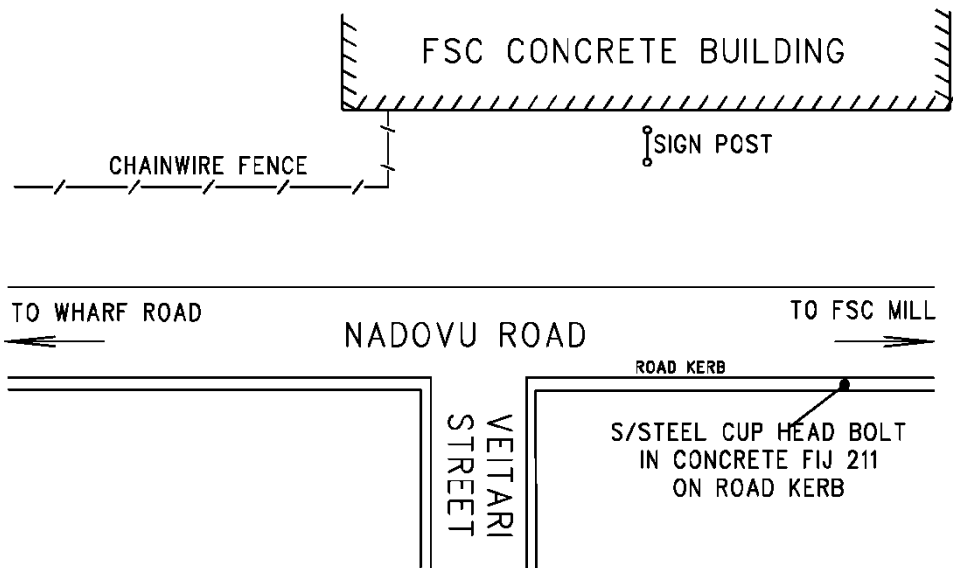
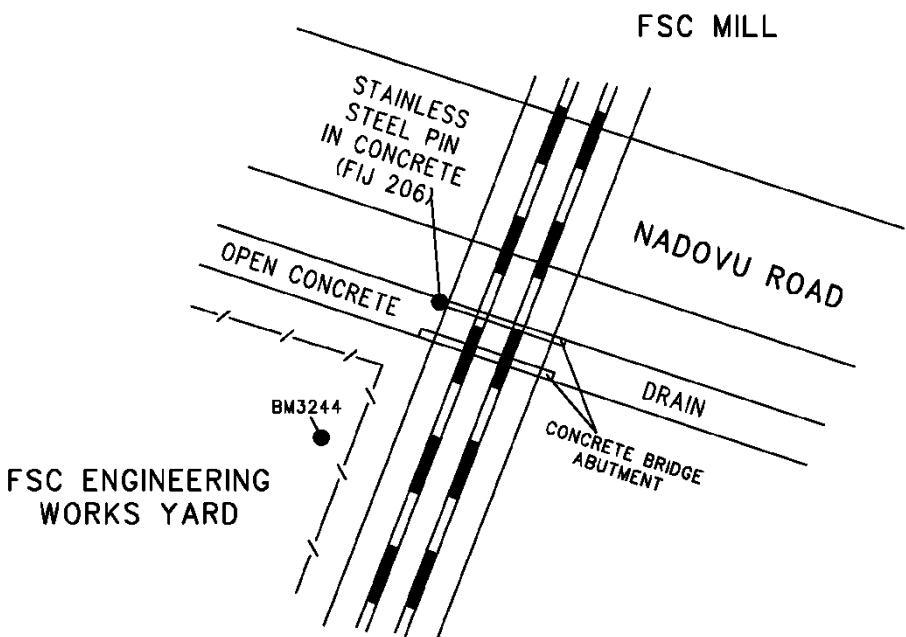
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 150 mm below ground level.

Treated pine witness posts 150 mm in diameter and 1.4 m high are located 1 metre to the north of each RM.

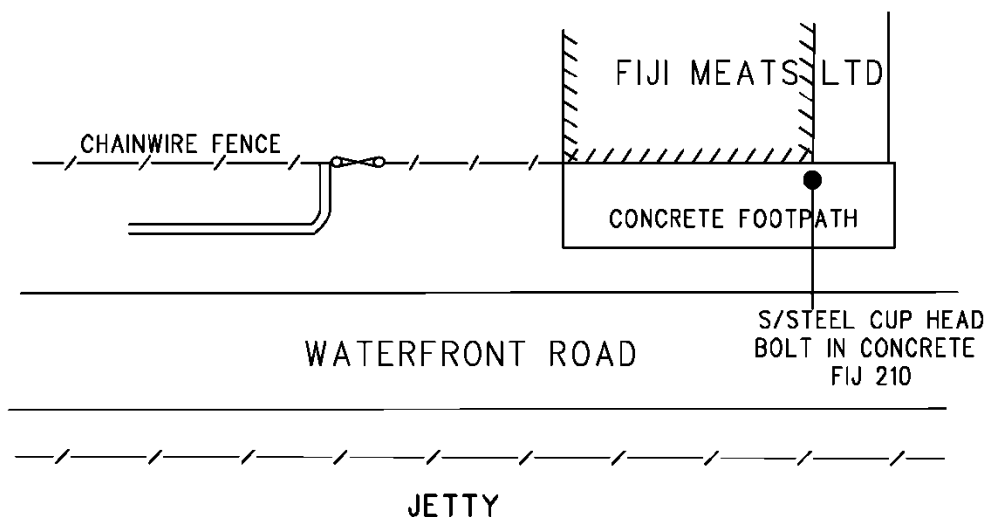


6 Temporary Holding Mark Locality Diagrams

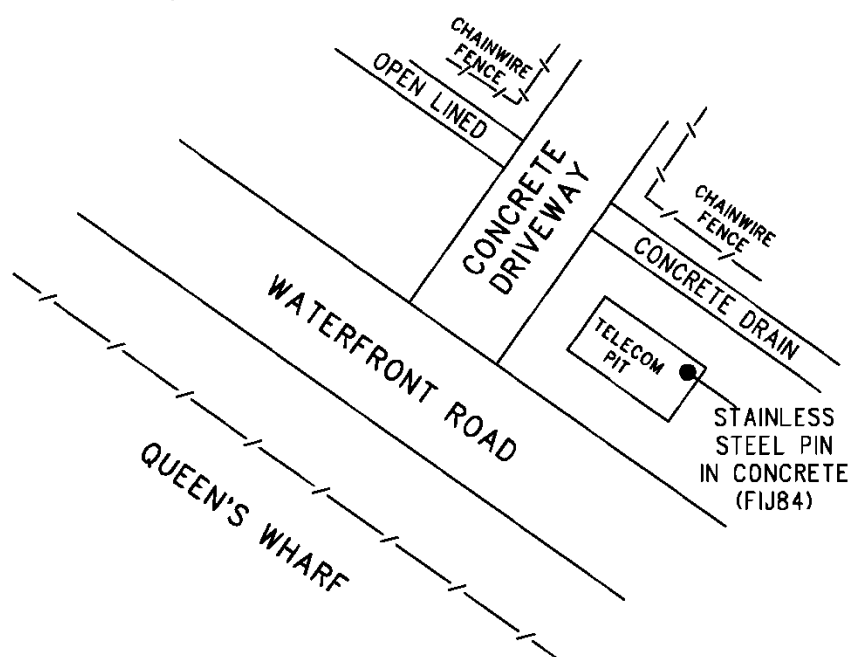


COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 854 POINT NO. FIJ211
PROJECT: SPSLCMP	SURVEYOR: M Deo & A Lal	DATE: 22-02-10
 The diagram for Point FIJ211 shows a survey setup at the intersection of NADOVU ROAD and VEITARI STREET. A CHAINWIRE FENCE is located to the left of the road. The FSC CONCRETE BUILDING is situated at the top of the diagram. A SIGN POST is positioned near the building. NADOVU ROAD runs horizontally, with arrows indicating directions 'TO WHARF ROAD' and 'TO FSC MILL'. A ROAD KERB is marked on the right side of the road. A S/STEEL CUP HEAD BOLT IN CONCRETE FIJ 211 is located ON ROAD KERB. The vertical road is labeled VEITARI STREET.		
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 855 POINT NO. FIJ206
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08
 The diagram for Point FIJ206 shows a survey setup near the FSC MILL and FSC ENGINEERING WORKS YARD. NADOVU ROAD runs diagonally. A STAINLESS STEEL PIN IN CONCRETE (FIJ 206) is located on the road. An OPEN CONCRETE area is marked. A BM3244 benchmark is shown. A DRAIN and CONCRETE BRIDGE ABUTMENT are also indicated. The FSC MILL is at the top right, and the FSC ENGINEERING WORKS YARD is at the bottom left.		

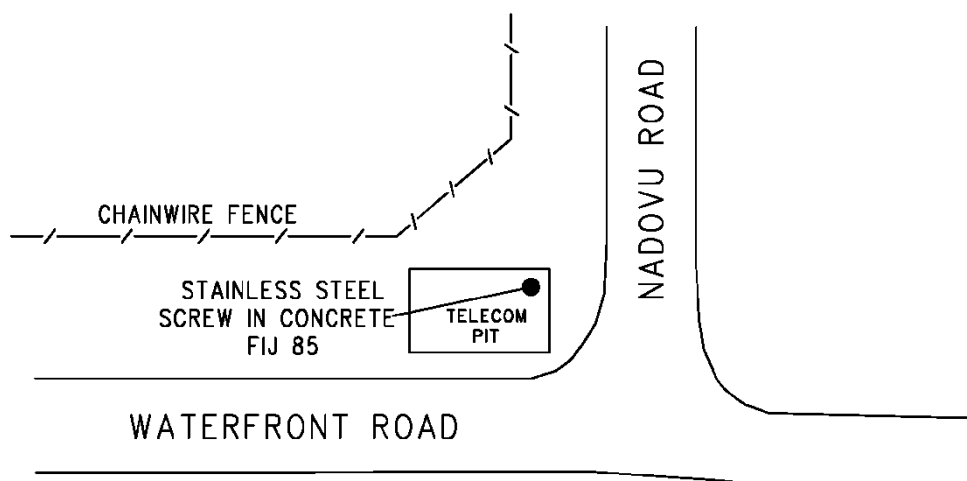
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 856 POINT NO. FIJ210
PROJECT: SPSLCMP	SURVEYOR: M Deo & A Lal	DATE: 22-02-10



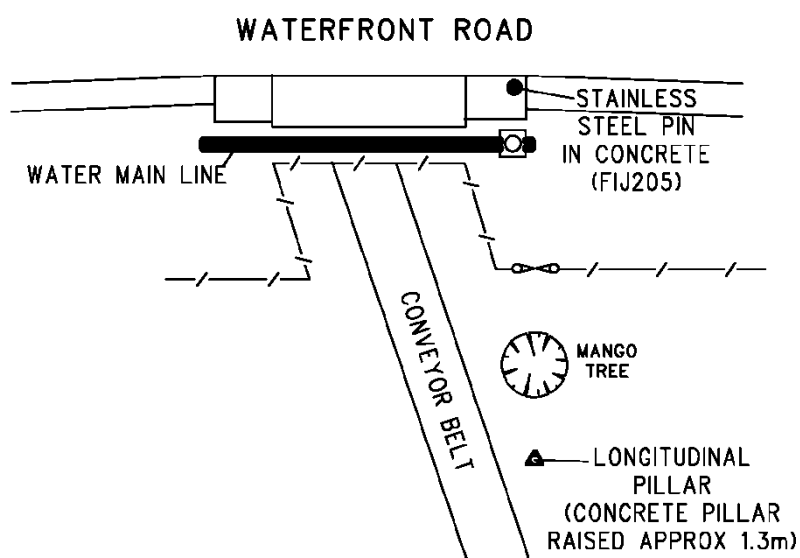
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 857 POINT NO. FIJ84
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



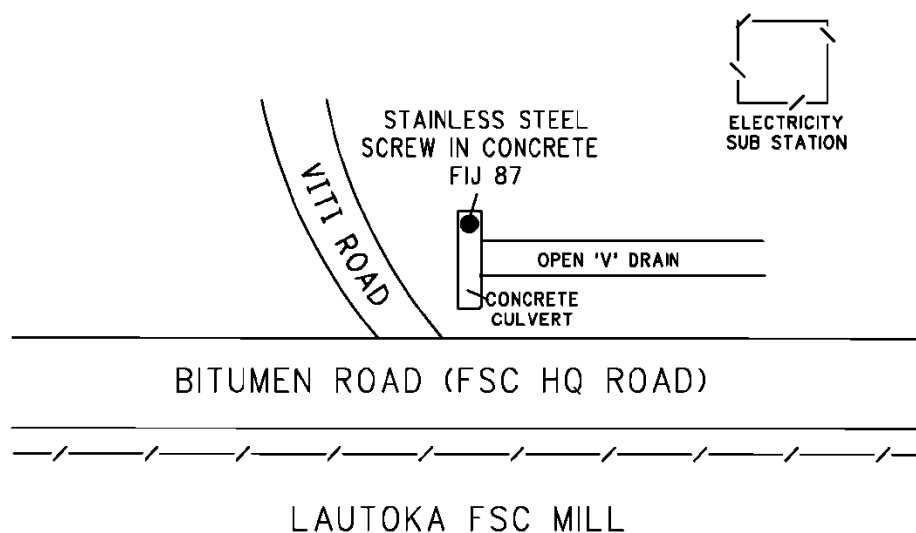
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 858 POINT NO. FIJ85
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



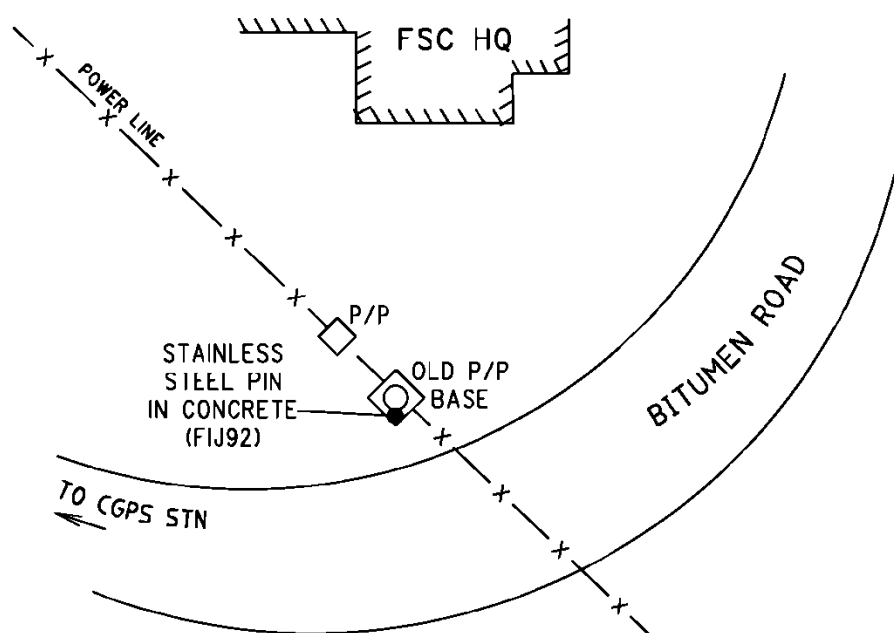
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 859 POINT NO. FIJ205
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



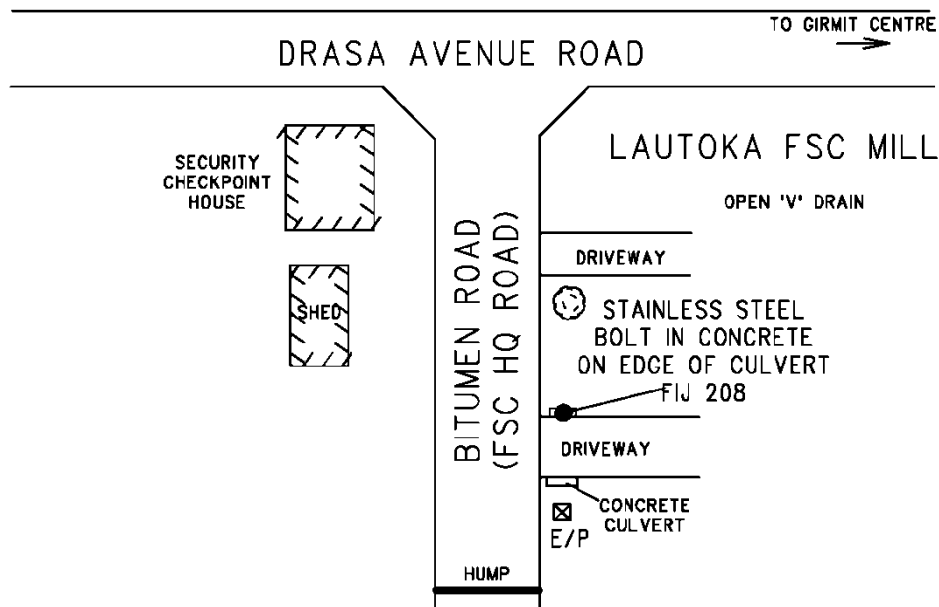
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 860 POINT NO. FIJ87
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



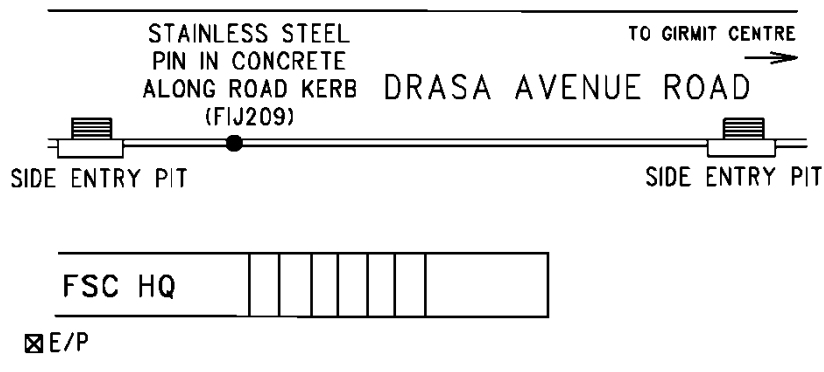
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 861 POINT NO. FIJ92
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08

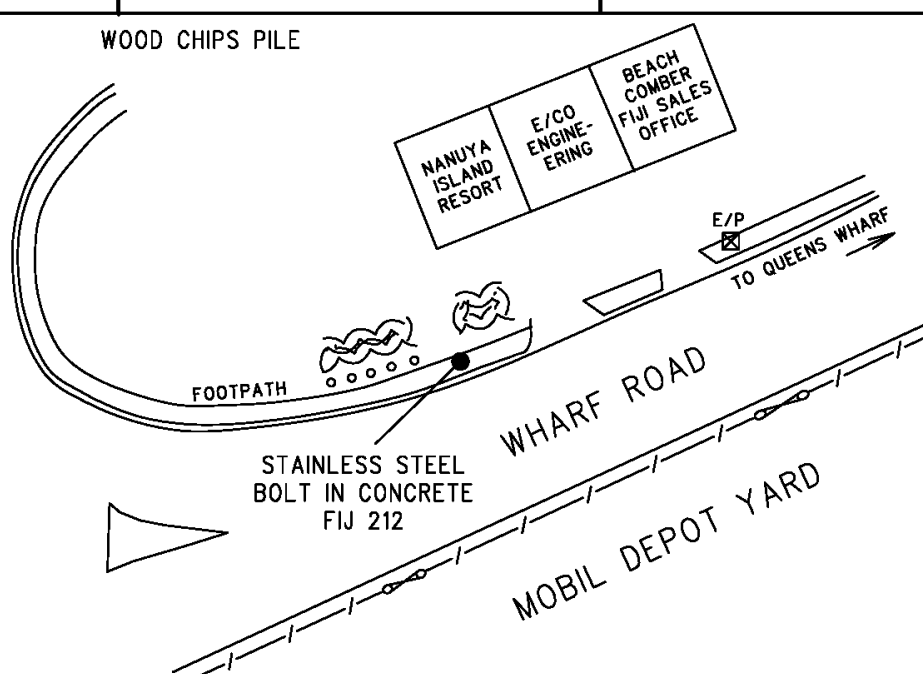
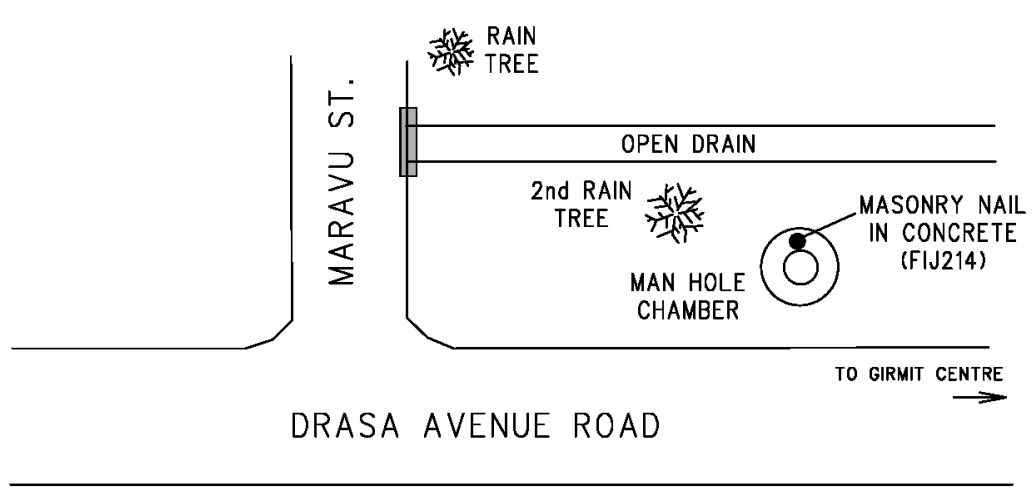


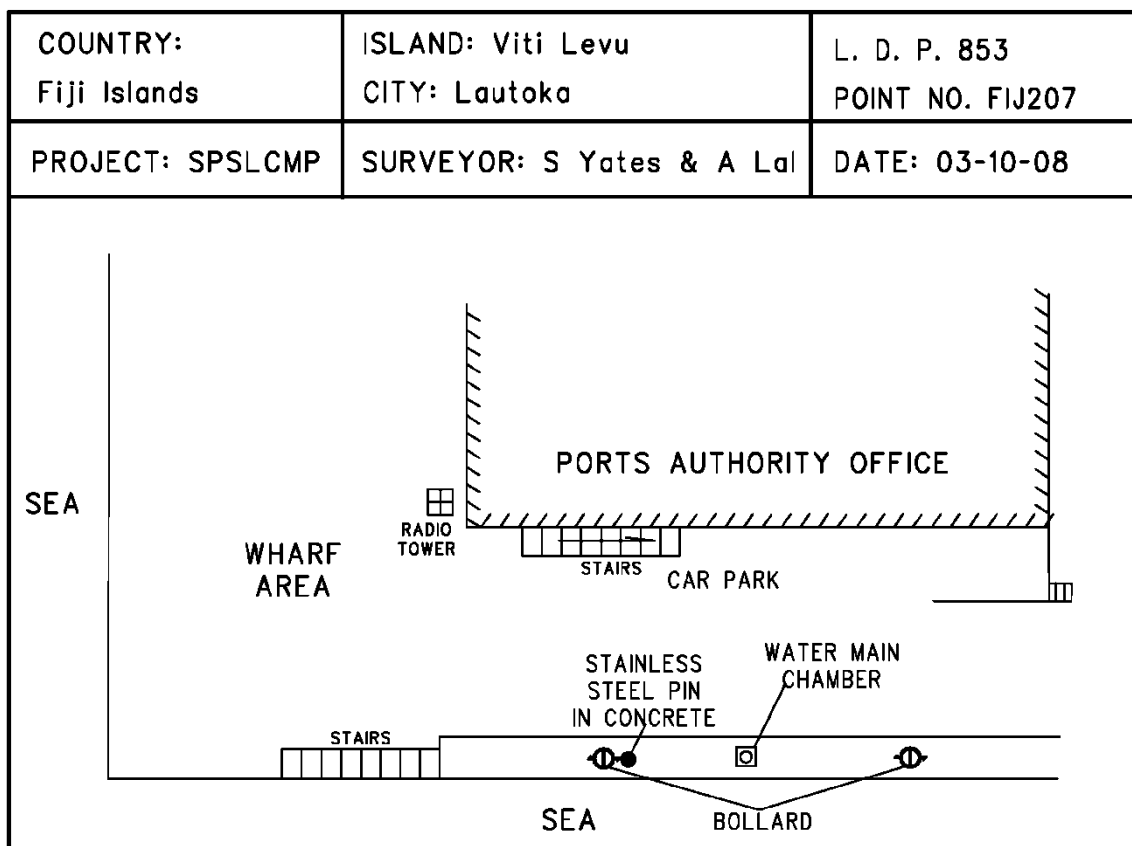
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 862 POINT NO. FIJ208
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 863 POINT NO. FIJ209
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 03-10-08



COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 870 POINT NO. FIJ212
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 27-07-11
 WOOD CHIPS PILE NANUYA ISLAND RESORT E/CO ENGINEERING BEACH COMBER FIJI SALES OFFICE FOOTPATH STAINLESS STEEL BOLT IN CONCRETE FIJ 212 WHARF ROAD MOBIL DEPOT YARD E/P TO QUEENS WHARF		
COUNTRY: Fiji Islands	ISLAND: Viti Levu CITY: Lautoka	L. D. P. 871 POINT NO. FIJ214
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 21-02-13
 MARAVU ST. RAIN TREE OPEN DRAIN 2nd RAIN TREE MAN HOLE CHAMBER MASONRY NAIL IN CONCRETE (FIJ214) DRASA AVENUE ROAD TO GIRIT CENTRE		



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.