



Australian Government
Geoscience Australia



Record 2014/31 | GeoCat 76794

EDM Height Traversing Levelling Survey Report

Port Vila, Vanuatu, October 2012

S. J. K. Yates, A. Lal

EDM Height Traversing Levelling Survey Report

Port Vila, Vanuatu, October 2012

GEOSCIENCE AUSTRALIA
RECORD 2014/31

S. J. K. Yates¹, A. Lal²



Australian Government
Geoscience Australia

-
1. National Geospatial Reference Systems, Minerals and Natural Hazards Division, Geoscience Australia GPO Box 378 Canberra ACT 2601
 2. Ocean & Islands Programme, Applied Geoscience and Technology Division (SOPAC), Secretariat of the Pacific Community, Suva, Fiji Islands

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

This paper is published with the permission of the CEO, Geoscience Australia



© Commonwealth of Australia (Geoscience Australia) 2014

With the exception of the Commonwealth Coat of Arms and where otherwise noted, all material in this publication is provided under a Creative Commons Attribution 3.0 Australia Licence.

(<http://www.creativecommons.org/licenses/by/3.0/au/deed.en>)

Geoscience Australia has tried to make the information in this product as accurate as possible.

However, it does not guarantee that the information is totally accurate or complete. Therefore, you should not solely rely on this information when making a commercial decision.

Geoscience Australia is committed to providing web accessible content wherever possible. If you are having difficulties with accessing this document please email clientservices@ga.gov.au.

ISSN 2201-702X (PDF)

ISBN 978-1-925124-20-0 (PDF)

GeoCat 76794

Bibliographic reference: Yates S. J. K, Lal A., 2014. *EDM Height Traversing Levelling Survey Report, Port Vila, Vanuatu, October 2012*. Record 2014/31. Geoscience Australia, Canberra.
<http://dx.doi.org/10.11636/Record.2014.031>

Contents

1 Introduction	1
1.1 The Survey.....	1
1.2 Bench Mark Locations – Port Vila.....	2
1.3 The Vanuatu Datum	2
1.4 Equipment.....	3
1.5 Method	3
1.6 Survey Support	3
1.7 Issues.....	3
1.8 Description of Marks – Port Vila, Vanuatu	4
1.9 Comparisons between 2012 and 2011 EDM Surveys	5
1.10 Combined Comparisons	7
1.11 Vanuatu 2012 Reduced Levels.....	8
1.12 Time Series of Bench Mark movement relative to Fixed Deep Bench Mark VAN3.....	9
2 Deep Bench Mark Locality Diagrams	13
3 Vanuatu Reference Mark Locality Diagrams	17
4 Temporary Holding Mark Locality Diagrams	21
5 References	32

1 Introduction

This report outlines the high precision level survey completed between the SEAFRAME (Sea Level Fine Resolution Acoustic Measuring Equipment) tide gauge and continuous GPS (Global Positioning System) station and the newly established Global Navigation Satellite System (GNSS) Station in Port Vila, Vanuatu from 16th – 21st October 2012.

Personnel involved in the survey were Steve Yates, Project Officer, Geoscience Australia and Andrick Lal, Surveyor, Secretariat of the Pacific Islands 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 Port Vila, which runs approximately 4km from the tide gauge sensor to the continuous GPS Station. Previous levelling surveys have been conducted along the route using this technique in 2006, 2008, 2009 and 2011.

In addition, precise differential levelling surveys were performed along the deep bench mark array from 1993 to 2004 by the National Tidal Centre (NTC) and the survey in 2006 included a comparison between the precise differential levelling and EDM height traversing technique. This report contains a comparison between the 2012 and 2011 EDM height traversing results as well as a combined comparison since the first levelling survey.

1.1 The Survey

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

VAN16	– SEAFRAME sensor bench mark
VAN14	– wall mounted survey bench mark adjacent to VAN16
VAN2	– deep driven bench mark
VAN3	– reference deep driven bench mark
VAN100	– deep driven bench mark (within meteorology compound)
VAN101	– deep driven bench mark (within parliament compound)
VANUBM	– reference bench mark for the CGPS pillar (within parliament compound)
PTVLBM	– reference bench mark for the GNSS pillar (within meteorology compound)
PTVL	– GNSS Pillar bench mark (within meteorology compound)

Also included in the survey were temporary holding marks - VAN160, VAN143, VAN200, VAN207, VAN208, VAN204, VAN132, VAN201, VAN154, VAN209, VAN202, VAN205, VAN164, VAN206, VAN138, and VAN166

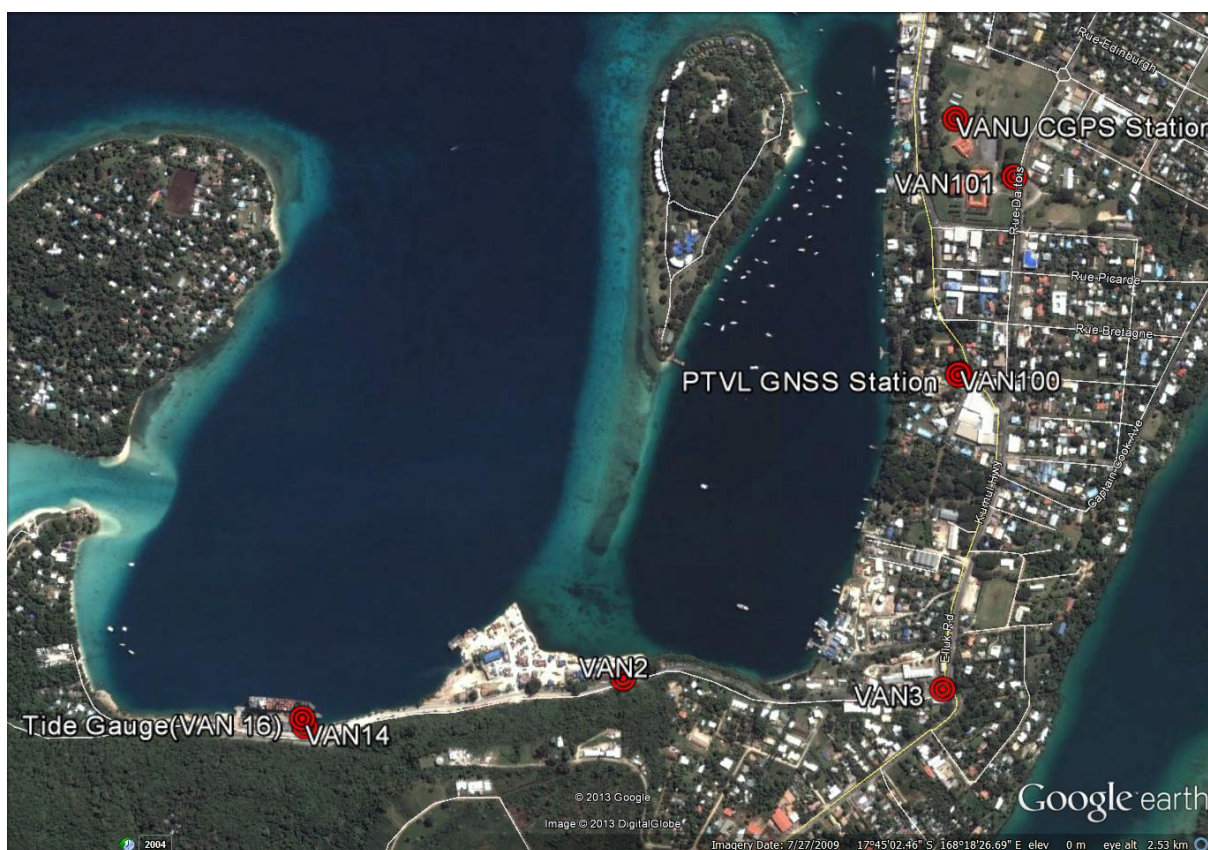
The Continuous GPS Reference Point - VANU and the three CGPS Reference Marks - RM1, RM2 and RM3 were also levelled. Two additional temporary holding marks were installed to support the levelling survey network (VAN210 and VAN211). These new marks are stainless steel bolts drilled in concrete and then glued in place with quality epoxy resin.

A new Continuous GNSS Station (PTVL) was established in the Meteorological Office compound to replace the existing VANU CGPS Station located at the parliament complex which will be decommissioned in the near future due to development and building of the cultural centre within the complex. The new reference benchmark, PTVLBM, for the PTVL GNSS Station and the three reference marks around the Pillar were levelled in the 2012 survey.

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 2012 reduced levels are detailed later in this report.

1.2 Bench Mark Locations – Port Vila



1.3 The Vanuatu Datum

All reduced levels for the Port Vila levelling survey are relative to VAN3 fixed at 23.54630 m (TGZ-ORSTOM). This value was determined by the NTC in 1993 by adopting the height of BC1 (VAN14) with RL of 2.819m MSL.

1.4 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

1.5 Method

The "Leap-Frog" EDM-height-traversing technique was employed for the Port Vila tide gauge levelling survey. The "Leap-Frog" EDM-height-traversing technique involves setting up a total station (TCA2003 or TM30) 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 (1mm) and vertical angle 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 bays 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.

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 at any one set-up. Results can also be gained with the EDM Height Traversing method by using a single set-up / single rod configuration. This "single set-up / single rod" configuration is particularly useful when levelling between bench marks which are close together e.g. between the CGNSS Bench Mark and the Reference Marks.

1.6 Survey Support

Due to a recent change in field procedures, two labourers, Ben Nawi and Jayson Sokomanu were hired to carry the Leica total station in the carry case during the survey. This was arranged through the kind assistance of Mr Martin Sokomanu.

1.7 Issues

Bench mark VAN101 is located within the Parliament House grounds and may be difficult to access on weekends.

Always ensure when the survey equipment is freighted to Port Vila, prior arrangements with Meteorological Office or Survey Office should be made for the clearance from Customs Authority for concession on tariffs.

1.8 Description of Marks – Port Vila, Vanuatu

VAN 3	– deep driven bench mark
VAN 2	– deep driven bench mark next to bus shelter along wharf road
VAN 100	– deep driven bench mark within meteorology office compound
VAN 101	– deep driven bench mark within parliament compound
VAN 16	– SEAFRAME sensor bench mark
VAN14 (BC 1)	– wall mounted bench mark within the main wharf area
VANUBM	– Reference bench mark for the CGPS pillar
VANU	– CGPS reference point
VANU RM1	– CGPS survey reference marks
VANU RM2	– CGPS survey reference marks
VANU RM3	– CGPS survey reference marks.
PTVLBM	– Reference bench mark for the GNSS pillar
PTVL	– GNSS reference point
PTVL RM1	– GNSS survey reference mark
PTVL RM2	– GNSS survey reference mark
PTVL RM3	– GNSS survey reference mark

Holding pins along survey route from tide gauge to CGPS (as listed previously) are all stainless steel bolts, drilled in concrete and glued in place with the exception of VAN154, a metal spike and VAN166, a bolt located at the base of a light pole along the entrance road to the VANU CGPS Pillar.

1.9 Comparisons between 2012 and 2011 EDM Surveys

Table 1.1 Results of Port Vila, Vanuatu 2012 EDM Height Traversing Comparison 2012 – 2011. VAN3 - adopted fixed height of 23.5463m

From	To	Levelled Ht. Diff.	RL 2012	Misclose (mm)	Dist. (km)	1mm√k	RL 2011	Difference (mm) 2012 - 2011
VAN3			23.54630					
VAN160	VAN160	-4.55954	18.98676	-0.013	0.180	0.424	18.9873	-0.51
VAN210	VAN210	-7.44061	11.54615	0.055	0.206	0.454	New Mark	New Mark
VAN143	VAN143	1.50430	13.05045	0.402	0.160	0.400	13.0512	-0.71
VAN2	VAN2	-3.04172	10.00873	0.070	0.246	0.496	10.0085	0.25
VAN211	VAN211	-2.00914	7.99960	0.230	0.107	0.327	New Mark	New Mark
VAN200	VAN200	-4.32661	3.67298	0.096	0.230	0.480	3.6729	0.07
VAN207	VAN207	0.00689	3.67988	0.213	0.167	0.408	3.6797	0.19
VAN208	VAN208	-0.69202	2.98785	-0.118	0.209	0.457	2.9860	1.88
VAN16	VAN16	1.98718	4.97503	-0.150	0.086	0.293	4.9769	-1.83
	VAN14	-1.40846	3.56658	0.100	0.030	0.174	3.5649	1.69
VAN3			23.54630					
VAN204	VAN204	-1.02470	22.52160	0.246	0.102	0.319	22.5215	0.14
VAN132	VAN132	-5.29730	17.22430	0.344	0.157	0.397	17.2243	0.02
VAN201	VAN201	-0.97169	16.25261	-0.188	0.152	0.389	16.2527	-0.11
VAN154	VAN154	3.84186	20.09447	0.050	0.166	0.407	20.0946	-0.14
VAN209	VAN209	2.12873	22.22320	-0.037	0.117	0.342	22.2230	0.22
VAN202	VAN202	1.93281	24.15601	0.183	0.079	0.281	24.1558	0.26
VAN205	VAN205	6.91594	31.07195	0.138	0.192	0.439	31.0717	0.24
VAN164	VAN164	2.68749	33.75945	-0.213	0.170	0.412	33.7580	1.43
VAN206	VAN206	1.99019	35.74964	0.013	0.882	0.939	35.7495	0.14
VAN138	VAN138	0.04188	35.79152	0.025	0.127	0.356	35.7913	0.19
VAN166	VAN166	-1.41426	34.37726	0.027	0.077	0.277	New Mark	New Mark
	VANUBM	-1.46627	32.91098	0.236	0.100	0.317	32.9114	-0.45
VAN202			24.15601					
VAN100	VAN100	-2.94399	21.21202	-0.175	0.121	0.348	21.2120	0.01
PTVLBM	PTVLBM	-0.56201	20.65002	0.040	0.019	0.139	New Mark	New Mark
	PTVL	0.96809	21.61811	-0.038	0.019	0.139	New Mark	New Mark
VAN206			35.74964					
	VAN101	0.36956	36.11920	-0.084	0.020	0.140	36.1192	0.01
			Misclose for all bays levelled =	1.452	4.119	2.030		

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

From	To	Levelled Ht. Diff.	RL 2012	Misclose (mm)	Dist. (km)	1mm√k	RL 2011	Difference (mm) 2012 - 2011
VANUBM			32.91098					
	VANURM1	-1.0599	31.85112	-0.010	0.025	0.157	31.85349	-2.37
VANUBM			32.91098					
	VANURM2	-0.6862	32.22482	-0.130	0.033	0.181	32.22511	-0.29
VANUBM			32.91098					
	VANURM3	-0.8043	32.10667	-0.121	0.037	0.192	32.10710	-0.43
VAN100			21.21202					
	PTVLRM1	0.4434	21.65546	0.000	0.029	0.170	New Mark	
VAN100			21.21202					
	PTVLRM2	-0.3544	20.85761	0.053	0.040	0.200	New Mark	
VAN100			21.21202					
	PTVLRM3	-1.0793	20.13270	-0.010	0.039	0.197	New Mark	
PTVL			20.65002					
	PTVL_MET	-1.4393	19.21071	0.010	0.055	0.234	New Mark	

1.10 Combined Comparisons

Examination of the level survey results do not show any significant changes in reduced levels from the 2011 survey. All indications are that no immediate or significant displacement of any of the deep driven bench marks has occurred.

The reduced levels derived after the 2002 earthquake, which particularly impacted the Port Vila wharf area, agree to approximately 1mm.

Table 1.2 Port Vila, Vanuatu – Deep Bench Mark final RL's for Precise Differential Levelling (1993 - 2006) and EDM Height Traversing (2006 - 2012).

Year	VAN1	VAN2	VAN14	VAN16	VAN100	VAN101	VANUBM	PTVLBM
1993.0	2.8537	10.0886	3.5690					
1994.0	2.8533	10.0894	3.5686					
1995.2	2.8542	10.0883	3.5693	5.0085				
1997.1	2.8554	10.0885	3.5702	5.0100				
1998.2	2.8558	10.0892	3.5708	5.0087				
1999.6	2.8545	10.0890	3.5703	5.0091	21.2136	36.1163		
2001.2	2.8560	10.0894	3.5716	5.0112	21.2130	36.1159		
2002.7	2.8489	10.0083	3.5637	4.9747	21.2133	36.1185	32.9096	
2004.4	2.8498	10.0087	3.5642	4.9760	21.2127	36.1182	32.9092	
2006.7	Destroyed	10.0083	3.5636	4.9729	21.2144	36.1213	32.9124	

Year	VAN1	VAN2	VAN14	VAN16	VAN100	VAN101	VANUBM	PTVLBM
2006.7		10.0088	3.5628	4.9713	21.2130	36.1198	32.9111	
2008.3		10.0082	3.5622	4.9744	21.2129	36.1194	32.9108	
2009.9		10.0086	3.5636	4.9742	21.2132	36.1207	32.9115	
2011.2		10.0085	3.5649	4.9769	21.2120	36.1192	32.9114	
2012.8		10.0087	3.5666	4.9750	21.2120	36.1192	32.9110	20.6500

The 2012 RL of VANU is 33.8644

**The RL of the Reference Point VANU (ARP) is derived from adding the static height difference of 0.9534 (VANUBM to VANU) to the 2012 levelled RL of VANUBM*

1.11 Vanuatu 2012 Reduced Levels

Table 1.3 Port Vila, Vanuatu – Reduced levels 2012 survey

Date: 16 – 21 October 2012

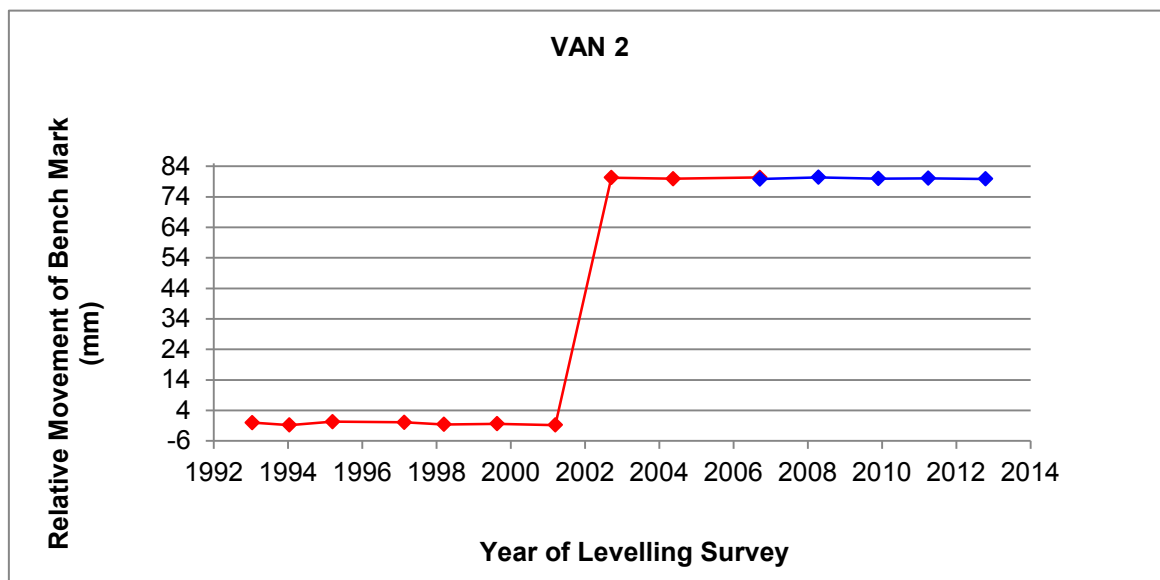
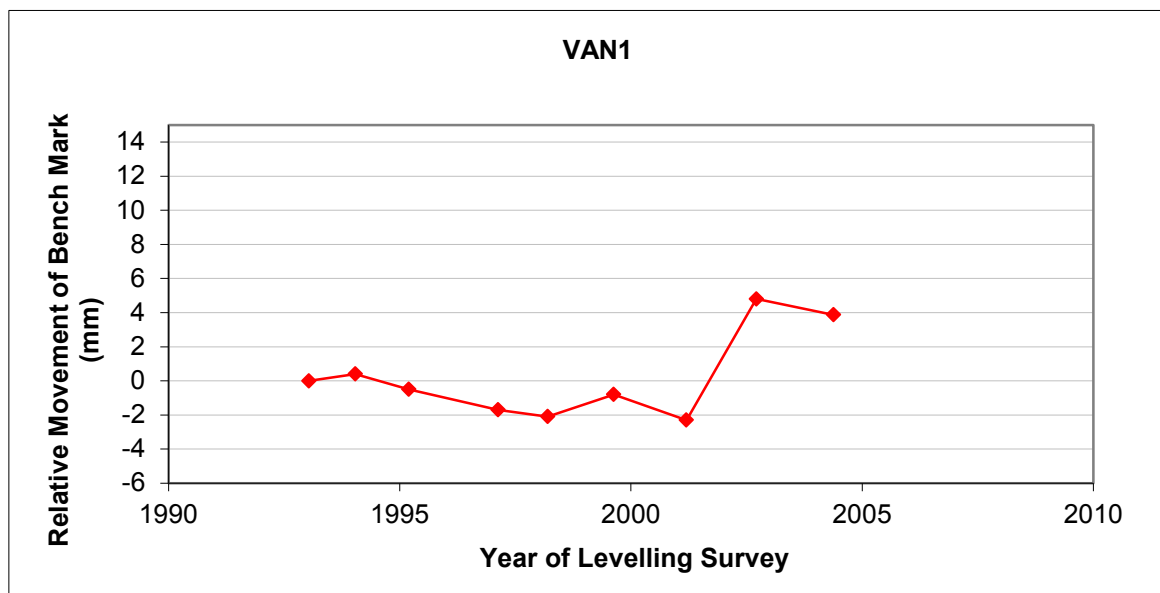
Datum: TGZ-ORSTOM (1993)

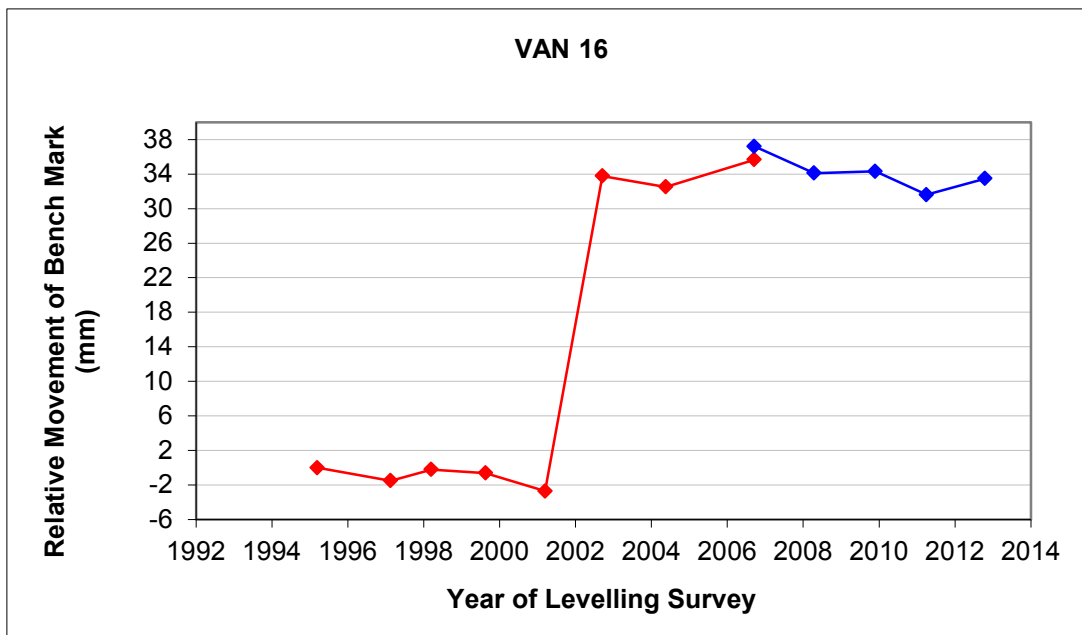
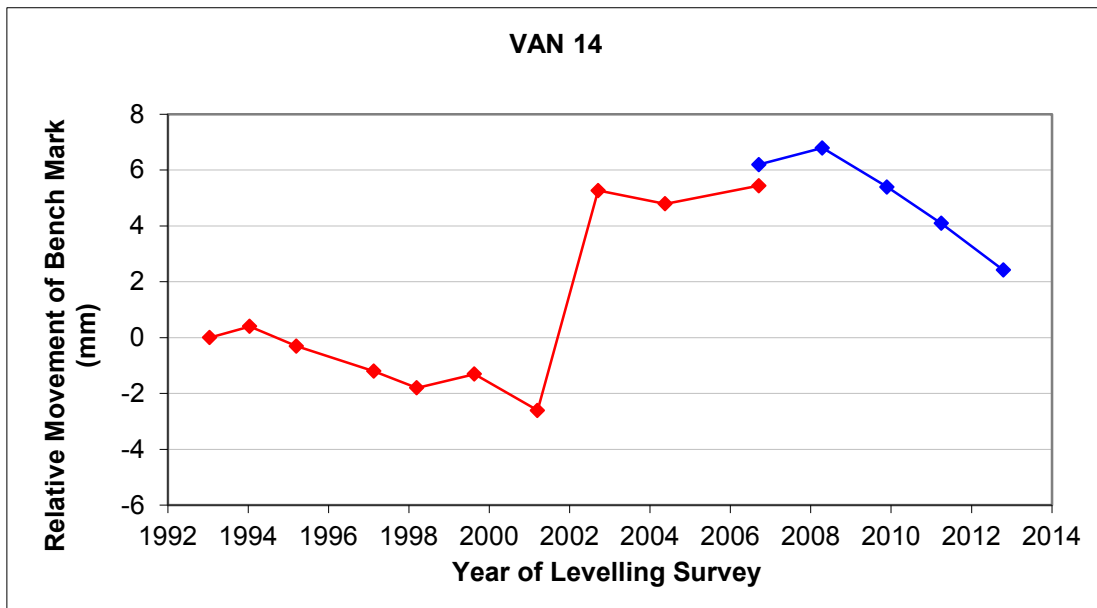
Point ID	2012 Reduced Level	Type
VAN3	23.5463	Stainless Steel Rod in Ground
VAN160	18.9868	Galvanised Bolt in Concrete
VAN210	11.5461	Stainless Steel Pin in Concrete
VAN143	13.0504	Stainless Steel Pin in Concrete
VAN2	10.0087	Stainless Steel Rod in Ground
VAN211	7.9996	Stainless Steel Pin in Concrete
VAN200	3.6730	Stainless Steel Pin in Concrete
VAN207	3.6799	Stainless Steel Pin in Concrete
VAN208	2.9879	Stainless Steel Pin in Concrete
VAN16	4.9750	Stainless Steel Pin
VAN14	3.5666	Galvanised Bolt on Concrete Wall
VAN204	22.5216	Stainless Steel Pin in Concrete
VAN132	17.2243	Stainless Steel Pin in Concrete
VAN201	16.2526	Stainless Steel Pin in Concrete
VAN154	20.0945	Metal Spike in Concrete
VAN209	22.2232	Stainless Steel Pin in Concrete
VAN202	24.1560	Stainless Steel Pin in Concrete
VAN205	31.0720	Stainless Steel Pin in Concrete
VAN164	33.7594	Stainless Steel Pin in Concrete
VAN206	35.7496	Stainless Steel Pin in Concrete
VAN138	35.7915	Stainless Steel Pin in Concrete
VAN166	34.3773	Galvanised Bolt in Concrete
VANUBM	32.9110	Stainless Steel Pillar Pin
*VANU	33.8644	Pillar Plate (ARP)
VAN100	21.2120	Stainless Steel Rod in Ground
PTVLBM	20.6500	Stainless Steel Pillar Pin
PTVL	21.6181	Stainless Steel Plate
VAN101	36.1192	Stainless Steel Rod in Ground
VANURM1	31.8511	Stainless Steel Rod in Ground
VANURM2	32.2248	Stainless Steel Rod in Ground
VANURM3	32.1067	Stainless Steel Rod in Ground
PTVLRM1	21.6555	Stainless Steel Rod in Ground
PTVLRM2	20.8576	Stainless Steel Rod in Ground
PTVLRM3	20.1327	Stainless Steel Rod in Ground
PTVL_MET	19.2107	Top of Met Station

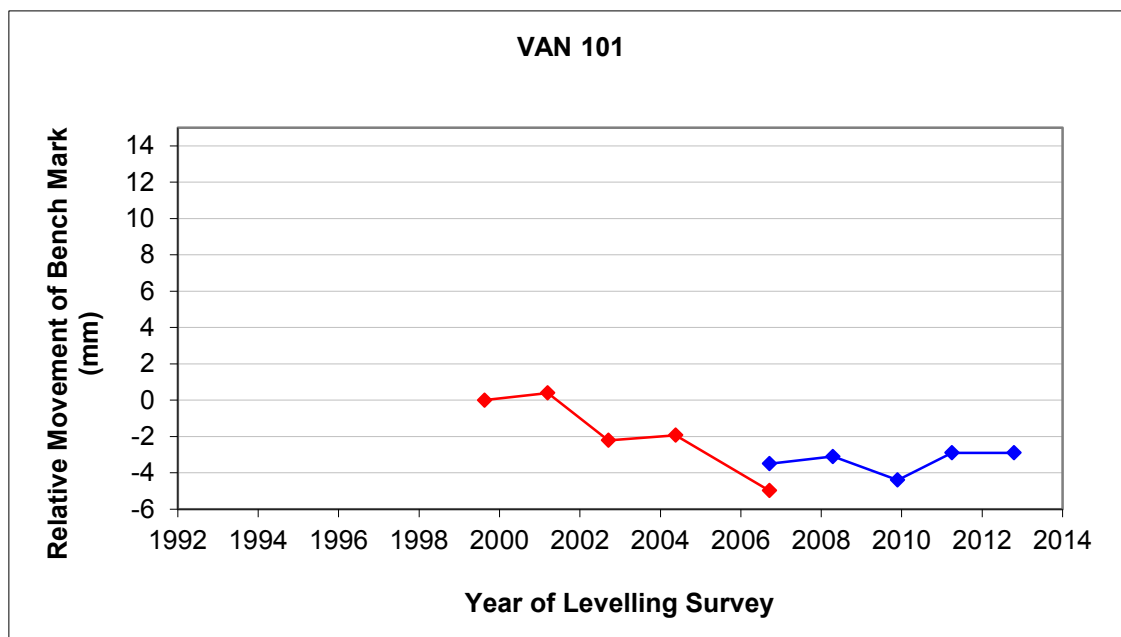
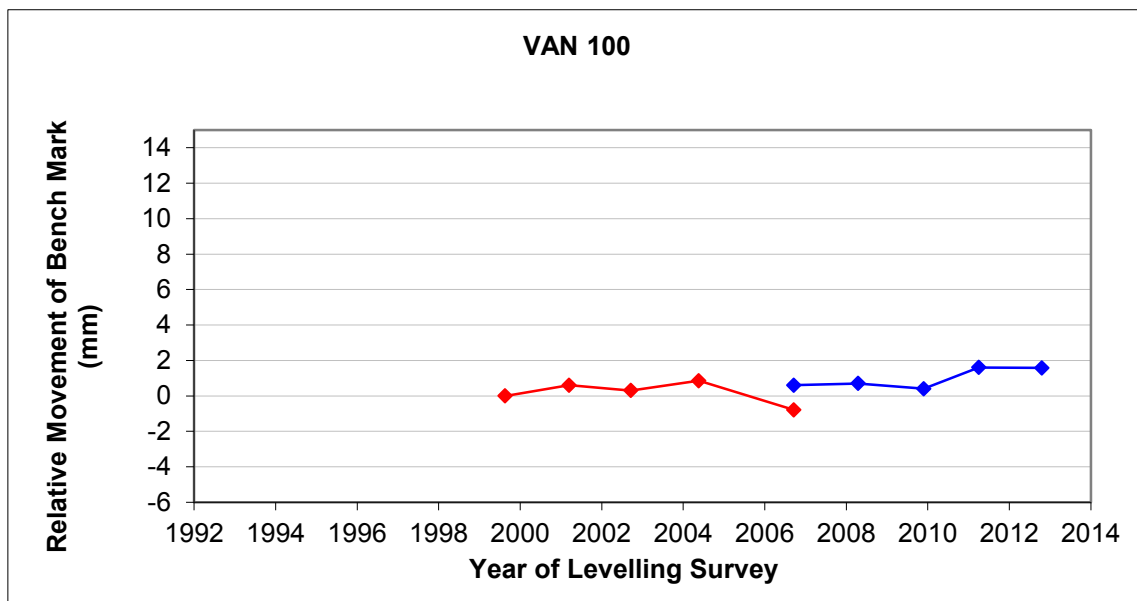
*The RL of the Reference Point VANU (ARP) is derived from adding the static height difference of 0.9534 (VANUBM to VANU) to the 2012 levelled RL of VANUBM.

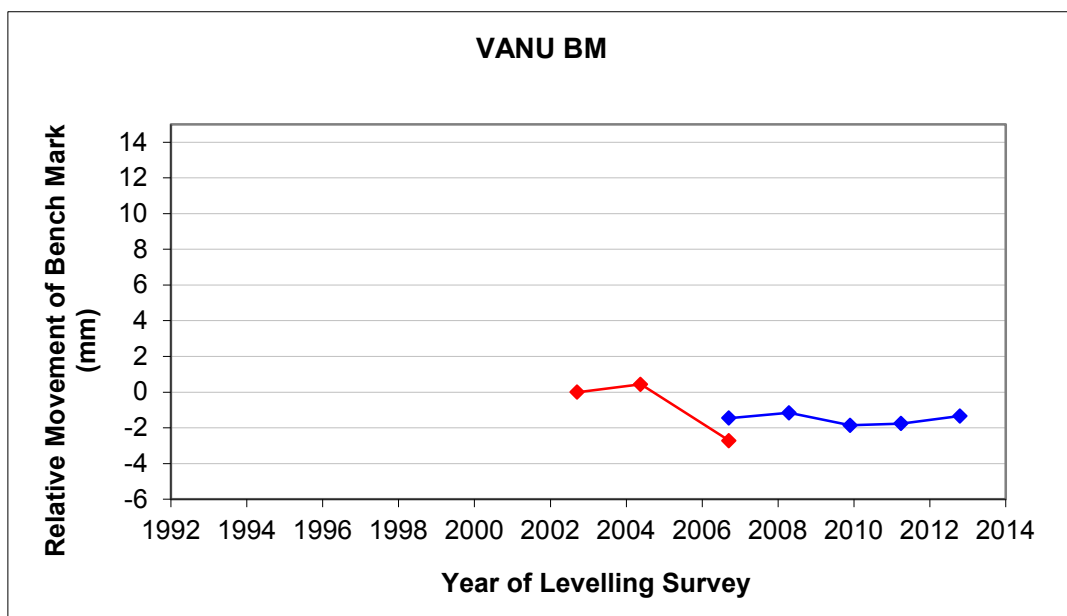
1.12 Time Series of Bench Mark movement relative to Fixed Deep Bench Mark VAN3

Precise Differential Levelling: 1993 - 2006 ◆ — ◆
EDM Height Traversing: 2006 onwards ◆ — ◆









2 Deep Bench Mark Locality Diagrams



SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING PROJECT



Survey Bench Mark Record

Bench Mark Number: VAN2

<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> 04-11-91
--	-----------------------

<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
--	--------------

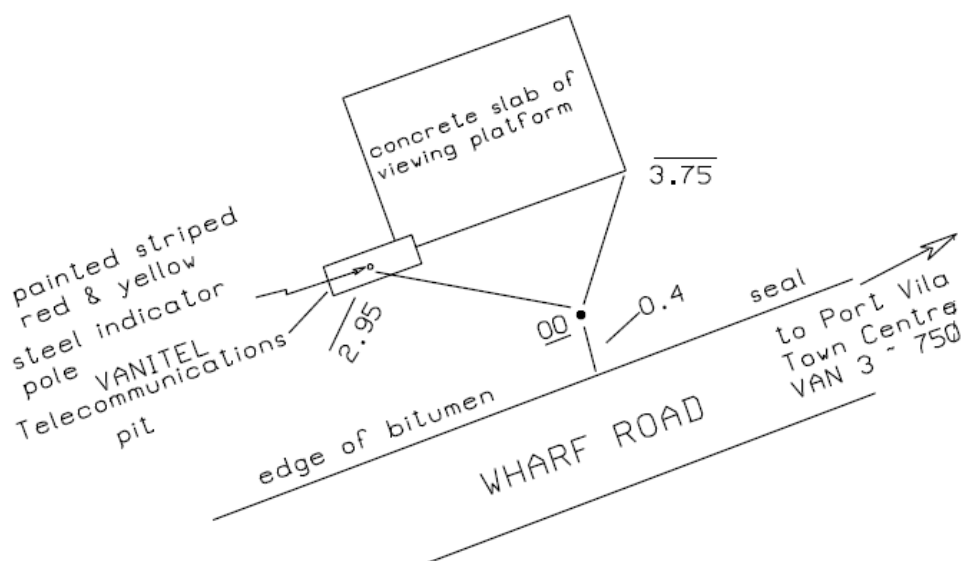
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Vanuatu <i>Island:</i> Efaté	<i>City:</i> Port Vila
---	------------------------

Marking and locality sketch

Bench Mark: 7.3m 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 0.2m below ground level.

Locality sketch: Mark approximately 800m from the tide gauge station.



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

Approved by: Geoscience Australia / SOPAC	Date: December 2006
---	---------------------



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



Survey Bench Mark Record

Bench Mark Number: VAN3

<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> 05-11-91
--	-----------------------

<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
--	--------------

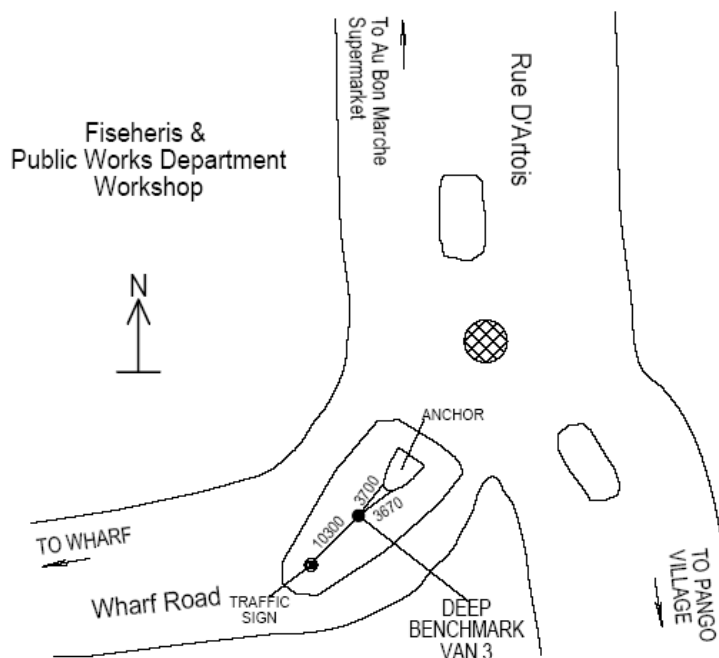
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Vanuatu <i>Island:</i> Efaté	<i>City:</i> Port Vila
---	------------------------

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 0.2m 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: December 2006
---	---------------------



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



Survey Bench Mark Record

Bench Mark Number: VAN100

<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> Aug 1999
--	-----------------------

<i>Existing Bench Mark Established by:</i>	<i>Date:</i>
--	--------------

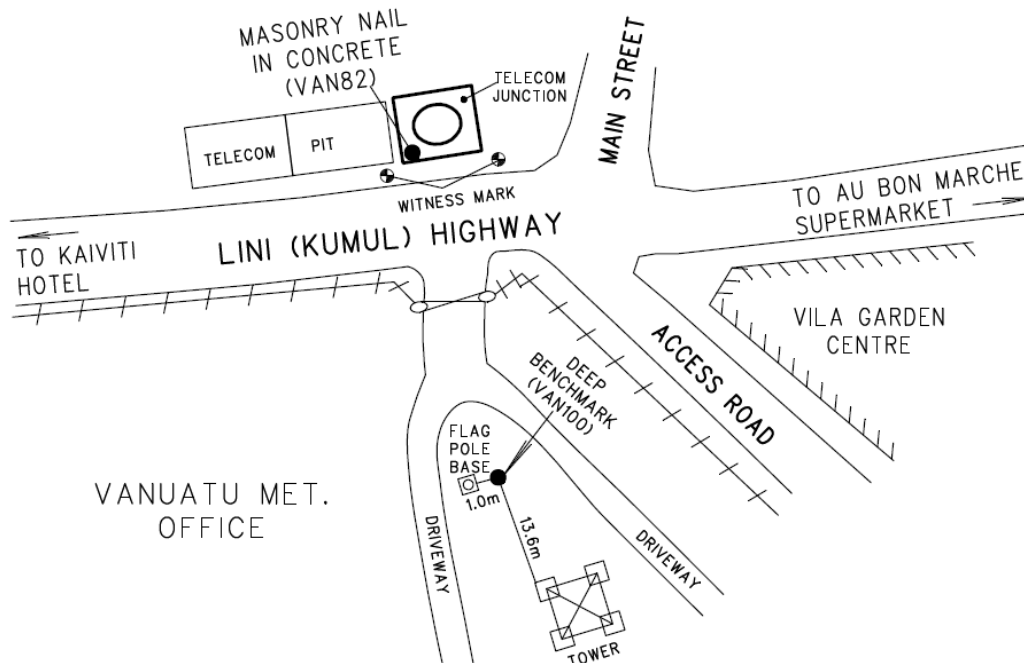
<i>Notes / References:</i> Deep Survey Benchmark This survey mark is in a good locality for GPS occupation.
--

<i>Country:</i> Vanuatu <i>Island:</i> Efate	<i>City:</i> Port Vila
---	------------------------

Marking and locality sketch

Bench Mark: 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 on ground level.

Locality sketch: Mark approximately 2500m from the tide gauge station.



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

Approved by: Geoscience Australia / SOPAC	Date: December 2006
---	---------------------



SOUTH PACIFIC SEA LEVEL & CLIMATE MONITORING PROJECT



Survey Bench Mark Record

Bench Mark Number: VAN101

Original Bench Mark Established by:
National Tidal Centre Australia, Oceanographic Services,
Bureau of Meteorology, 25 College Rd, Kent Town, SA.

Date: Aug 1999

Existing Bench Mark Established by:

Date:

Notes / References: Deep Survey Benchmark
This survey mark is in a good locality for GPS occupation.

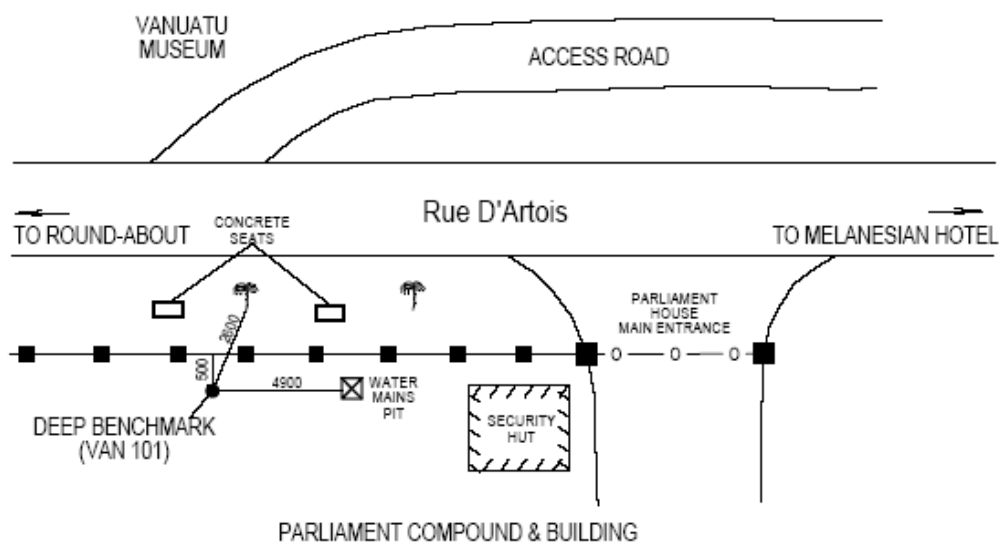
Country: Vanuatu
Island: Efate

City: Port Vila

Marking and locality sketch

Bench Mark: 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 3100m from the tide gauge station.



Not to scale

Distances in Metres

Magnetic bearings

Approved by: Geoscience Australia / SOPAC

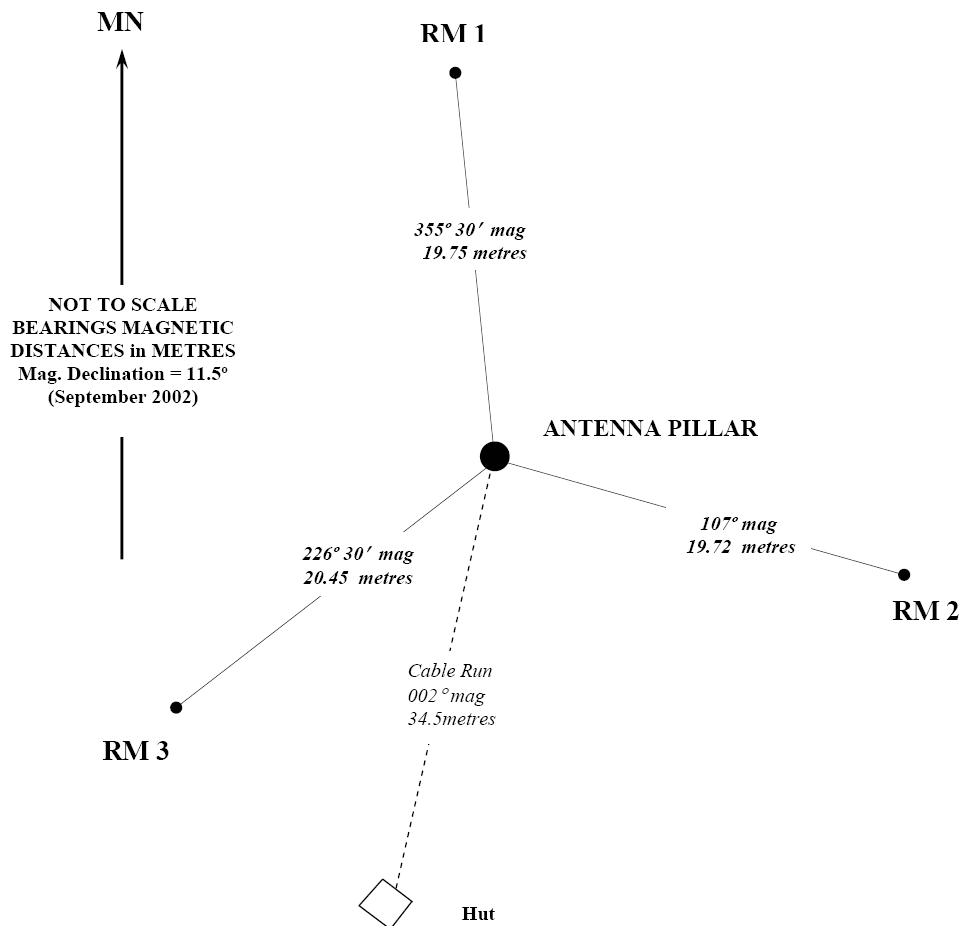
Date: December 2006

3 Vanuatu Reference Mark Locality Diagrams

VANUATU CGPS Station, Port Vila. – Reference Marks

REFERENCE MARKS

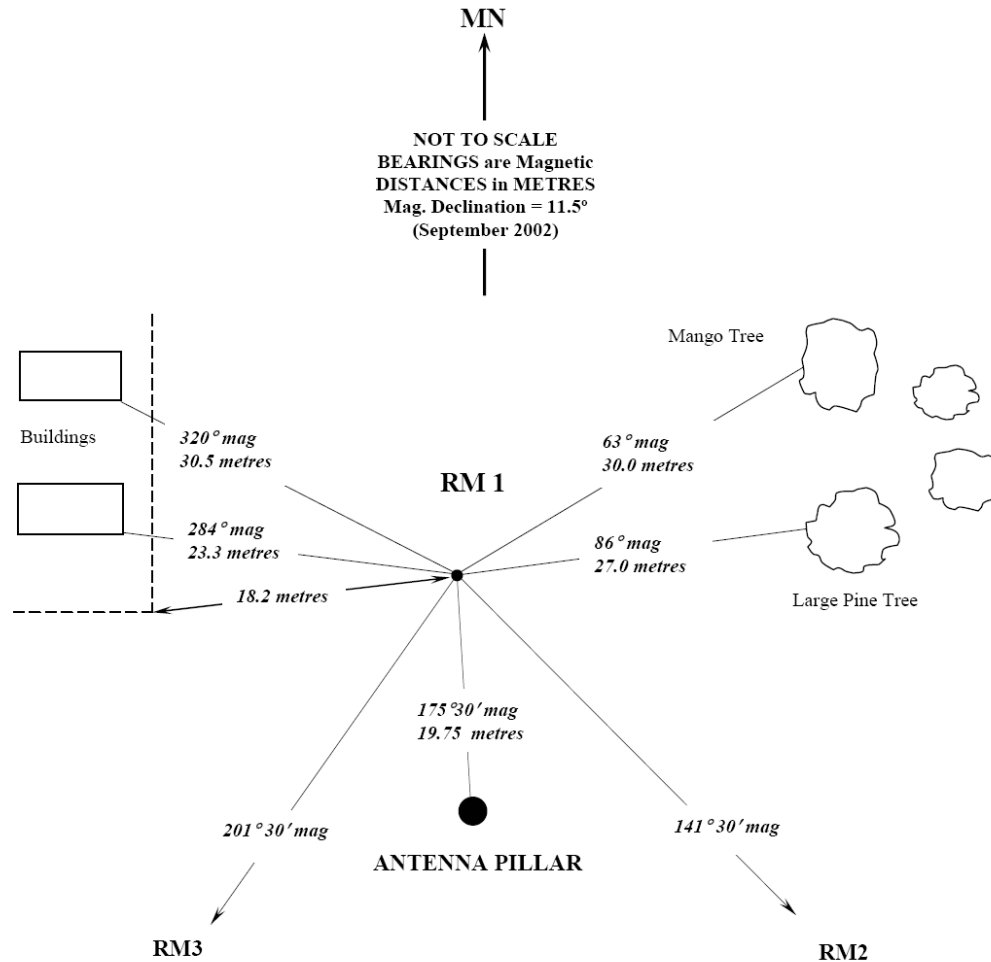
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



VANUATU CGPS Station, Port Vila. – RM 1

REFERENCE MARKS

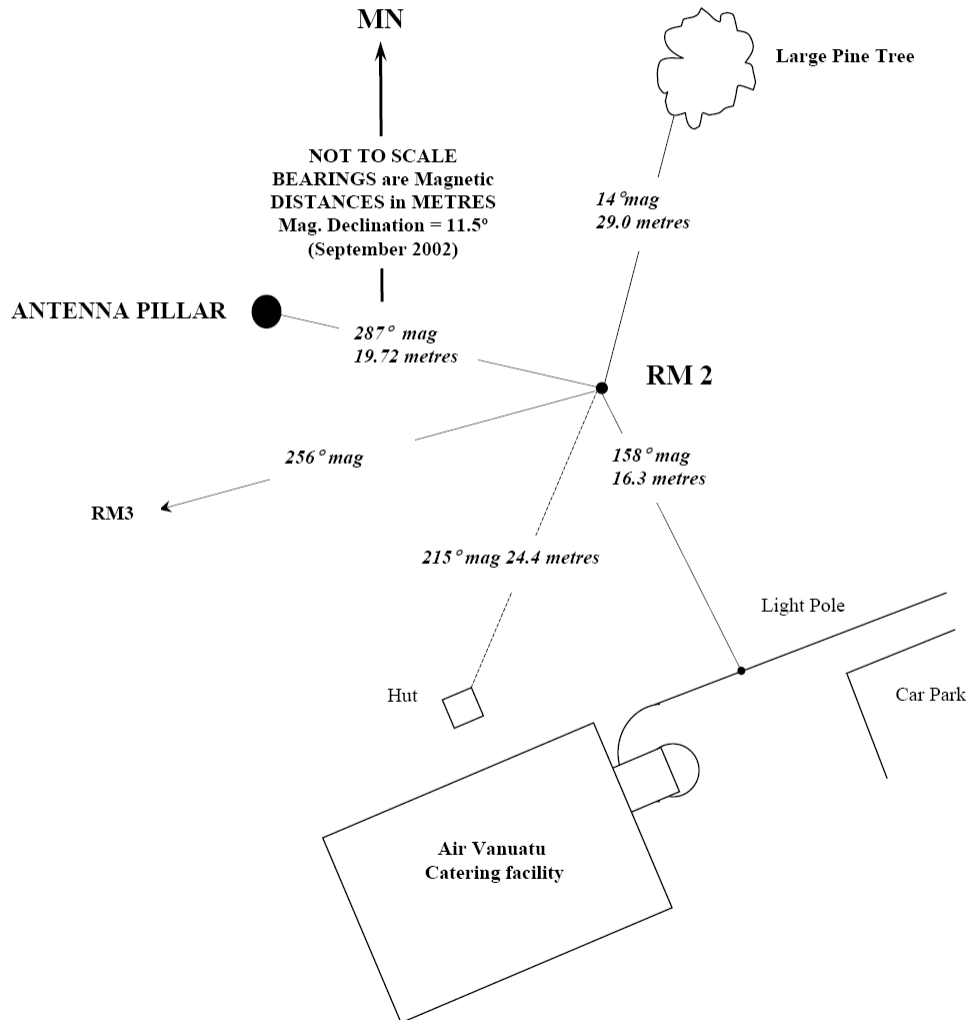
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



VANUATU CGPS Station, Port Vila. – RM 2

REFERENCE MARKS

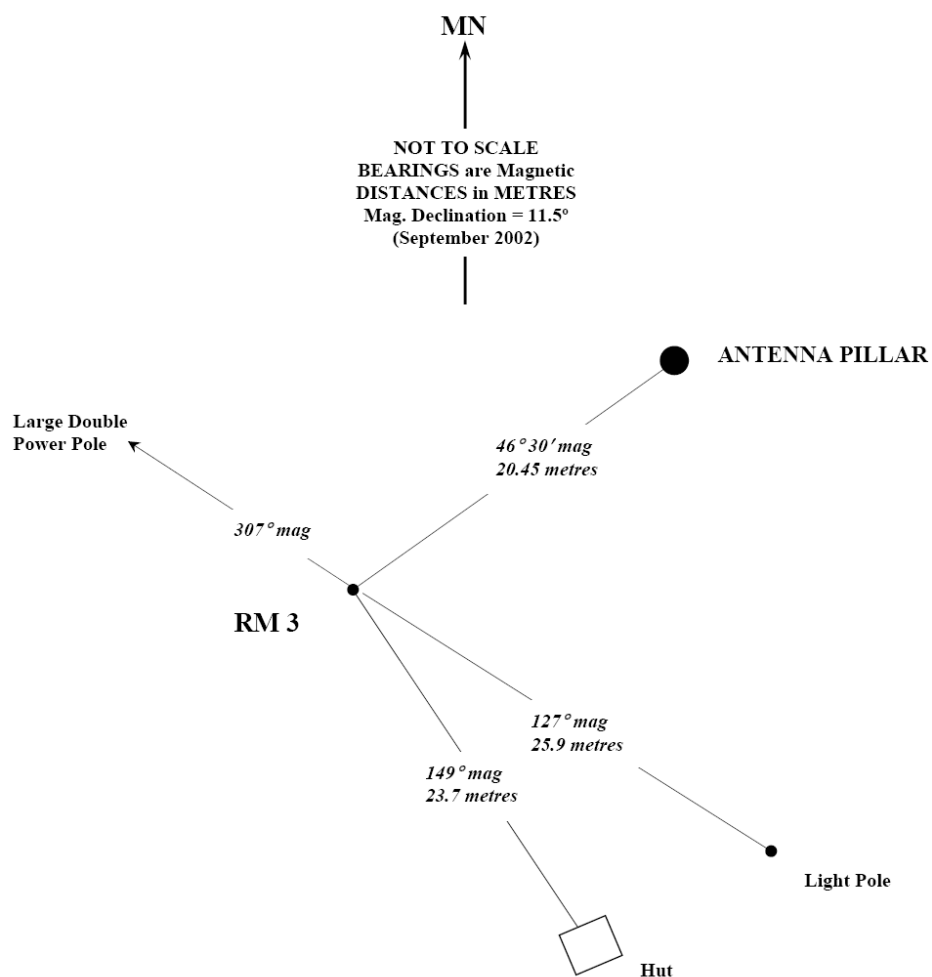
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



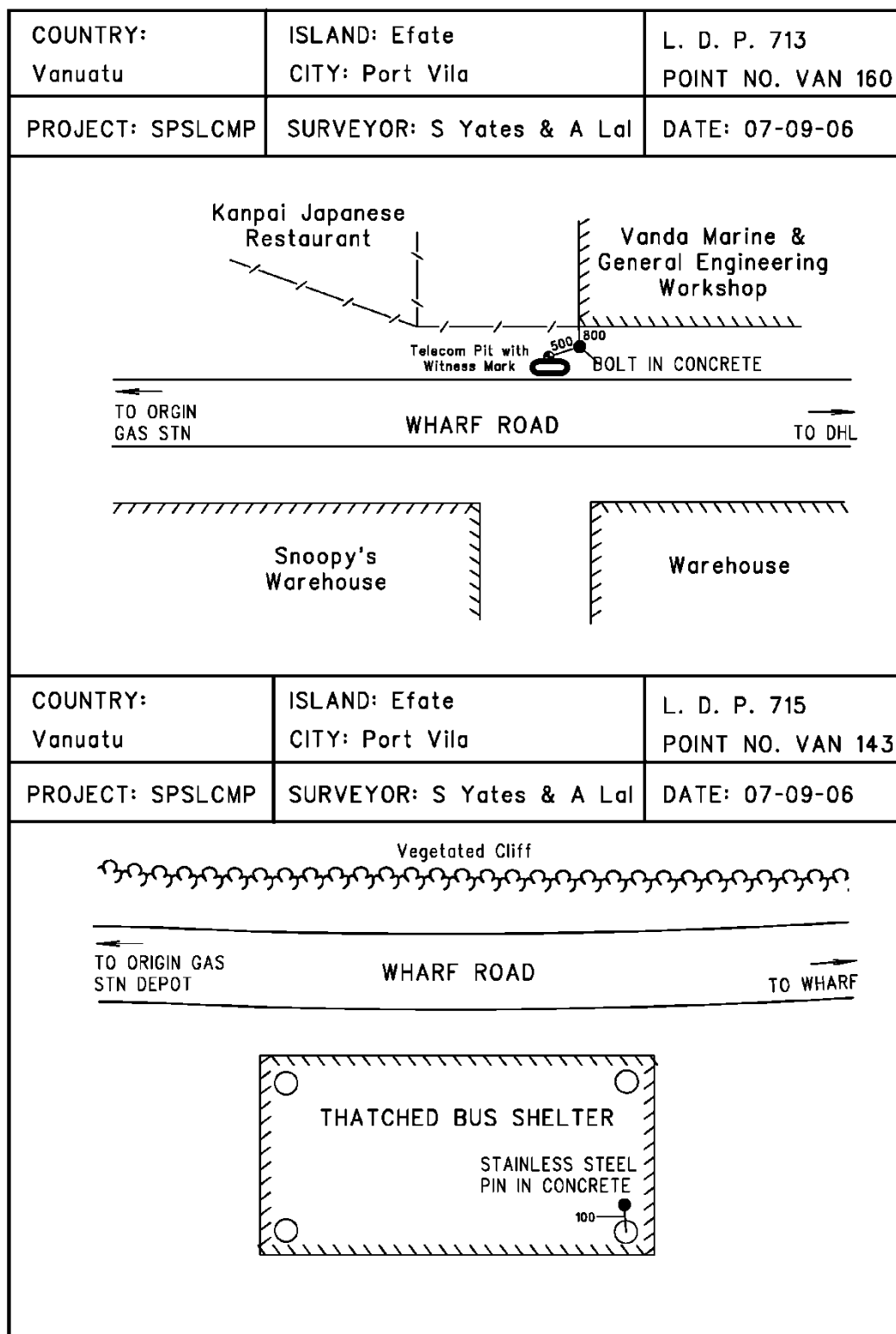
VANUATU CGPS Station, Port Vila. – RM 3

REFERENCE MARKS

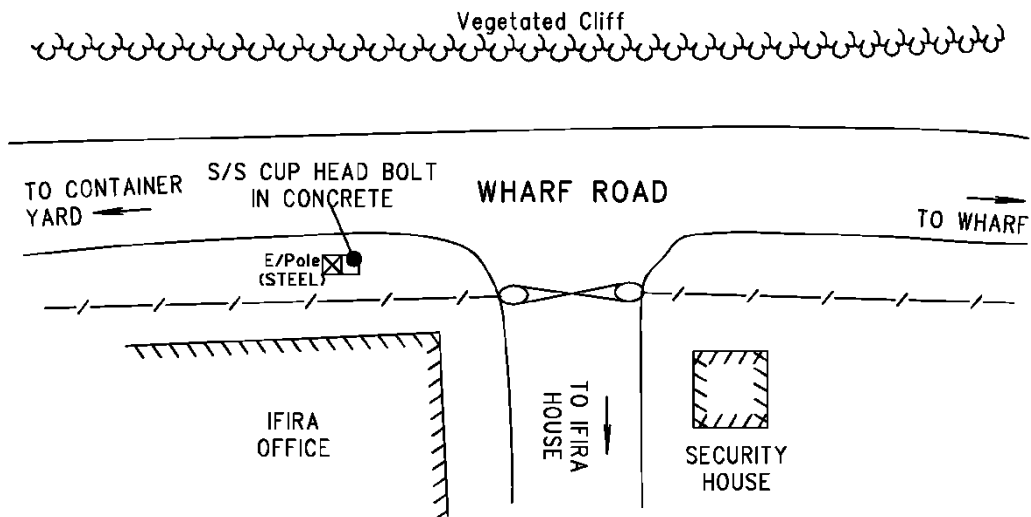
All RM's are capped 20 mm stainless steel rods driven to refusal and protected by 150 mm PVC pipe within circular poly carbonate valve boxes. The valve box lids are approximately 50mm below ground level.



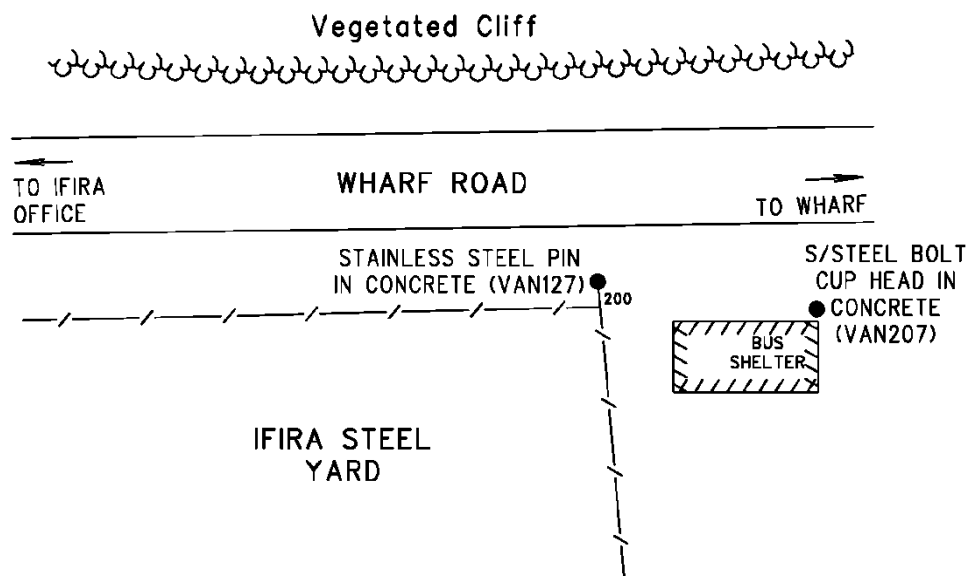
4 Temporary Holding Mark Locality Diagrams



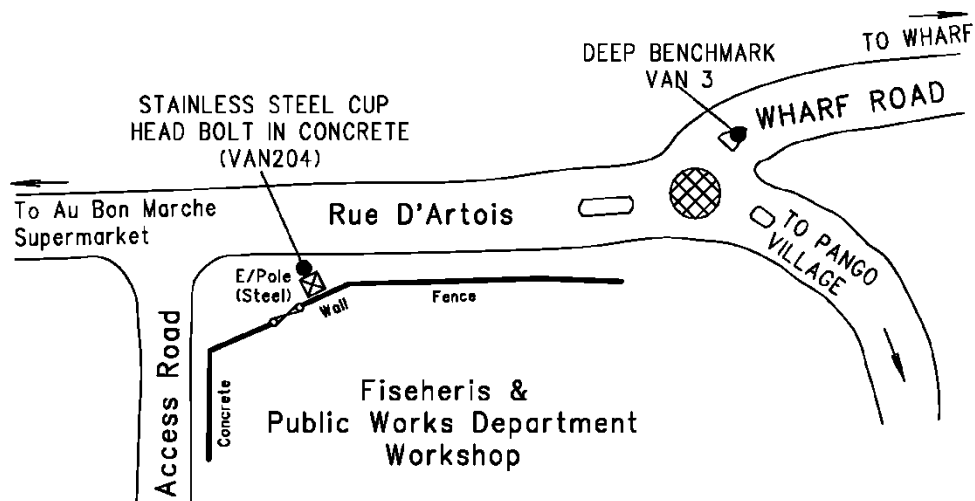
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 813 POINT NO. VAN 200
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 02-04-08



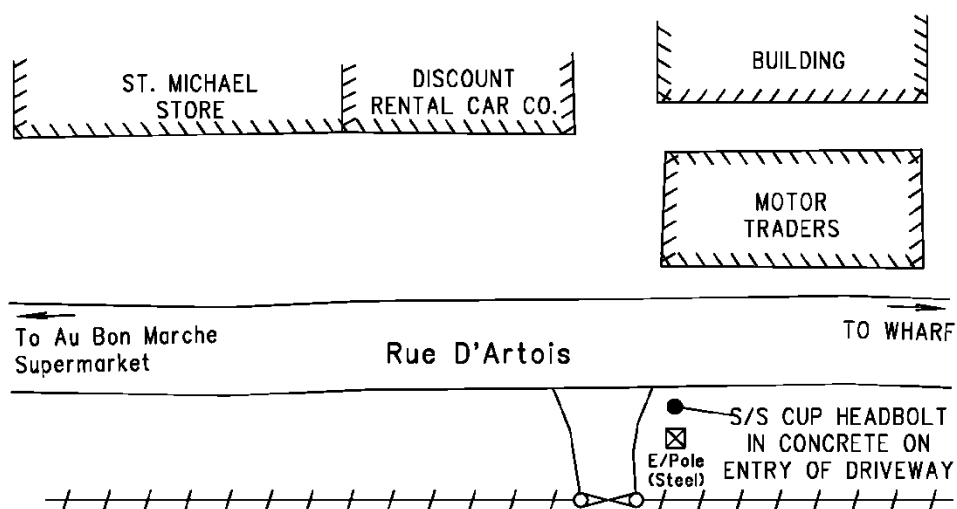
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 720 POINT NO. VARIOUS
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 01-04-11



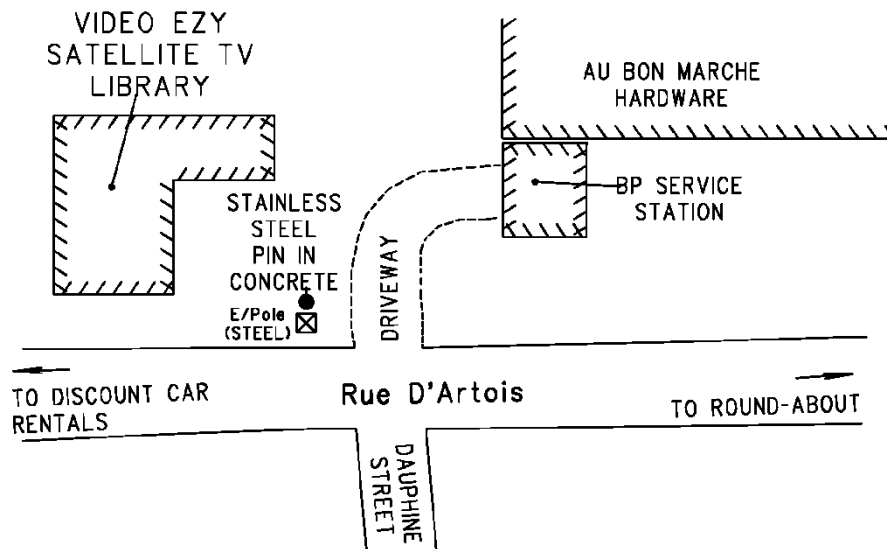
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 910 POINT NO. VAN 204
PROJECT: SPSLCMP	SURVEYOR: A Woods & A Lal	DATE: 29-09-09



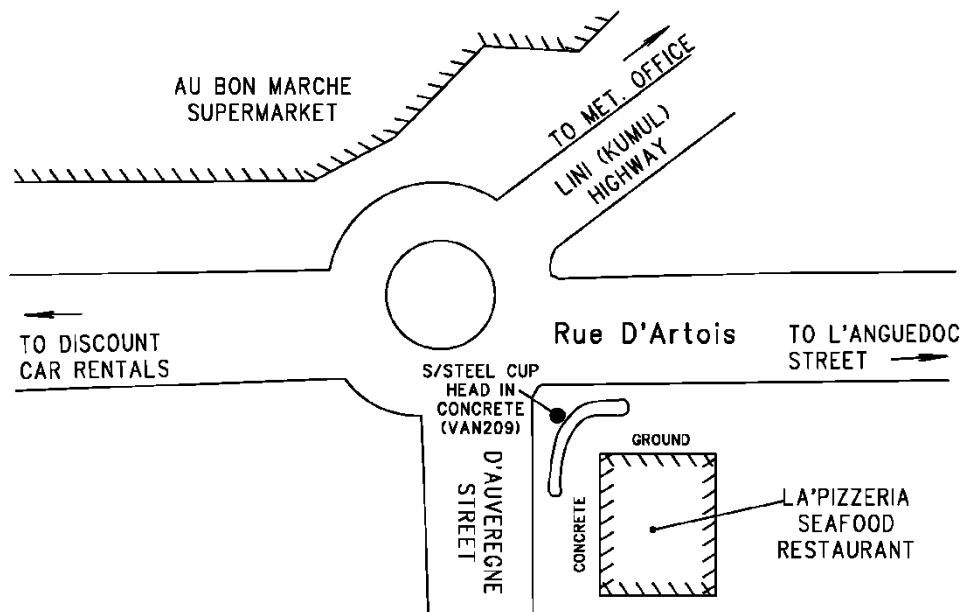
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 814 POINT NO. VAN 201
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 02-04-08



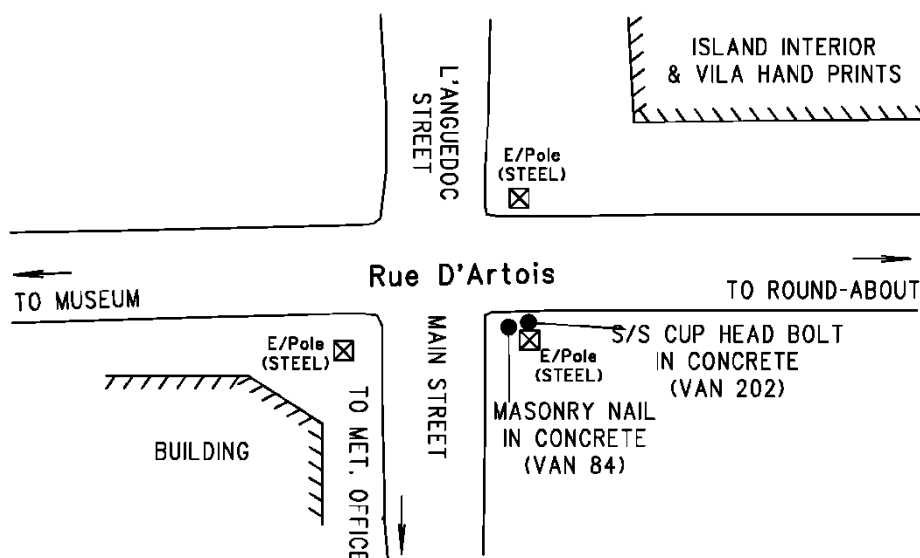
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 725 POINT NO. VAN 154
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 07-09-06



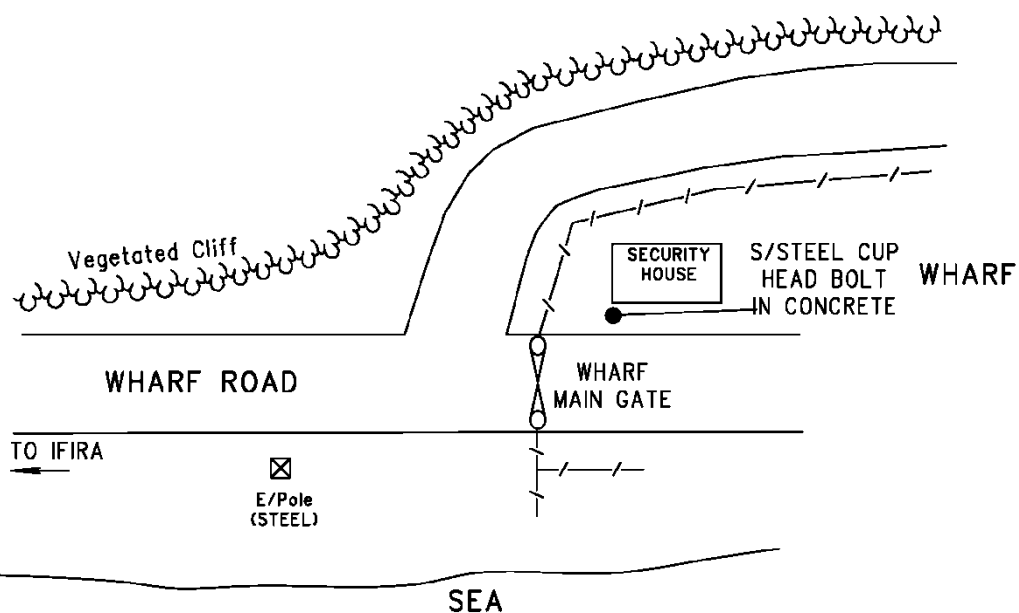
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 726 POINT NO. VAN 209
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 01-04-11



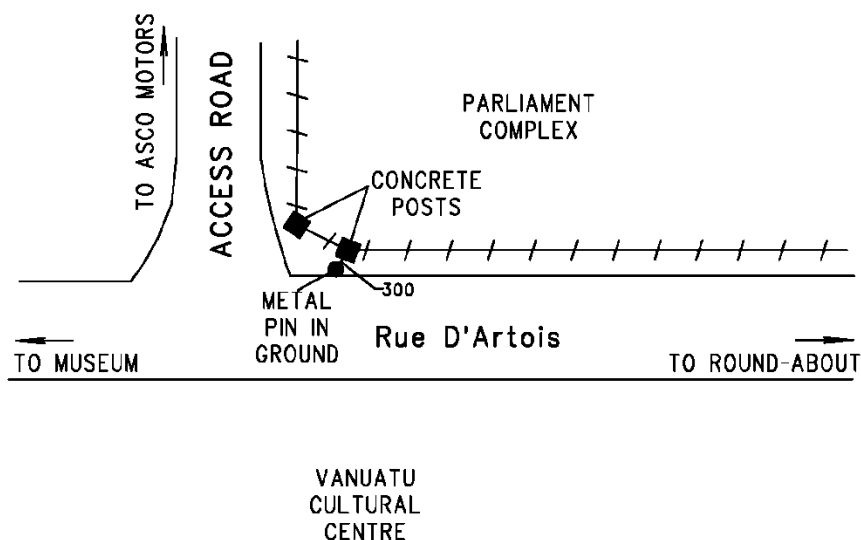
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 815 POINT NO. VAN 202
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 05-04-08



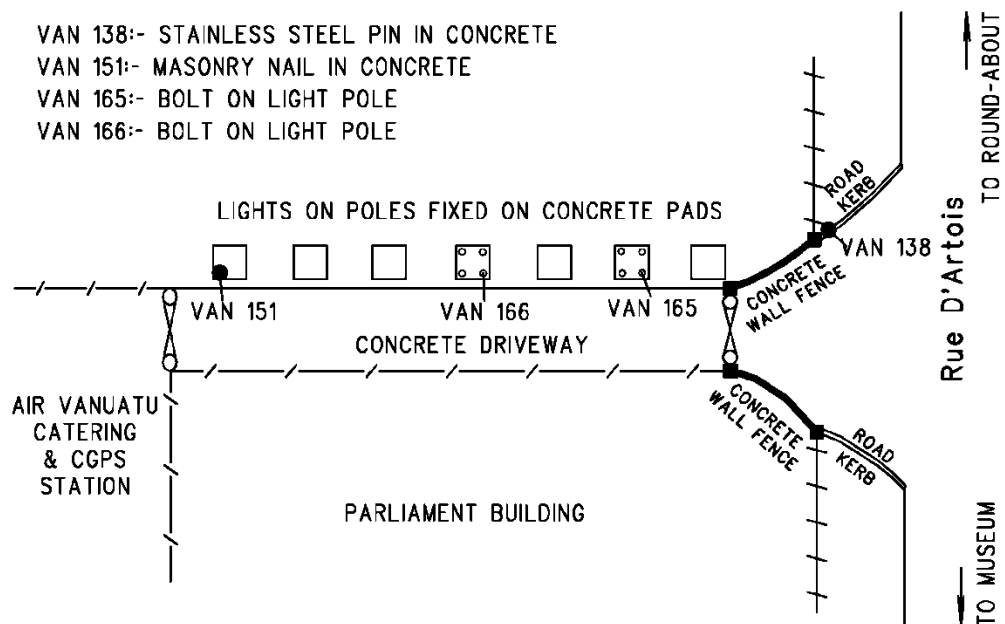
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 911 POINT NO. VAN 208
PROJECT: SPSLCMP	SURVEYOR: A Woods & A Lal	DATE: 01-04-11



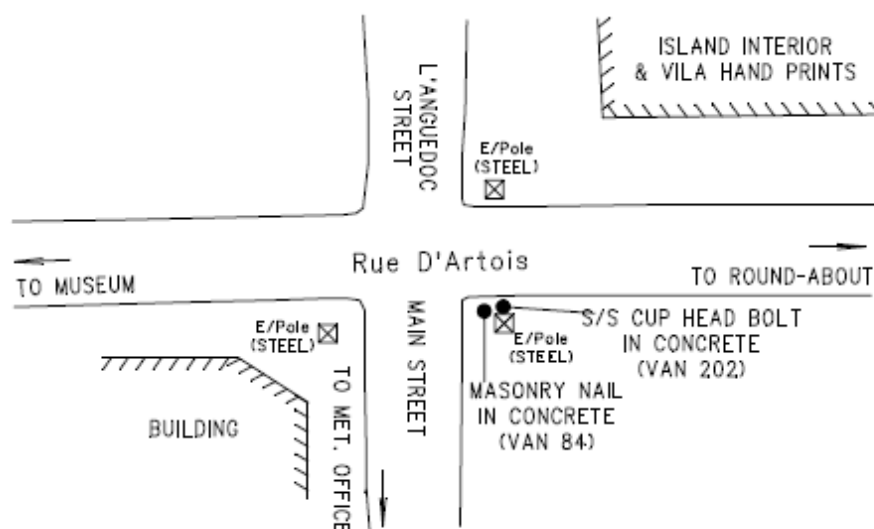
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 731 POINT NO. VAN 164
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 07-09-06



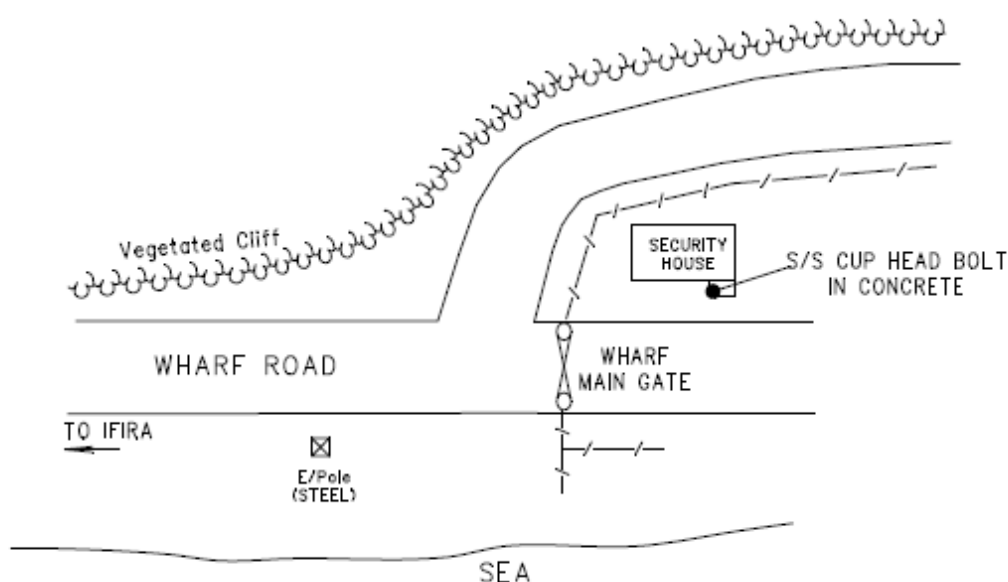
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 732 POINT NO. VARIOUS
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 07-09-06

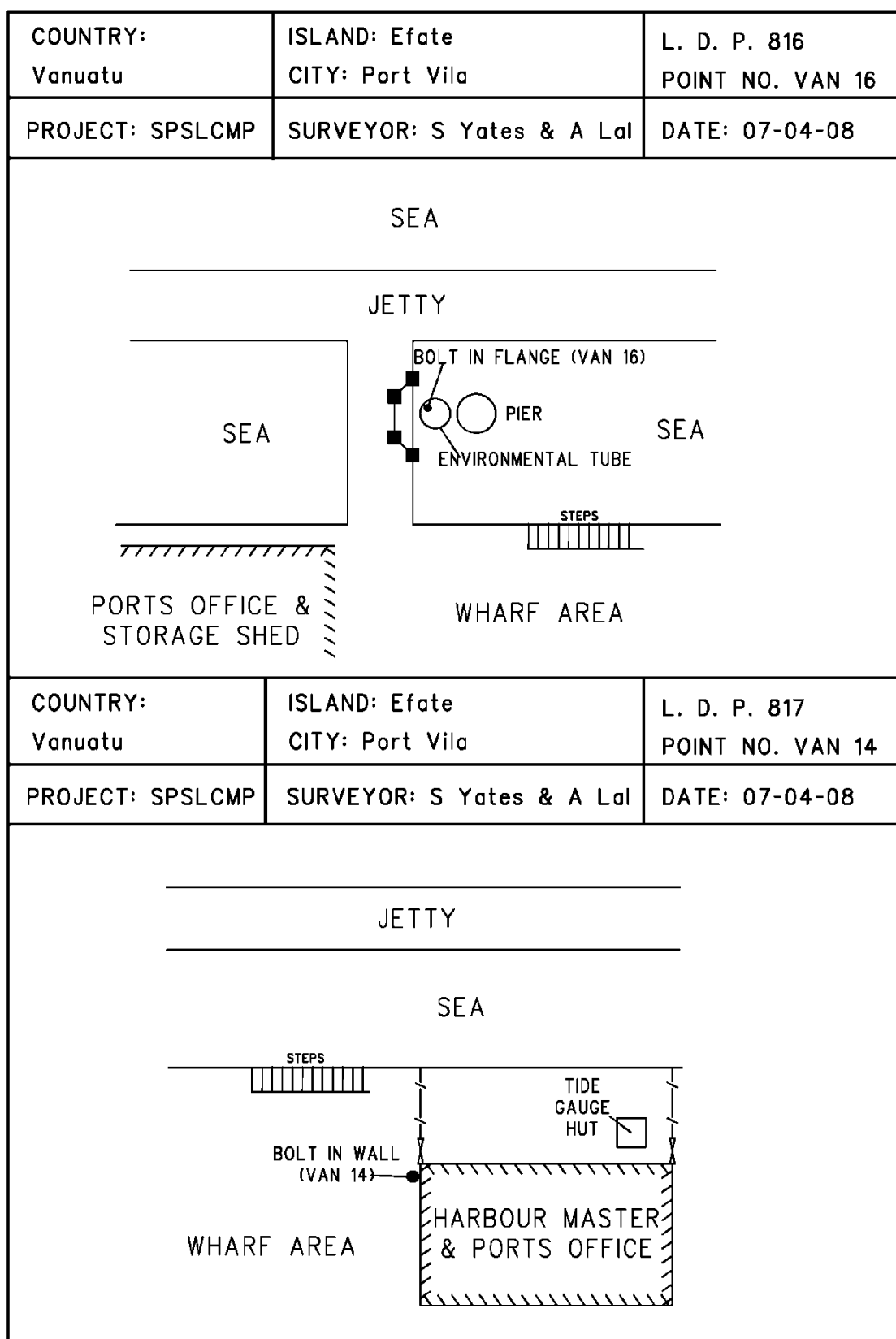


COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 815 POINT NO. VAN 202
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 05-04-08



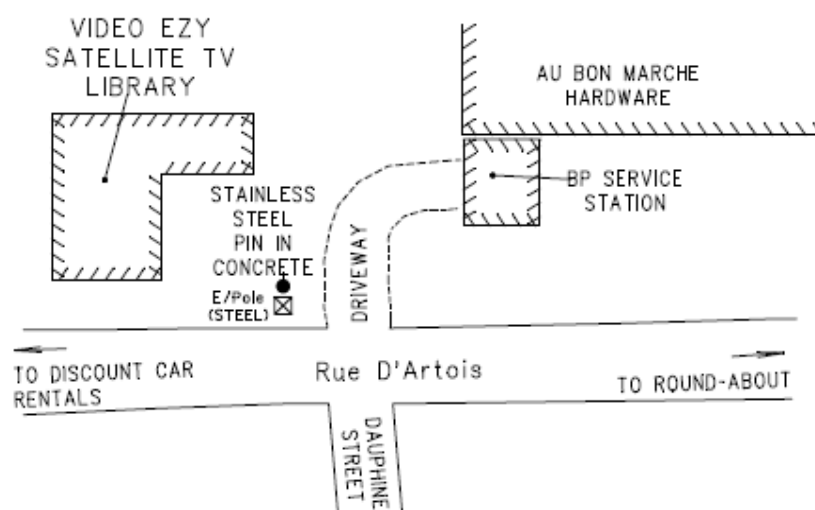
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 911 POINT NO. VAN 203
PROJECT: SPSLCMP	SURVEYOR: A Woods & A Lal	DATE: 29-09-09



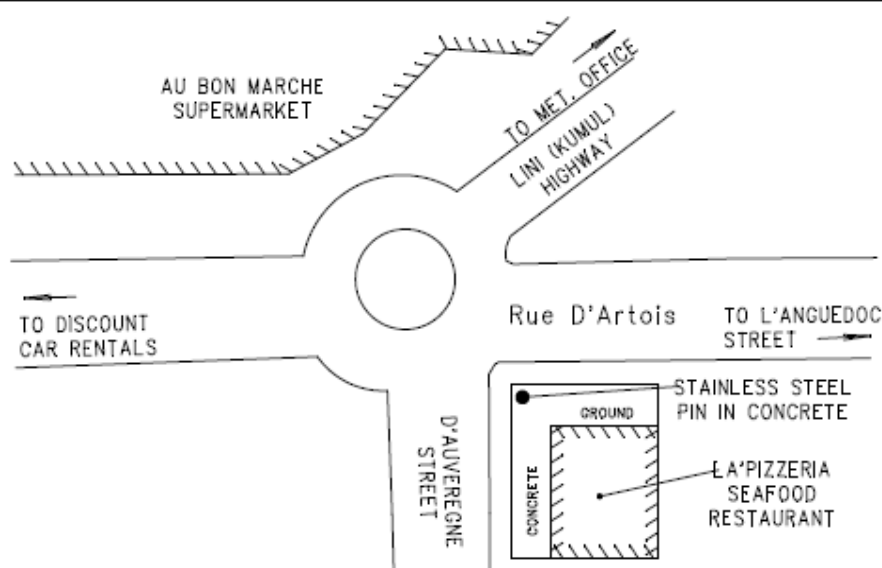


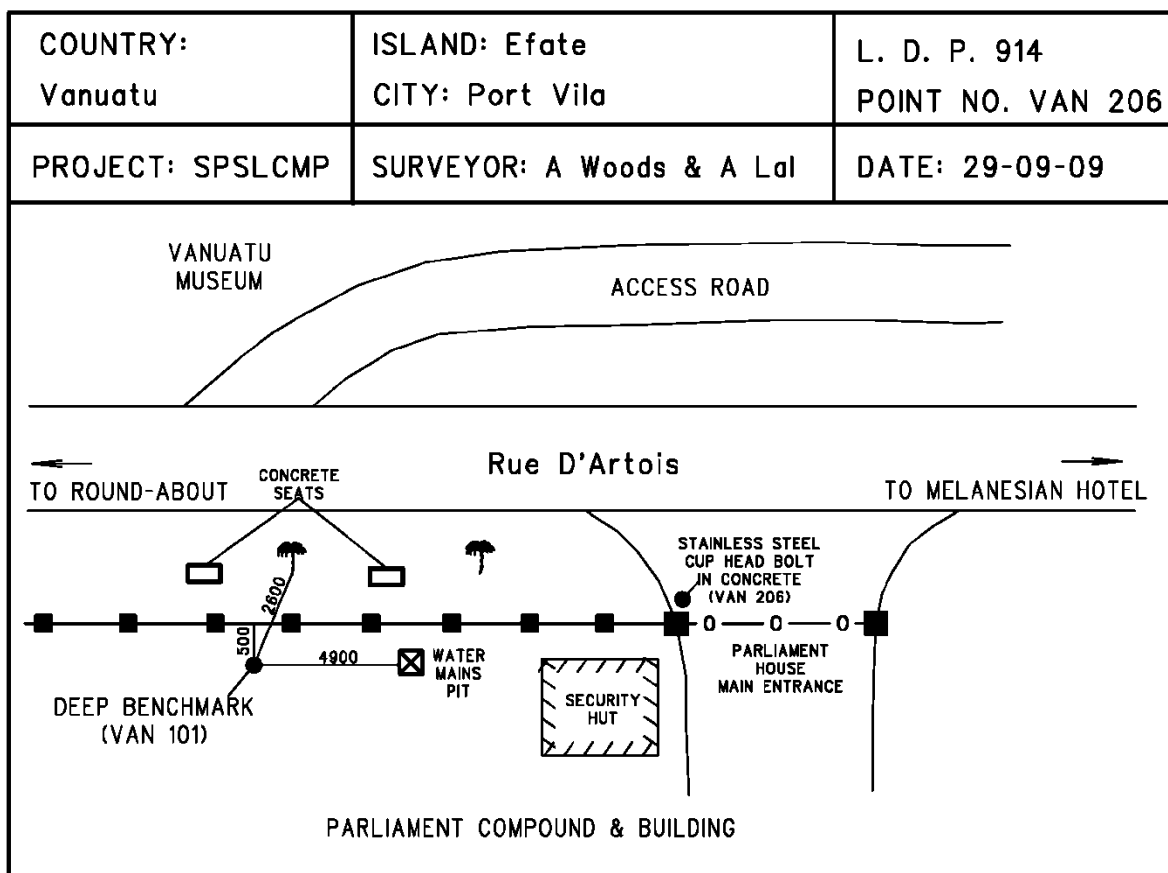
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 912 POINT NO. VAN 132
PROJECT: SPSLCMP	SURVEYOR: A Woods & A Lal	DATE: 29-09-09
COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 913 POINT NO. VAN 205
PROJECT: SPSLCMP	SURVEYOR: A Woods & A Lal	DATE: 29-09-09

COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 725 POINT NO. VAN 154
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 07-09-06



COUNTRY: Vanuatu	ISLAND: Efate CITY: Port Vila	L. D. P. 726 POINT NO. VAN 134
PROJECT: SPSLCMP	SURVEYOR: S Yates & A Lal	DATE: 07-09-06





5 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.