



Landgate Requirements for Control Surveys by Differential Levelling

GSU-03 Version 3



Locate



Value



Secure

Survey Sept 2023 Version 3

Document control

Landgate Requirements for Control Surveys by Differential Levelling, Version 3 – Sept 2023

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1. Connection of Datum

Vertical control surveys shall commence from a verified geodetic survey mark. The SSM or BM used shall be validated using its reference marks (RMs) and the results recorded for each mark used. The validation should ensure mark stability before commencing the survey.

2. Differential Levelling Quality

Differential levelling run should start and finish on the same mark. Any misclose of forward and back level runs of a traverse, including individual bays, must not exceed maximum allowable value as defined by the following formula:

$$r = n\sqrt{k}$$

Where

r = maximum allowable misclose in mm

n = an empirical value describing the outcome (for majority of Landgate Geodetic work it is $n = 12$ between existing geodetic marks)

k = distance in km

It is expected that modern survey level instruments with calibrated staves can achieve better accuracy than $r = 12\sqrt{k}$ and if misclose values are consistently close to the limits, the survey methodology and instruments should be reviewed and checked.

See [ICSM Guideline for Control Surveys by Differential Levelling](#) section 5 for practical example.

3. Differential Levelling Equipment

For equipment requirements refer to [ICSM Guideline for Control Surveys by Differential Levelling](#) section 3.1.1.

4. Differential Levelling Observation Techniques

- Staff readings shall be recorded to at least 0.0001m in digital files.
- The length of any sight must not exceed 80 metres.
- Temperature, at the instrument, shall be recorded at the start of each levelling bay between geodetic marks. Generic Bureau of Meteorology provided values are not acceptable.

- The overall distance of levelling line must be recorded. The difference between the sum of the back sight distances and the sum of the fore sight distances should be less than 10m.
- As a rule, two-way levelling is always required. **One-way levelling is only to be used with the prior approval of Landgate.**

For details of the differential levelling techniques refer to [ICSM Guideline for Control Surveys by Differential Levelling](#) section 3.1.2

5. Calibration of Instruments

- Instrument (level) collimation shall be checked at appropriate intervals and always before commencing a new survey.
- The Two Peg Test shall be applied, and results recorded. Collimation should be corrected where the error exceeds 0.0015m over a distance of 80m.

6. Calibration of Barcoded Staves

- Bar coded staves shall be calibrated within 2 months prior to commencement of Landgate contract. Calibrated staves used in previous Landgate contracts can continue to be used without additional recalibration for 5 years so long as there is no noticeable wear or damage to the staff.
- The staves should be constructed of wood, fibreglass or invar. **The use of aluminium staves is only via prior approval from Landgate.**
- Staff bubbles shall be checked to ensure verticality and adjusted as necessary.
- Regular staff calibration should be performed at Landgate's Boya Site
- Procedures and booking sheets for Boya can be found on the staff calibrations website. <https://staffcalibration0.es.landgate.wa.gov.au>

7. Data Supplied to Landgate

- Levelling plan/sketch.
- Raw digital level files.
- ASCII file of digital level file.
- Completed Abstract of results. See [Appendix A](#) for example abstract. Abstract template available [here](#).
- Job report.
- Additional notes if required.
- Scan of amendments to summary sheets of existing marks, noting reference marks found and any changes to the summary sketch highlighted. These can be hand drawn. See [Appendix B](#) for Example of amendments to summary sketch.

8. Additional Resources

[ICSM Standard for Australian Survey Control Network \(SP1 v2.2\)](#)

[ICSM Guideline for Control Surveys by Differential Levelling \(SP1 v2.2\)](#)

[ICSM Guideline for Adjustment and Evaluation of Survey Control \(SP1 v2.2\)](#)

9. Appendix A – Example of Abstract

SURVEYOR		ABSTRACT OF CLASS C LEVELLING										Calculation File GS	
Level Book No. GS		Job No.		C Const = 1.000000 COE = 0.000010		Inst. No.		Date		Computer			
Temp	Distance km	From BM	To BM	Total Distance From	Difference in Elevation			Calibrated Mean	Adjustment Closure	Elevation Above AHD			Remarks
					Forward	Backward	Mean			Observed	BM	Adjusted	
23	1.00	SSM A	SSM B	1.00	1.000	-1.000	1.000	1.000	0.003	101.000	SSM A	100.000	
23	2.00	SSM B	SSM C	3.00	-3.000	3.000	-3.000	-3.000	0.010	98.000	SSM B	101.003	Allow 0.021
											SSM C	98.010	
23	1.00	SSM B	SSM D	1.00	1.000	-1.000	1.000	1.000		1.000	SSM B	101.003	From Above
											SSM D		
23	1.00	SSM E	SSM F	1.00	1.000	-1.000	1.000	1.000		101.000	SSM E	100.000	GS xx/xxxx/xx
											SSM F		

Figure 1 - Evaluating forward and backwards misclose and adjustment.

SURVEYOR		ABSTRACT OF CLASS C LEVELLING										Calculation File GS			
Level Book No. GS		Job No.		C Const = 1.000000 COE = 0.000010		Inst. No.		Date		Computer					
Distance km	From BM	To RM	Total Distance From	Difference in Elevation			Calibrated Mean	Difference (Allow 0.010)	Elevation Above AHD			Remarks	DBs		
				Forward	Backward	Mean			Original Diff	Original Diff	Dist Diff(m)			Az Diff(m)	
SSM A	RM 1		-0.123	-0.125	-0.124	0.001	-0.125	RM 1							
	RM 2		-0.234	-0.236	-0.235	0.002	-0.237	RM 2							
	RM 3		-0.345	-0.343	-0.344	0.003	-0.347	RM 3							
										RO	14 19 42.48	0 0 0			
SSM B	RM 1		-0.123	-0.125	-0.124			RM 1							
	RM 2		-0.234	-0.236	-0.235			RM 2							
	RM 3		-0.345	-0.343	-0.344			RM 3							
										RO	54 34 51.48	250 15 29			
SSM C	RM 1		-0.123	-0.125	-0.124	0.001	-0.125	RM 1							
	RM 2		-0.254	-0.256	-0.255	-0.018	-0.237	RM 2							
	RM 3		-0.385	-0.383	-0.384	-0.037	-0.347	RM 3							
										RO	4 136 2 24 29.81	4 138 192 21 01	0 0 0	-0.002	0.004
										RO	3 908 4 12 58.81	3 908 4 16 27.61	261 48 29	0.000	-0.004
										RO	3 907 8 35 37.81	3.857 308.25.40	116 11 6	0.050	0.041

Figure 2 - Evaluating RMs, Distances and Azimuths miscloses.

10. Appendix B – Example of Amendments to Summary Sketch

