



STATE CONTROL SURVEY

**SPECIFICATIONS FOR**

**SECOND ORDER  
LEVELLING**

# SPECIFICATION

for

## SECOND ORDER LEVELLING

### NEW SOUTH WALES

#### STATEMENT OF WORK AND LINES TO BE LEVELLED.

- (4) The Consultant shall furnish all personnel, materials, instruments and necessary equipment except as herein provided, and provide all transportation necessary for the satisfactory performance of the contracts. He shall execute and complete the levelling assignment in an expeditious and professional manner and shall deliver to the Surveyor General the original field notes, records of observations, certificates and reports as are required by this specification, and shall observe good survey practice. The survey shall be effected personally by a Registered Surveyor in the form specified to the complete satisfaction of the Surveyor General.

#### STATE CONTROL SURVEY

#### SPECIFICATIONS

- (a) The Surveyor General shall furnish to the Consultant a specific instruction, all necessary illustrative maps, fieldbooks, location diagrams, trigonometrical charts and schedule of stations to be levelled.

FOR

#### TECHNICAL REQUIREMENTS.

#### SECOND ORDER LEVELLING

##### Datum.

All levels shall be based on Australian Height Datum (A.H.D.) as defined by the originating Bench Mark Value supplied by the Surveyor General. Levelling operations shall commence at this originating Bench Mark.

##### Equipment.

All levelling shall be carried out with modern precision levels of the automatic collimation type and with calibrated invar levelling staves. Before commencing the survey, the Surveyor shall notify the Surveyor General of the equipment to be used, which, in general terms, shows the make, model, year of manufacture and the date of purchase of the aforementioned instruments.

(a) Levels

(b) Invar Staves

(c) Staff or Invar tape or steel

##### Method of Levelling.

The levels shall be run along the lines set out in the accompanying schedule. The levelling of each line shall be carried out in both forward and backward direction at substantially different times (preferably one way in the morning and the reverse in the afternoon). The two staff method shall be employed and the interval of time between consecutive sights at each end of the level shall be kept to a minimum. The order of observations shall be alternated between backsight first and foresight first at successive stations (for example, backsight first at odd stations and foresight first at even stations).

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New South Wales

SPECIFICATION

for

SECOND ORDER LEVELLING.

NEW SOUTH WALES.

STATEMENT OF WORK AND LINES TO BE LEVELLED.

1. (a) The Consultant shall furnish all personnel, materials, instruments and necessary equipment except as herein provided, and provide all transportation necessary for the satisfactory performance of the contracts. He shall execute and complete the levelling assignment in an expeditious and professional manner and shall deliver to the Surveyor General the original field notes, records of observations, certificates and reports as are required by this specification, other written advices and sound survey practice. The survey shall be effected personally by a Registered Surveyor in the form specified to the complete satisfaction of the Surveyor General.
- (b) The Surveyor General shall furnish to the Consultant a specific instruction, all necessary illustrative maps, fieldbooks, location diagrams, trigonometrical charts and schedule of stations to be levelled.

TECHNICAL REQUIREMENTS.

2. Datum.

All levels shall be based on Australian Height Datum (A.H.D) as defined by the originating Bench Mark Value supplied by the Surveyor General. Levelling operations shall commence at this originating Bench Mark.

3. Equipment.

All levelling shall be carried out with modern precision levels of the automatic collimation type and with calibrated invar levelling staves. Before commencing the survey, the Surveyor shall notify the Surveyor General of the equipment to be used, which, in general terms, means the make, model, year of manufacture and the date of purchase of the undermentioned instruments.

- (a) Level
- (b) Invar Staves
- (c) Steel or invar tape or band

4. Lines of Levelling.

The levels shall be run along the lines set out in the accompanying schedule. The levelling of each section shall be carried out in both forward and backward direction at substantially different times (preferably one way in the morning and the reverse in the afternoon). The two staff method shall be employed and the interval of time between consecutive sights at each set up of the level shall be kept to a minimum. The order of observation shall be alternated between backsight first and foresight first at successive stations (set-ups), for instance, backsight first at odd stations and foresight first at even stations.

5. Bench Marks.

The Contractor shall locate Bench Marks as placed and effect levelling to each of such marks. Where any Bench Mark is destroyed, damaged or not located, the circumstances are to be reported to the Surveyor General. Where an alternate Bench Mark is established by arrangement with the Surveyor General, such should conform, as closely as possible, to the type of mark placed originally. Each alternate Bench Mark is to be fully described in the field level book.

6. Recovery Data.

The Contractor should examine the numbering of each Bench Mark to ensure that such agrees with the detail shown on the diagram, sketch or description provided. He should also annotate the diagram or sketch with any further information to facilitate location in the future.

7. Consistency.

The two levellings of each section between Permanent Bench Marks shall not differ by more than  $0.008 \sqrt{\text{km}}$  where km is the distance between Permanent Bench Marks in kilometres.

8. Records.

A Record of all field observations shall be written in ink in the field book provided. No erasures, blotting out or overwriting should be made in the field book. Incorrect readings may be lightly ruled in ink, with the corrected field reading noted in ink on the next line below the cancelled reading.

Only original notes will be accepted. Transcription of original notes is expressly forbidden.

No adjusting of recorded readings shall be made. Final adjustment of levels to a common datum will be arranged by the Surveyor General.

Any subsequent notations in the field level books, other than actual observed readings, are to be neatly made in pencil to avoid confusion with field readings.

Where a section of levelling has to be repeated an entirely separate record is required with the appropriate cross reference and cancellation of the superseded data.

Location sketches to adequately define the general location of each line of levels shall be drawn in each field level book.

9. Reports.

On completion of the work the Consultant shall supply a report to the Surveyor General on the whole of the survey. The report, neatly bound in a properly fitted folder, shall include:-

- (i) An appropriate diagram of the survey showing the approximate locations of permanent bench marks in relation to the local road system.

- (ii) A list of the differences in level between successive bench marks as determined by the two or more levelling runs. Where any run has been rejected the list should be prominently noted.
- (iii) The adopted mean value of the observations in each section.
- (iv) Maps, diagrams, sketches as provided originally with the instruction.

10. Certification.

At the conclusion of work each day the responsible Surveyor shall initial and date every level book page on which observations have been recorded during the day. Each level book and all reports required in the terms of this specification shall be certified by the Surveyor.

11. Instruments.

The consultant shall ensure that all equipment used is maintained in adjustment during the survey. Vertical collimation error of the instruments should at no time exceed four seconds of arc. Field tests for vertical collimation error shall be made at the commencement and completion of the contract and at intervals not exceeding thirty kilometres during the progress of the work. The consultant will assume full responsibility for the performance of the level instrument used.

All field tests are to be fully recorded in the field books and the residual errors before and after adjustment should be noted. A complete page of the field level book is to be used for each vertical collimation test. A method of collimation check is detailed in appendix 'A' attached hereto.

12. Staff Calibration.

All invar staves shall be calibrated and the certificate made available when required.

13. Use of Automatic Collimation levels.

At each setting the instrument should be levelled by the circular bubble within the tolerance laid down in the manufacturer's handbook. The level must always be set firmly so as to ensure complete stability during observations. The circular bubble must be in precise adjustment at all times.

To mitigate systematic error due to dislevelment of the horizontal plane definition, the following routine should be followed:-

- (i) Ensure that circular bubble is in the correct adjustment and the instrument is levelled carefully at each station.

(ii) At each alternate bay, level the instrument with telescope pointing in a similar direction. Thus at 1st and 3rd stations the telescope should point towards the backsight and at 2nd and 4th stations the telescope should point towards the foresight when levelling the instrument. When staffmen are 'leap frogging', this is resolved by pointing the telescope always to the same staff when levelling the instrument.

14. Staves

The staves used must be handled with care and every effort made to preserve the markings from defacement.

15. Lengths of sight.

The length of any levelling sight shall be such as to allow the positive resolution of staff graduations and no sight shall exceed fifty metres. Lengths of Back and Fore sights should be equal. The interval can be determined by tape stadia or other appropriate means. The total lengths of back sights and foresights in each Section of levelling between Bench Marks should balance.

16. Placement of Staves.

The base of each staff should be inspected and kept free of all foreign materials. Metal base plates of a design approved by the Surveyor General are preferred as the staff footing at each change point. Departure from the procedure shall be reported and method use justified. The staff shall be held vertical in accordance with sound survey practice.

17. Time of observation.

Levels shall only be taken when atmospheric conditions allow reading the staff with certainty. If unfavourable conditions are encountered the length of sight shall be reduced until certainty can be achieved.

18. Readings.

The staff readings shall be recorded to the nearest millimetre.

19. Temperature and refraction.

The temperature of the air and time shall be recorded at the commencement, middle and conclusion of each days work.

All sight lines shall clear the intervening ground between the level and staff by at least 0.2m.

20. Holding Marks.

If, for any reason, levelling operations have to be suspended for a period, a substantial and stable holding mark shall be established at the terminal.

When circumstances oblige a holding mark to be in use overnight or for longer periods a subsidiary Bench Mark shall be established and detail fully documented in the field book.

21. The same staff must be used on the bench mark at the end of each section. To achieve this, the number of change points must be odd, and where no change point is needed, the same staff should be used on both marks.



Instrument No. Askania  
 Staff No. (A) 1749  
 Staff No. (B) 1150  
 Observer  
 Date 3.4.74  
 Weather Sunny  
 Temperature 24

Secondary Levelling

Example Collimation Adjustment

- at (1) sight A (long sight) & read/record
- sight B (short sight) & read/record
- at (2) sight A (short sight) & read/record
- sight B (long sight) & read/record

(1) 40m Staff A 1.632 m  
 4m Staff B  $\frac{1.302 \text{ m}}{0.331}$

(2) 4m Staff A 1.684  
 40m Staff B  $\frac{1.361}{0.323}$  .008 is collimation error. Carry out adjustment.

(2) Reset as necessary on long sight (Staff B) & record

40m Staff B 1.356  
 4m Staff A  $\frac{1.684}{0.328}$

(1a) 4m Staff B 1.326  
 40m Staff A  $\frac{1.654}{0.328}$

Do not adjust if  
 0.002 or less

