TECHNICAL INSTRUCTIONS

29.194 SURVEY CAMP

BATHURST - DECEMBER, 1983

SCHOOL OF SURVEYING

THE UNIVERSITY OF NEW SOUTH WALES

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Technical Instructions

CONTENTS:

I. GENERAL

1. SURVEY PROJECTS

The survey projects - field astronomy, triangulation, trigonometric levelling, ground control for photogrammetry, land use survey and cadastral survey - have been chosen so that the work involved will consolidate the third year class material. At the same time, the projects serve to introduce the fourth year. The technical programme, which includes one week of supervised "office work" on campus, can be completed well within the times allocated, providing the weather is suitable.

2. ORGANISATION

2.1 Computation Days

Computation days have been interspersed between the actual field days in order to provide sufficient time to process the field measurements at the camp site. These days should be utilised for this purpose only.

2.2 Use of Equipment

In order to make maximum use of the equipment and the time available, the class will be divided into groups of three. A work schedule is attached which should be strictly adhered to. However, should a group complete a project early, then it may commence work on any other project if the necessary equipment is available.

2.3 Use of Computing Facilities

A HP 9810 calculator, together with cassette memory, will be available at camp and on campus; TI59s and printers will also be available. On campus, the programme SVY041 for computations on the CDC Cyber computer will be available for the parametric solution. You will be encouraged to write your own programmes for the reduction of your work.

2.4 Use of Vehicles

Students will NOT use private vehicles on private property, except with the express permission of a supervisor and the owner of the land in question.

3. PROJECTIONS

Two distinct projections will be used in the calculations. These are the Australian Map Grid (AMG) and the Integrated Survey Grid (ISG) systems. The ISG system should be adopted for all projects except the triangulation survey, where the AMG system shall be chosen. Both projections refer to the Australian National Spheroid (a = 6378160m and f = 1:298.25). The elevations are on Australian Height Datum (AHD).

4. SUBMISSIONS

4.1 Report

Separate reports on each of the survey projects performed at camp shall be submitted by the due dates given in Sec. I-4.3. These reports are to contain the following:

(a) an index page;
(b) a summary of results;
(c) an abstract of all field measurements;
(d) reductions, calculations and adjustments;
(e) explanatory remarks to clarify procedures adopted; and
(f) appropriate cross-referencing where data used in one project is derived in another part.

4.2 Field Notes

The field notes and field books shall also be submitted.

4.3 Deadlines

The deadlines for submissions to the Technical Director will be 1600 hours on December 23, 1983. An extension of time WILL NOT be granted under any circumstances.

5. DATA

5.1 Projections

QUANTITY	AMG	ISG
Zone Width	6°	2°
Zone Number	55	55/3
Central Meridian	147°E	149°E
Scale Factor (k_o)	0.9996	0.99994
False Origin - East	-500 000 m	-300 000 m
- North	-10 000 000 m	-5 000 000 m

5.2 Formulae

5.2.1 Arc-to-chord

$$\delta = \frac{(N_1' - N_2')\,(2E_1' + E_2')}{6\,k_o^2\,\rho\nu\,\sin 1''} \qquad \text{[in arc seconds]}$$

5.2.2 Scale factor

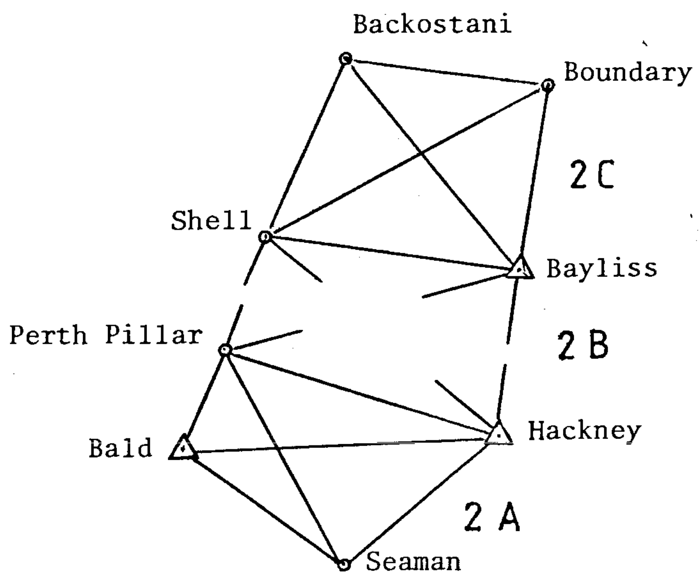
$$\frac{S}{s} = k_o \left[1 + \frac{E_1'^2 + E_1' E_2' + E_2'^2}{6\,k_o^2\,\rho\nu} \right]$$

5.2.3

$$\frac{10^8}{\rho\nu\,\sin 1''} + 0.5083754$$

NOTE: N_1' N_2' E_1' E_2' refer to true coordinates.

5.3 Triangulation



Scheme 2A: Perth-Pillar, Hackney, Seaman, Bald

2B: Shell, Bayliss, Hackney, Perth Pillar

2C: Backostani, Boundary, Bayliss, Shell

5.4 Coordinates and Elevations

5.4.1 AMG

POINT	E (m)	N (m)	HT (m)
Bayliss	740 300.49	6 294 601.30	716.85
Hackney	740 218.93	6 292 453.65	-
Bald	735 930.76	6 292 379.23	851.63
Backostani	738 677.76	6 297 777.36	-

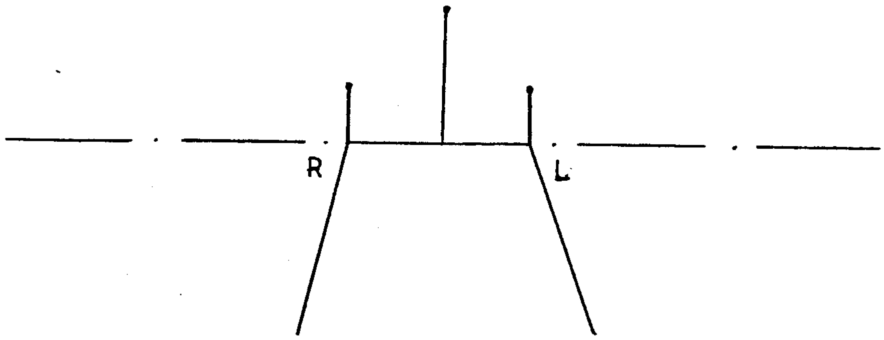
5.4.2 Coordinates in ISG 55/3 system, elevations on AHD

DATA CASSETTE FILE NO.	STATION	EASTING	NORTHING	ELEVATION
90	Red Hill	333 166.56	1 291 080.33	
91	Mulley (CMA)	352 623.70	1 299 490.10	731.76(Top pillar)
92	Durham Court Pillar	361 005.51	1 299 149.74	768.07(Top pillar)
93	Baanya Pillar	350 940.80	1 301 958.80	731.82(Top pillar)
94	Avondale Pillar	350 502.00	1 307 950.10	723.52(Top pillar)
95	Clarke	330 143.97	1 283 996.21	
96	Macquarie	316 673.11	1 275 602.25	
97	Errol	322 236.56	1 284 793.46	
98	Crackersack	338 149.77	1 304 547.17	
99	Edrop	344 963.09	1 309 186.82	
100	Rankin	347 444.18	1 312 180.98	
101	Lowes Pillar	375 182.00	1 281 532.89	1 133.52(Top pillar)
102	Ovens Pillar	372 099.23	1 301 416.35	1 273.90(Top pillar)
103	Rocks Pillar	337 609.29	1 298 393.38	1 038.45(Top pillar)
104	Bald	350 107.74	1 293 874.29	851.63
105	Bayliss	354 432.44	1 296 179.34	716.85
106	El Woodara	342 929.60	1 299 282.28	
107	Cherry Tree	349 031.23	1 299 106.63	827.96
108	Evernden Pillar	350 451.01	1 284 884.82	990.5*
110	Hackney	354 392.26	1 294 031.23	753.0*
112	Hollis	351 552.61	1 290 745.47	787.97
113	Humby	350 537.41	1 299 155.91	788.0*
114	Lenehan	347 131.77	1 292 057.34	812.88
115	Boundary	354 869.26	1 298 610.71	680.5*
117	Shell	351 143.71	1 296 558.49	873.5*
118	Peel	363 578.74	1 307 341.58	878.18
120	Seaman	352 176.26	1 292 479.96	734.5*
121	St. Stanislaus	353 015.28	1 299 583.33	738.36 (see sketch)
122	Three Brothers	336 080.31	1 275 516.46	
124	Williams	348 604.89	1 292 964.50	795.37
126	Panorama	350 822.85	1 297 238.54	874.02(Top pillar)
127	Perth-Pillar	350 579.52	1 295 238.07	879.5*
128	Rutherford	355 518.02	1 303 906.86	701.98
131	Lee Pillar	358 911.85	1 300 003.49	740.00
134	Bushranger Pillar	344 729.91	1 292 362.33	865.37(Top pillar)
135	Oakleigh Pillar	358 450.04	1 303 347.43	771.23(Top pillar)

DATA CASSETTE FILE NO.	STATION	EASTING	NORTHING	ELEVATION
136	Tareen Pillar	358 673.00	1 297 009.00	754.46(Top pillar)
137	Hackney Pillar	354 784.60	1 294 999.64	741.08(Top pillar)
138	Gormans Hill Pillar	354 945.01	1 298 271.82	687.75(Top pillar)
139	SSM2234	351 784.39	1 296 552.98	
140	Cadastral	352 354.25	1 296 421.39	
143	Tarella Pillar	359 894.80	1 315 005.36	
150	Carrawarra	354 088.39	1 305 469.67	
	Carto School (TAFE)	352 495.86	1 299 096.42	710.57
	Backostani	3~~8~~52 749.45	1 299 322.53	717.7

* Rounded to the nearest 0.5m. If higher accuracy is needed, use your own data determined in the trigonometric levelling project.

Sketch: St. Stanislaus - Central Tower



6. ORGANISATION OF TECHNICAL PROGRAMMES

6.1 Projects and Supervisors

IDENT.	PROJECT	DAYS ALLOCATED	SUPERVISORS
1	Reconnaissance & Briefing	1/2	Mr. Pollard
2	Triangulation & Trig. Levelling	2	Mr. Pollard
3	Ground Control for Aerial Mapping	2	A/Prof. Trinder/Mr. Ganeshan
4	Cadastral Survey	2	Mr. Holstein/Dr. Forster
5	Field Astronomy	Nights	Mr. Ganeshan
6	Land Use Survey	1	Mr. Holstein/Dr. Forster
C	Computations		Individual Supervisors
R	Rest Day		

6.2 Directors

Administrative Director - Mr. L.C. Holstein

Technical Director - Mr. J.R. Pollard

6.3 Post-Camp Supervision

In the one week period following the camp prior to report submission, the following staff will be available for consultation at specific times, which they will notify: A/Prof. J.S. Allman, Dr. B.C. Forster, Dr. A.J. Robinson, Dr. J.M. Rueger and A/Prof. J.C. Trinder.

7. WORK SCHEDULE: DECEMBER, 1983

DAY DATE \ GROUP	1	2	3	4	5	6	7	8	9	10	11	12
MON 5	1	1	1	1	1	1	1	1	1	1	1	1
TUE 6	4	4	4	3	3	2A	2A	2C	2C	3	3	3
WED 7	4	4	4	3	3	2A	2A	2C	2C	3	3	3
THU 8	3	3	2A	4	4	4	6	6	6	2A	2C	2C
FRI 9	3	3	2A	4	4	4	C	C	C	2A	2C	2C
SAT 10	C	C	C	C	C	C	4	4	4	C	C	C
SUN 11	2A	2A	3	2C	2C	3	4	4	4	6	6	6
MON* 12	2A	2A	3	2C	2C	3	3	3	3	4	4	4
TUE** 13	6	6	6	6	6	6	3	3	3	4	4	4
WED 14	C	C	C	C	C	C	C	C	C	C	C	C
THU 15	WEATHER DAY											
FRI 16	LEAVE CAMP											
MON TO FRI 19-23	COMPUTATIONS & COMPILATION OF TECHNICAL REPORT. SUBMISSION DUE 4.00 P.M. ON 23/12/83											

	TASK
1.	Travel to Bathurst, Briefing, Reconnaissance
2.	Trig. & Trig. Levelling; 2A - Area A, 2C - Area C
3.	Ground Control for Aerial Surveying
4.	Cadastral Surveying
5.	Field Astronomy - evenings until exercise completed
6.	Land Use Survey
C.	Computations
*	Visit C.M.A. (a.m.)
**	Social Occasion (p.m.)

II. PROJECTS

1. RECONNAISSANCE

This exercise will involve a familiarisation of the camp area and surrounding control network, erection or dismantling of beacons, and the preparation of access and recovery sketches. (See Appendix A).

Details will be discussed during the briefing session, which is to be given at 1.00 p.m. on the day of arrival at the camp.

2. TRIANGULATION AND TRIGONOMETRIC LEVELLING

2.1 Equipment

1 x 1"	Theodolite + Tripod
1	Plumbob with long string
1 x 30m	Tape
1	Umbrella with steel base
1	Hammer

2.2 Project

2.2.1 Triangulation

On all four stations of the quadrilateral, each group member shall measure four arcs of horizontal directions to the stations of the braced quadrilateral which is specified in the network schedule.

Before commencing the daily observations and before leaving the site, all the signals must be checked for verticality, and the offsets in E-W and N-S direction entered in a table in the camp.

At each station, the reduced observations shall be statistically tested by the Variance Ratio Test to confirm the hypothesis that the internal precision is consistent with previous experience with 1 second theodolites, i.e. a sample of a population with a variance of ($6.25\ sec^2/2$) for the mean of Face Left and Face Right.

On completion of the field work, the observations will be corrected for arc-to-chord. Students shall check quadrilateral observations for angular and side equation closures, tolerances for which will be specified by your Supervisor. Observations will then be adjusted by the "parametric" method to give corrections to the observations, the station coordinates and the error ellipses. The variance of the observations is given by:

$$\sigma^2 \text{ mean} = \left(\frac{6.25}{2n} + 0.3\right) sec^2$$

where n is the number of arcs and 0.3 is an external component to allow for plumbing and atmospheric uncertainties. Each student is to use his own observations in the performance of the above tasks. Refer to Appendix B for the form of the observation equations and other details.

(7) All surveys shall be made in accordance with the Survey Practice Regulations.

See ss 8-13 Survey Practice
s 21 Country Surveys
ss 25-29 Redetermination of Boundaries
ss 41, 42A-44 Accuracy
ss 47-48, 50-53 Field Notes
ss 54-57 Plans

Reference should also be made to the N.S.W. Crown Lands Office Survey Directions, 1981.

(8) Check all equipment before commencing survey. In particular, check you are familiar with the operation of your particular EDM instrument and that each tribrach is in adjustment. You are required to standardise your steel band with a nominated baseline, located in the racetrack area.

(9) Traverses should be connected into at least two of the following control marks - SSM 2234 "CADASTRAL" and "CADASTRAL 2". The location of "CADASTRAL 2" will be available at survey camp.

(10) Traverse closures and final adjusted coordinates of boundary corners should be approved by the supervisor before traverse marks are removed.

(11) Every mark shown on a plan which refers to the boundaries of the subject property must be shown as either "found", "found (disturbed)", or "gone".

(12) You will be required to calculate radiations to nominated "missing" corners on the area under survey.

SUBMISSIONS

The report is to comprise both an individual and group submission.

Group Submission:

(1) Field notes - final adjusted bearings and distances of all observations must be shown in the field notes, preferably in a different colour.

(2) Calculations and report - this will include the traverse misclosures and adjustments, the calculation of boundaries, the comparisons, the coordination of the boundaries and the work sheet.

(3) A graphical metric interpretation of the old system metes and bounds description.

Booking observations should conform with the example shown in Appendix B.6. Special booking forms will be supplied and your supervisor will advise you on the booking method to be adopted.

2.2.2 Trigonometric levelling

Each student will measure two arcs of vertical angles to the remaining stations of the braced quadrilateral before and after the horizontal direction observations. The measurement of height of instrument and signal is important.

The measurement of two arcs of vertical angles should be carried out in the following sequence: $O_L\ O_R\ O_R\ O_L$, where O_L (O_R) is the reading of the centre hair on Face Left (Right). Some simple meteorological observations will also be required. Special booking forms will be supplied.

The individual height differences are to be calculated using the following formulae (dimensions are in metres):

$$\Delta h = d\left(1 + \frac{H}{R}\right)\left[\cot Z + \frac{(1-k)\,d}{2R}\right] + (HI - HO)$$

where

- h is the height difference;
- d is the spheroidal distance at sea level;
- H is the altitude of observation station;
- R is the radius of spheroidal section (6369 700m for this project);
- Z is the observed zenith distances;
- k is the refraction coefficient (+0.14 for this project);
- HI is the height of instrument; and
- HO is the height of object.

The spheroidal distance d should be computed from the given I.S.G. coordinates (see I-5.4.2).

The mean height difference for each line will then be entered into a least squares adjustment to produce the adjusted heights of the stations. The variance of a mean height difference from reciprocal observations should be estimated by the formula:

$$S^2_{\Delta h} = 0.20\ D^2\ (S^2_z + 0.4\ D^2)$$

where

- $S^2_{\Delta h}$ is the variance of the mean height difference in cm^2;
- D is the distance in km; and
- S_z is the estimated standard deviation of the zenith distance in seconds of arc (±2" to be assumed for this project).

2.3 Submission

Each student shall submit for assessment the field notes, calculations and a report on the project, including a discussion of the achieved precision.

The submissions for the project are to be prepared in accordance with Section I-4 of these instructions.

3. GROUND CONTROL FOR PHOTOGRAMMETRY

3.1 Equipment

1 x 1"	Theodolite + Tripod
1	100m Steel band
1	EDM instrument + Ancillary equipment (when available)
1	Pair of photographs
1	Pocket stereoscope

3.2 Ground Control

The task at camp will be to reconnoitre, identify and fix two ground control points whose approximate positions will be marked in the photograph by the supervisor. See Appendix C1 and C2 for examples of typical control points. The points should be fixed in plan and height with a precision of 0.10m or better, but separate plan and height controls may be chosen in each of the two locations if a suitable single point cannot be found.

The control points may be fixed by traverse, triangulation or resection, provided that there are redundant observations for each point fixed. The calculation of the coordinates must include all observations that are made. Repeated arcs or repeated measurements of the same distance will not count as redundant observations. This means that there must be an independent geometric check for each point.

All trig. stations may be used for fixing the photo control with the exception of those having the following data cassette file numbers: 104, 105, 107, 110, 112, 113, 114, 115, 117, 120, 121, 124, 140. This restriction may be reviewed when the exact location of planned new photography is known.

3.3 Submissions

A single group report will be submitted including reconnaissance sketches, computations and field notes. Photo identification diagrams and summary of coordinates should be submitted by each person in the group.

4. CADASTRAL SURVEY OF CAMP BOUNDARY

4.1 Object

The purpose of the exercise is to redefine the boundaries for the consolidation of title and Real Property Application of nominated land adjacent to Karingal Village, and to coordinate the corners in the I.S.G. system. Information relating to procedures can be found in Appendix D.

4.2 Equipment

1 x 10"	Theodolite + Tripod
1	100m Steel band + Spring balance + Thermometer
1	Short Range EDM instrument + Accessories (available 1 day only for selected lines)
2	Sighting Targets + Tripods + Tribrachs

Plus other necessary aids.

4.3 Survey

The method of survey will consist of a loop traverse around the boundaries together with connections to two of the listed controls. Cutting of scrub an timber is not permitted. Please take care not to break branches or stand on any seedlings, especially if working on the south side of the Campsite. Traverse lines must therefore be selected so as to be clear of all obstacles.

Details on survey techniques to be employed will be discussed at a briefing session prior to the commencement of the project.

4.4 Computations

The control survey should be adjusted by an appropriate method. Projection distances will be derived and shown on the plan of survey. The report on the project will contain a comparison between measured ground distances (reduced for slope) and distances shown on the relevant survey plans. At a final stage in the computations, I.S.G. coordinates will be derived for all boundary corners.

4.5 Submissions

Each group is required to submit field notes and calculations, together with an individual plan of survey, and report on the project prepared by each student. The plan should be at suitable scale and drawn on tracing linen in accordance with the specifications of the Registrar General's Office. (See Appendix D).

5. FIELD ASTRONOMY

5.1 Equipment

1 x 1"	Theodolite + Tripod
1	Plumbob
1 x 4V	Battery
1	Stop watch
1	Illumination Unit
1	Torch

Radio, thermometer, barometer and observing sheets will be available. Eyepiece filters will be provided for the sun observations.

5.2 Project

5.2.1 Approximate position and orientation

The approximate values of the latitude and longitude of the observing site from a map of the area are $\phi = 33°27'30''S$, $\lambda = 9^h58^m15^sE$. The azimuth of the R.O., which is a red aircraft navigation light situated near Oakleigh Pillar, may be taken as 42°00′.

5.2 Azimuth Observations

Each student must:

Determine the azimuth of a traverse line in the Cadastral Survey by observations to the sun by the hour angle method. Chapter 8 of Field Astronomy for Surveyors gives all the necessary background information. Two arcs of observations will be sufficient for this work as follows:

Arc 1		Arc 2	
FL	RO	FR	RO
	þ		þ
FR	ɋ	FL	ɋ
	RO		RO

Observations are to be reduced using the HP 9810 programme provided. The latitude and longitude values used in these reductions are to be derived from those values obtained from the star observations.

5.2.3 Latitude and Longitude Observations

Each student must:

(1) Determine the latitude from one pair of well balanced circum-meridian observations.

Limits: Zenith distance - 40°-60° (with a preference for high altitude observations)

Balance in zenith distance - ±5°

Difference in RA - $\not>40^m$

Six acceptable observations on each face on each star. Timing is to be done with a stop watch by the recorder to the NEAREST SECOND.

Time checks must be taken before and after the observations.

NOTE: When preparing the programme, make use of the additional stars available in the supplementary and circum-polar lists. An example of part of a working list is given in Appendix E.2.

(2) Determine the longitude from a pair of well balanced near prime vertical observations.

Limits: Zenith distance - 40°-60°
Azimuth - prime vertical ±10°
Declination balance - ±2°

Six acceptable observations on each face on each star.

Timing must be done as accurately as possible BY THE OBSERVER both on the stars and for the time checks. At least three time checks must be taken, which must include one before and one after the star observations.

To assist in the preparation of an observing programme, computer printouts are given in Appendices E.3-E.5 listing pairs of stars suitable for the determination of longitude and which meet the above criteria. From this information, a working list is to be prepared. An example is given in Appendix E.2.

5.3 Field Notes

Observations must be booked on the field sheets provided and these must be signed by the observer and the supervisor at the end of the observations. A carbon copy of these signed field notes is to be handed to the supervisor before leaving. The front sheet, containing clock corrections, etc., must be filled in correctly. Field notes must be of an acceptable standard.

5.4 Report 1 (Latitude and Longitude only)

The report must include the following:

(a) Title page

(b) List of contents

(c) Summary of final results including estimates of precision

(d) Original field notes including calculations and graph of clock corrections on front sheet.

(e) Manual calculations properly set out and showing formulae used.

(f) Computer output mounted on ordinary sheets.

(g) Tabulation of individual results of each pointing showing the residuals (v's). If any observations are rejected, the reason for rejection must be given.

(h) Calculation of the adjusted values (final results) and the estimates of precision. The estimates of precision required are the standard deviation of a single observation and the standard deviation of the adjusted values.

(i) Conclusions and comments.

The field sheets and calculations should be properly cross referenced.

5.5 Report 2 (Azimuth only)

The report must include the following:

(a) Title page

(b) List of contents

(c) Summary of final results (azimuth and I.S.G. bearing of the line)

(d) Original field notes including graph of clock corrections on front sheet.

(e) The derivation of the latitude and longitude values used in the reduction.

(f) Computer output mounted on ordinary sheets.

(g) Calculation of grid convergence

(h) Conclusion and comments

6. LAND USE SURVEY

6.1 Purpose

The purpose of this exercise is for each group of students to carry out a land use survey of a selected area in the environs of Bathurst. Information relating to detailed procedures can be found in Appendix F.

6.2 Equipment

1 Pair of photographs
1 Mirror stereoscope
1 1:25 000 Map sheet
Tracing paper overlays

6.3 Survey

In making this survey, both field sampling and air photo interpretation techniques will be employed to produce a coded and symbolised land use map. The task will entail three distinct stages:

(1) Air photograph selection of representative areas.

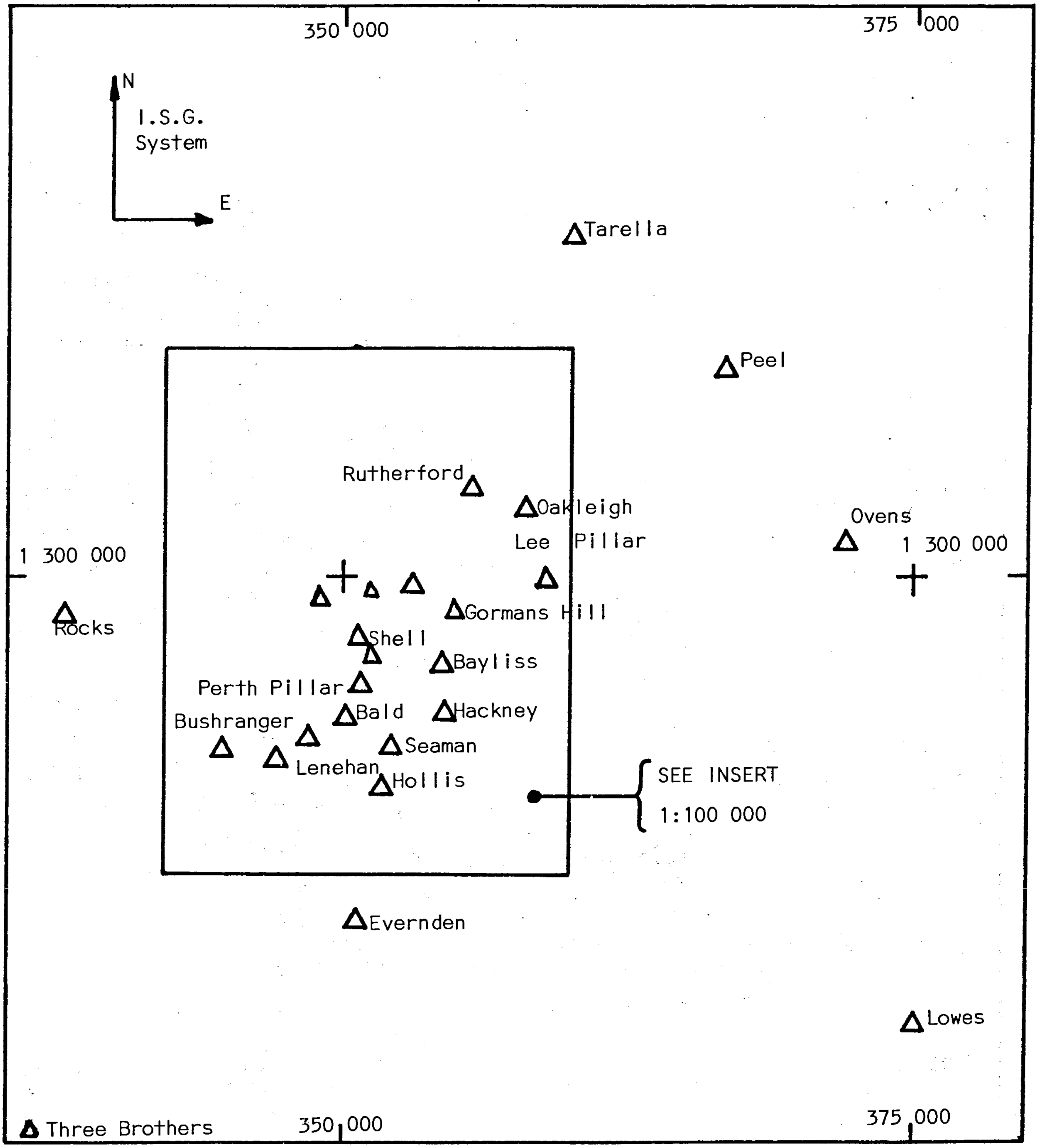
(2) Ground inspection and interpretation of those selected areas.

(3) Air photo interpretation based on ground inspected areas.

6.4 Submissions

Each group is required to submit photo overlay, field notes of site visits, coded land use map and a report.

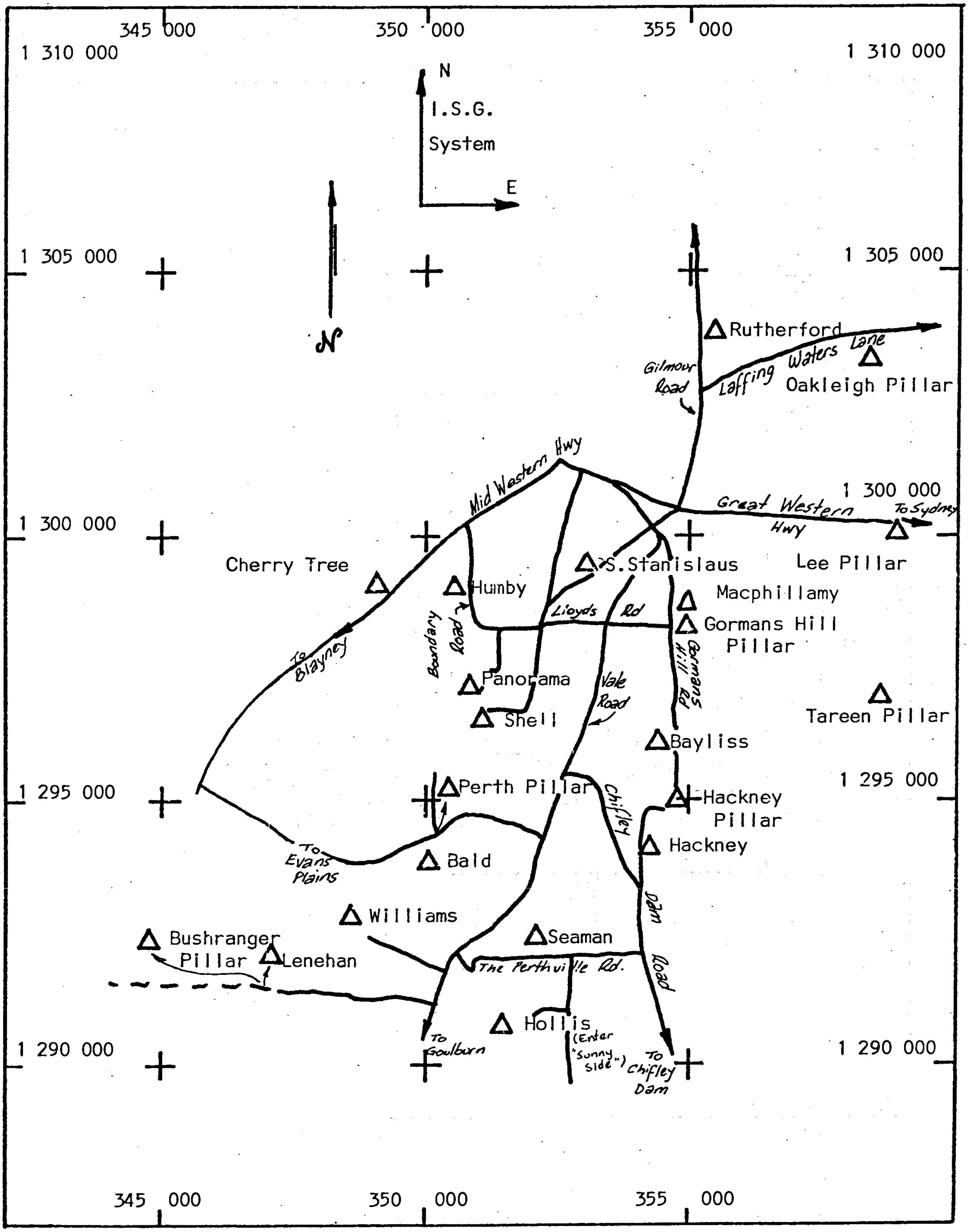
Appendix A.



PLAN

SHOWING TRIG STATIONS IN THE BATHURST AREA.

SCALE: 1:250 000



INSERT

SHOWING TRIG STATIONS AND LOCAL ROAD SYSTEMS.

SCALE: 1:100 000

CENTRAL MAPPING AUTHORITY

Department of Lands

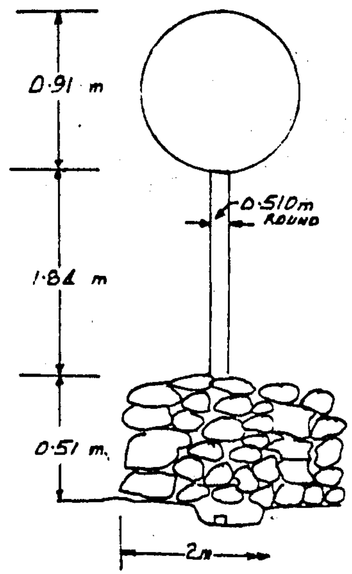
Trigonometrical Survey of N.S.W.

RECONNAISSANCE and MAINTENANCE REPORT

STATION *DOME T.S.*

Co:	Ph:
Map Sheet:	No:
Inspected by: *D. KAIN*	Date: *1 JUNE 1973.*
Authority *C.M.A.*	Field Book:

Beacon Diagram — Not to Scale



This Trig. Station has been:-

Note: Cross out word or words which do not apply

1. Completely cleared to permit 360° vision to surrounding Trigs.
2. Cleared by lanes bearing .... from Trig. Mast
3. Trig. Mast & Vanes have been painted white & black respectively.
4. The Trig. was unpiled/~~not unpiled~~, dimensions now being:

   Description of mark *COPPER CARTRIGE CASE* .... should be explicit, e.g. Steel plug, Brass plug, Bolt, G.I. Pipe

   Height of mark *0:022* ....m above/~~below~~ ~~rock~~/concrete ..*0:20*...m ~~above~~/below G.L.

   Height of Top Vanes to Top Mark *3:444* m. Diameter of Vanes (vertical) *0:916* m.

   Height of Cairn *0:510* ......m. Diameter of Cairn *2:0* ...... m.

   Length of Mast *2:528* ......m. (approximate if not unpiled)

5. A *CU NAIL* ....set in conc/~~rock~~ has been placed *2:680* m. bearing *86* ......°M from Trig. Mast
6. A *G.I.PIPE* ....set in conc/~~soil~~ has been placed *2:065* m. bearing *23* ......°M from Trig. Mast
7. A..........set in conc/soil has been placed..........m. bearing..........°M from Trig. Mast
8. A..........set in conc/rock has been placed..........m. bearing..........°M from Trig. Mast
9. Connection *PLUG* ...to *CU NAIL* : *2:680* m. bearing *266* °M
10. Connection *PLUG* ...to *G.I.P.* : *2:065* m. bearing *113* °M
11. Connection *G.I.P.* ...to *CU NAIL* : *4:595* m. bearing *279* °M
12. Connection..........to..........: .... m. bearing..........°M
13. Diff. Ht. *TRIG PLUG* ..... is *0:210* m. above/~~below~~ *CU NAIL*..........
14. Diff. Ht. *TRIG PLUG* ..... is *0:190* m. above/~~below~~ *G.I.PIPE*..........
15. Diff. Ht. .... is........m. above/below ....
16. Diff. Ht. .... is........m. above/below ....

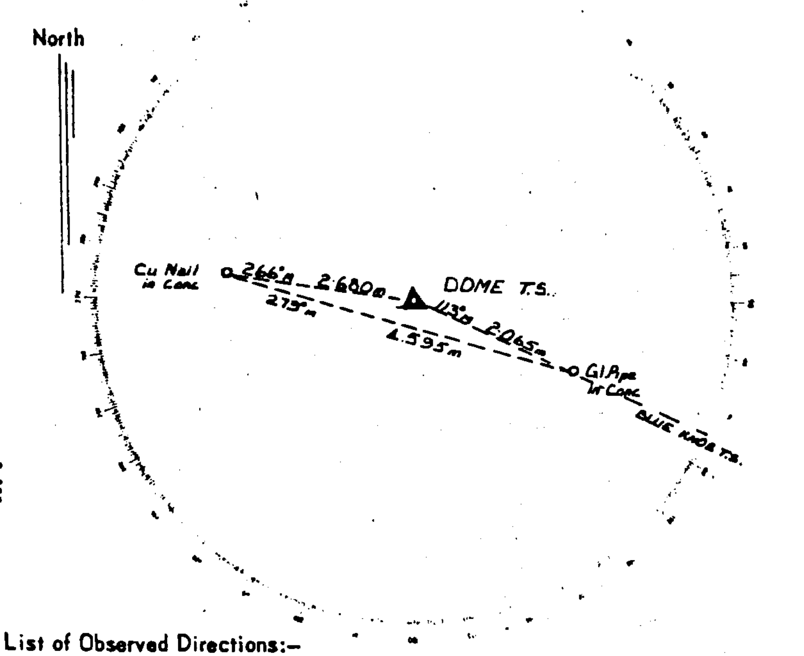
Date	Record of Station

Prepared by: .... Checked: .... Noted on U.T.M. Card *KA 1/3/74* Checked

STATION DOME T.S.

Station Diagram

Not to Scale



List of Observed Directions:–

Standpoint:		Standpoint:	
Station	Direction	Station	Direction
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Station	Direction	Station	Direction
....	....	....	....
....	....	....	....
....	....	....	....
....	....	....	....

Owners Name........................ Current Occupant........................

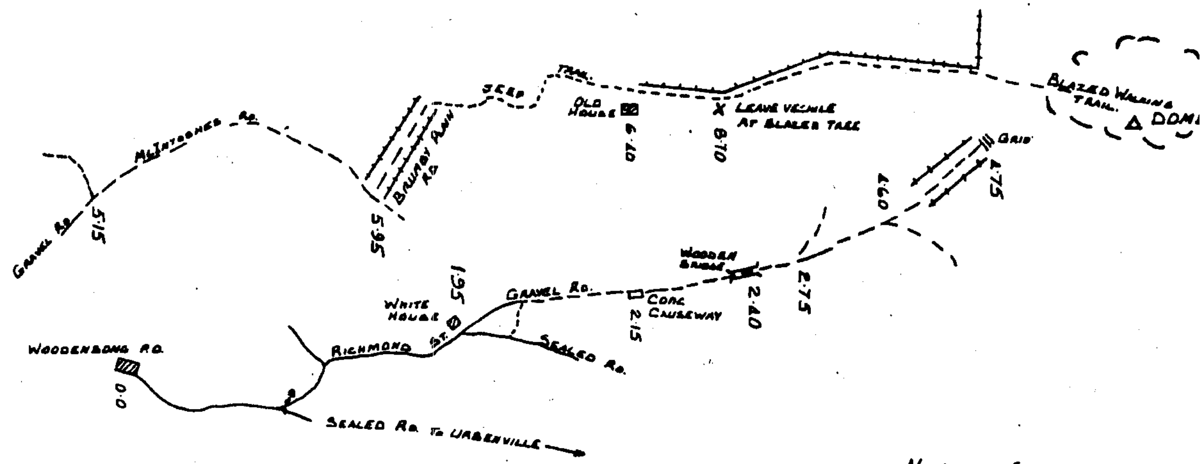
Address........................ Address........................

....

Access

AT WOODENBONG POST OFFICE AT 0.0 MILES ON MACPHERSON STREET TRAVEL TOWARDS URBENVILLE BONALBO.

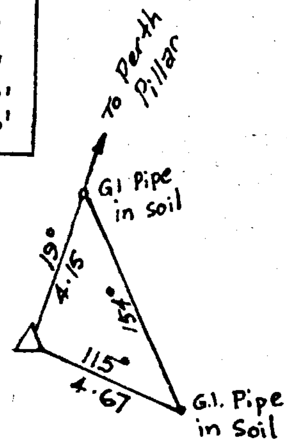
0.05 TURN LEFT INTO "GLENNIE STREET" SIGNPOST.
1.05 TURN RIGHT INTO "RICHMOND STREET" SIGNPOST FOLLOW SEALED ROAD.
1.95 PASS WHITE HOUSE ON LEFT
2.00 TAKE GRAVEL ROAD ON LEFT
2.15 CROSS OVER CONCRETE CAUSEWAY.
2.40 CROSS WOODEN BRIDGE OVER CREEK FOLLOW GOOD GRAVEL ROAD.
2.75 TAKE RIGHT FORK IN ROAD FOLLOW GOOD GRAVEL ROAD
4.60 TAKE LEFT FORK IN ROAD UP LANE BETWEEN FENCES.
4.75 CROSS OVER GRID SIGNPOST AT GRID "NORTH YABBRA ROAD".
5.15 TAKE RIGHT TURN ONTO "McINTOSHES ROAD" SIGNPOST.
5.95 TAKE GRAVEL ROAD ON LEFT "BRUMBY PLAINS FOREST ROAD" SIGNPOST.
6.40 PASS OLD DISUSED HOUSE ON LEFT FOLLOW JEEP TRAIL
8.70 END OF TRAIL BLAZED TREES. FENCE ON LEFT LEAVE VEHICLE AND FOLLOW FENCE UP FAIRLY STEEP SLOPE THROUGH LANTANA THEN THROUGH RAIN FOREST. STAY WITH FENCE UNTIL FENCE TURNS SHARPLY DOWN TO YOUR LEFT. JUST AT TOP OF RANGE BEAR SLIGHTLY TO YOUR RIGHT THROUGH RAIN FOREST TO TRIG SITUATED ON WESTERN SIDE OF FLAT TOPPED RANGE. WALKING TIME FROM SHARP TURN IN THE FENCE TO TRIG IS ABOUT 5 MINUTES. WALKING TRAIL WAS CUT AND BLAZED FROM HERE TO TRIG. WALKING TIME FROM VEHICLE IS ABOUT 45 MINUTES WITH LIGHT LOAD.



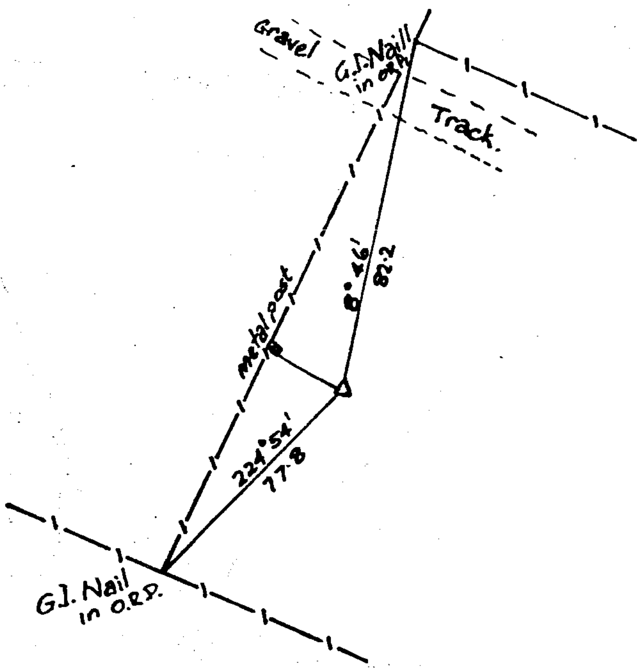
NOT TO SCALE.

'BALD T.S.'

STATION	DIRN
Perth Pillar	19° 06'
Bayliss	61° 57'
Hackney	87° 54'
Seaman	123° 59'
Lenehan	238° 36'
Williams	238° 49'
Bushranger	254° 20'

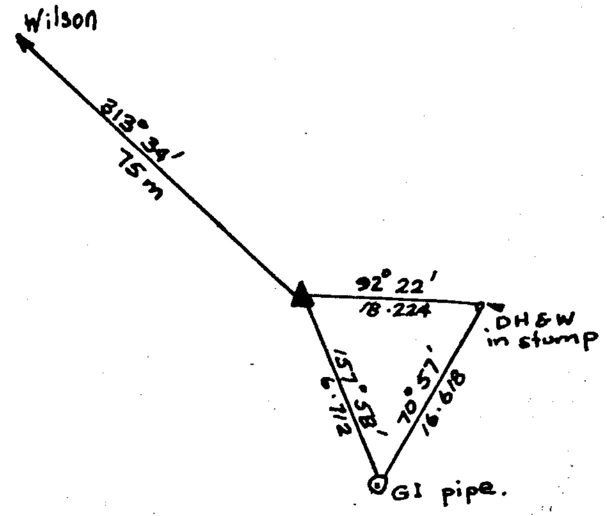


'BAYLISS T.S.'



STATION	DIRN
Mc Phillammy	9° 33'
Hackney	181° 04'
Bald	241° 57'
Perth Pillar	256° 16'
Shell	276° 35'
Cherry Tree	298° 27'
Humby	307° 23'

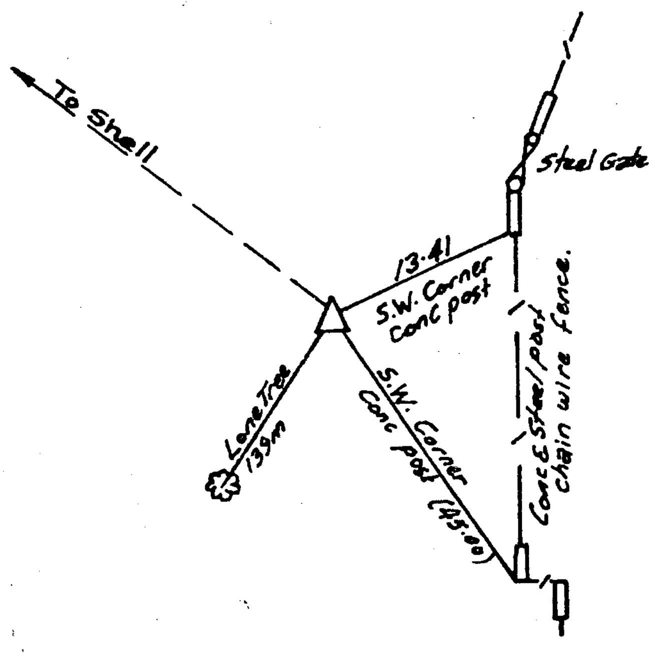
'CHERRY TREE T.S.'



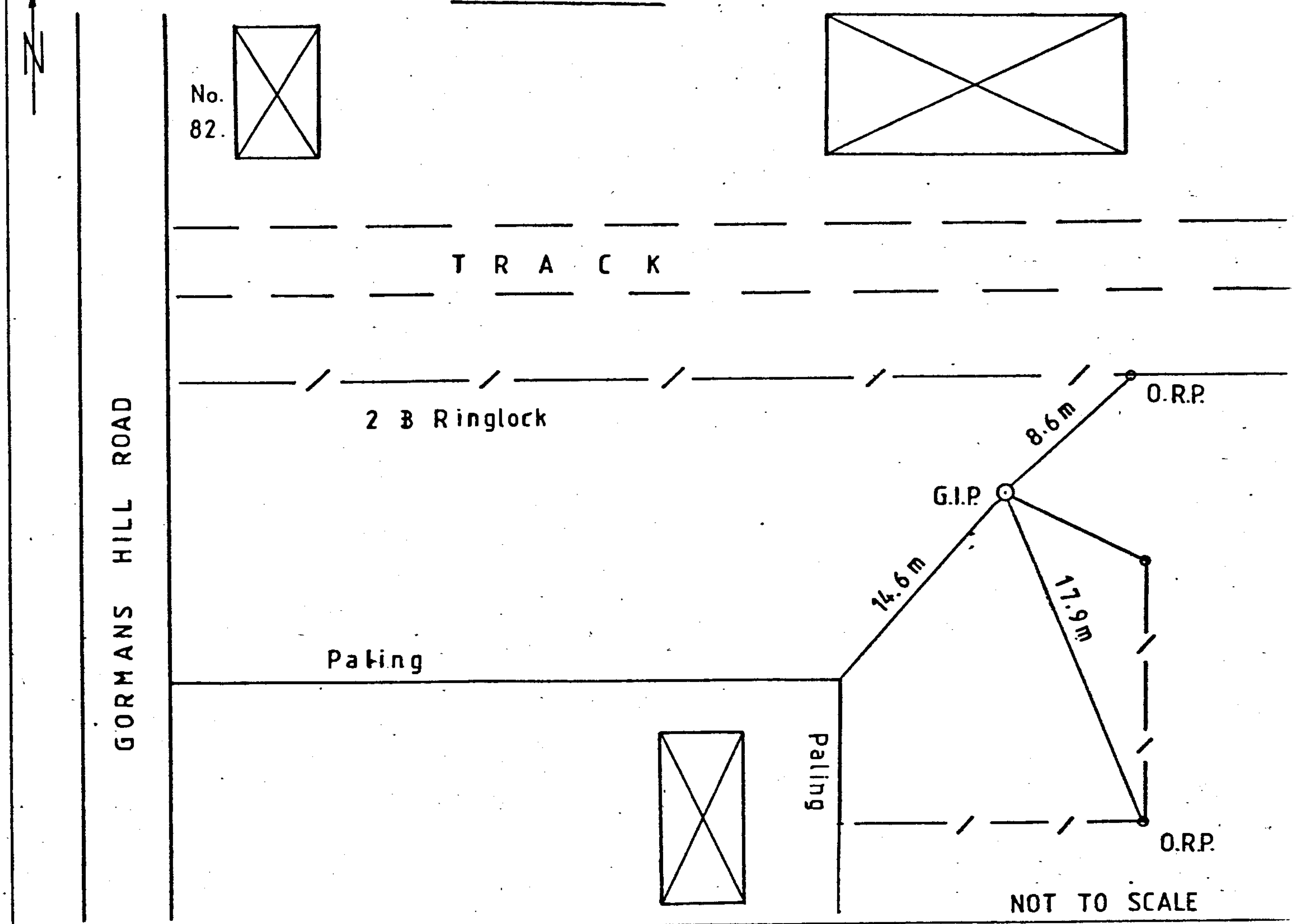
STATION	DIRN
Tarella	34° 20'
Peel	60° 29'
St Stanislaus	83° 11'
Humby	88° 08'
MacPhillamy	94° 51'
Bayliss	118° 27'
Panorama	88°
Perth Pillar	158° 11'
Bald	168° 22'
Everden	174° 17'
Williams	183° 58'
Lenehan	195° 05'
Bushranger	212° 33'
Wilson	331° 34'

'HACKNEY T.S.'

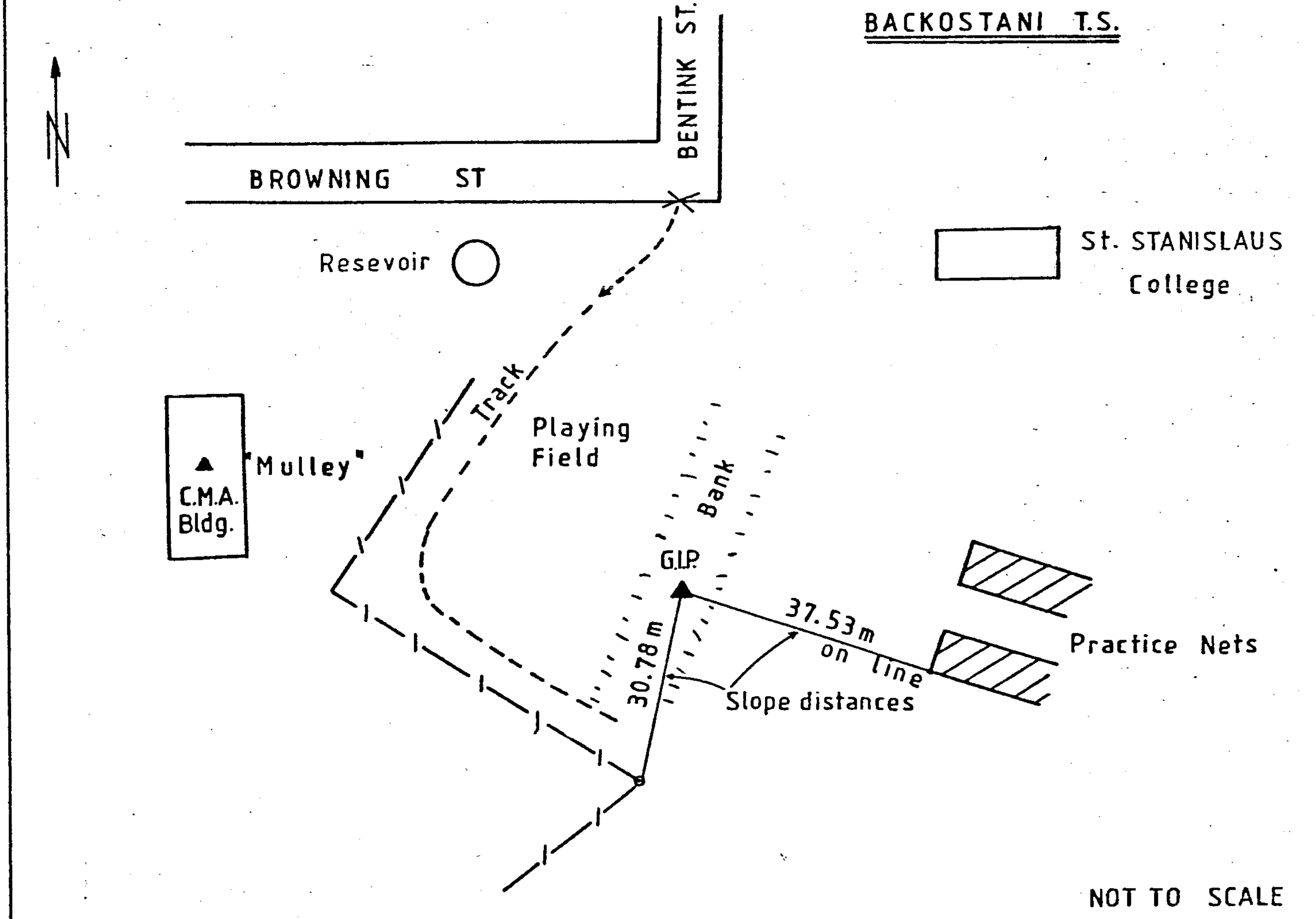
STATION	DIRN
Shell Tower	0° 00'
St. stanislaus	38° 10'
Bayliss	53° 10'
McPhillamy	57° 42'
Seaman	287° 04'
Williams	311° 36'
Bald	319° 57'
Perth	339 37'



BOUNDARY T.S.



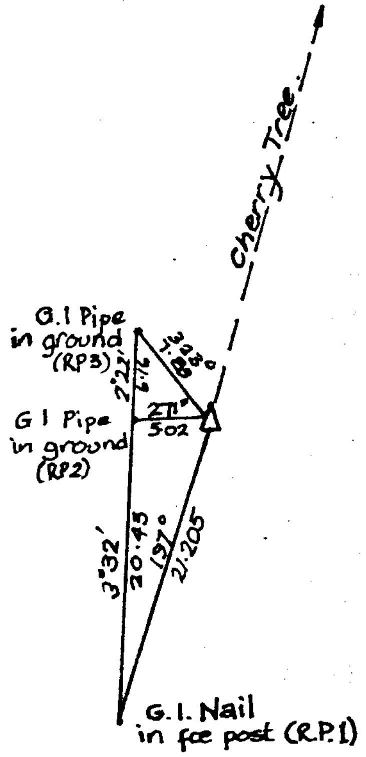
BACKOSTANI T.S.



MARK: G.I.Pipe

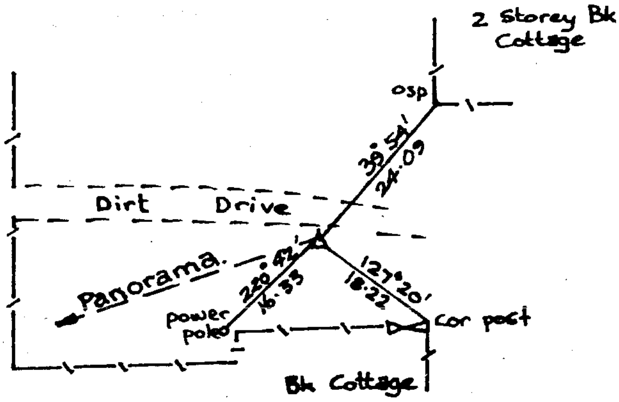
A.8

'LENEHAN T.S.'



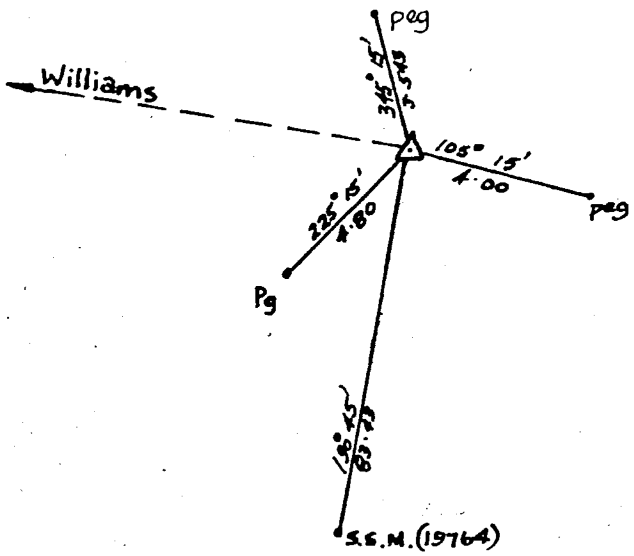
STATION	DIRN
Cherry Tree	0°00'00"
Perth Pillar	32°13'
Bald	43°31'
Bushranger	262°11'

'Mc PHILLAMY T.S.'



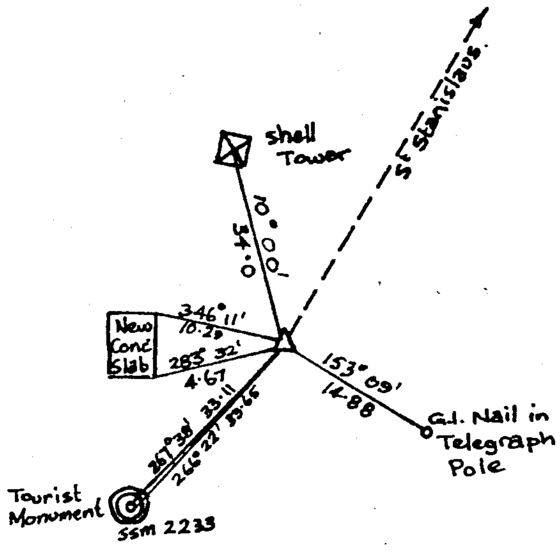
STATION	DIRN
Hackney	185°37'
Perth Pillar	231°37'
Shell	240°56'
Panorama	251°06'
Cherry Tree	274°51'
Humby	277°10'
St Stanislaus	297°57'
Tarella	17°08'

'SEAMAN T.S.'



STATION	DIRN
Lenehan	265° 13'
Williams	277° 44'
Bald	303° 59'
Perth	329° 56'
Shell	345° 48'
Hackney	55° 01'
Three Brothers	223° 15'

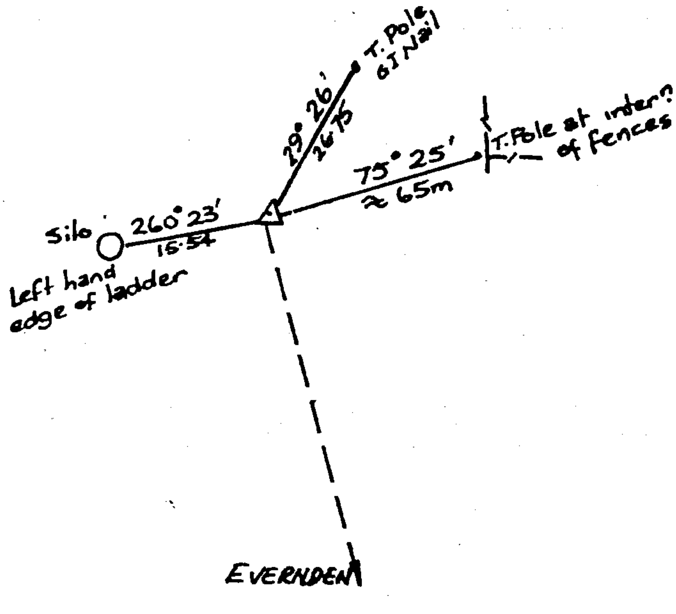
'SHELL T.S.'



STATION	DIRN
Panorama	334° 45'
Humby	346° 52'
St Stanislaus	31° 45'
McPhillamy	60° 56'
Bayliss	96° 35'
Hackney	127° 53'
Perth Pillar	203° 08'

'WILLIAMS. T.S.'

STATION	DIRN
Evenden	0° 00'
Three Brothers	48° 33'
Lenehan	71° 16'
Cherry Tree	196° 52'
Perth Pillar	283° 52'
Seaman	290° 37'



Appendix B

COMPENDIUM OF FORMULAE for the LEAST SQUARES ADJUSTMENT of CONTROL NETWORKS by the VARIATION OF COORDINATES

1. NOTATION AND BACKGROUND

A set of n linearized observation equations is given by:

$$v = Bx + T$$

where v is the vector of residuals of the n observations p_i

B is the matrix of coefficients b_{ij} (calculated from approximate values of parameters $\overline{x}$),

x is the vector of u independent parameters, and

T is the vector of absolute terms.

The vector of absolute terms is calculated from

$$T = p^o - p$$

where p is the vector of observed values, and

p^o is the vector of constant terms, calculated from approximate values of parameters $\overline{x}$.

The number of redundancies, r, is given by

$$r = n - u$$

The population variance σ_i^2 of each observation p_i can be expressed by a variance estimator S_i^2 :

$$S_i^2 = S^2 . \; g_{ii} \quad ,$$

where S^2 is the *a priori* (dimensionless) variance factor, and

g_{ii} is the weight coefficient of the particular observation.

The weight coefficients g_{ii} form a matrix G, which is a diagonal matrix for the case of uncorrelated observations.

2. SOLUTION

The most probable values for the parameters x are found according to the Principle of Least Squares by minimizing the quadratic form M by variation of the parameters.

$$M = v^T G^{-1} v = [\frac{vv}{g}]$$

This minimization leads to the normal equation system:

$$N x + C = 0 ,$$

which can be solved by suitable methods. The matrix of normal equation coefficients N and vector of constant terms are given by:

$$N = B^T G^{-1} B$$

$$C = B^T G^{-1} T$$

The solution for the parameters is found by

$$\Delta X = -N^{-1} B^T G^{-1} T$$

$$= -N^{-1} C.$$

Values of final parameters x are calculated from

$$x = \overline{x} + \Delta x.$$

3. CHECK CALCULATIONS

Values for the adjusted observations P_i are calculated from the final parameters x . Hence the residuals are found as the difference between P_i^a and the original observations P_i:

$$v_i = P_i^a - P_i . \qquad i = 1, \dots n$$

i) As an important check calculation the individual residuals v_i also may be calculated by substitution of the parameters x into the observation equations:

$$v = B.\Delta x + T .$$

ii)

$$[\frac{B_{ij} v_i}{g_{ii}}] = 0 \qquad \text{for all} \quad j = 1, \dots u.$$

iii) The minimum (least squares) is found by the equation

$$M = (B^T G^{-1} T)^T \Delta X + T^T G^{-1} T ,$$

and is compared as a check calculation with

$$M = [\frac{v_i v_i}{g_{ii}}] ,$$

calculated from individual residuals v_i.

4. INVESTIGATION OF PRECISION

4.1 A posteriori Variance factor

An a posteriori estimate $\bar{S}^2$ for the variance factor may be obtained from the minimum M:

$$\bar{S}^2 = \frac{M}{r} .$$

The null hypothesis that both variance factors (a priori and a posteriori) belong to the same population, can be tested using the F-distribution. If the variance ratio

$$\frac{\bar{S}^2}{S^2} < F_{(1-\alpha, r_1, r_2)} ,$$

the null hypothesis has to be accepted at the α significance level, and for r_1 and r_2 as the number of degrees of freedom used in determining $\bar{S}^2$ and S^2 respectively. If S^2 has been taken from experience r_2 is to be assumed equal to ∞ .

4.2 Precision of adjusted parameters

An estimate of the variance -covariance matrix of the adjusted parameters (S_x) is found by application of the general law of propagation of variances as:

$$(S_x) = S^2 \; Q_{xx} ,$$

where the cofactor matrix Q_{xx} is the inverse of N:

$$Q_{xx} = N^{-1} .$$

5. OBSERVATION EQUATIONS FOR A CONTROL NETWORK

i) Direction from station P to station Q , D_{PQ} :

P to Q : $v_D = a_{PQ}\, dN_P + b_{PQ}\, dE_P - a_{PQ}\, dN_Q - b_{PQ}\, dE_Q - dO_P + T_D$

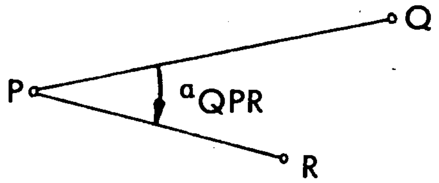
$T_D = \Theta_{PQ} - (D_{PQ} + \bar{O}_P)$

ii) Distance between stations P and Q, d_{PQ} :

P to Q: $v_d = -\cos\Theta_{PQ}\, dN_P - \sin\Theta_{PQ}\, dE_P + \cos\Theta_{PQ}\, dN_Q + \sin\Theta_{PQ}\, dE_Q + T_d$

$T_d = d_{PQ}^{calc.} - d_{PQ}^{observ.}$

iii) Angle at station P between stations Q and R, α_{QPR} :



$$v_\alpha = (a_{PR} - a_{PQ})\, dN_P + (b_{PR} - b_{PQ})\, dE_P + a_{PQ} dN_Q + b_{PQ} dE_Q$$
$$- a_{PR}\, dN_R - b_{PR} dE_R + l_\alpha$$

$$l_\alpha = (\Theta_{PR} - \Theta_{PQ}) - \alpha_{QPR}$$

NOTATION

For these observation equations the following notation has been adopted:

$\overline{E}$, $\overline{N}$: are approximate coordinates of stations

dE , dN : are the least squares parameters for the unknown coordinates

$E = \overline{E} + dE$, and

$N = \overline{N} + dN$: are the adjusted final coordinates

$\overline{O}_p$: is the approximate orientation of the direction observations at station P, with respect to the coordinate system.

dO_p : is the least squares parameter for the orientation at station P.

$O_p = \overline{O}_p + dO_p$: is the adjusted final orientation at station P.

D , d , α : are the observed values for direction, distance and angle respectively.

V_D , d_d , v_α : are the corrections (residuals) to these observed values

T_D , T_d , T_α : are the absolute terms

Θ , S : are the preliminary bearing and distance, calculated from approximate coordinates $\overline{E}$, $\overline{N}$.

a , b : are the direction coefficients, calculated according to the equations

$$a_{PQ} = \frac{\rho'' \sin \Theta_{PQ}}{S_{PQ}} \quad , \quad b_{PQ} = -\frac{\rho'' \cos \Theta_{PQ}}{S_{PQ}}$$

$$\rho'' = 206\ 264.81''$$

Attention: Dimensions.

6. CALCULATION OF POINT ERROR ELLIPSES

The weight coefficient Q_{xx} of the adjusted parameters dN_i , dE_i and dO_i is of the general form:

$$Q_{xx} = \begin{bmatrix} Q_{N_1N_1} & Q_{N_1E_1} & \cdots & & & \cdot \\ Q_{E_1N_1} & Q_{E_1E_1} & & & & \cdot \\ \cdot & & Q_{N_iN_i} & Q_{N_iE_i} & & \cdot \\ \cdot & & Q_{E_iN_i} & Q_{E_iE_i} & & \cdot \\ \cdot & & & & \ddots & \cdot \\ \cdot & \cdots & & & & Q_{O_jO_j} \end{bmatrix}$$

The basic parameters of the error ellipse at the station i are calculated from the following equations:

i) The a priori variance factor S^2

ii) The eigen values $\lambda_{1,2}$ of the cofactor matrix for the station i :

$$\lambda_{1,2} = \tfrac{1}{2}(Q_{N_iN_i} + Q_{E_iE_i}) \pm \tfrac{1}{2}\sqrt{(Q_{N_iN_i} - Q_{E_iE_i})^2 + 4Q^2_{N_iE_i}}$$

(positive sign for λ_1)

iii) Semi major and minor axis of the point error ellipse:

Semi major axis : $\sqrt{S^2\ \lambda_1}$

Semi minor axis : $\sqrt{S^2\ \lambda_2}$

iv) Orientation of semi major axis Θ_i :

$$\Theta_i = \tfrac{1}{2} \arctan \frac{2 \cdot Q_{N_iE_i}}{Q_{N_iN_i} - Q_{E_iE_i}}$$

DIRECTION OBSERVATIONS

Page 1

STATION Alpha	DATE 1/4/55 TIME 1600 to 1700	WEATHER Clear	OBSERVER J. Jones BOOKER W. Smith THEOD. T2 # 36487

ARC	STATION	F.L.	F.R.	DIFF "	MEAN	RED. MEAN	q	V	VV	COMMENTS
	BETA	0 00 05	180 00 22	+ 17	0 00 13.5	0 00 00	0.00	+0.17	0.03	
	GAMMA	74 39 55	254 40 19	+ 24	74 40 07.0	74 39 53.5	1.62	1.79	3.20	
	DELTA	99 01 04	279 01 19	+ 15	99 01 11.5	99 00 58.0	-2.12	-1.95	3.80	
							-0.50	+0.01		
	BETA	45 02 29	225 02 52	+ 23	45 02 40.5	0 00 00	0.00	-0.50	0.25	
	GAMMA	119 42 22	319 42 42	+ 20	119 42 32.0	74 39 51.5	-0.38	-0.88	0.77	
	DELTA	144 03 32	364 03 53	+ 21	144 03 42.5	99 01 02.0	+1.88	+1.38	1.90	
							+1.50	0.00		
	BETA	90 04 57	270 05 18	+ 21	90 05 07.5	0 00 00	0.00	0.00	0.00	
	GAMMA	164 44 49	344 45 09	+ 20	164 44 59.0	74 39 51.5	-0.38	-0.38	0.14	
	DELTA	189 06 00	9 06 16	+ 16	189 06 08.0	99 01 00.5	+0.38	+0.38	0.14	
							0.00	0.00		
	BETA	135 07 28	315 07 42	+ 14	135 07 35.0	0 00 00	0.00	-0.25	0.06	
	GAMMA	209 47 21	29 47 31	+ 10	209 47 26.0	74 39 51.0	+0.88	+0.63	0.40	
	DELTA	234 08 26	54 08 44	+ 18	234 08 35.0	99 01 00.0	-0.12	-0.37	0.14	
							+0.76	+0.01	10.85	
		GRAND MEANS								
		BETA	0 00 00							
		GAMMA	74 39 51.88							
		DELTA	99 01 00.12							

$$S^2_{FL,FR} = \frac{10.85}{6} = 1.81$$

$$S^2_{Past\ experience} = \frac{6.25}{2} = 3.12$$

hence

$$\frac{S^2_{FL,FR}}{S^2_{PE}} < F0.95,\ 6,\ \infty\ (2.1)$$

$$\frac{S^2_{PE}}{S^2_{FL,FR}} = \frac{3.12}{1.81} < F_{0.975,\infty,6}\ (4.8)$$

THIS SAMPLE CONSISTENT WITH PAST EXPERIENCE

n = No. of Arcs ...... i = 1,n

k = No. of Stations .. j = 1,k

q_{ij} = (Red. Mean)$_{ij}$ - (Grand Mean)$_j$

$$V = q_{ij} - \frac{\left(\sum_{j=1}^{k} q_{ij}\right)}{k}$$

VARIANCE ESTIMATES.

single direction observation (mean FL, FR)

$$S^2_{S.D.} = \frac{[VV]}{(n-1)(k-1)}$$

APPENDIX C

Photogrammetric Control

The following sketches illustrate a selection of suitable and unsuitable points to be considered during photo-identification for planimetric and height control. They should be used as a general guide only, as the selection of suitable points will depend on the photo scale. For small scale photography points marked "Bad" in these sketches may prove to be satisfactory.

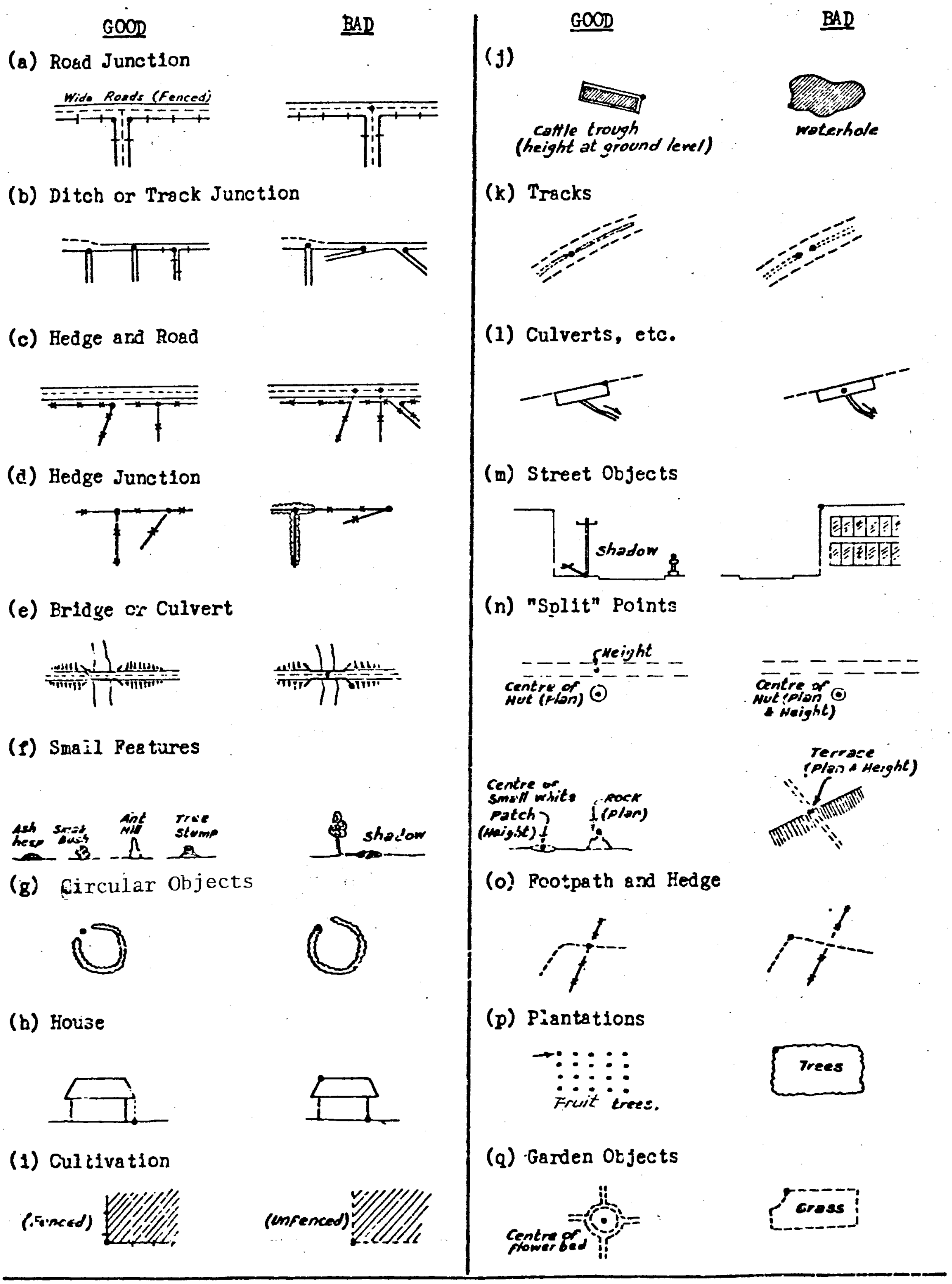


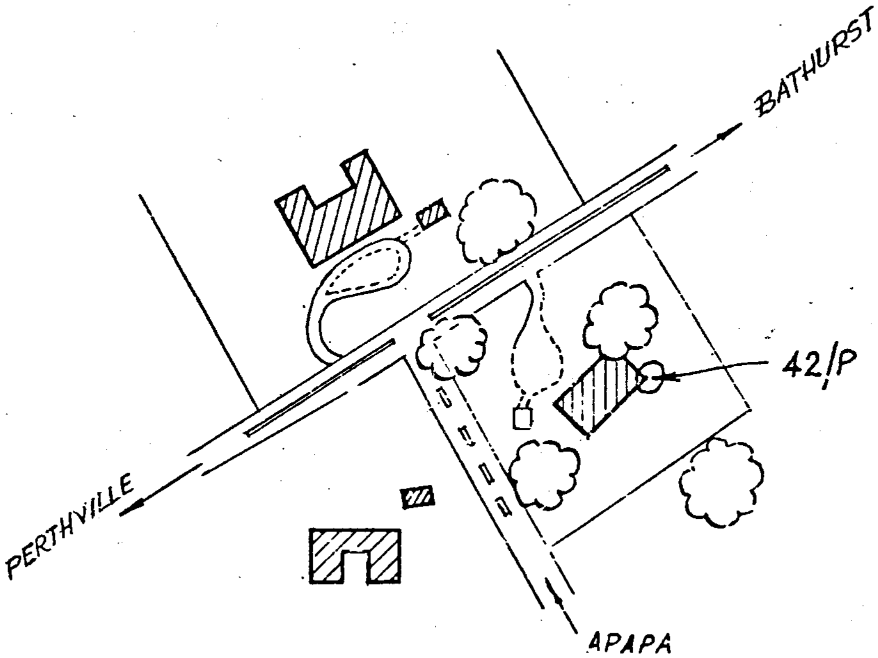
PHOTO POINT DESCRIPTION

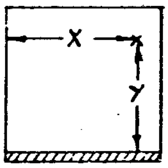
SPECIMEN

Survey: BATHURST 1:10.000 Page 7

Job no. 1961/2

Station 42/P





Circled on photograph no. 261

Photograph co-ordinates X 17·8 mm

Y 18·4 mm

Description of mark: Corner of house

Location of station: S.E. Corner of house south of BATHURST-PERTHVILLE Road

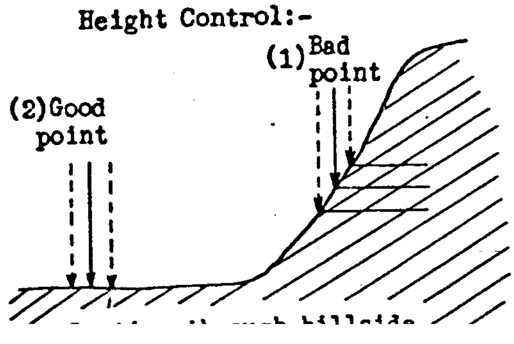
Co-ordinates: E 364 210·71 Drawn by E.X. PERT.

N 241 365·81 Date 3-6-61

Height: —

Signed O.B. SERVER

Height Control:-



It can be seen clearly that any slight error in field identification or in placing the floating mark during the plotting process, will cause considerable height error in (1), but will have no appreciable effect in (2).

APPENDIX D

Cadastral Project

PURPOSE

The assumed purpose of the survey is for a primary application to bring the old system title (as occupied by the Church of England Diocesan Centre) and surrounding lands to a Torrens title, i.e. to bring the land under the provisions of the Real Property Act. This survey should include not only the land held under the old system title but also any easements that may be appurtenant to the land.

BACKGROUND

As an example of the land that you will survey, the camp site is part of POR. 38 Parish of Bathurst originally granted to William Lane and known as Orton Park.

This land is described in the conveyance no. 248 Book 2594 which was based in part on the survey made by Mr. Surveyor Bayliss on the 10th September, 1959. Please note the reference to easements which form part of the title. Exact details of the land you will survey will be given to you at Survey Camp.

A number of other surveys defining Con Rod Straight and the lots surrounding all have a bearing on the redefinition of the boundary of the subject land. Copies of the most important documents will be issued to students at the survey camp. Other plans of lesser importance, which nevertheless should still be examined, will also be available.

BASIC CONSIDERATIONS

A number of considerations will determine what survey information is most necessary and what boundary adoptions should be made.

(1) Where the land is surrounded by other old system land, attention should be given to the position and age of existing occupations as this will help to indicate the position of the boundaries as originally surveyed.

(2) Where the land is surrounded by land held under Torrens title, greatest consideration should be given to preserving those titles, the balance then going to the land which is the subject of the primary application. If substantial differences with occupations exist, consideration would need to be given to an application based on adverse possession.

(3) When the land in question has been the subject of a previous survey or surveys that have been accepted by the Registrar General's Office, greatest weight should be given to any marks established or monuments fixed under those previous surveys.

(4) Where a number of previous surveys relating to the same boundaries are in existence, some minor disagreement in dimensions will usually be found. While always considering the pre-eminence of marks (where by measurement they an be shown not to have moved), the survey that has redefined the boundaries by interpolation from surrounding information, as compared to one which has extrapolated from information to the subject land, should be given greatest weight.

(5) In most surveys, the road alignment (if any) should be given particular consideration. This alignment should be such that sufficient dimensions exist between it and the boundaries forming the opposite side of the road.

(6) When examining the primary application, the Registrar General's Office is only concerned with the re-established external boundaries of the land in question (and in the position of any easements) and not with the position of any internal boundaries created by parcels that are part of the total application. There must be a one to one relationship between the parcel of land and easements defined by survey and the ensuing title that issues.

SURVEY HINTS AND REQUIREMENTS

(1) The traverse legs which form the framework from which the boundary evidence is measured should, where possible, clearly parallel the occupation. Long radiations from instrument stations to pegs, corner posts, etc., should be kept to a minimum.

(2) All marks measured from the basic traverse framework must have in addition at least one redundant measurement for checking purposes. Note that whilst the traverse surround can be checked by closure, the measurements to any marks connected to this traverse by radiation or offset are not checked as part of the total closure.

(3) Where short boundaries are traversed, an extended backsight should be provided for the transfer of azimuth to the subsequent traverse leg.

(4) The bearings and distances shown on any old plans that are to be utilised in the survey must be checked by calculation prior to any final adopted boundaries being determined. Errors in old plans are not without precedent.

(5) Measurements to and description of occupation (particularly corner posts) should be made, as these can act in future years as monuments. Measurements are usually made to the centre base of the post, the position of which should be projected onto the top or face of the post. Where the centre base obviously does not represent the true corner position, the intersection of the line of fences can be taken.

(6) Field notes should be clear and concise, indicating all measurements and the sketched relationships between all marks measured. Information must be immediately entered into the field book. All pages should be signed and dated by the group and the supervisor.

Individual Submissions:

(1) A formal report including the following aspects relating to the survey:

(a) method of survey

(b) any problems in interpreting the old system description or any of the plans of survey

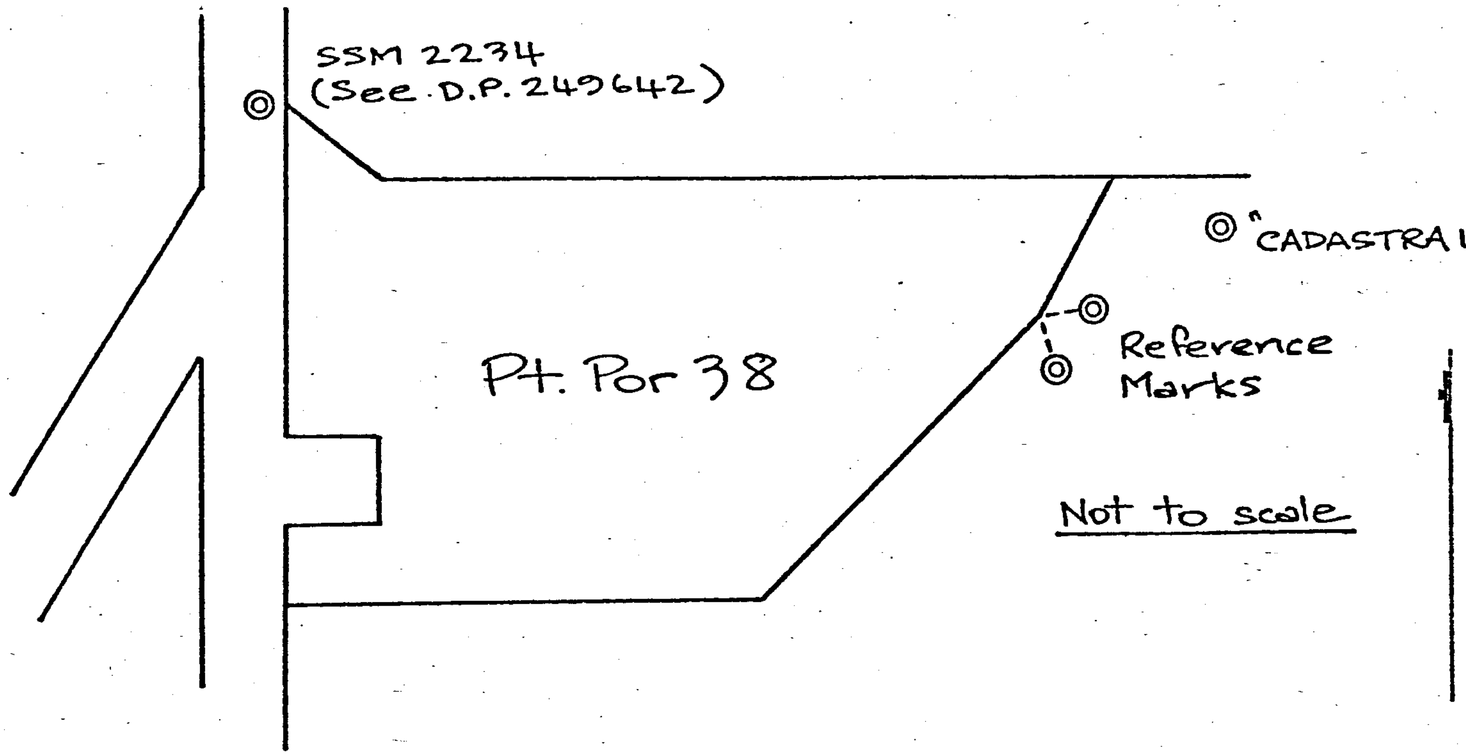
(c) a discussion on any differences between various plans of survey and the measured values

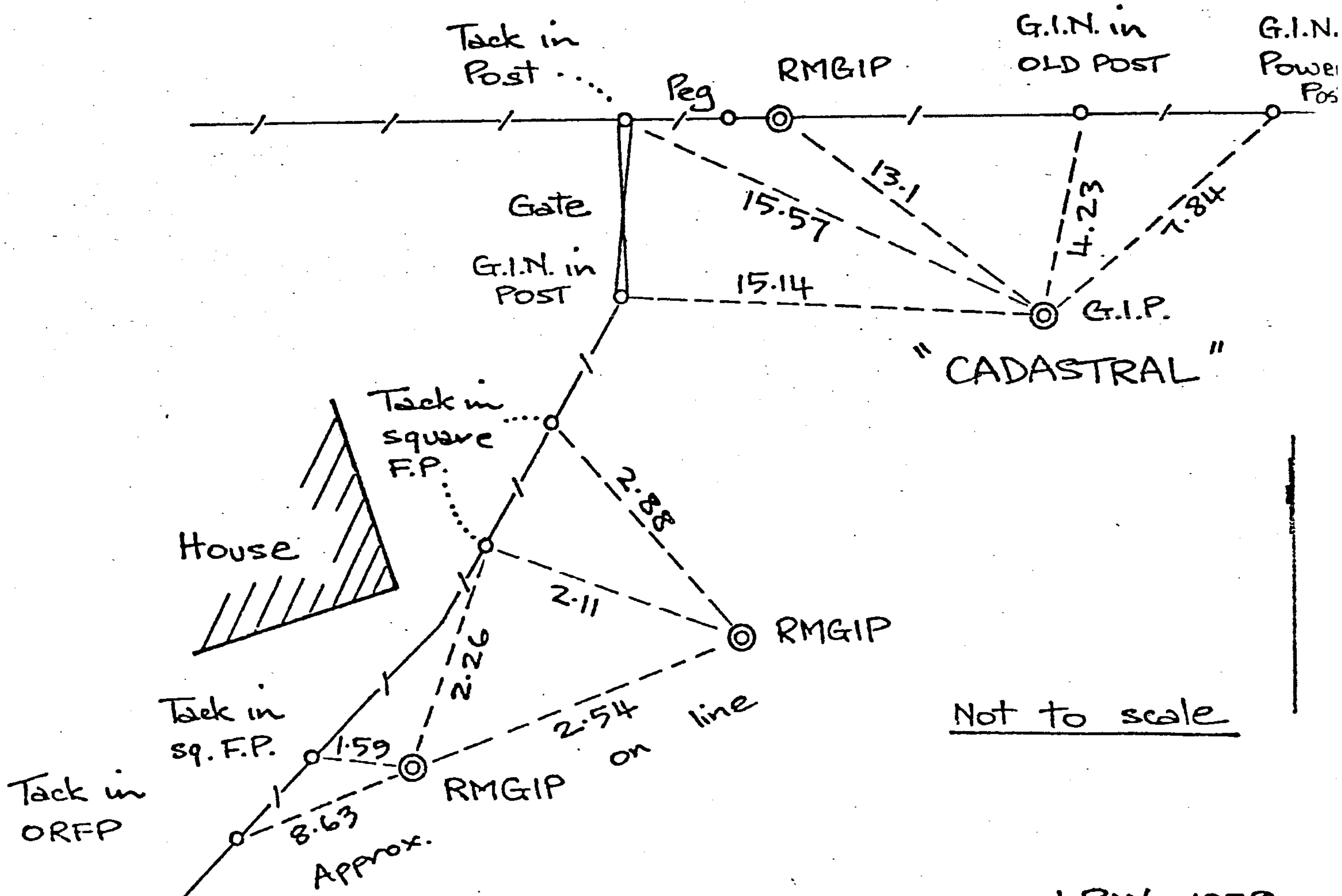
(d) the method of fixation of boundaries and any problems confronted in the boundary definition. Discuss each boundary separately.

(2) A neatly drawn plan of survey is to be submitted. It is to be drafted in a manner acceptable for lodgement for registration at the Registrar General's Office. Reference should be made to the Survey Practice Regulations, Real Property Act Regulations, Conveyancing Act Regulations and the directions issued by the Registrar General on plan preparation.

Briefly, the plan will be drafted with black ink on the standard Plan Form 2, which will be supplied.

CONTROL and REFERENCE MARKS for CADASTRAL EXERCISE





I.P.W. 1979

APPENDIX E

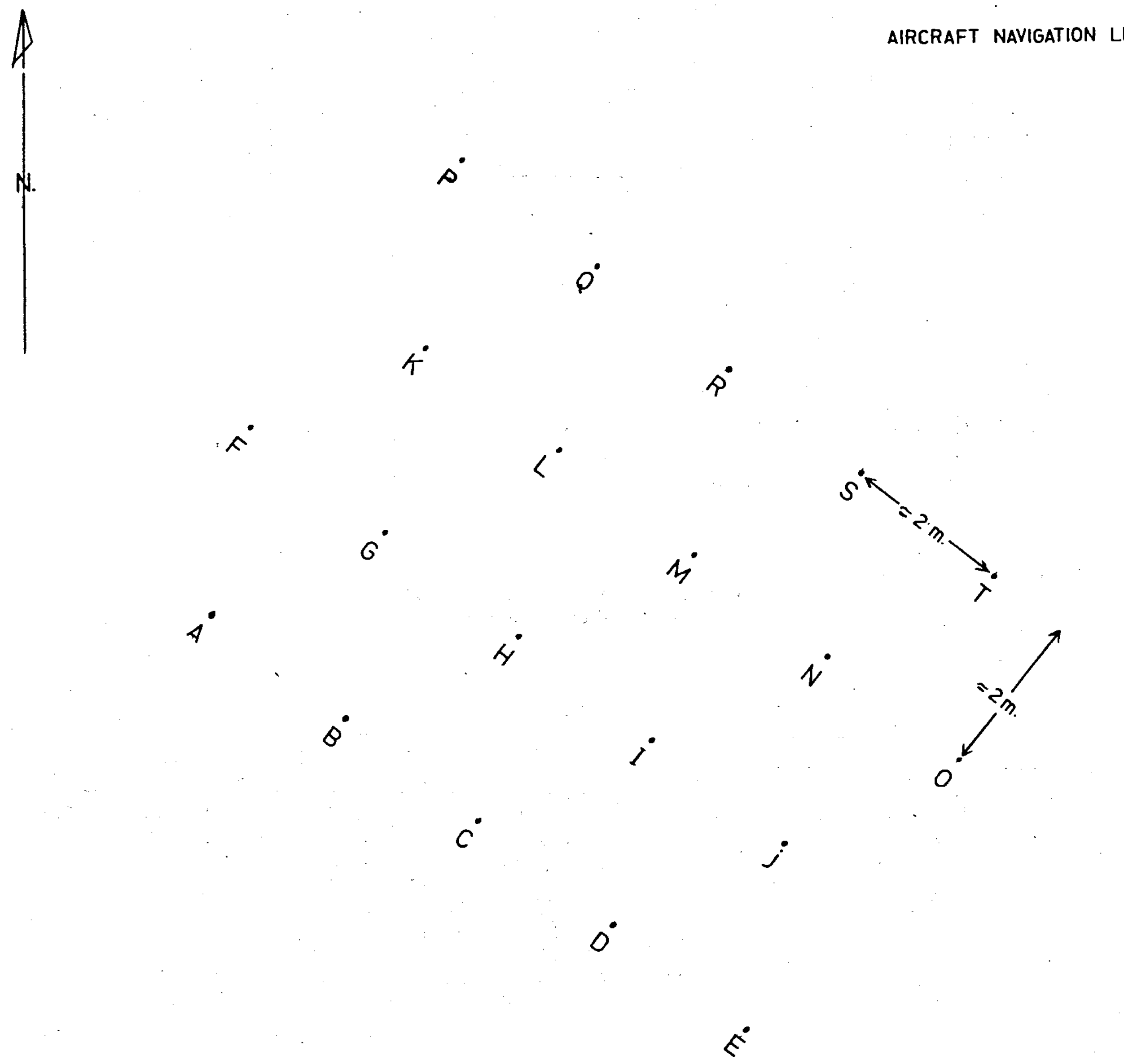
FIELD ASTRONOMY

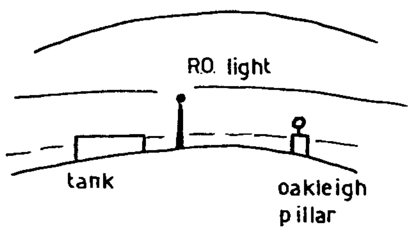
ASTRO STATIONS

BATHURST

R.O. 031° MAG.

AIRCRAFT NAVIGATION LIGHT. (RED)





LOCATION OF R.O. LIGHT

NOT TO SCALE

EACH STATION IS MARKED WITH A SMALL WOODEN PEG AND A SMALL INDICATOR.

EXTRACT FROM THE WORKING LIST FOR A LATITUDE OBSERVATION

Friday 5th March 1976

ϕ - 33°27'
λ + 9^h58^m

Pair	Aspect	No.	Mag.	L.S.T.	Std. Time	FL VΘ	FL HΘ	FR VΘ	FR HΘ
1	N	256	3.8	9^h02^m	23^h10^m	70°21'	3°11'	289°39'	183°11'
				9 07	23 15		2 07		182 07
				9 12	23 20		1 03		181 03
	Transit →			9 17	23 25		0 00		180 00
				9 22	23 30		358 57		178 57
				9 27	23 35		357 53		177 53
				9 32	23 40		356 49		176 49
	S	596	3.7	9 34	23 42	68 57	179 43	291 03	359 43
	Transit →			9 39	23 47		180 00		0 00
				9 44	23 52		180 17		0 17
				9 49	23 57		180 34		0 34
				9 54	0 02		180 52		0 52
				9 59	0 07		181 09		1 09
				10 04	0 12		181 26		1 26

EXTRACT FROM THE WORKING LIST FOR A LONGITUDE OBSERVATION

ϕ - 33°27'
λ + 9^h58^m

Friday 5th March 1976

WEST — PREDICTION — EAST

Pair	No.	Mag.	FL VΘ	FL HΘ	FR VΘ	FR HΘ	LST	Std Time	FL VΘ	FL HΘ	FR VΘ	FR HΘ	Mag.	No.
1	59	4.4	50°18'	280°00'	309°42'	100°00'	6^h09^m	20^h18^m	58°36'	83°54'	301°24'	263°54'	3.8	274
			51 20	279 12	308 40	99 12	6 14	20 23	57 33	83 07	302 27	263 07		
			52 22	278 22	307 38	98 22	6 19	20 28	56 30	82 20	303 30	262 20		
			53 23	277 32	306 37	97 32	6 24	20 33	55 27	81 34	304 33	261 34		
			54 24	276 42	305 36	96 42	6 29	20 38	54 24	80 48	305 36	260 48		
			55 27	275 57	304 33	95 57	6 34	20 43	53 22	79 59	306 38	259 59		
			56 30	275 12	303 30	95 12	6 39	20 48	52 21	79 10	307 39	259 10		
			57 33	274 27	302 27	94 27	6 44	20 53	51 19	78 20	308 41	258 20		
			58 36	273 42	301 24	93 42	6 49	20 58	50 18	77 30	309 42	257 30		

LATITUDE =-33.45

WEST STAR CATNO	MAG	Z.D.	AZ	L.S.T.	AZ	Z.D.	EAST STAR MAG	CATNO
562	3.3	50.8 55.0 59.1	278.2 275.1 272.1	23 50 0 10 0 30	86.1 83.1 79.9	59.1 55.0 50.8	3.2	96
591	3.9	36.2 40.3 44.5	277.3 274.0 271.0	0 3 0 23 0 43	87.9 84.9 81.5	44.5 40.3 36.2	4.0	73
562	3.3	54.8 58.9 63.1	275.2 272.3 269.5	0 9 0 29 0 49	89.9 87.1 84.1	63.1 58.9 54.8	4.0	119
591	3.9	37.7 41.8 46.0	276.0 272.9 270.0	0 10 0 30 0 50	88.7 85.8 82.5	46.0 41.8 37.7	4.3	81
581	4.2	52.6 56.8 61.0	273.2 270.3 267.6	0 50 1 10 1 30	90.9 88.2 85.2	61.0 56.8 52.6	3.3	134
601	3.0	45.5 49.7 53.8	280.3 277.0 273.9	0 54 1 14 1 34	83.4 80.1 76.6	53.8 49.7 45.5	4.0	119
591	3.9	47.1 51.2 55.4	269.3 266.7 264.2	0 55 1 15 1 35	95.7 93.2 90.5	55.4 51.2 47.1	3.3	130
588	4.3	51.0 55.2 59.4	274.9 272.0 269.2	0 57 1 17 1 37	89.9 87.1 84.1	59.4 55.2 51.0	3.3	134
595	3.8	49.2 53.4 57.5	276.5 273.5 270.6	1 6 1 26 1 46	88.7 85.8 82.7	57.5 53.4 49.2	3.3	134
591	3.9	49.8 54.0 58.1	267.6 265.0 262.6	1 8 1 28 1 48	95.2 92.6 89.9	58.1 54.0 49.8	3.0	142
591	3.9	51.1 55.3 59.4	266.8 264.2 261.8	1 15 1 35 1 55	98.1 95.7 93.2	59.4 55.3 51.1	3.8	154
591	3.9	52.2 56.3 60.5	266.1 263.6 261.2	1 20 1 40 2 0	96.7 94.2 91.6	60.5 56.3 52.2	3.9	161
605	4.4	48.7 52.8 57.0	281.3 277.9 274.8	1 23 1 43 2 3	84.1 80.9 77.5	57.0 52.8 48.7	4.3	138
595	3.8	53.1 57.3 61.4	273.7 270.8 268.1	1 25 1 45 2 5	89.4 86.6 83.6	61.4 57.3 53.1	3.7	155
601	3.0	52.5 56.7 60.9	274.9 271.9 269.1	1 28 1 48 2 8	89.0 86.1 83.1	60.9 56.7 52.5	3.7	155
637	3.8	39.4 43.5 47.7	276.9 273.7 270.6	1 58 2 18 2 38	88.5 85.5 82.2	47.7 43.5 39.4	3.0	142
631	3.5	45.6 49.7 53.9	280.7 277.4 274.3	2 1 2 21 2 41	84.1 80.9 77.5	53.9 49.7 45.6	3.7	155
631	3.5	46.7 50.9 55.0	279.8 276.5 273.5	2 7 2 27 2 47	84.0 80.8 77.4	55.0 50.9 46.7	3.8	163
637	3.8	41.7 45.9 50.1	275.0 272.0 269.2	2 10 2 30 2 50	90.2 87.4 84.3	50.1 45.9 41.7	3.9	161
627	4.2	54.4 58.5 62.7	277.1 274.1 271.2	2 33 2 53 3 13	86.5 83.6 80.4	62.7 58.5 54.4	4.3	190
631	3.5	53.3 57.5 61.7	274.7 271.8 269.0	2 39 2 59 3 19	90.6 87.8 84.9	61.7 57.5 53.3	4.1	195

LATITUDE =-33.45

WEST STAR							EAST STAR	
CATNO	MAG	Z.D.	AZ	L.S.T.	AZ	Z.D.	MAG	CATNO
20	4.4	36.8 41.0 45.1	264.2 262.0 260.0	3 51 4 11 4 31	99.7 97.6 95.5	45.1 41.0 36.8	2.4	205
59	4.4	50.3 54.4 58.6	280.0 276.7 273.7	6 9 6 29 6 49	83.9 80.8 77.5	58.6 54.4 50.3	3.8	274
89	4.3	51.5 55.6 59.7	265.4 263.0 260.6	7 38 7 58 8 18	98.4 96.0 93.5	59.7 55.6 51.5	3.2	321
89	4.3	53.8 57.9 62.1	264.0 261.6 259.3	7 50 8 10 8 30	100.7 98.4 96.0	62.1 57.9 53.8	2.8	335
145	2.7	43.5 47.6 51.8	279.4 276.1 273.0	8 34 8 54 9 14	86.4 83.3 79.9	51.8 47.6 43.5	2.8	324
145	2.7	45.2 49.3 53.5	278.0 274.8 271.9	8 42 9 2 9 22	86.1 83.0 79.7	53.5 49.3 45.2	3.1	330
177	2.0	40.0 44.1 48.3	282.3 278.7 275.4	9 7 9 27 9 47	82.2 78.8 75.0	48.3 44.1 40.0	3.1	330
193	3.1	37.9 42.1 46.3	273.5 270.5 267.8	9 51 10 11 10 31	91.0 88.3 85.2	46.3 42.1 37.9	3.3	350
192	3.7	41.6 45.7 49.8	264.2 262.0 259.8	10 14 10 34 10 54	98.3 96.0 93.6	49.8 45.7 41.6	3.5	366
177	2.0	54.7 58.9 63.0	270.9 268.1 265.5	10 18 10 38 10 58	91.9 89.2 86.3	63.0 58.9 54.7	2.9	388
200	3.8	40.4 44.6 48.7	266.8 264.4 262.1	10 20 10 40 11 0	97.7 95.4 92.9	48.7 44.6 40.4	3.5	366
185	-1.6	52.7 56.8 61.0	274.1 271.2 268.4	10 28 10 48 11 8	90.6 87.8 84.9	61.0 56.8 52.7	2.9	388
196	2.0	47.4 51.5 55.6	263.4 261.1 258.9	10 46 11 6 11 26	99.6 97.3 94.9	55.6 51.5 47.4	3.4	393
200	3.8	46.7 50.8 54.9	263.2 261.0 258.8	10 50 11 10 11 30	99.2 96.9 94.5	54.9 50.8 46.7	3.4	393
193	3.1	54.9 59.0 63.1	262.7 260.4 258.0	11 12 11 32 11 52	100.4 98.0 95.6	63.1 59.0 54.9	2.5	428
222	2.9	48.1 52.2 56.4	266.1 263.6 261.3	11 45 12 5 12 25	96.5 94.0 91.4	56.4 52.2 48.1	2.5	428
241	4.2	42.1 46.2 50.3	264.4 262.1 260.0	12 5 12 25 12 45	97.8 95.5 93.1	50.3 46.2 42.1	3.0	426
241	4.2	45.2 49.3 53.4	262.7 260.5 258.3	12 20 12 40 13 0	100.0 97.7 95.4	53.4 49.3 45.2	1.2	441
283	4.1	44.3 48.4 52.6	280.5 277.2 274.1	13 28 13 48 14 8	84.4 81.2 77.8	52.6 48.4 44.3	2.6	464
283	4.1	47.2 51.3 55.5	278.1 275.0 272.0	13 42 14 2 14 22	86.1 83.0 79.7	55.5 51.3 47.2	3.6	483
293	3.3	45.0 49.1 53.2	281.0 277.7 274.5	13 53 14 13 14 33	84.4 81.3 77.8	53.2 49.1 45.0	3.6	483

LATITUDE =-33.45

WEST STAR CATNO	MAG	Z.D.	AZ	L.S.T.	A7	7.D.	EAST STAR MAG	CATNO
296	4.2	53.5 57.7 61.9	271.3 268.6 265.9	14 50 15 10 15 30	93.7 91.0 88.2	61.9 57.7 53.5	4.0	537
321	3.2	37.4 41.6 45.7	276.2 273.1 270.2	14 52 15 12 15 32	87.6 84.5 81.1	45.7 41.6 37.4	4.0	502
321	3.2	42.0 46.1 50.3	272.8 269.9 267.3	15 14 15 34 15 54	90.8 88.0 84.9	50.3 46.1 42.0	3.6	524
321	3.2	42.5 46.7 50.9	272.4 269.5 266.9	15 17 15 37 15 57	92.0 89.3 86.4	50.9 46.7 42.5	3.9	528
321	3.2	43.2 47.4 51.6	271.9 269.1 266.5	15 20 15 40 16 0	91.5 88.7 85.8	51.6 47.4 43.2	3.0	533
335	2.8	39.8 44.0 48.2	273.0 270.1 267.4	15 30 15 50 16 10	90.3 87.5 84.4	48.2 44.0 39.8	3.9	528
330	3.1	51.5 55.7 59.9	275.3 272.4 269.6	16 6 16 26 16 46	88.4 85.5 82.4	59.9 55.7 51.5	3.3	562
335	2.8	54.5 58.6 62.7	263.6 261.3 258.9	16 40 17 0 17 20	100.1 97.7 95.3	62.7 58.6 54.5	3.9	591
350	3.3	49.9 54.1 58.2	266.7 264.2 261.6	17 2 17 22 17 42	97.5 95.0 92.5	58.2 54.1 49.9	3.9	591
366	3.5	39.5 43.6 47.8	267.6 265.2 262.8	17 6 17 26 17 46	95.4 92.9 90.3	47.8 43.6 39.5	4.3	573
388	2.9	48.2 52.3 56.5	278.5 275.4 272.4	18 10 18 30 18 50	84.8 81.7 78.3	56.5 52.3 48.2	4.4	605
388	2.9	52.7 56.9 61.0	275.1 272.2 269.4	18 32 18 52 19 12	90.6 87.8 84.8	61.0 56.9 52.7	3.5	631
413	3.8	41.4 45.5 49.6	264.1 261.9 259.7	18 48 19 8 19 28	99.0 96.8 94.4	49.6 45.5 41.4	4.2	620
411	4.0	48.5 52.6 56.7	280.3 277.0 274.0	18 53 19 13 19 33	84.6 81.5 78.1	56.7 52.6 48.5	4.2	627
428	2.5	44.2 48.4 52.5	271.1 268.4 265.8	19 15 19 35 19 55	92.4 89.7 86.8	52.5 48.4 44.2	3.8	637
430	2.9	54.8 59.0 63.2	268.3 265.7 263.1	20 5 20 25 20 45	94.8 92.1 89.4	63.2 59.0 54.8	2.2	14
505	2.8	38.0 42.2 46.3	262.9 260.9 258.9	21 19 21 39 21 59	100.6 98.6 96.4	46.3 42.2 38.0	4.4	20
528	3.9	43.0 47.1 51.3	273.3 270.4 267.7	22 12 22 32 22 52	91.5 88.7 85.7	51.3 47.1 43.0	4.2	42
537	4.0	41.7 45.8 50.0	280.8 277.4 274.2	22 14 22 34 22 54	83.0 79.6 76.0	50.0 45.8 41.7	3.7	34
512	2.9	52.0 56.1 60.2	262.1 259.8 257.6	22 26 22 46 23 6	100.2 97.8 95.4	60.2 56.1 52.0	4.2	67
528	3.9	52.6 56.8 60.9	266.9 264.3 261.9	22 58 23 18 23 38	98.0 95.6 93.0	60.9 56.8 52.6	4.3	81
573	4.3	37.6 41.8 45.9	271.0 268.3 265.7	23 35 23 55 24 15	91.8 89.1 86.1	45.9 41.8 37.6	4.2	67

APPENDIX F

Bathurst Land Use Survey

AIM AND SCOPE

The aim and scope of the land use survey is for each group of three students to undertake a survey in the environs of Bathurst. In making this survey, both field sampling and air photograph interpretation techniques will be employed. The final result will be a coded and symbolised map showing the land use of an area about one stereomodel in extent.

SCENARIO

This type of survey could well be undertaken to provide land use information for a local government authority or a land data bank. Other information within that data bank could be the legal description, coordinates, rate and valuation information, soil information and census data. The smallest unit or reference for this type of data bank is usually the land parcel. Therefore, we require the land use survey in this exercise to be property based. Accordingly, in this exercise, make your land use decision based on the most predominant use within the properties' boundaries as portrayed on the scale 1:25 000 map as far as possible.

METHOD

Each group will produce a land use map of the area covered by one stereo-pair of the aerial photographs of the scale 1:25 000 photography. The task will entail three distinct stages:

(1) Air photograph selection of representative areas

(2) Ground inspection and interpretation of those selected areas

(3) Air photograph interpretation based on the ground inspected areas

STAGE 1

Selection of Representative Areas:

This stage will be carried out at base, using mirror stereoscopes. Time involved ≅ about 2 hours. The aim of this stage is to select areas, which appear to represent many similar areas in the model, suitable for ground inspection. These areas will become the key to the whole survey.

This selection will be carried out by, firstly, broadly classifying the land patterns over the whole model according to the photographic TONE, TEXTURE and PATTERN, and secondly, by picking out 2 or 3 areas in each class with suitable road access for easy ground inspection.

To achieve these ends, a systematic inspection of the model under the mirror stereoscope will be made. Evolve a simple classification system based on the tone, texture and pattern of the photograph - whether an area is light or dark, or has a rough or smooth appearance. The whole model should be classified according to your system. A suggested classification system for your black and white photography may be:

3 Tones	-	light, medium dark
2 Textures	-	rough, smooth
2 Patterns	-	no, yes

This information should be recorded on an overlay to one of the black and white photographs. This classification system should not be based on land use, but on the appearance it has in the photograph. At this stage, inspect the colour prints that will be available for any additional or conflicting information that may be evident. On completion of this classification over the whole model, select wo to three areas in each class suitable for ground inspection. In contemplating this, remember that you will not be able to venture onto private property. The total number selected should be between 15-20 representative areas, preferably with some of differing classes being adjacent to each other.

STAGE 2

Ground Inspection and Land Use Interpretation of Selected Areas:

In this stage, the TONE, TEXTURE and PATTERN classification will be matched with the Land Use categories (as listed on last page of this Appendix). Time involved in field ≅ about three hours.

Upon reaching the site of the selected area, make a brief note of the activity carried out on the land (in excess of the land use category) and re-inspect the aerial photography.

Decide into which category this land should fall.

STAGE 3

Air Photo Interpretation:

Armed with the "ground truth" information gathered from Stages 1 and 2, you are now in a position to carry out a land use survey. Using the mirror stereoscope, re-examine the whole model making land use decisions under the categories listed. The information should be recorded on a map dyeline using the appropriate code and a land use decision made for each property/portion as delineated on the scale 1:25 000 map. Where the property does not appear on the map, note the land use regardless of this handicap. Finally, on this map or on another dyeline, show the land use by colours. This is a map and therefore it will need a key, a date, title, who surveyed it, methods used and the location of the survey to be shown.

SUBMISSION

This whole exercise is a GROUP EXERCISE, including the REPORT.

1. Overlay to the photograph showing the TONE/TEXTURE/PATTERN classification from Stage 1 as well as portraying the actual sites visited on the ground.

2. The "field notes" of the visits to the selected sites stating the actual land use at each site and any immediate implications of your findings on the ground.

3. The Land Use map showing the land coded in both numbers and colours. This may be completed on one or two separate maps, as you wish.

4. A report of about 2 pages in length that should include the following considerations: brief introduction giving methods used and any problem encountered; suggestions for improvements to the methods used; how would your group organise a land use survey over the whole of the Bathurst/Orange area? Would different types of aerial photography flown at a chosen time of year assist in this task? General comments and conclusions.

CODES FOR THE BATHURST LAND USE SURVEY

Code No.	Attribute/or Class/or Sub-Class	Colour or Symbol
1	Non-urban (rural)	
1.1	under cultivation (crops except grass)	brown
1.12	cereals	light brown
1.14	vegetables/flowers/vines	brown
1.16	orchard	brown stripes
1.2	forest (including scrub)	green
1.22	plantations (cultivated)	lime green
1.24	natural	dark green
1.242	dense timber	green & label (D)
1.244	open (scattered) timber	green & label (O)
1.26	scrub	very light green
1.3	pasture (grazing)	yellow
1.32	improved	light yellow
1.34	natural	yellow
1.4	water	blue
1.42	man-made	light blue
1.44	natural	dark blue
1.46	swamp	dark blue & label (S)
1.5	unused/unclass/waste	blank (white)
1.6	intensive animal production	purple stripes
1.62	poultry sheds, pigs	purple stripes & label (P)
1.64	stud yards, lot feed cattle	purple stripes & label (S)
1.7	mining and quarrying	purple & label (Q)
2	Residential (urban)	light red
3	Business (urban)	red
4	Industrial (urban)	purple
5	Special Uses Label accordingly, e.g. school, hospital, church and parking	light grey
6	Open Space (recreation)	
6.1	passive	green stripes & label (P)
6.2	active	green stripes & label (A)
7	Roads	black line
7.1	bitumen	black line & label (B)
7.2	loose metal	black line & label (M)

APPENDIX G

Constants of EDM Instruments

INSTRUMENT	SERIAL NUMBER	ADD. CONST.	σ ADD CONST.	DATE OF CALIBRATION	REFLECTOR TO WITH ADD. CONST. REFERS
AGA 14	14075	−4mm	±0.9mm	15.8.81	New AGA
HP 3800B	1141A00110	−1mm	±0.6mm	7.78	HP/Old AGA
HP 3800B	1226A00368	+1mm	±0.5mm	7.78	HP/Old AGA
HP 3805A	1338A00123	−2mm	±0.7mm	23.4.83	HP/Old AGA
HP 3805A	1440A01439	+3mm	±0.4mm	4.6.81	HP/Old AGA
HP 3820A	1650A00131	−1mm	±1.5mm	23.4.83	HP/Old AGA
KERN DM501	250942	(SEE NEXT PAGE)			KERN
TELLUROMETER CA 1000	6249-E, 6250-E	−23mm	±11mm	16.8.80	N.A.
TOPCON DM-C2	911266	+4mm	±0.4mm	9.8.80	New AGA
TOPCON GTS-2	B45056	+1mm*	±0.2mm	20.10.83	Topcon

* Internal additive constant setting = -07 (mm)

DM 501 ADD. CONST.:

→ EITHER SCALE OF DIAGRAM BELOW OR COMPUTE FROM EQ. USING <u>ALL</u> TERMS!

DISTANCES < 100 m → CLOSED DIAPHRAGM

> 100 m → OPEN DIAPHRAGM

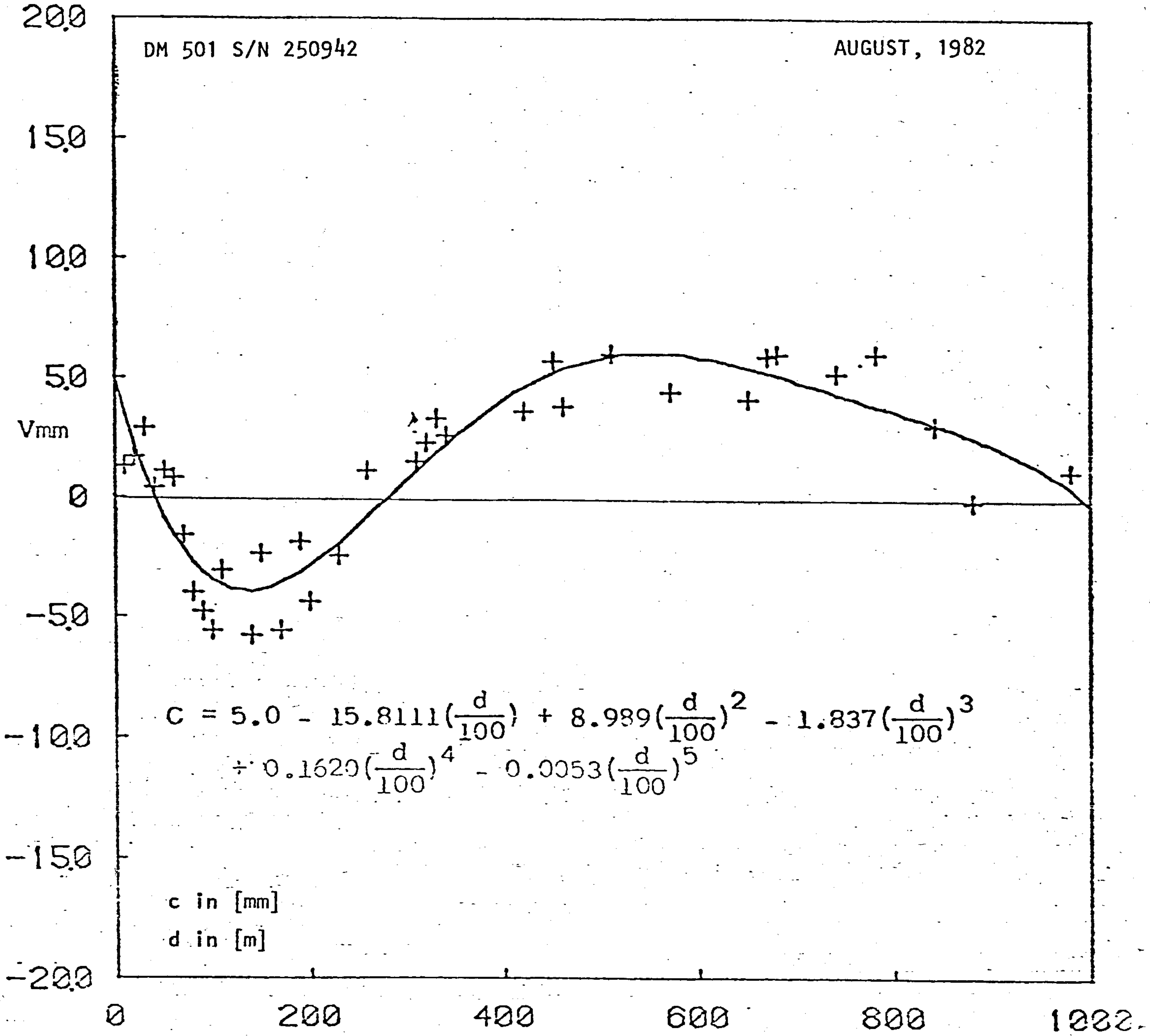


Fig. 15: Curve fitted to residuals from Regents Park and 100m Baseline.