UNIVERSITY OF NEW SOUTH WALES

SCHOOL OF SURVEYING

29.001 SURVEYING 1A

PART TIME COURSE 1976

FIELD EXERCISE: LEVELLING II (LINE LEVELLING)

1. AIMS

To familiarise students with the technique of line levelling between Bench Marks and the determination of reduced levels of intermediate points to an accuracy of about ± 1 mm (standard deviation).

2. EQUIPMENT

1 Automatic Level (ZEISS NI2) and tripod
1 Metric Staff
1 Change spike
1 Change plate
1 Hammer
1 Staff bubble
1 Sign Chalk
1 Linen or fibreglass tape
1 Writing board (A4) with bulldog clip
1 ranging rod.

Line levelling includes some walking. As it is not very convenient to carry all parts of the equipment in ones hands the whole way, you should bring a suitable bag for the transport of the smaller objects with you. Do not forget your 2 m spring steel tape, too.

3. EXERCISE: PART A

3.1
Check the permanent adjustments of your automatic level as described in chapter 3.5.3 of your textbook (page 25; W.S. Whyte: Revision notes on Plane Surveying) and in chapter 3 of the exercise "Levelling I". No adjustments should be made by students. Results in field book.

3.2
The tests should be made near the Civil Engineering Building. Use the change plate on one end (hard surface) and the change spike on the other end (firm ground) for the two peg test. Distance between: 50 m. The test should be done once per group. If the difference between the height difference obtained on midway point and the height difference obtained on point close to staff exceeds 3 mm, another group member should repeat the (whole) test. If your first result is confirmed, call your demonstrator for adjustment, if not, repeat a second time (and so on).

3.3
The ranging rod should be used to stabilize the staff in the plane perpendicular to the line of sight.

3.4
All bookings of two-peg test on field forms "Line Levelling".

4. EXERCISE: PART B

Instead of determining Reduced levels (R.L.) of new points, you check the given R.L.s of the State Survey Mark (SSM) 4775 and of the "private" Bench Mark on the Chemistry Building by a line levelling from SSM 4779 to SSM 4780 and back. You can find the recovery sketches of all points in the Appendix as well as an extract of the campus plan with the approximate locations of these four points.

4.1
The levelling should be done in the following order: 4779 - 4775 - BM Chemistry - 4780 - BM Chemistry - 4775 - 4779. Your supervisor will tell you where and in which direction to start to avoid a start of all groups at the same point.

4.2
Sighting distances in back and foresight must be equal for any one of the instrument set ups, Set out by pacing. The maximum allowed sighting distance is 50 m. But, if you cannot estimate mm on this distance, choose sighting distances around 35-40 m or smaller.

4.3
Choose your changing points on firm ground, so that you can peg in your change spike. If you cannot avoid hard surfaces, use the change place but make sure that it does not change its position when you turn the staff on it.

4.4
Stabilize the staff always with the ranging rod in a perpendicular plane to the line of sight.

4.5
The circular bubble of automatic levels must be centred carefully whilst the telescope is facing the staff on the backsight point (Reason in lectures).

4.6
Make sure before you do all staff readings, that the compensator of your automatic level is swinging freely. Turn the slow motion screw fast forward and backward to see the cross hairs moving.

4.7
If you find it difficult to set up your staff on the chemistry BM, use your 2 m spring steel tape instead.

4.8
Use the field forms "Line Levelling" for booking, but do not fill in the columns "Red Level", "V", "Final Level". Leave three lines open after arriving on one of the four points and use them for the computation checks for every line section.

4.9
All members of the group must share the observations. The acting observer must be stated on the field form.

4.10
When you have finished your line levelling (the whole line must be levelled twice!) you compare (in the fieldbook) the height differences between the Bench Marks you got in the two runs. You can compare the height differences in three sections. 4779 - 4775, 4775 - BM Chemistry, BM Chemistry - 4780. All line sections showing 5 mm or more discrepancy in the two height differences should be levelled a third time.

5. REPORT

The report's goal is to find the adjusted Reduced Levels (R.L.) of the two intermediate Bench Marks SSM 4775 and BM "Chemistry", based on your observations and the given R.L.'s of SSM 4779 and SSM 4780.

Reduced Levels (given) SSM 4779 = 32,258 m

SSM 4780 = 34,140 m

Datum: Mean Sea Level

5.1
All necessary calculations to get the adjusted R.L.'s and the requested standard deviations are shown in an example in the appendix. The following definitions and formulas are used:

d = difference of height differences in a levelling line section

d = onward height difference minus backward height difference (same sign then onward h.d.)

D = length of a levelling line section (in km)

p = weight = $\frac{1}{D_i}$ D_i in km

w = misclosure = (Total measured Height difference between end points) minus (Height difference between endpoints, calculated from given R.L.'s)

V_i = residual of level line section "i".

$$V_i = \frac{W}{\left[\frac{1}{p}\right]} \frac{1}{p} = -\frac{W}{[D]} D_i$$

$S_{1\text{ km single}}$ = Standard deviation of one single run levelling over 1 km

$$= \pm\sqrt{\frac{[pdd]}{2n}}$$

$S_{1\text{ km double}}$ = Standard deviation of a double run levelling over 1 km (levelling onwards and backwards)

$$= \pm\sqrt{\frac{[pdd]}{4n}}$$

n = number of line sections

5.2
The adjusted R.L.'s for the two intermediate points should be compared with given values:

Given Reduced Levels SSM 4775 = 27.992 m

BM "Chemistry" = 100.00 feet

= 30.480 m

Comment appearing discrepancies.

5.3
Compare your $S_{1\text{ km double}}$ with standard deviations published by manufacturers:

$S_{1\text{ km double}}$ = ± 1.5 mm WILD NA2

$S_{1\text{ km double}}$ = ± 1.5 - 2.5 mm ZEISS (WEST GERMANY) NI2

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Lecturer
February 1976

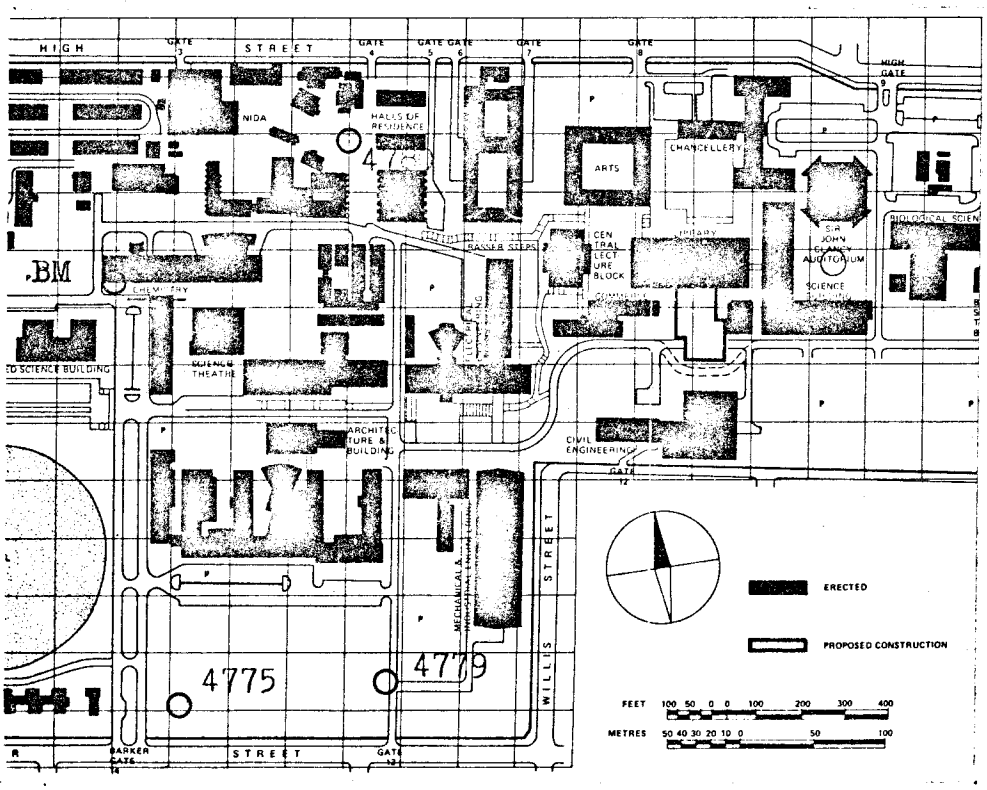
Duplicate Levelling line between two points of known height:
Adjustment and computation of standard deviations

STA NO	ΔH onward	ΔH backw.	d	D	dd	pdd	ΔH Mean	v	ΔH adjust	R.L.	Notes
	m	m	mm	km			m	mm	m	m	
75										28.734	given
76	+1.815	+1.814	+1	0.42	1	2.4	+1.8145	+0.8	+1.815	30.549	
77	+3.626	+3.629	-3	0.74	9	12.2	+3.6275	+1.4	+3.629	34.178	
82	+2.511	+2.509	+2	0.51	4	7.8	+2.5100	+1.0	+2.511	36.689	
84	-1.613	-1.612	-1	0.64	1	1.6	-1.6125	+1.2	-1.611	35.078	given
				2.31		24.0	+6.3395	+4.4	+6.344		
					given		+6.3440	← ↑ — — →			
					w=		-0.0045	m ← !			

$$p = \frac{1}{D}$$

$$v = \frac{+4.5\text{mm}}{2.31\text{km}} \cdot D$$

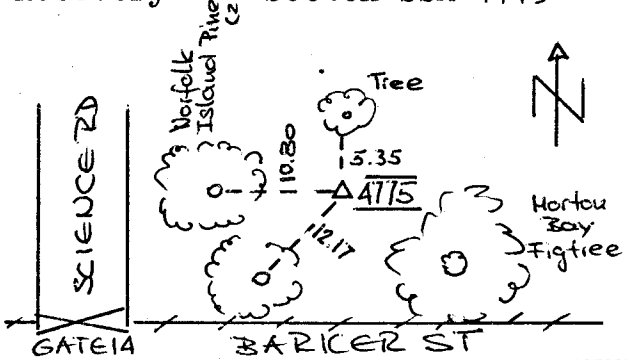
$$s_{1\text{ km single}} = \pm\sqrt{\frac{24.0}{8}} = \underline{\pm\ 1.7\text{ mm}} \qquad s_{1\text{ km double}} = \underline{\pm\ 1.2\text{ mm}}$$



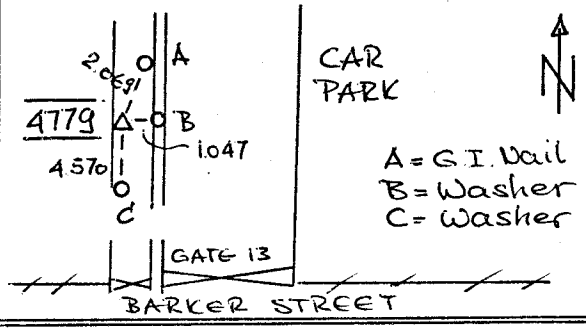
Location of BM
Campus-plan
1:5320

○ = Bench Mark

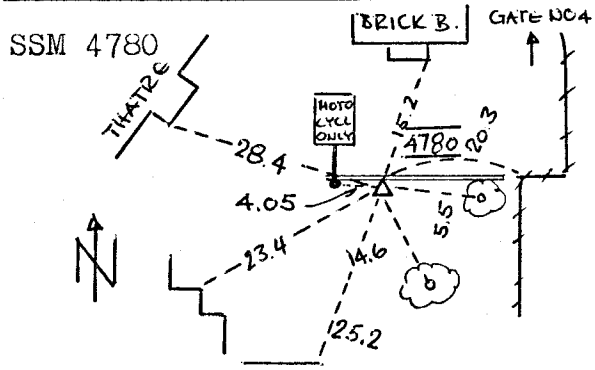
Recovery- Scetch SSM 4775



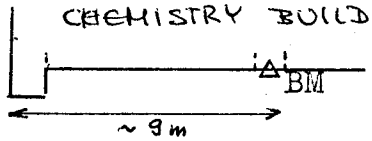
Recovery Scetch SSM 4779



SSM 4780



Recovery Scetch BM "Chemistry"
(R.L.100.00feet Stadard Datum)



Square bolt (aluminium) on prop in South West Corner of Chemistry Building. About 1 m over ground.