

Chapter 2

2.1

- a. 138.32'
- b. 1.56 sq. mi.
- c. 57.877 m
- d. 306°
- e. 148.2417°
- f. 43,054 sf
- g. $7/8''$
- h. 4,781.04'
- i. 105 m^2
- j. $35^\circ 52' 21''$

2.2 $104^\circ 15' 15''$; 104.2542°

2.3

- a. $B = 45^\circ$, $b = 4.87'$, $c = 6.89'$
- b. $A = 60^\circ$, $B = 30^\circ$, $a = 30.35'$
- c. $c = 44.72'$, $A = 26^\circ 33' 54''$, $B = 63^\circ 26' 06''$
- d. $c = 110'$, $A = 36^\circ 52' 12''$, $B = 53^\circ 07' 48''$

2.4 $BD = 530.06'$ (needed to solve remaining sides)
 $AB = 224.87'$, $BC = 609.73'$, $CD = 351.06'$

2.5 $c = 54.33'$, $A = 51^\circ 03' 58''$, $B = 103^\circ 56' 01''$

2.6 $A = 57^\circ 46' 09''$, $B = 84^\circ 22' 28''$, $C = 37^\circ 51' 23''$

2.7

- a. 721.9 sf
- b. 250 m^2
- c. 3594 sf
- d. 406 m^2
- e. 5,672 sf

2.8

- a. Area = 7,000 sf
- b. $AC = 128.1'$
- c. $BAC = 51^\circ 20' 25''$
- d. Yes; the bearings of AC and ED are identical

CHAPTER 3

3.1 a) F, b) F, c) F, d) T, e) F

3.2 For very short distances (less than 100ft or 30 m), measurements using a steel tape are usually more accurate and faster to accomplish. For longer distances, total stations and other electronic instruments are superior, both for accuracy and length of time of measurement. When distances are long and the terrain is difficult, the advantages of electronic techniques become much more pronounced

- 3.3**
- a) - looking for survey evidence to begin a survey;
rough-checking a construction layout
 - b) - auto: identifying rural fence corners;
wheel: frontage measurements for assessment purposes;
wheel: measurements for accident surveys
 - c) - taking a baseline measurement;
measuring over long distances or difficult terrain
 - d) - measuring across a busy highway;
setting a calibration baseline for industrial use
 - e) - doing quantity measurements on a construction site;
measuring less important detail
 - f) - measuring control lines for any small-area survey;
measuring key components in a structural layout.

- 3.4**
- a) $16.23 \times 66 = \mathbf{1,071.18 \text{ ft.}}$ $\times .3048 = \mathbf{326.50 \text{ m}}$
 - b) $70.10 \times 66 = \mathbf{4626.60 \text{ ft.}}$ $\times .3048 = \mathbf{1410.19 \text{ m}}$
 - c) $6.77 \times 66 = \mathbf{446.82 \text{ ft.}}$ $\times .3048 = \mathbf{131.19 \text{ m}}$
 - d) $4.10 \times 66 = \mathbf{270.60 \text{ ft.}}$ $\times .3048 = \mathbf{82.48 \text{ m}}$

3.5 Clearance = $61.6 + 3.8 = \mathbf{65.4 \text{ ft}}$ (Tan $45^\circ = 1.00$)

3.6 Distance = $88.00 - 0.8 = \mathbf{87.20 \text{ ft}}$

3.7 Distance = $100.00 + 0.48 = \mathbf{100.48 \text{ ft}}$

3.8 $H = 37.277 \cos 1^\circ 42' = \mathbf{37.261 \text{ m}}$

3.9 $H = \sqrt{90.07^2 - 5.21^2} = \mathbf{89.92 \text{ ft}}$

3.10 Tan(slope angle) = .02; slope angle = $\arctan(.02) = 1.1457628^\circ$
 $H = (118.060) \cos 1.1457628^\circ = \mathbf{118.036 \text{ m}}$

3.11

The impact of temperature on the layout distance is minimal at such short distances

Line	Layout Distance (ft.)			
	a. T = 68°F	b. T = 100°F	c. T = 10°F	d. Slope = 10%, T = 68°
1-2	29.15	29.14	29.16	29.26 (slope distance = $\sqrt{2.5^2 + 29.15^2}$)
1-3	35.36	35.37	35.35	35.45
1-4	29.15	29.16	29.14	29.19
1-5	21.21	21.22	21.21	21.26
1-6	24.61	24.62	24.61	24.69
1-7	24.61	24.62	24.61	24.65
1-8	32.53	32.54	32.52	32.59
1-9	32.53	32.54	32.52	32.63

Note on (d); draw a profile along the centerline of the N-S drive to find the distance from point 1 to points 2-9 perpendicular to the slope. At 10% slope, points 2 and 3 are 2.5' higher than point 1; points 4 and 5 are 1.5' higher; points 6 and 8 are 2.0' higher; point 7 is 1.43' higher, and point 9 is 2.56' higher.

e.	8X8 slab	10X10 slab
Diagonal (edge of slab)	11.31'	14.14'
Diagonal (outside of formwork)	11.67' (11' 8 $\frac{1}{16}$ ")	14.49' (14'- 5 $\frac{15}{16}$ ")

3-12

PACING EXERCISE			
PACES/100.00 FT	$(40+40.5+41+41.5)/4 = 40.5 \text{ paces/100ft}$		
STA	FWD (PACES)	BACK (PACES)	AVE DIST (FT)
1			
	163	164	$163.5p \times 100ft/40.5p = 403.7ft$
2			
	70	70	172.84ft
3			
	87	89	217.28ft
4			
	48	49	119.75ft
1			

TAPING EXERCISE				
STA	FWD	BACK	AVE DIST (FT)	DIFF (FT)
1				
	404.79	404.81	404.80	+1.1
2				
	174.42	174.35	174.39	+1.5'
3				
	218.55	218.54	218.55	+1.3
4				
	120.02	119.94	119.98	+0.23
1				
The crew is consistently underestimating the distance when pacing. Check pace calibration on grass versus hard surface. Factors such as slope, soft ground, long grass, etc. can cause pace length to vary significantly.				

CHAPTER 4

4.1 a) i 2.05	b) i 1.165	c) i 2.05	d) i 1.085	e) i 3.10	f) i 1.165
ii 1.90	ii 1.120	ii 1.79	ii 1.005	ii 2.8	ii 1.045
iii 1.56	iii 1.020	iii 1.45	iii 0.970	iii 2.54	iii 0.990
iv 1.20	iv 0.960	iv 1.25	iv 0.940	iv 2.26	iv 0.915
v 0.90	v 0.910	v 0.95	v 0.900	v 1.98	v 0.860

4.2	STATION	BS	HI	FS	ELEVATION
	BM 50	1.27	315.04		313.77
	TP 1	<u>2.33</u>	342.16	4.91	310.13
	TP 2			<u>6.17</u>	306.29
	$\Sigma BS = 3.60$		$\Sigma FS = 11.08$		$313.77 + 3.60 - 11.08 = 306.29$ check

4.3	STATION	BS	HI	IS	FS	ELEVATION
	BM 61	4.72	324.92			320.20
	0+00			4.42		320.50
	0+50			4.30		320.62
	TP 1	<u>5.11</u>	328.02		2.01	322.91
	1+00			4.66		323.36
	1+50			3.98		324.04
	1+75			1.20		326.82
	TP 2			<u>1.80</u>		326.22
	$\Sigma BS = 9.83$		$FS = 3.81$		$320.20 + 9.83 - 3.81 = 326.22$ check	

4.4	STATION	BS	HI	FS	ELEVATION
	BM 3	1.613	399.635		398.022
	TP 1	1.425	399.133	1.927	397.708
	TP 2	1.307	398.730	1.710	397.423
	TP 3	<u>1.340</u>	398.797	1.273	397.457
	BM 3			<u>0.780</u>	398.017
	$\Sigma BS = 5.685$		$\Sigma FS = 5.690$		$398.022 + 5.685 - 5.690 = 398.017$ ck

4.5 Error = $398.022 - 398.017 = 0.005\text{m}$

2nd order Class 1 (U.S.) = $6\text{mm} \sqrt{K} = .006 \sqrt{0.7} = .005$

2nd order (Canada) = $8\text{mm} \sqrt{K} = .008 \sqrt{.7} = .007$. The error qualifies for 2nd order in both countries.

4.6	STATION	BS	HI	FS	ELEVATION
	BM 100	2.71	179.27		176.56
	TP 1	3.62	178.01	4.88	174.39
	TP 2	3.51	177.55	3.97	174.04
	TP 3	3.17	177.91	2.81	174.74
	TP 4	<u>1.47</u>	177.76	1.62	176.29
	BM 100			<u>1.21</u>	176.55
	$\Sigma BS = 14.48$		$\Sigma FS = 14.49$		$176.56 + 14.48 - 14.49 = 176.55$ check

4.7 Error = $176.56 - 176.55 = 0.01 \text{ ft}$. 2nd order allowable error = $.035 \sqrt{1000/5280} = 0.015$

Therefore the results qualify for second order – according to Table 4.2.

4.8 STATION	BS	HI	IS	FS	ELEVATION
BM S101	0.475	202.500			202.025
0+000			0.02		202.48
0+020			0.41		202.09
0+040			0.73		201.77
0+060			0.70		201.80
0+066.28			0.726		201.774
0+080			1.38		201.12
0+100			1.75		200.75
0+120			2.47		200.03
TP 1	0.666	200.173		2.993	199.507
0+140			0.57		199.60
0+143.78			0.634		199.539
0+147.02			0.681		199.492
0+160			0.71		199.46
0+180			0.69		199.48
0+200			1.37		198.80
TP 2	<u>0.033</u>	198.501		1.705	198.468
BM S102				<u>2.891</u>	195.610
Σ BS = 1.174		Σ FS = 7.589			
202.025 + 1.174 - 7.589 = 195.610 <i>check</i>					

4.9

STATION	BS	HI	FS	SS	ELEV	DESCRIPTION
BM1	4.58	104.58			100.00	X on conc., 1st floor, East entry
TP1	8.25	111.24	1.59		102.99	
TP2	8.19	117.83	1.60		109.64	
1	4.59	117.80	4.62		113.21	X on conc., 2nd floor, top of E stairs
TP3	4.58	117.92	4.46		113.34	
2	2.25	115.57	4.60		113.32	X on conc., 2nd floor, top of N stairs
TP4	4.61	108.43	11.75		103.82	
TP5	1.65	101.25	8.83		99.60	
3	4.58	101.25	4.58		96.67	X on conc., 1st floor, N entry
4	4.58	101.92	3.91		97.34	X on conc., top of ramp in N-S hallway
5	4.64	104.65	1.91		100.01	X on conc., top of ramp in E-W hallway
6				9.25	95.40	Floor of mezzanine level
7				5.76	98.89	Floor of sunken area in main lobby
8				15.22	89.43	Floor of mechanical room, basement level
BM1			4.64		100.01	(100.00)

- Difference between 1st and 2nd floors at east end of building - 13.21'
 - Difference between 1st and 2nd floors at north end of building - 16.65'
 - Difference between 2nd floor and mechanical room floor - 23.78 to 23.87' (2nd floor is not level)
 - Difference between 1st and 2nd floors at east end of building - 13.21'
- (Note: 2nd floor is not level as seen by difference in elevation at top of N stairs and top of E stairs)

4.10 (inadvertently duplicates 4.8)

4.11	STATION	BS	HI	IS	FS	ELEVATION
	BM 41	6.21	353.76			347.55
	TP 13	4.10	356.97		0.89	352.87
	12+00					
	50 ft. left			3.9		353.1
	18.3 ft. left			4.6		352.4
	□			6.33		350.64
	20.1 ft. right			7.9		349.1
	50 ft. right			8.2		348.8
	13+00					
	50 ft. left			5.0		352.0
	19.6 ft. left			5.7		351.3
	□			7.54		349.43
	20.7 ft. right			7.9		349.1
	50 ft. right			8.4		348.6
	TP 14	<u>7.39</u>	363.24		1.12	355.85
	BM S22				<u>2.41</u>	360.83
	Σ BS = 17.70			Σ FS = 4.42		
	347.55+17.70 - 4.42= 360.83 <i>check</i>					

4.12

Station	BS	HI	FS	Elevation	Left	℄	Right
BM 107	7.71	206.60		198.89			
80+50					60' 28' 0' 32' 60'		
					9.7 8.0 5.7 4.3 4.0		
					196.9 198.6 200.9 202.3 202.6		
81+00					60' 25' 0' 30' 60'		
					10.1 9.7 6.8 6.0 5.3		
					196.5 196.9 199.8 200.6 201.3		
81+50					60' 27' 0' 33' 60'		
					11.7 11.0 9.2 8.3 8.0		
					194.9 195.6 197.4 198.3 198.6		
TP 1			10.17	196.43			

- 4.13**
- Correct difference in elevation = $8.72 - 5.61 = 3.11$ ft.
 - Correct reading @ A would have been $5.42 + 3.11 = 8.53$ ft.
 - Error is $(8.57 - 8.53) = +0.04$ ft. in 300 ft.
 - Upper/lower reticle capstan screws are loosened/tightened until the cross hair falls on 8.53 on the rod @ A.

- 4.14**
- $V = 148.61 \sin 9^\circ 26' = 24.36$ ft.
Elevation of lower station = $324.28 + 4.66 - 24.36 - 4.88 = 299.70$ ft.
 - $H = 148.61 \cos 9^\circ 26' = 146.60$ ft.
Lower station = $110 + 71.25 + 146.42 = 112 + 17.85$

- 4.15**
- First elevation difference = $2.417 - 0.673 = 1.744$
Second elevation difference = $2.992 - 1.252 = 1.740$
Average elevation difference = 1.742
Elevation of B = $187.298 - 1.742 = 185.556$ m
 - Error = 0.004 m

4.16 a) Error = 167.174 – 167.185 = - 0.011m

Accuracy limit for 2nd order = $.007 \sqrt{.8} = .006$

Accuracy limit for 3rd order = $.012 \sqrt{.8} = .011$ (U.S.)

or = $.024 \sqrt{.8} = .021$ (Canada)

(See Tables 4.2 and 4.3)

Therefore the error of - 0.011 satisfies the requirements for 3rd order accuracy in both the U.S. and Canada.

4.16(b)

Station	Cumulative Distance	Elevation	Correction	Adjusted Elevation
BM 130		168.657		168.657
TP 1	130	168.248	$130/780 \times .011 = +.002$	168.250
TP 2	260	168.539	$260/780 \times .011 = +.004$	168.543
TP 3	390	166.318	$390/780 \times .011 = +.006$	165.324
BM K110	520	166.394	$520/780 \times .011 = +.007$	166.401
TP 4	650	166.579	$650/780 \times .011 = +.009$	166.588
BM 132	780	167.618	$780/780 \times .011 = +.011$	167.629

C = 167.629 – 167.618 = - 0.011

The adjusted elevation of BM K110 is 166.401m

4.17

- a. Error = 0.11' in 3 miles. The project requires at least Third Order control per Table 2.3(a):

Allowable error = $0.06 \sqrt{3} = 0.10'$. The results are minimally acceptable for Third order work.

BM	Cumulative Loop Distance (mi)	Field Elevation (ft)	Correction (ft)	Adjusted Elevation (ft)
111	--	1320.28 (fixed)	--	1320.28
1	0.4	1325.15	$0.4/3.0 \times 0.11 = 0.01'$	1325.14
2	0.7	1328.94	$0.7/3.0 \times 0.11 = 0.03'$	1328.91
3	0.95	1331.55	$0.95/3.0 \times 0.11 = 0.03'$	1328.52
4	1.20	1329.01	$1.20/3.0 \times 0.11 = 0.04'$	1328.97
5	1.8	1327.86	$1.8/3.0 \times 0.11 = 0.07'$	1327.79
6	2.4	1333.67	$2.4/3.0 \times 0.11 = 0.09'$	1333.58
111	3.0	1320.39	$3.0/3.0 \times 0.11 = 0.11'$	1320.28
		Error = 1320.39 – 1320.28 = 0.11'		

CHAPTER 5

- 5.1** Prism constant = AC-AB-BC
 $= 488.255 - 198.690 - 289.595 = -0.030\text{m}$
- 5.2** $H = 2,183.71 \cos +2^\circ 45' 30'' = 2,181.18 \text{ ft.}$
 $V = 2,183.71 \sin +2^\circ 45' 30'' = 105.09 \text{ ft.}$
Elevation of target station = $285.69 + 105.09 = 390.78 \text{ ft.}$
- 5.3** Inst. @ A, $H = 1,458.777 \cos -2^\circ 40' 40'' = 1,457.184\text{m}$
Elevation difference = $1,458.777 \sin 1^\circ 26' 50'' = -68.153\text{m}$
Inst. @ B, $H = 1,458.757 \cos 2^\circ 40' 00'' = 1,457.177\text{m}$
Elevation difference = $1,458.757 \sin 2^\circ 40'' = 67.869\text{m}$
a) Horizontal distance = $(1,457.184 + 1,457.177)/2 = 1,457.181\text{m}$
b) Elev. B = $211.841 - (68.153 + 67.869)/2 = 143.833\text{m}$
- 5.4** $LL^1 = 3,000.00 \sin 3^\circ 30' = +183.15 \text{ ft.}$
 $c+r = .0206 \times 3^2 = +0.19 \text{ ft.}$
Elevation difference, K to L, = $+183.34 \text{ ft}$
Elevation of L = $232.47 + 183.34 = 415.81 \text{ ft.}$
- $MM^1 = 3000.00 \sin -1^\circ 30' = -78.53 \text{ ft.}$
 $c+r = .0206 \times 3^2 = +0.19 \text{ ft.}$
Elevation difference, K to M, = -78.34 ft.
Elevation of M = $232.47 - 78.34 = 154.13 \text{ ft.}$
- $c+r = .0206 \times 2^2 = +0.08 \text{ ft.}$
Elevation difference, K to N, = $+0.08 \text{ ft.}$
Elevation of N = $232.47 + 0.08 = 232.55 \text{ ft.}$
- 5.5** $\Delta HR - \Delta hi = 0.150 - 0.100 = 0.050\text{m}$
 $\sin \Delta \alpha = (0.050 \cos 4^\circ 18' 30'')/387.603$
 $\Delta \alpha = 0^\circ 00' 27''$
 $\alpha_K = 0^\circ 00' 27'' + 4^\circ 18' 30'' = 4^\circ 18' 57''$
 $H = 387.603 \cos 4^\circ 18' 57'' = 386.504\text{m}$
Elevation of B = $110.222 + 1.601 + (387.603 \sin 4^\circ 18' 57'') - 1.915$
 $= 139.077\text{m.}$
- 5.6** $\Delta HR - \Delta hi = 0.39 - 0.31 = 0.08 \text{ ft.}$
 $\sin \Delta \alpha = (0.08 \cos 3^\circ 14' 30'')/536.88$
 $\Delta \alpha = 0^\circ 00' 31''$
 $\alpha_K = 0^\circ 00' 31'' + 3^\circ 14' 30'' = 3^\circ 15' 01''$
 $H = 536.88 \cos 3^\circ 15' 01'' = 536.02 \text{ ft.}$
Elevation B = $531.49 + 5.21 + (536.88 \sin 3^\circ 15' 01'') - 5.78$
 $= 561.36 \text{ ft.}$

CHAPTER 8

- 8.1** E = $114^{\circ} 31'$
- 8.2** A $70^{\circ}10'30'' + 30 = 70^{\circ}11'00''$
B $142^{\circ}41'00'' + 30 = 142^{\circ}41'30''$
C $83^{\circ}51'30'' + 30 = 83^{\circ}52'00''$
D $117^{\circ}25'30'' + 30 = 117^{\circ}26'00''$
E $\frac{125^{\circ}49'00''}{539^{\circ}57'30''} + 30 = \frac{125^{\circ}49'30''}{150^{\circ} 537^{\circ}179'60''} = 540^{\circ}00'00''$
- 8.3** a) S $7^{\circ}29'W$ d) N $56^{\circ}09'E$
b) S $38^{\circ}06'E$ e) S $73^{\circ}42'W$
c) N $14^{\circ}43'30''W$ f) S $43^{\circ}09'E$
- 8.4** a) $347^{\circ}09'$ d) $183^{\circ}12'$
b) $66^{\circ}14'$ e) $326^{\circ}47'$
c) $144^{\circ}56'$ f) $179^{\circ}54'$
- 8.5** a) $8^{\circ}23'$ d) $209^{\circ}33'$
b) $347^{\circ}52'$ e) $81^{\circ}50'$
c) $150^{\circ}09'50''$ f) $346^{\circ}59'$
- 8.6** a) S $7^{\circ}51'E$ d) N $4^{\circ}39'E$
b) S $76^{\circ}14'W$ e) S $37^{\circ}18'E$
c) N $33^{\circ}33'W$ f) N $0^{\circ}38'W$
- 8.7** AB = N $20^{\circ}41'E$
B + $1^{\circ}03'$
BC = N $21^{\circ}44'E$
C + $2^{\circ}58'$
CD = N $24^{\circ}42'E$
D - $7^{\circ}24'$
DE = N $17^{\circ}18'E$
E - $6^{\circ}31'$
EF = N $10^{\circ}47'E$
F + $1^{\circ}31'$
FG = N $12^{\circ}18'E$
G - $8^{\circ}09'$
GH = N $4^{\circ}09'E$
- 8.8** Angle at A = Azimuth DA + $180 -$ Azimuth AB (subtract 360° if > 1 rev)
A = **$51^{\circ}05'$**
B = **$134^{\circ}33'$**
C = **$102^{\circ} 04'$**
D = **$72^{\circ}18'$**
Sum of interior angles = 360° (check)
- 8.9** **CLOCKWISE**
AB N $48^{\circ} 30'E$
BC S $53^{\circ} 41'E$
CD S $21^{\circ} 37'W$
DE S $88^{\circ} 32'W$
EA N $30^{\circ} 02'W$

8.10 CLOCKWISE

Az AB = $58^{\circ}40'$
Az BA = $238^{\circ}40'$
-B $102^{\circ}11'$
Az BC = $136^{\circ}29'$
Az CB = $316^{\circ}29'$
-C $104^{\circ}42'$
Az CD = $211^{\circ}47'$
Az DC = $391^{\circ}47'$
-D $113^{\circ}05'$
Az DE = $278^{\circ}42'$
Az ED = $458^{\circ}42'$
-E $118^{\circ}34'$
Az EA = $340^{\circ}08'$
Az AE = $160^{\circ}08'$
-A $101^{\circ}28'$
Az AB = $58^{\circ}40'$ **CHECK**

8.11 CLOCKWISE

Az AB = $55^{\circ}55'$
Az BA = $235^{\circ}55'$
-B $102^{\circ}11'$
Az BC = $133^{\circ}44'$
Az CB = $313^{\circ}44'$
-C $104^{\circ}42'$
Az CD = $209^{\circ}02'$
Az DC = $389^{\circ}02'$
-D $113^{\circ}05'$
Az DE = $275^{\circ}57'$
Az ED = $455^{\circ}57'$
-E $118^{\circ}34'$
Az EA = $337^{\circ}23'$
Az AE = $157^{\circ}23'$
-A $101^{\circ}28'$
Az AB = $55^{\circ}55'$ **CHECK**

COUNTER-CLOCKWISE

Az AB = $55^{\circ}55'$
+A $101^{\circ}28'$
Az AE = $157^{\circ}23'$
Az EA = $337^{\circ}23'$
+E $118^{\circ}34'$
Az ED = $455^{\circ}57'$
Az ED = $95^{\circ}57'$
Az DE = $275^{\circ}57'$
+D $113^{\circ}05'$
Az DC = $389^{\circ}02'$
Az DC = $29^{\circ}02'$
Az CD = $209^{\circ}02'$
+C $104^{\circ}42'$
Az CB = $313^{\circ}44'$
Az BC = $133^{\circ}44'$
+B $102^{\circ}11'$
Az BA = $235^{\circ}55'$
Az AB = $55^{\circ}55'$ **CHECK**

8.12

a) A $51^{\circ}23'$ b)
B $105^{\circ}39'$
C $78^{\circ}11'$
D $124^{\circ}47'$
358 $^{\circ}120'$
360 $^{\circ}00'$

CHECK

(n-2)180 =
(4-2)180 = 360 $^{\circ}$

AZIMUTH

Az AB = $64^{\circ}40'$
Az BA = $244^{\circ}40'$
-B $105^{\circ}39'$
Az BC = $139^{\circ}01'$
Az CB = $319^{\circ}01'$
-C $78^{\circ}11'$
Az CD = $240^{\circ}50'$
Az DC = $420^{\circ}50'$
-D $124^{\circ}47'$
Az DA = $296^{\circ}03'$
Az AD = $116^{\circ}03'$
-A $51^{\circ}23'$
Az AB = $64^{\circ}40'$

BEARING

N64 $^{\circ}40'$ E

S40 $^{\circ}59'$ E

S60 $^{\circ}50'$ W

N63 $^{\circ}57'$ W

N64 $^{\circ}40'$ E **CHECK**

c)

<u>Course</u>	<u>Azimuth</u>	<u>Bearing</u>	<u>Distance</u>	<u>Latitude</u>	<u>Departure</u>
AB	64°40'	N64°40'E	713.93	305.48	645.27
BC	139°01'	S40°59'E	606.06	-457.51	397.48
CD	240°50'	S60°50'W	391.27	-190.69	-341.66
DA	296°03'	N63°57'W	<u>781.18</u>	<u>343.06</u>	<u>-701.82</u>
			P = 2492.44	$\Sigma L = + 0.34$	$\Sigma D = -0.73$

Error, $E = \sqrt{0.34^2 + 0.73^2} = 0.81$. Precision = $E/P = 0.810/2492.44 = 1:3,095 = 1:3,100$

8.13

<u>Course</u>	<u>C_{LAT}</u>	<u>C_{DEP}</u>	<u>Corrected Lat.</u>	<u>Corrected dep.</u>
AB	-0.09	+0.22	+305.39	+645.49
BC	-0.09	+0.18	-457.60	+397.66
CD	-0.05	+0.11	-190.74	-341.55
DA	<u>-0.11</u>	<u>+0.22</u>	<u>+342.95</u>	<u>-701.60</u>
			-0.34	+0.73
			0.00	0.00

<u>Course</u>	<u>Corrected Bearing</u>	<u>Corrected Azimuth</u>	<u>Corrected Distance</u>
AB	N64°40'50"E	64°40'50"	714.09',
BC	S40°59'27"E	139°00'33"	606.24',
CD	S60°49'07"W	240 49'07"	391.20',
DA	N63°57'00"W	296°03'00"	<u>780.93'</u>
			P = 2,492.46'

8.14

<u>Coordinates</u>		
<u>Station</u>	<u>North</u>	<u>East</u>
A	1,000.00	1,000.00
	+ 305.39	+ 645.49
B	1,305.39	1,645.49
	- 457.60	+ 397.66
C	847.79	2,043.15
	- 190.74	- 341.55
D	657.05	1,701.60
	+ <u>342.95</u>	- 701.60
A	1,000.00,	1,000.00
CHECK		

8.15

$X_A(Y_D - Y_B) = 1000.00(657.05 - 1305.39) = - 648340$

$X_B(Y_A - Y_C) = 1645.49(1000.00 - 847.79) = + 250,460$

$X_C(Y_B - Y_D) = 2043.15(1305.39 - 657.05) = + 1,324,656$

$X_D(Y_C - Y_A) = 1701.60(847.79 - 1000.00) = - 259,001$

Double Area, $2A = 667,775$ sq ft.

Area = 333,888 sq ft.

Also, Area = $333,888/43,560 = 7.665$ acres,.

8.16

a) Angles

A 38°30'
B 100°38'
C 149°50'
D 85°59'
E 165°03'

537°180'
= 540°00'

CHECK

(n-2)180 =
3 x 180 = 540°

b)

Azimuth

Az AB = 306°31'
Az BA = 126°31'
+ B 100°38'

Az BC = 227°09'
Az CB = 47°09'
+ C 149°50'
Az CD = 196°59'
Az DC = 16°59'
+ D 85°59'
Az DE = 102°58'
Az ED = 282°58'

+ E 165°03'
Az EA = 448°01'

or,

Az EA = 88°01'
Az AE = 268°01'
+ A 38°30'
Az AB = 306°31'

Bearing

N53°29'W

S47°09'W

S 16°59'W

S77°02'E

N88°01'E

N53°29'W **CHECK**

8.16 c) Distance Course

	<u>Distance</u>	<u>Azimuth</u>	<u>Bearing</u>	<u>Latitude</u>	<u>Departure</u>
AB	371.006	306°31'	N53°29'W	220.770	-298.172
BC	110.222	227°09'	S47°09'W	- 74.960	-80.808
CD	139.872	196°59'	S 16°59'W	-133.772	- 40.856
DE	103.119	102°58'	S77°02'E	- 23.138	100.490
EA	<u>319.860</u>	88°01'	N88°01'E	<u>11.070</u>	<u>319.668</u>
	1,044.079			- 0.030	+0.322

ERROR, E = $\sqrt{0.030^2 + 0.322^2} = 0.323\text{m}$

ACCURACY = E/P = 0.324/1044.079 = 1/3228 = 1/3200

8.17

<u>Course</u>	<u>C_{LAT}</u>	<u>C_{DEP}</u>	<u>Corrected lat.</u>	<u>Corrected dep.</u>
AB	+0.011	-0.114	220.781	-298.286
BC	+0.003	-0.034	- 74.957	-80.842
CD	+0.004	-0.044	-133.768	- 40.900
DE	+0.003	-0.032	- 23.135	100.458
EA	<u>+0.009</u>	<u>-0.098</u>	<u>11.079</u>	<u>319.570</u>
	+0.030	-0.322	0.000	0.000

8.18

Coordinates

<u>Station</u>	<u>North</u>	<u>East</u>
B	1,000.000	1,000.000
	- 74.957	- 80.842
C	925.043	919.158
	-133.768	- 40.900
D	791.275	878.258
	-23.135	+100.458
E	768.140	978.716
	+ 11.079	+319.570
A	779.219	1,298.286
	+220.781	- 298.286
B	1,000.000	1,000.000 Check

8.19

$$X_A(Y_E - Y_B) = 1298.286(768.140 - 1000.000) = -307,595$$

$$X_B(Y_A - Y_C) = 1000.000(779.219 - 925.043) = -101,857$$

$$X_C(Y_B - Y_D) = 919.158(1000.000 - 791.275) = +205,309$$

$$X_D(Y_C - Y_E) = 878.258(925.043 - 768.140) = +134,625$$

$$X_E(Y_D - Y_A) = 978.716(791.275 - 779.219) = -35,876$$

$$2A = 105,394 \text{ m}^2$$

$$\text{Area, } A = 52,697 \text{ m}^2$$

$$\text{or, Area, } A = 5.27 \text{ ha}$$

8.20

<u>Course</u>	<u>Distance</u>	<u>Bearing</u>	<u>Latitude</u>	<u>Departure</u>
AB	80.32	N70°10'07"E	+ 27.25	+ 75.56
BC	953.83	N74°29'00"E	+255.17	+919.07
CD	818.49	N70°22'45"E	<u>+274.84</u>	<u>+770.9</u>
AD			+557.26	+1765.59

$$\text{Tan Brg AD} = 1765.59/557.26, \text{Brg AD} = \text{N72}^\circ\text{28}'\text{59}"\text{E}$$

$$\text{Distance AD} = \sqrt{557.26^2 + 1765.59^2} = 1851.44 \text{ ft.}$$

8.21

<u>Course</u>	<u>Distance</u>	<u>Bearing</u>	<u>Latitude</u>	<u>Departure</u>
EA	483.669	N26°58'31"W	+431.047	- 219.395
AB	537.144	N37°10'49"E	+427.963	+ 324.609
BC	1,109.301	N79°29'49"E	<u>+202.212</u>	<u>+1090.715</u>
EC			+1,061.222	+1,195.929

$$\text{Tan Brg EC} = 1195.929/1061.222; \text{Brg EC} = \text{N48}^\circ\text{24}'\text{55}"\text{E}$$

$$\text{Distance EC} = \sqrt{1061.222^2 + 1195.929^2} = \text{1598.887 m}$$

$$\text{Angle @ C} = 48^\circ\text{24}'\text{55}" - 18^\circ\text{56}'\text{31}" = 29^\circ\text{28}'\text{24}"$$

$$\sin 29^\circ\text{28}'\text{24}" \times 1598.887/953.829 = \sin D$$

$$D = 55^\circ\text{33}'\text{52}" \text{ Or } 124^\circ\text{26}'\text{08}": \text{ From given data, } D = 124^\circ\text{26}'\text{08}"$$

$$E = 180^\circ - (124^\circ\text{26}'\text{08}" + 29^\circ\text{28}'\text{24}") = 26^\circ\text{05}'\text{28}"$$

$$CD = \sin 26^\circ\text{05}'\text{28}" \times 1598.887/\sin 124^\circ\text{26}'\text{08}"$$

$$CD = 852.597 \text{ m.}; \text{Bearing DE} = \text{S74}^\circ\text{30}'\text{23}"\text{W}$$

8.22

$$\text{Distance AB} = \sqrt{(738.562 - 559.319)^2 + (666.737 - 207.453)^2} = 493.021 \text{ m}$$

$$\text{Tan Brg AB} = 459.284/179.243, \text{Brg AB} = \text{N68}^\circ\text{40}'\text{52}"\text{E}$$

$$\text{Distance BC} = \sqrt{(541.742 - 738.562)^2 + (688.350 - 666.737)^2} = 198.003 \text{ m}$$

$$\text{Tan Brg BC} = 21.613/-196.82; \text{Brg BC} = \text{S } 6^\circ\text{16}'\text{00}"\text{E}$$

$$\text{Distance CD} = \sqrt{(379.861 - 541.742)^2 + (839.008 - 688.350)^2} = 221.141 \text{ m}$$

$$\text{Tan Brg CD} = 150.658/-161.881; \text{Brg CD} = \text{S42}^\circ\text{56}'\text{36}"\text{E}$$

$$\text{Distance DE} = \sqrt{(296.099 - 379.861)^2 + (604.048 - 839.008)^2} = 249.444 \text{ m}$$

$$\text{Tan Brg DE} = -234.960/-83.762; \text{Brg DE} = \text{S70}^\circ\text{22}'\text{45}"\text{W}$$

$$\text{Distance EF} = \sqrt{(218.330 - 296.099)^2 + (323.936 - 604.048)^2} = 290.707 \text{ m}$$

$$\text{Tan Brg EF} = -280.112/-77.769; \text{Brg EF} = \text{S74}^\circ\text{29}'\text{00}"\text{W}$$

$$\text{Distance FA} = \sqrt{(559.319 - 218.330)^2 + (207.453 - 323.936)^2} = 360.336 \text{ m}$$

$$\text{Tan Brg FA} = -116.483/340.989; \text{Brg FA} = \text{N18}^\circ\text{51}'\text{37}"\text{W}$$

8.23

$$X_A(Y_B - Y_F) = 207.453(738.562 - 218.330) = +107,924$$

$$X_B(Y_C - Y_A) = 666.737(541.742 - 559.319) = - 11,719$$

$$X_C(Y_D - Y_B) = 688.350(379.861 - 738.562) = -246,912$$

$$X_D(Y_E - Y_C) = 839.008(296.099 - 541.742) = -206,096$$

$$X_E(Y_F - Y_D) = 604.048(218.330 - 379.861) = - 97,572$$

$$X_F(Y_A - Y_E) = 323.936(559.319 - 296.099) = + 85,266$$

$$2A = 369,109$$

$$\text{Area, } A = 184,555\text{m}^2$$

$$\text{or, } A = 18.455 \text{ hectares}$$

8.24Coordinates

<u>Station</u>	<u>North</u>	<u>East</u>
K	2000.000	2000.000
	+ 10.000	- 33.000
A	2010.000	1967.000
K	2000.000	2000.000
	+ 25.271	+ 19.455
B	2025.271	2019.455
K	2000.000	2000.000
	- 0.311	+ 38.285
C	1999.689	2038.285
K	2000.000	2000.000
	- 30.055	+ 7.245
D	1969.945	2007.245
K	2000.000	2000.000
	- 12.481	- 30.100
E	1987.519	1969.900

8.25

$$X_A(Y_E - Y_B) = 1967.000(1987.519 - 2025.271) = - 74,258$$

$$X_B(Y_A - Y_C) = 2019.455(2010.000 - 1999.689) = + 20,823$$

$$X_C(Y_B - Y_D) = 2038.285(2025.271 - 1969.945) = +112,770$$

$$X_D(Y_C - Y_E) = 2007.245(1999.689 - 1987.519) = + 24,428$$

$$X_E(Y_D - Y_A) = 1969.900(1969.945 - 2010.000) = - 78,904$$

$$2A = 4,859$$

$$\text{Area, } A = 2,430\text{m}^2$$

8.26

<u>Course</u>	<u>Lat</u>	<u>Dep</u>	<u>Bearing</u>	<u>Distance (m)</u>
AB	+15.271	+52.455	N73°46'06"E	54.633
BC	-25.582	+18.830	S36°21'20"E	31.765
CD	-29.744	-31.040	S46°13'17"W	42.991
DE	+17.574	-37.345	N64°47'56"W	41.273
EA	+22.481	- 2.900	N 7°21'02"W	22.667
Check	0.000	0.000		

Chapter 9

- 9-1** A to B; $\Delta N = -77.773$; $\Delta E = -280.126$
Distance AB = 290.722; Brg = S74°29'00.4"W
- B to C; $\Delta N = -35.982$; $\Delta E = -223.047$
Distance BC = 225.931; Brg = S80°50'09.5W
- C to D; $\Delta N = +2.638$; $\Delta E = +206.021$
Distance CD = 206.038m; Brg = N89°15'59.0"E
- D to A; $\Delta N = +111.117$; $\Delta E = +297.152$
Distance DA = 317.248; Brg = N69°29'50.0"E
- 9-2** A 4°59'10.4"
B 186°21'09.1"
C 8°25'49.5"
D 160°13'51.0"
358°118'120.0" = 360°00'00.0" **Check**

Chapter 10

10-2

Interior Angles

A	92°53'	
B	184°00'	Check
C	90°50'	(n-2) 180,
D	112°10'	5 x 180 = 900°
E	127°37'	
F	208°53'	
G	83°37'	
	<u>896°240'</u>	
=	900°00'	

Traverse Computations Used to Demonstrate Closure

Course	Bearing	Distance	Latitude	Departure	
AB	N. 3°30'E.	56.05	+ 55.95	+ 3.42	
BC	N. 0°30'W.	61.92	+ 61.92	- 0.54	
CD	N.88°40'E.	100.02	+ 2.33	+ 99.99	
DE	S. 23°30'E.	31.78	- 29.14	+ 12.67	
EF	S.28°53'W.	69.11	- 60.51	+ 33.38	
FG	SOUTH	39.73	- 39.73	0	
GA	N.83°37'W.	82.67	<u>+ 9.18</u>	<u>- 82.16</u>	
			0.00	0.00	check

10-5(d)

Area Computations

First, compute coordinates - assume coordinates for station A to be 1,000.00 N and 1,000.00 E

Station	Northing	Easting	
A	1,000.00	1,000.00	
	<u>+ 55.95</u>	<u>+ 3.42</u>	
B	1,055.95	1,003.42	
	<u>+ 61.92</u>	<u>- 0.54</u>	
C	1,117.87	1,002.88	
	<u>+ 2.33</u>	<u>+ 99.99</u>	
D	1,120.20	1,102.87	
	<u>- 29.14</u>	<u>+ 12.67</u>	
E	1,091.06	1,115.54	
	<u>- 60.51</u>	<u>- 33.38</u>	
F	1,030.55	1,082.16	
	<u>- 39.73</u>	<u>0.00</u>	
G	990.82	1,082.16	
	<u>+ 9.18</u>	<u>- 82.16</u>	
A	1,000.00	1,000.00	check

Second, compute the area:

$$XA(YB - YG) = 1,000.00(1,055.95 - 990.82) = 65,130$$

$$B(YC - YA) = 1,003.42(1,117.87 - 1,000.00) = 118,273$$

$$XC(YD - YB) = 1,002.88(1,120.20 - 1,055.95) = 64,435$$

$$XD(YE - YC) = 1,102.87(1,091.06 - 1,117.87) = -29,568$$

$$XE(YF - YD) = 1,115.54(1,030.55 - 1,120.20) = -100,008$$

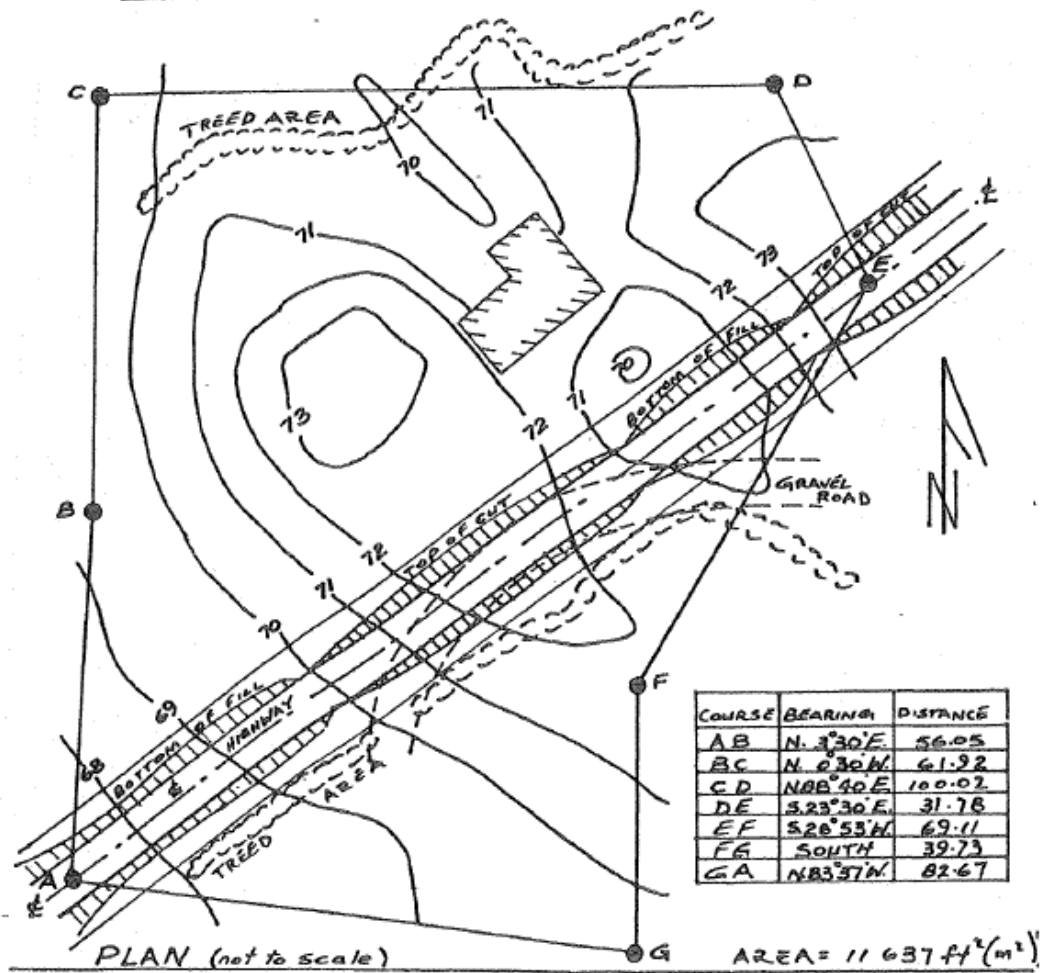
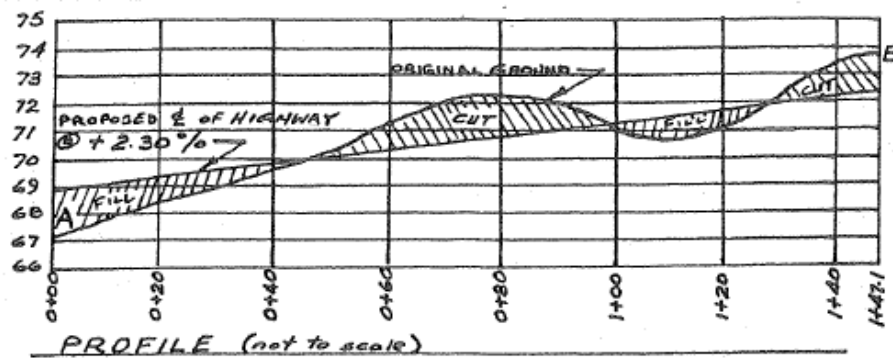
$$XF(YG - YE) = 1,082.16(990.82 - 1,091.06) = -108,476$$

$$XG(YA - YF) = 1,082.16(1,000.00 - 1,030.55) = -33,060$$

$$\text{Double area} = -23,274$$

$$\text{Area} = 11,637 \text{ ft}^2 \text{ or } \text{m}^2$$

10-6 and 10-8



- 23