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° 52' 21"

2.2 104° 15' 15"; 104.2542°

2.3

a. B = 45°, b = 4.87', c = 6.89'
b. A = 60°, B = 30°, a = 30.35'
c. c = 44.72', A = 26° 33' 54", B = 63° 26' 06"
d. c = 110', A = 36° 52' 12", B = 53° 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° 03' 58", B = 103° 56' 01"

2.6 A = 57° 46' 09", B = 84° 22' 28", C = 37° 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° 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 x 66 = **1,071.18 ft**. x.3048 = **326.50 m**
b) 70.10 x 66 = **4626.60 ft**. x.3048 = **1410.19 m**
c) 6.77 x 66 = **446.82 ft**. x.3048 = **131.19 m**
d) 4.10 x 66 = **270.60 ft**. x.3048 = **82.48 m**

3.5 Clearance = 61.6 + 3.8 = **65.4 ft** (Tan 45^o = 1.00)

3.6 Distance = 88.00 - 0.8 = **87.20 ft**

3.7 Distance = 100.00 +0.48 = **100.48 ft**

3.8 H = 37.277 Cos $1^o42'$ = **37.261 m**

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

3.10 Tan(slope angle) = .02; slope angle = arctan(.02) = 1.1457628^o
H = (118.060)cos 1.1457628^o = **118.036 m**

3.11
The impact of temperature on the layout distance is minimal at such short distances

	Layout Distance (ft.)			
Line	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 $^1/_{16}$")	14.49' (14'- 5 $^{15}/_{16}$")

3-12

PACING EXERCISE			
PACES/100.00 FT	(40+40.5+41+41.5)/4 = 40.5 paces/100ft		
STA	FWD (PACES)	BACK (PACES)	AVE DIST (FT)
1			
	163	164	163.5p X 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	2.33	342.16	4.91	310.13
TP 2			6.17	306.29
	Σ BS = 3.60		*Σ 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	5.11	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				1.80	326.22
	Σ 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	1.340	398.797	1.273	397.457
BM 3			0.780	398.017
	Σ BS = 5.685		Σ FS = 5.690	398.022 +5.685 -5.690 = 398.017 ***ck***

4.5 Error = 398.022 – 398.017 = 0.005m
2nd order Class 1 (U.S.) = 6mm √K = .006 √0.7 = .005
2nd order (Canada) = 8mm√ K = .008√.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	1.47	177.76	1.62	176.29
BM 100			1.21	176.55
	Σ BS = 14.48		Σ FS = 14.49	

176.56 +14.48 -14.49 = 176.55 ***check***

4.7 Error = 176.56 -176.55 = 0.01 ft. 2nd order allowable error = .035 √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	0.033	198.501		1.705	198.468
BM S102				2.891	195.610
	Σ BS = 1.174		Σ FS = 7.589		

202.025 +1.174 -7.589 = 195.610 ***check***

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)**

a. Difference between 1st and 2nd floors at east end of building - 13.21'
b. Difference between 1st and 2nd floors at north end of building - 16.65'
c. Difference between 2nd floor and mechanical room floor - 23.78 to 23.87' (2nd floor is not level)
d. 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	7.39	363.24		1.12	355.85
BM S22				2.41	360.83
	Σ BS = 17.70			Σ FS = 4.42	

347.55+17.70 - 4.42= 360.83 ***check***

4.12

Station	BS	HI	FS	Elevation	Left		℄		Right
BM 107	7.71	206.60		198.89					
					60'	28'	0'	32	60'
80+50					9.7	8.0	5.7	4.3	4.0
					196.9	198.6	200.9	202.3	202.6
					60'	25'	0'	30'	60'
81+00					10.1	9.7	6.8	6.0	5.3
					196.5	196.9	199.8	200.6	201.3
					60'	27'	0'	33'	60'
81+50					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 a) Correct difference in elevation = 8.72-5.61 = 3.11 ft.
b) Correct reading @ A would have been 5.42+3.11 = 8.53 ft.
c) Error is (8.57- 8.53) = +0.04 ft. in 300 ft.
d) Upper/lower reticle capstan screws are loosened/tightened until the cross hair falls on 8.53 on the rod @ A.

4.14 a) V = 148.61 sin 9º26' = 24.36 ft.
Elevation of lower station = 324.28 + 4.66 - 24.36 - 4.88 = 299.70 ft.
b) H = 148.61 cos 9º26' = 146.60 ft.
Lower station = 110+71.25 + 146.42 = 112+17.85

4.15 a) 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 = 185.556m
b) Error = 0.004m

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

Accuracy limit for 2nd order = .007 √.8 = .006

Accuracy limit for 3rd order = .012 √.8 = .011 (U.S.)

or = .024 √.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 x.011 = +.002	168.250
TP 2	260	168.539	260/780 x.011 = +.004	168.543
TP 3	390	166.318	390/780 x.011 = +.006	165.324
BM K110	520	166.394	520/780 x.011 = +.007	**166.401**
TP 4	650	166.579	650/780 x.011 = +.009	166.588
BM 132	780	167.618	780/780 x.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 X 0.11 = 0.01'	1325.14
2	0.7	1328.94	0.7/3.0 X 0.11 = 0.03'	1328.91
3	0.95	1331.55	0.95/3.0 X 0.11 = 0.03'	1328.52
4	1.20	1329.01	1.20/3.0 X 0.11 = 0.04'	1328.97
5	1.8	1327.86	1.8/3.0 X 0.11 = 0.07'	1327.79
6	2.4	1333.67	2.4/3.0 X 0.11 = 0.09'	1333.58
111	3.0	1320.39	3.0/3.0 X 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 = - 0.030m

5.2 H = 2,183.71 Cos +2°45'30" = 2,181.18 ft.
V = 2,183.71 Sin +2°45'30" = 105.09 ft.
Elevation of target station = 285.69 +105.09 = 390.78 ft.

5.3 Inst. @ A, H = 1,458.777 Cos - 2° 40' 40" = 1,457.184m
Elevation difference = 1,458.777 Sin 1°26'50" = - 68.153m
Inst.@ B, H = 1,458.757 Cos 2° 40' 00" = 1,457.177m
Elevation difference = 1,458.757 Sin 2° 40" = 67.869m
a)Horizontal distance = (1,457.184+1,457.177)/2 = 1,457.181m
b)Elev. B = 211.841 - (68.153+ 67.869)/2 = 143.833m

5.4 LL^1 = 3,000.00 Sin 3°30' = +183.15 ft.
c+r = .0206 x 3^2 = +0.19 ft.
Elevation difference, K to L, = +183.34 ft
Elevation of L = 232.47+183.34 = 415.81 ft.

MM^1 = 3000.00 Sin -1°30' = - 78.53 ft.
c+r = .0206 x 3^2 = +0.19 ft.
Elevation difference, K to M, = -78.34 ft.
Elevation of M = 232.47- 78.34 = 154.13 ft.

c+r = .0206 x 2^2 = + 0.08 ft.
Elevation difference, K to N, = +0.08 ft.
Elevation of N = 232.47 + 0.08 = 232.55 ft.

5.5 ΔHR - Δhi = 0.150 - 0.100 = 0.050m
SinΔα = (0.050 Cos 4°18'30")/387.603
Δα = 0°00'27"
α_K = 0°00'27"+4°18'30" = 4°18'57"
H = 387.603 Cos 4°18'57" = 386.504m
Elevation of B = 110.222+1.601+ (387.603 Sin 4°18'57") - 1.915
= 139.077m.

5.6 ΔHR-Δhi = 0.39-0.31 = 0.08 ft.
SinΔα = (0.08 Cos 3°14'30")/536.88
Δα = 0°00'31"
α_K = 0°00'31"+3°14'30" = 3°15'01"
H = 536.88 Cos 3°15'01" = 536.02 ft.
Elevation B = 531.49+5.21 + (536.88 Sin 3°15'01") - 5.78
=561.36 ft.

CHAPTER 8

8.1 E = 114° 31'

8.2
A 70°10'30" +30 = 70°11'00"
B 142°41'00" +30 = 142°41'30"
C 83°51'30" +30 = 83°52'00"
D 117°25'30" +30 = 117°26'00"
E 125°49'00" +30 = 125°49'30"
539°57'30" 150" 537°179'60" = 540°00'00"

8.3
a) S 7°29'W
b) S 38°06'E
c) N14°43'30"W
d) N 56°09E
e) S73°42'W
f) S 43°09'E

8.4
a) 347°09'
b) 66°14'
c) 144°56'
d) 183°12'
e) 326°47'
f) 179°54'

8.5
a) 8°23'
b) 347°52'
c) 150°09'50"
d) 209°33'
e) 81°50'
f) 346°59'

8.6
a) S7°51'E
b) S76°14'W
c) N33°33'W
d) N 4°39'E
e) S 37°18'E
f) N 0°38'W

8.7
AB = N20°41'E
B + 1°03
BC = N21°44'E
C +2°58'
CD = N24°42'E
D - 7°24'
DE = N17°18'E
E - 6°31'
EF = N 10°47'E
F +1°31'
FG = N 12°18'E
G - 8°09'
GH = N 4°09E

8.8 Angle at A = Azimuth DA + 180 – Azimuth AB (subtract 360° if > 1 rev)
A = **51°05'**
B = **134°33'**
C = **102° 04'**
D = **72°18'**
Sum of interior angles = 360° (check)

8.9 **CLOCKWISE**
AB N48° 30′E
BC S53° 41′E
CD S21° 37′W
DE S88° 32′W
EA N30° 02′W

8.10 CLOCKWISE

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

8.11 CLOCKWISE

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

COUNTER-CLOCKWISE

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

8.12

a) A 51°23'
B 105°39'
C 78°11'
D 124°47'
358°120'
360°00'

CHECK
(n-2)180 =
(4-2)180 = 360°

b)

AZIMUTH

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

BEARING

N64°40'E

S40°59'E

S60°50'W

N63°57'W

N64°40'E **CHECK**

c)

Course	Azimuth	Bearing	Distance	Latitude	Departure
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	781.18	343.06	-701.82
			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

Course	C_{LAT}	C_{DEP}	Corrected Lat.	Corrected dep.
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	-0.11	+0.22	+342.95	-701.60
	-0.34	+0.73	0.00	0.00

Course	Corrected Bearing	Corrected Azimuth	Corrected Distance
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"	780.93'
			P = 2,492.46'

8.14

Station	Coordinates North	East
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
	+ 342.95	- 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	Bearing
	Az AB = 306°31'	N53°29'W
	Az BA = 126°31'	
	+ B 100°38'	
	Az BC = 227°09'	S47°09W
	Az CB = 47°09	
	+ C 149°50'	
	Az CD = 196 59'	S 16°59'W
	Az DC = 16°59'	
	+ D 85°59'	
	Az DE = 102°58'	S77°02'E
	Az ED = 282°58'	
	+ E 165°03'	
	Az EA = 448°01'	
or,	Az EA = 88°01'	N88°01'E
	Az AE = 268°01'	
	+ A 38°30'	
	Az AB = 306°31'	N53°29'W **CHECK**

8.16 c)

Course	Distance	Azimuth	Bearing	Latitude	Departure
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	319.860	88°01'	N88°01'E	11.070	319.668
	1,044.079			- 0.030	+0.322

ERROR, E = $\sqrt{0.030^2 + 0.322^2} = 0.323$m
ACCURACY = E/P = 0.324/1044.079 = 1/3228 = 1/3200

8.17

Course	C_{LAT}	C_{DEP}	Corrected lat.	Corrected dep.
AB	+0.011	-0.114	220.781	-298.286
BC	+.003	-0.034	- 74.957	-80.842
CD	+.004	-0.044	-133.768	- 40.900
DE	+0.003	-0.032	- 23.135	100.458
EA	+0.009	-0.098	11.079	319.570
	+0.030	-0.322	0.000	0.000

8.18

Station	Coordinates North	East
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 m^2
Area, A = 52,697 m^2
or, Area, A = 5.27 ha

8.20

Course	Distance	Bearing	Latitude	Departure
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	+274.84	+770.9
AD			+557.26	+1765.59

Tan Brg AD = 1765.59/557.26,Brg AD = N72°28'59"E
Distance AD = $\sqrt{557.26^2 + 1765.59^2}$ = 1851.44 ft.

8.21

Course	Distance	Bearing	Latitude	Departure
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	+202.212	+1090.715
EC			+1,061.222	+1,195.929

Tan Brg EC = 1195.929/1061.222; Brg EC = **N48°24'55"E**
Distance EC = $\sqrt{1061.222^2 + 1195.929^2}$ = **1598.887 m**

Angle @ C = 48°24'55" -18°56'31" = 29°28'24"
Sin 29°28'24" x 1598.887/953.829 = Sin D
D = 55°33'52" **Or** 124°26'08": From given data, D = 124°26'08"
E = 180° - (124°26'08" + 29°28'24") = 26°05'28"
CD = Sin 26°05'28" x 1598.887/Sin124°26'08"
CD = 852.597 m.; Bearing DE = S74°30'23"W

8.22

Distance AB =$\sqrt{(738.562-559.319)^2 + (666.737-207.453)^2}$ = 493.021m
Tan Brg AB = 459.284/179.243,Brg AB = N68°40'52"E
Distance BC =$\sqrt{(541.742-738.562)^2 + (688.350-666.737)^2}$ = 198.003m
Tan Brg BC = 21.613/-196.82; Brg BC = S 6°16'00"E
Distance CD =$\sqrt{(379.861-541.742)^2 + (839.008-688.350)^2}$ = 221.141m
Tan Brg CD = 150.658/-161.881;Brg CD = S42°56'36"E
Distance DE = $\sqrt{(296.099-379.861)^2 + (604.048-839.008)^2}$ = 249.444m
Tan Brg DE = -234.960/-83.762;Brg DE = S70°22'45"W
Distance EF =$\sqrt{(218.330-296.099)^2 + (323.936-604.048)^2}$ = 290.707m
Tan Brg EF = -280.112/-77.769;Brg EF = S74°29'00"W
Distance FA = $\sqrt{(559.319-218.330)^2 + (207.453-323.936)^2}$ = 360.336m
Tan Brg FA = -116.483/340.989;Brg FA = N18°51'37"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
Area, A = 184,555m^2
or, A = 18.455 hectares

8.24

	Coordinates	
Station	North	East
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
Area, A = 2,430m^2

8.26

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

Chapter 9

9-1 A to B; ΔN = -77.773: ΔE = -280.126
Distance AB = 290.722: Brg = S74°29'00.4"W

B to C; ΔN = -35.982: ΔE = -223.047
Distance BC = 225.931: Brg = S80°50'09.5W

C to D; ΔN = +2.638: ΔE = +206.021
Distance CD = 206.038m: Brg = N89°15'59.0"E

D to A; ΔN = +111.117: ΔE = +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'	
	896°240'	
=	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	+ 9.18	- 82.16	
			0.00	0.00	***check***

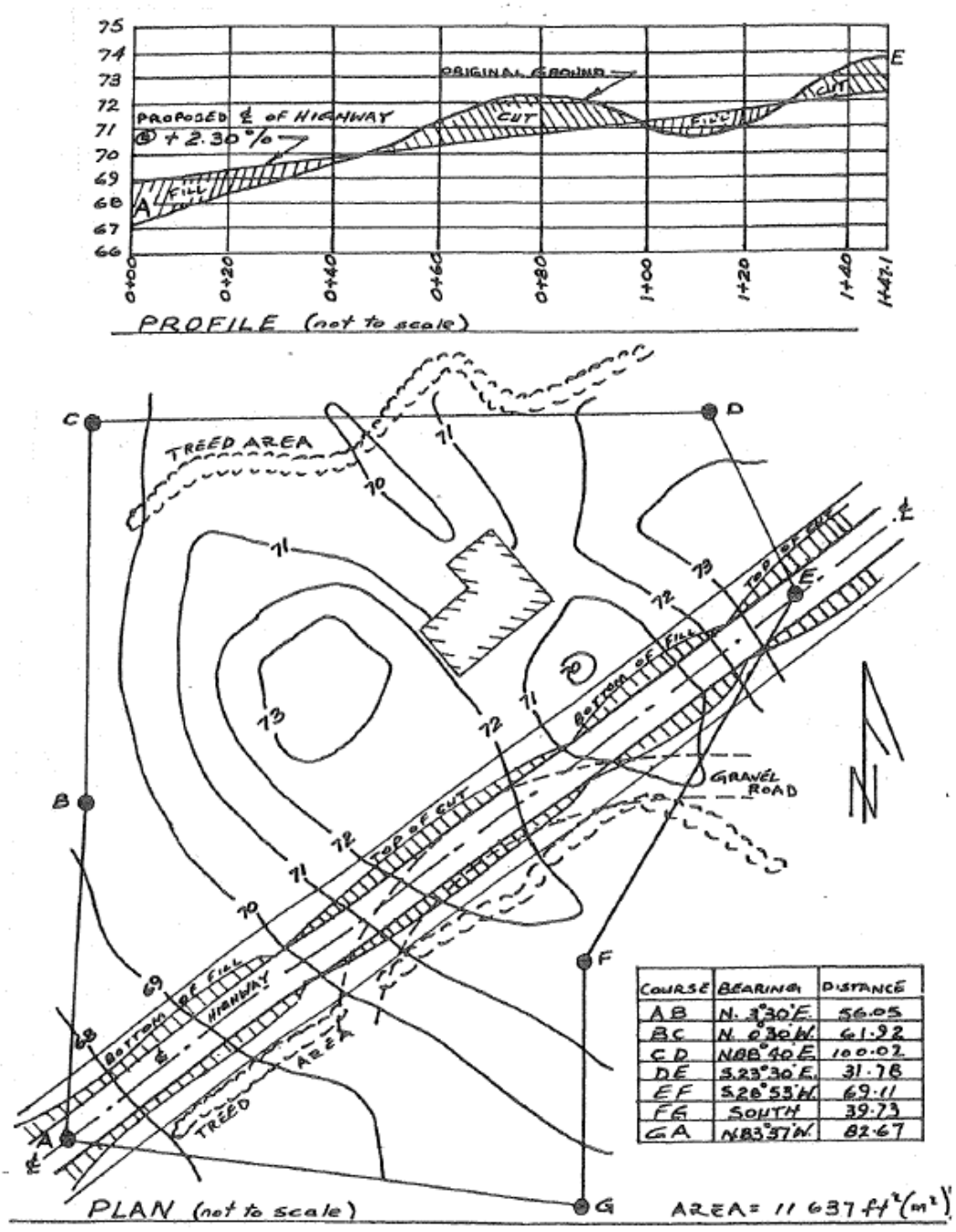
10-5(d)

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	
	+ 55.95	+ 3.42	**Second,** compute the area:
B	1,055.95	1,003.42	XA(YB - YG) = 1,000.00(1,055.95 - 990.82) = 65,130
	+ 61.92	- 0.54	B(YC - YA) = 1,003.42(1,117.87 - 1,000.00) = 118,273
C	1,117.87	1,002.88	XC(YD - YB) = 1,002.88(1,120.20 - 1,055.95) = 64,435
	+ 2.33	+ 99.99	XD(YE - YC) = 1,102.87(1,091.06 - 1,117.87) = - 29,568
D	1,120.20	1,102.87	XE(YF - YD) = 1,115.54(1,030.55 - 1,120.20) = - 100,008
	- 29.14	+ 12.67	XF(YG - YE) = 1,082.16(990.82 - 1,091.06) = - 108,476
E	1,091.06	1,115.54	XG(YA - YF) = 1,082.16(1000.00 - 1,030.55) = - 33,060
	- 60.51	- 33.38	Double area = - 23,274
F	1,030.55	1,082.16	
			Area = 11,637 ft^2 or m^2
	- 39.73	0.00	
G	990.82	1,082.16	
	+ 9.18	- 82.16	
A	1,000.00	1,000.00	***check***

10-6 and 10-8



COURSE	BEARING	DISTANCE
AB	N. 3°30'E.	56.05
BC	N. 0°30'W.	61.92
CD	N88°40'E.	100.02
DE	S.23°30'E.	31.78
EF	S.26°55'W.	69.11
FG	SOUTH	39.73
GA	N83°37'W.	82.67

10.9 **a)** H = SR.f = 20,000 x .153 = 3060m
Altitude = 3060 + 180 = 3240m

b) SR = 20,000 x 12 = 240,000
H = SR.f = 240,000 x 6.022/12 = 120,440 ft.
Altitude = 120,400 + 520 = 120,920 ft.

10.10 **a)** Photo scale = 50,000 x 4.75/23.07 = 1:10,295

b) Photo scale = 100,000 x 1.85/6.20 = 1:29,839

10.11 **a)** No. of photos required = $30 \times 45/1 \ \frac{(10,000)^2}{(30,000)^2} = 150$

b) No. of photos required = $15 \times 33/0.4 \ \frac{(10,000)^2}{(15,000)^2} = 550$

c) SR is 1:500 x 12 or 1:6000
No. of photos required = $10 \times 47/0.4 \ \frac{(10,000)^2}{(6,000)^2} = 3264$

10.12 Assume that the negative size is 9 in. (228mm) square, the normal size.

a) Dimension across flight line = 10,000 x .228 = 2280m
or 10,000 x 0.75 = 7,500 ft.
Dimension along flight line = 2280 x 0.60 = 1368m
or 7,500 x 0.60 = 4500 ft.

b) SR is 1:400 x 12 or 1:4,800
Dimension across flight line = 4,800 x .228 = 1094m
or 4,800 x 0.75 = 3,600 ft.
Dimension along flight line = 1094 x 0.60 = 656 m
or 3,600 x 0.60 = 2160 ft.

10.13 **a**) (i) Ground speed of aircraft = 350 km/hr
$= \frac{350 \times 1000}{60 \times 60} = 97.2$ m/s
camera would move $97.2 \times \frac{1}{100} = .972$m during exposure.

(ii) Ground speed of aircraft = 350 km/hr = 97.2 m/s
camera would move $97.2 \times \frac{1}{1000} = .097$m

(iii) Ground speed of aircraft = 200 miles per hour
$= \frac{200 \times 5280}{60 \times 60} = 293$ ft./sec.
camera would move 293 x1/500 = 0.59 ft. (018m)

b) The "image motion" during the exposure is least in situation (ii). Therefore, the resolution of an airphoto taken under these conditions would be higher, assuming that all other conditions (weather, film types) are equal.