Problem #1

Use triangle E A K_1

Bearing E → A

dep EA = 2522.37 − 1000.00 = 1522.37
lat EA = 1316.87 − 1000.00 = 316.87

brng EA = atan $\frac{dep}{lat}$ = atan $\frac{1522.37}{316.87}$ = N 78°14'32" E

Bearing A → D

dep AD = 484.70 − 2522.37 = −2037.67
lat AD = 2181.01 − 1316.87 = 864.14

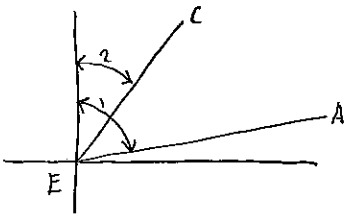
brng AD = atan $\frac{dep}{lat}$ = atan $\frac{-2037.67}{864.14}$ = N 67°01'09" W

Bearing E → C

dep EC = 1680.63 − 1000.00 = 680.63
lat EC = 2143.14 − 1000.00 = 1143.14

brng EC = atan $\frac{dep}{lat}$ = atan $\frac{680.63}{1143.14}$ = N 30°46'11" E

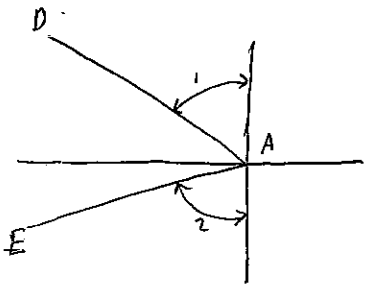
Angle CEA



∠1 = 78°14'32"
∠2 = 30°46'11"

∠CEA = 78°14'32" − 30°46'11"
47°28'21"

Angle DAE



∠1 = 67°01'09"
∠2 = 78°14'32"

∠DAE = 180° − 67°01'09" − 78°14'32"
= 34°44'19"

Angle E K_1 A = 180° − 47°28'21" − 34°44'19" = 97°47'20"

dist EA = $\sqrt{dep^2 + lat^2}$ = $\sqrt{1522.37^2 + 316.87^2}$ = 1555.00 ft

Law of Sines

$$\frac{\overline{EK_1}}{\sin 34°44'19"} = \frac{1555.00}{\sin 97°47'20"} \qquad \overline{EK_1} = 894.34$$

Lat E → K_1 = cos (brng) * dist = cos(30°46'11") * 894.34 = 768.44
Dep E → K_1 = sin (brng) * dist = sin (30°46'11") * 894.34 = 457.53

N at K_1 = 1000.00 + 768.44 = **1768.44**
E at K_1 = 1000.00 + 457.53 = **1457.53**

Law of Sines

$$\frac{\overline{AK_1}}{\sin 47°26'21''} = \frac{1555.00}{\sin 97°47'20''} \qquad \overline{AK_1} = 1156.63$$

Lat $A \to K_1$ = cos (brng) * dist = cos (67°01'09") * 1156.63 = 451.58
Dep $A \to K_1$ = sin (brng) * dist = sin (67°01'09") * 1156.63 = -1064.83

N at K_1 = 1316.87 + 451.58 = **1768.45**
E at K_1 = 2522.37 - 1064.83 = **1457.54** Checks

Problem #2

Station	Dist	Fill Area	Avg Fill	Fill Vol	Cut Area	Avg Cut	Cut Vol
10+00		1852					
10+50	50	1447	1649.5	82475			
11+00	50	988	1217.5	60875			
11+50	50	513	750.5	37525			
11+72	22	418	465.5	10241	0		
12+00	28	223	320.5	8974	555	185	5180
12+50	50	169	206	10300	768	661.5	33075
12+81	31	0	63	1953	984	874	27218
13+00	19				1124	1056	20064
13+50	50				1344	1234	61700
14+00	50				1479	1411.5	70575
14+50	50				1912	1695.5	84775

212343
÷ 27
7864.6 yd^3
≈ 7860 yd^3

302567
÷ 27
11206.9 yd^3
≈ 11210 yd^3

Problem #3

RTK uses a real time differential correction signal. Positions are adjusted in real time. Post processing downloads correction data from base station afterwards and then applies position corrections. RTK is used for stakeout, field work, red heads, etc. Post processing is used for control surveys. RTK tells you (rover) where you are. Post processing tells you (rover) where you were.

Problem #4

$R = \frac{5729.58}{8} = 716.20$

$T = R \tan\frac{\Delta}{2} = 716.20 * \tan\frac{48}{2} = 318.87$

$L = 100\frac{\Delta}{D_a} = 100\frac{48}{8} = 600.00$

$PC = PI - T = 2177.00 - 318.87 = \boxed{18+58\ 13}$

$PT = PC + L = 1858.13 + 600.00 = \boxed{24+58\ 13}$

$def/ft = \frac{\Delta/2}{L} = \frac{24^\circ}{600} = .04^\circ/ft = 0^\circ 2' 40''/ft$

	Station	Arc	Deflection	LC
PC	18+58 13			
	19+00	41.87	1°40'29"	41.86
	19+50	91.87	3°40'29"	91.81
	20+00	141.87	5°40'29"	141.64
	20+50	191.87	7°40'29"	191.30
	21+00	241.87	9°40'29"	240.72
	21+50	291.87	11°40'29"	289.85
	22+00	341.87	13°40'29"	338.63
	22+50	391.87	15°40'29"	387.00
	23+00	441.87	17°40'29"	434.89
	23+50	491.87	19°40'29"	482.26
	24+00	541.87	21°40'29"	529.04
	24+50	591.87	23°40'29"	575.17
PT	24+58 13	600.00	24°00'00"	582.61

Problem #5

$PVC\ sta = PVI\ sta - \frac{L}{2} = 166+80\ 00 - \frac{800}{2} = \boxed{162+80\ 00}$

$PVC\ elev = PVI\ elev + (-g_1)\left(\frac{L}{2}\right) = 4577.44 + (4.4)(4) = \boxed{4595.04\ ft}$

$PVT\ sta = PVI\ sta + \frac{L}{2} = 166+80\ 00 + \frac{800}{2} = \boxed{170+80\ 00}$

$PVT\ elev = PVI\ elev + (g_2)\left(\frac{L}{2}\right) = 4577.44 + (3.6)(4) = \boxed{4591.84\ ft}$

$x' = \frac{g_1 L}{g_2 - g_1} = \frac{(-4.4)(8)}{-3.6 - 4.4} = 4.4$

Low Point Sta = PVC sta + x' = 162+80 + 4+40 = **167+20**

$r = \frac{g_2 - g_1}{L} = \frac{3.6 - (-4.4)}{8} = 1$

Low pt elev

$y = \frac{r}{2}x^2 + g_1 x + PVC = \frac{1}{2}(4.4)^2 - (4.4)(4.4) + 4595.04 =$ **4585.36 ft**

At Pipe Location

$x =$ Pipe Sta − PVC sta = 166+23 − 162+80 = 3.43

$y = \frac{1}{2}(3.43)^2 - 4.4(3.43) + 4595.04 = 4585.63$

Clearance = pipe elev − curve elev = 4609 − 4585.63 = **23.17 ft**

Problem #6

$E = R\left(\frac{1}{\cos\frac{\Delta}{2}} - 1\right)$

$105 = R\left(\frac{1}{\cos\frac{42°}{2}} - 1\right)$ $\quad R = 1475.86$

$D_a = \frac{5729.58}{R} = \frac{5729.58}{1475.86} =$ **3.9°**

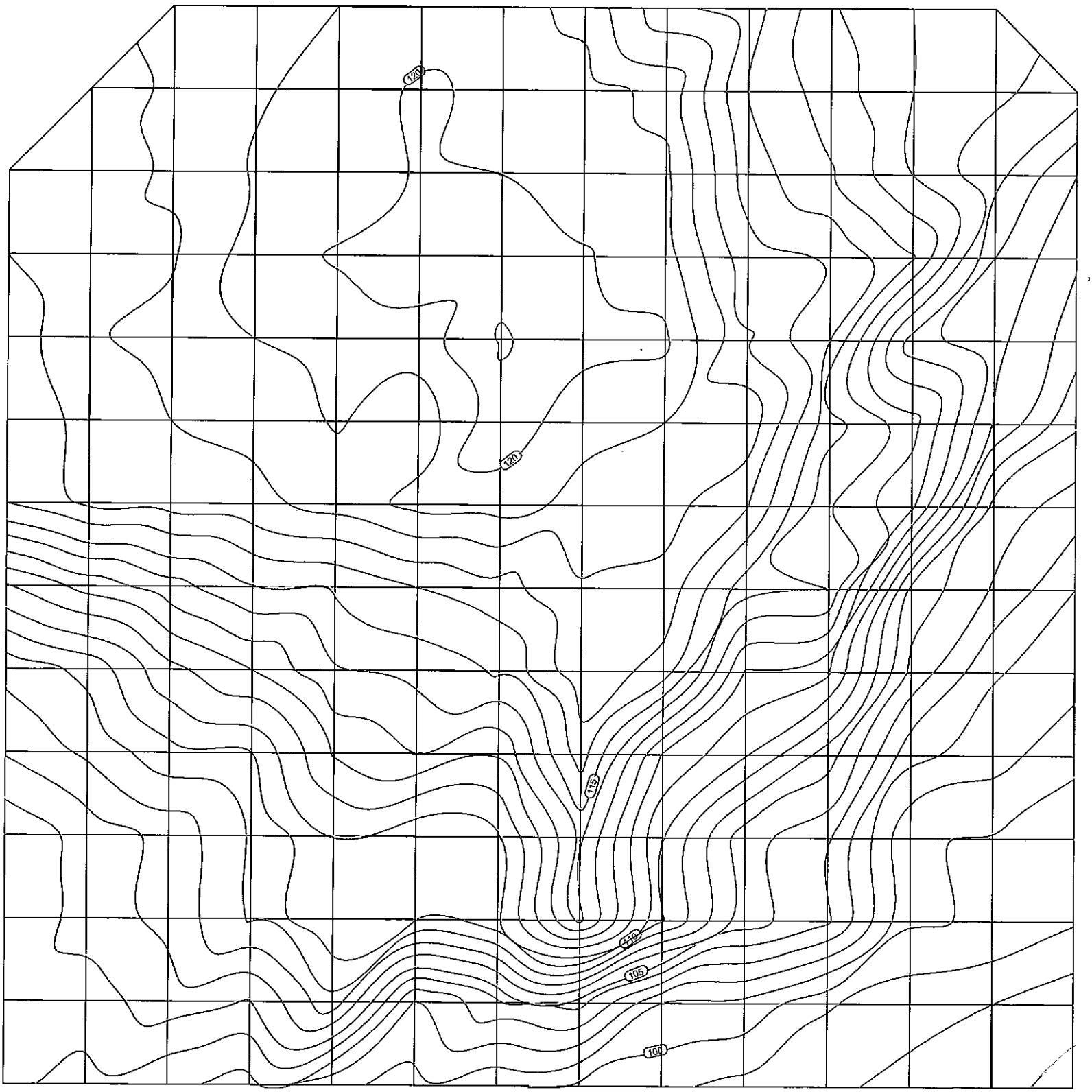
Problem #7

Grid	Depths				Avg Depth	Grid Area	Volume
A	19.8	20.6	21.1	19.5	20.25	2500	50625
B	20.6	21.1	21.8	21.1	21.15	↓	52875
C	21.1	21.3	22.5	21.8	21.675		54187.5
D	21.3	23.00	22.5	22.5	22.325		55812.5
E	19.4	21.1	20.7	19.6	20.2		50500
F	21.1	21.8	21.1	20.7	21.175		52937.5
G	21.8	22.5	21.9	21.1	21.825		54562.5
H	22.5	22.5	21.9	21.9	22.2		55000

427050. ft3

÷ 27

15813 yd3


120
120
115
110
105
100

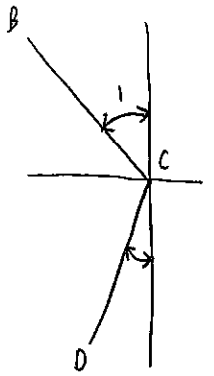
Problem # 8

Step 1: Inverse Between Known Points

C → B N 44° 54' 03" W 900.72 ft

C → D S 02° 32' 17" W 589.09 ft

Step 2: Calculate Angle C



$C = 180 - \angle 1 - \angle 2 = 180° - 44°54'03" - 02°32'17"$

$= 132° 33' 40"$

Step 3: Calculate ∠(B+D)

$(B+D) = 360 - (C + X_1 + X_2) = 360 - (132°33'40" - 70° - 65°)$

$= 92° 26' 20"$

Step 4: Separate B and D

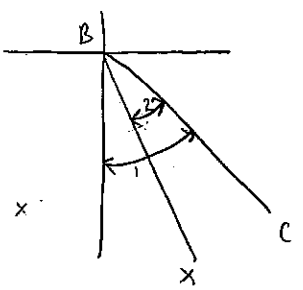
$$B = \operatorname{atan}\left(\frac{CD * \sin X_1 * \sin(B+D)}{CB * \sin X_2 + CD * \sin X_1 * \cos(B+D)}\right)$$

$$= \operatorname{atan}\left(\frac{589.09 * \sin 70° * \sin 92°26'20"}{900.72 * \sin 65° + 589.09 * \sin 70° * \cos 92°26'20"}\right) = 34°54'03"$$

$$D = \operatorname{atan}\left(\frac{CB * \sin X_2 * \sin(B+D)}{CD * \sin X_1 + CB * \sin X_2 * \cos(B+D)}\right)$$

$$= \operatorname{atan}\left(\frac{900.72 * \sin 65 * \sin 92°26'20"}{589.09 * \sin 70 + 900.72 * \sin 65 * \cos 92°26'20"}\right) = 57°32'17"$$

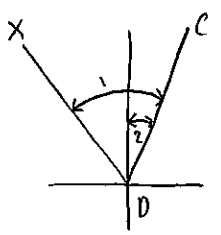
Step 5 Calculate BX + DX Bearings



Brng B → X = ∠1 − ∠2

= 44°54'03" − 34°54'03"

= S 10°00'00" E



Brng $D \to X = \angle 1 - \angle 2 = 57°32'17" - 02°32'17"$

$= N\ 55°\ W$

Step 6: Calculate Dist BX and DX

$C_1 = 180 - X_1 - B = 180° - 70° - 34°54'03" = 75°05'57"$

$BX = CB * \frac{\sin C_1}{\sin X_1} = 900.72 \frac{\sin 75°05'57"}{\sin 70°} = 926.29\ ft$

$C_2 = 180 - X_2 - D = 180° - 65° - 57°32'17" = 57°27'43"$

$DX = CD * \frac{\sin C_2}{\sin X_2} = 589.09 \frac{\sin 57°27'43"}{\sin 65°} = 547.96\ ft$

Step 7: Calculate Lat & Dep of BX and DX

Lat BX = cos (brng BX) * BX = −912.22 Dep BX = sin (brng BX) * BX = +160.85

Lat DX = cos (brng DX) * DX = +314.30 Dep DX = sin (brng DX) * DX = −448.86

Step 8: Coordinates of X

From B N = 1712.22 − 912.22 = 800.00

E = 489.15 + 160.85 = 650.00

From D N = 485.70 + 314.30 = 800.00

E = 1098.86 − 448.86 = 650.00