Ogunbye Adedapo Almarfeer
Civil Engineering 17/ENG03/038

1a) Methods of levelling considering the advantages and drawbacks

Height of collimation method

i) It is rapid as it involves few calculations

ii) There is no check on the reduced level of the intermediate sight

iii) Errors in the intermediate reduced levels cannot be detected

iv) There are two checks on the accuracy of reduced level calculation

v) This method is suitable for longitudinal levelling where there are a number of intermediate sights

Rise and fall method

It is laborious involving several calculations

There is no check on the reduced level of the intermediate points

Errors in the intermediate reduced levels can be detected as all the points are correlated

There are three checks on the accuracy of the reduced level calculation

This method is suitable for longitudinal levelling where there are no intermediate sights

BS	IS	FS	Height of Collimation	Reduced Level (c/d)	Remarks	Dist
0.711			148.771	148.0		10
0.802		1.520	148.053	147.251 ⑤	CP	20
	2.311			145.742 ③		30
3.580		1.990	149.643	146.063 ④	CP	40
	1.220			148.423 ⑤		50
	3.675			145.968 ⑥		60
2.408		4.020	148.031	145.623 ⑦	CP	70
	0.339			147.692 ⑧		80
0.780		0.157	148.654	147.874 ⑨	CP	90
	1.535			147.119 ⑩		100
	1.955			146.699 ⑪		110
	2.430			146.224 ⑫		120
	2.985			145.669 ⑬		130
1.155		3.480	146.329	145.174 ⑭	CP	140
	1.960			144.369 ⑮		150
	2.365			143.964 ⑯		160
0.933		3.640	143.624	142.689 ⑰	CP	170
	1.045			142.579 ⑱		180
	1.630			141.994 ⑲		190
		2.545		141.079 ⑳		200
ΣBS =		ΣFS =				
10.481		17.352				

Check

$\Sigma FS - \Sigma BS$ = RL@1st point − RL@ last point

17.352 − 10.481 = 148 − 141.079

⇒ 6.924 = 6.924

RL(1) = 110 + Matic Number = 110 + 38 = 148m

RL(2) = [redacted] 148·771 - 1520 = 147·251m

RL(3) = 148·053 - 2·311 = 145·742m

RL(4) = 148·053 - 1·990 = 146·063m

RL(5) = 149·643 - 1·220 = 148·423m

RL(6) = 149·643 - 3·675 = 145·968m

RL(7) = 149·643 - 4·020 = 145·623m

RL(8) = 148·031 - 0·339 = 147·692m

RL(9) = 148·031 - 0·157 = 147·874m

RL(10) = 148·654 - 1·535 = 147·119m

RL(11) = 148·654 - 1·955 = 146·699m

RL(12) = 148·654 - 2·430 = 146·224m

RL(13) = 148·654 - 2·985 = 145·669m

RL(14) = 148·654 - 3·480 = 145·174m

RL(15) = 146·329 - 1·960 = 144·369m

RL(16) = 146·329 - 2·365 = 143·964m

RL(17) = 146·329 - 3·640 = 142·689m

RL(18) = 143·624 - 1·045 = 142·579m

RL(19) = 143·624 - 1·630 = 141·994m

RL(20) = 143·624 - 2·545 = 141·079m

H of C(1) = 148·080 + 0·711 = 148·791 m

H of C(2) = 147·251 + 0·802 = 148·053m

H of C(4) = 148·063 + 3·580 = 149·643m

H of C(7) = 145·623 + 2·408 = 148·031 m

H of C(9) = 147·874 + 0·780 = 148·654 m

H of C(14) = 145·174 + 1·155 = 146·329 m

H of C(17) = 142·689 + 0·935 = 143·624 m

2a)

Chainage(m)	0	30	60	90	120	150	180	210	240	270
Offset length(m)	0	2.65	3.80	3.75	4.65	3.60	5.00	5.80	6.10	5.85

Average ordinate

$$A = \frac{\Sigma O \cdot nd}{n+1}$$

$n = 10$

$d = 30$

$$A = \frac{(0+2.65+3.80+3.75+4.65+3.60+5.00+5.80+6.10+5.85)}{11} \times (10 \times 30)$$

$A = 1123.64 m^2$

Mid ordinate

$A = \Sigma h d$

$d = 30$

$h_1 = \frac{0+2.65}{2} = 1.325m$ $h_2 = \frac{2.65+3.80}{2} = 3.225m$

$h_3 = \frac{3.80+3.75}{2} = 3.775m$ $h_4 = \frac{3.75+4.65}{2} = 4.2m$

$h_5 = \frac{4.65+3.60}{2} = 4.125m$ $h_6 = \frac{3.60+5.00}{2} = 4.375m$

$h_7 = \frac{5.00+5.80}{2} = 5.40m$ $h_8 = \frac{5.80+6.10}{2} = 5.95m$

$h_9 = \frac{6.10+5.85}{2} = 5.975m$

$A = (1.325 + 3.225 + 3.775 + 4.2 + 4.125 + 4.375 + 5.40 + 5.95 + 5.975) \times 30$

$A = 1150.5\ m^2$

Trapezoidal

$A = d\left[\left(\frac{O_1 + O_n}{2}\right) + O_2 + O_3 + O_{n-1}\right]$

$A = 30\left[\left(\frac{0 + 5.85}{2}\right) + 2.65 + 3.80 + 3.75 + 4.65 + 3.60 + 5.00 + 5.80 + 6.10\right]$

$A = 1148.25 m^2$

Simpson's

Since the number of offsets is even, the last offset is removed

$A = \frac{d}{3}\left[(O_1 + O_n) + 4(O_2 + O_4 + O_6 + O_8) + 2(O_3 + O_5 + O_7)\right]$

$d = 30$

$A = \frac{30}{3}\left[(0 + 6.10) + 4(2.65 + 3.75 + 3.60 + 5.80) + 2(3.80 + 4.65 + 5.00)\right]$

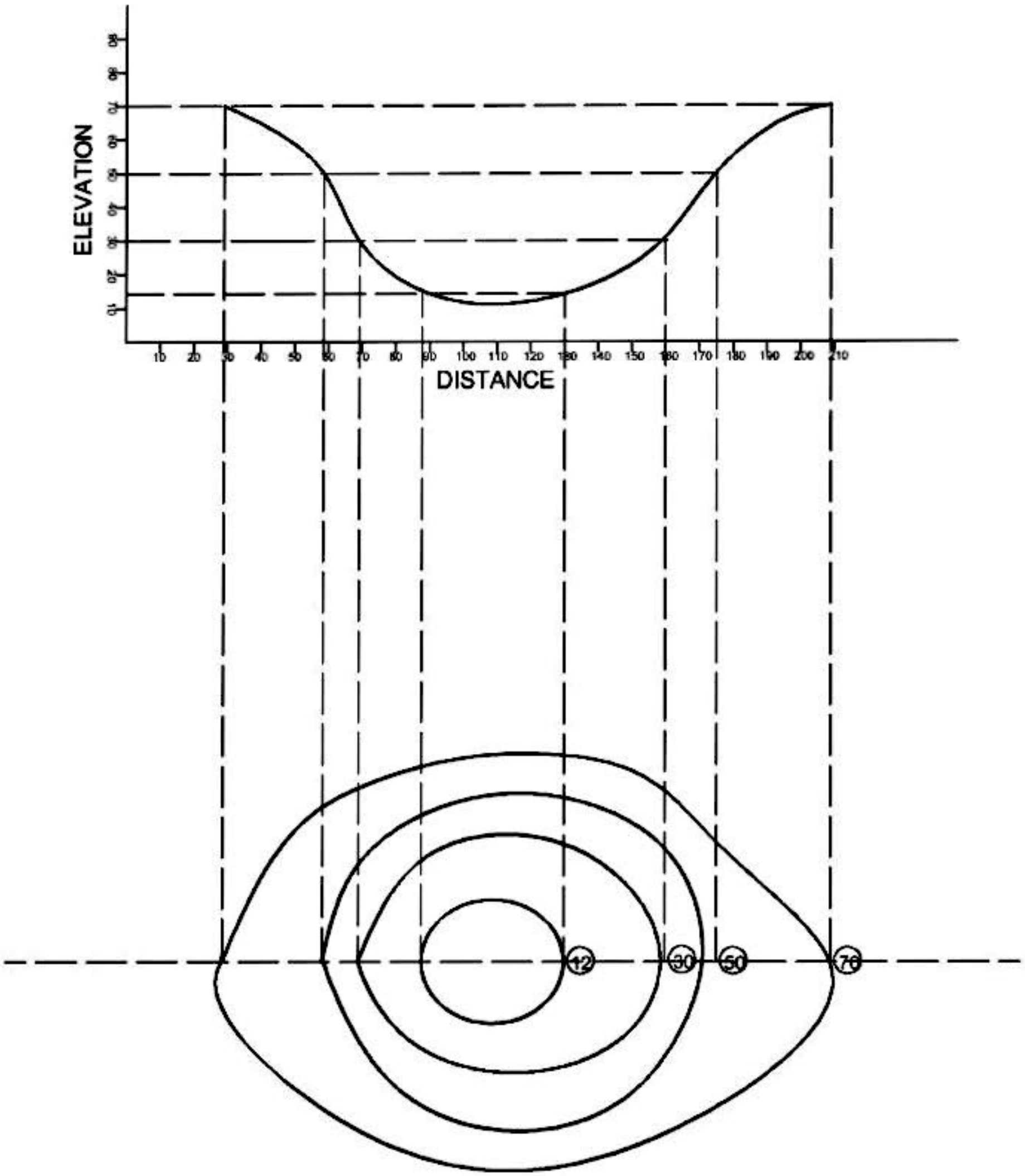
$A_1 = 962\ m^2$

Including the last offset,

$A = 30\left[\frac{6.10 + 5.85}{2}\right]$

$A_2 = 179.25 m^2$

$A = A_1 + A_2 = 962 + 179.25 = 1141.25 m^2$


ELEVATION
10
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80
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DISTANCE
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100
110
120
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200
210
12
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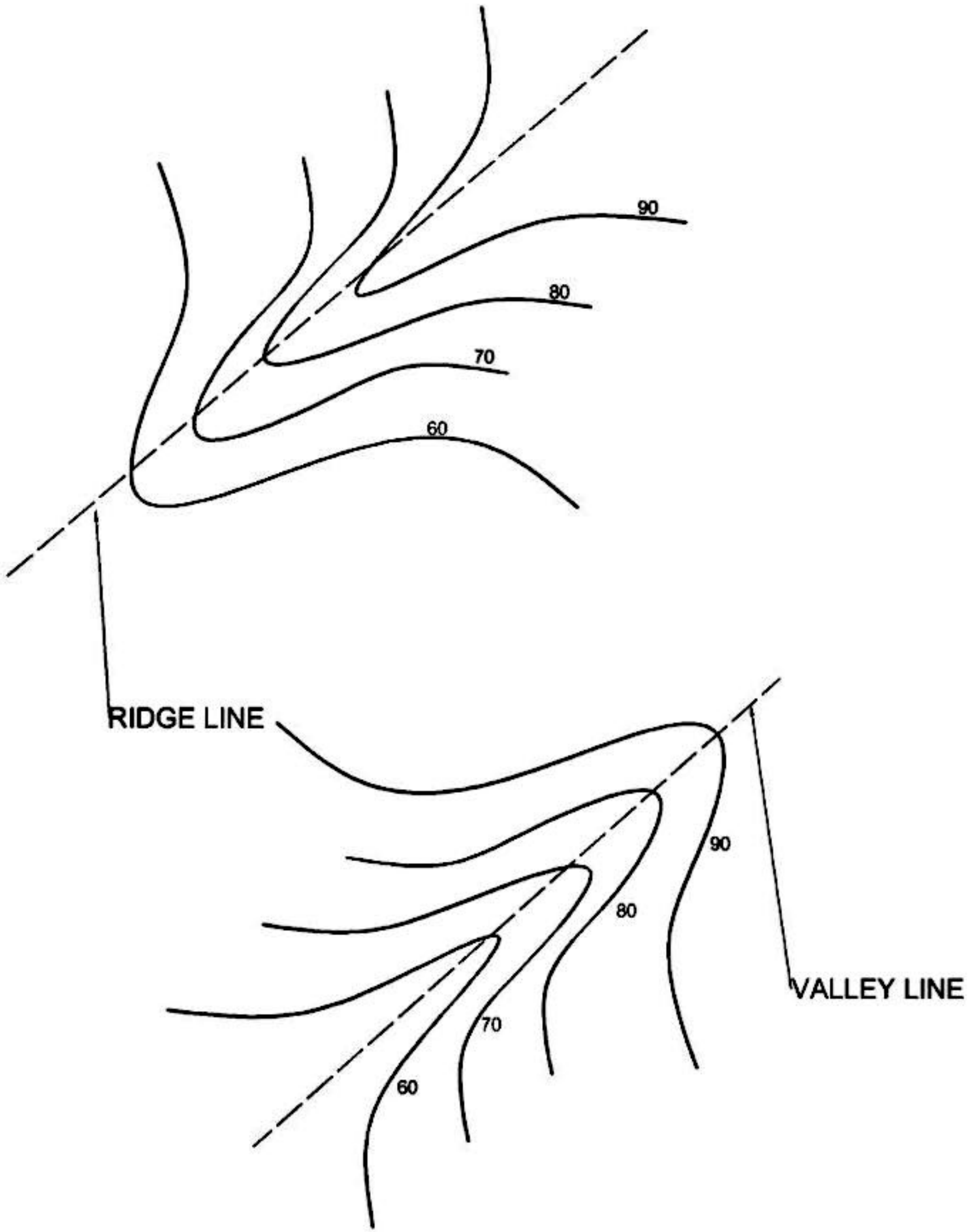
50
76


90
80
70
60
RIDGE LINE
90
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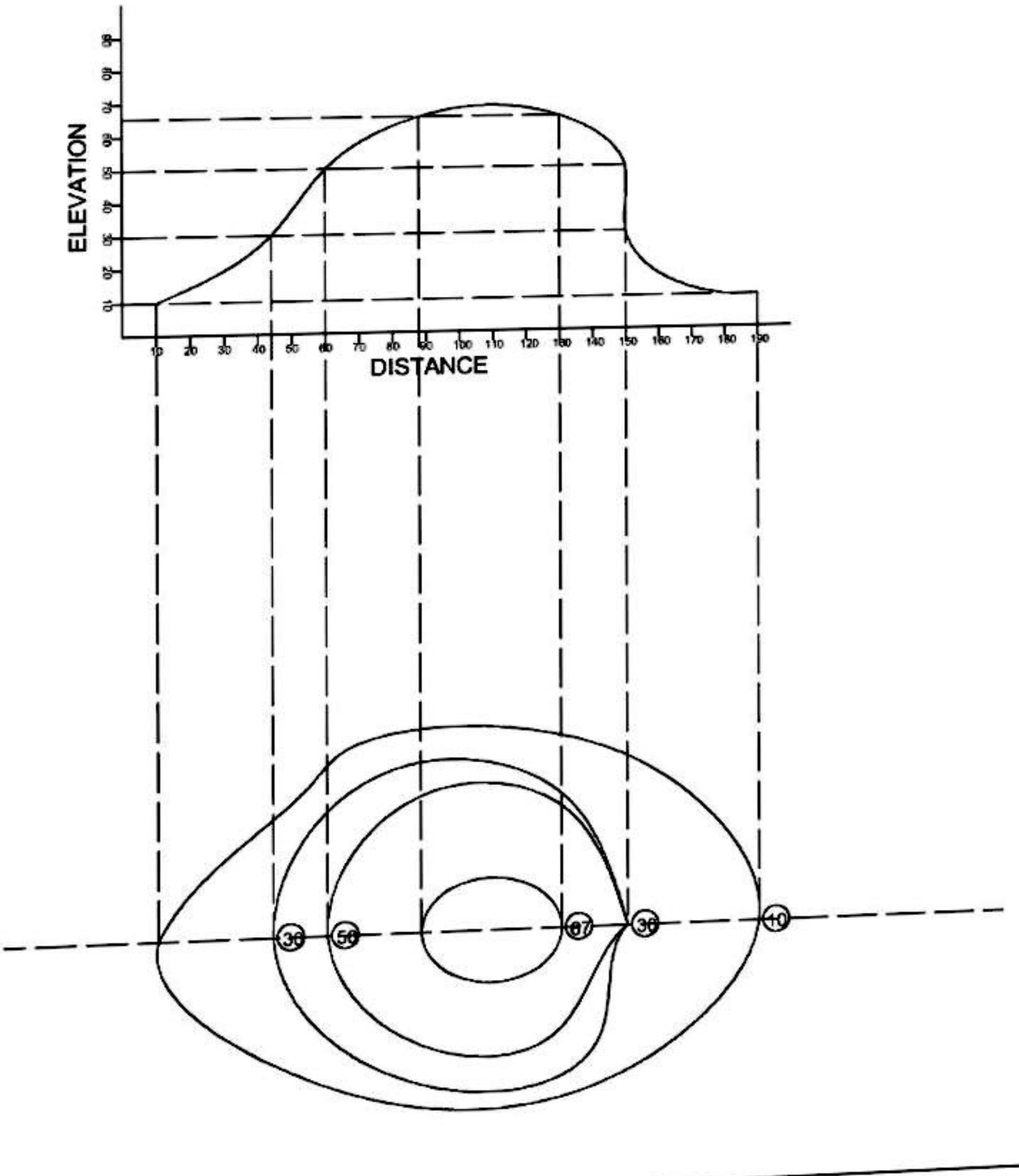
60
VALLEY LINE


ELEVATION
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DISTANCE
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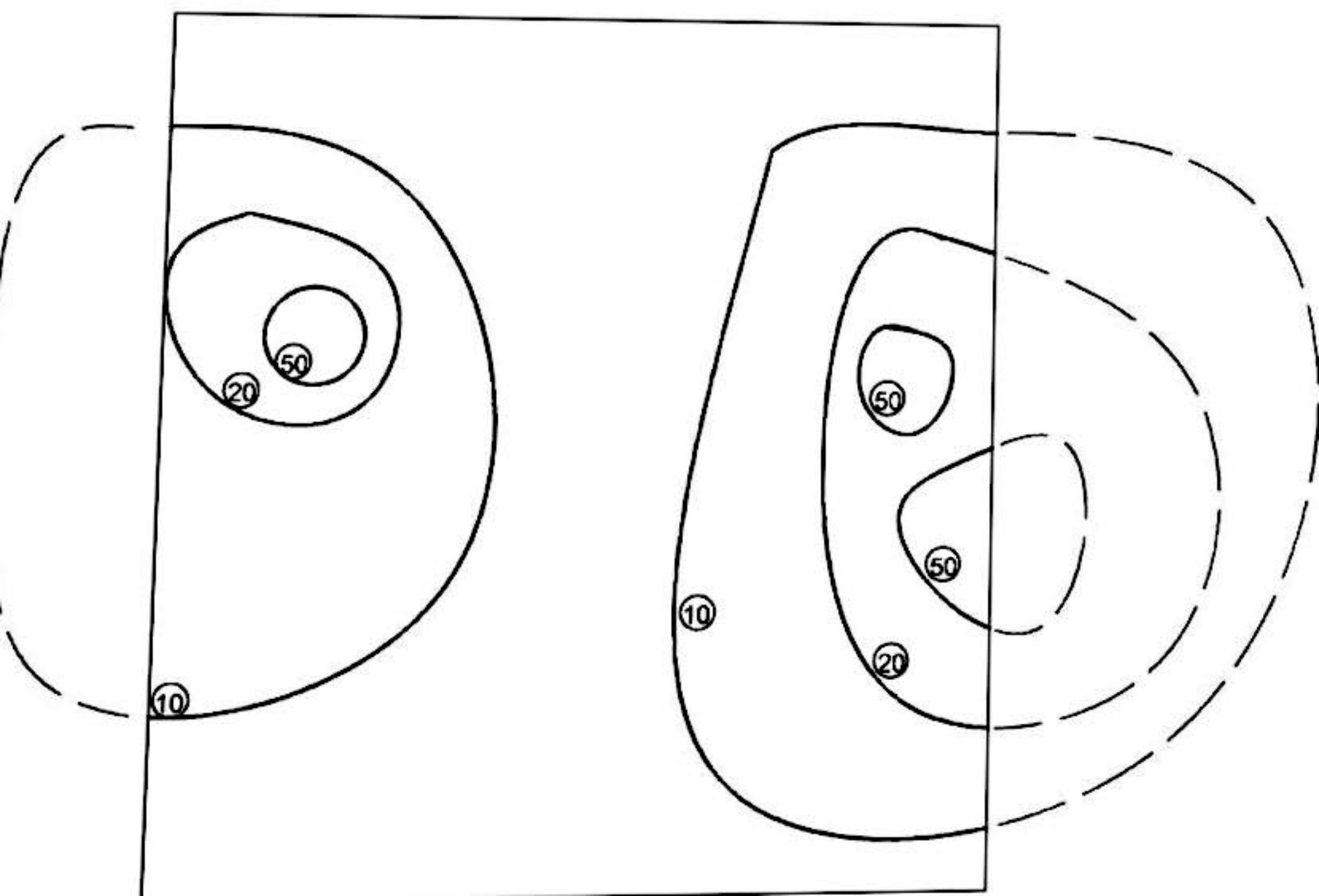
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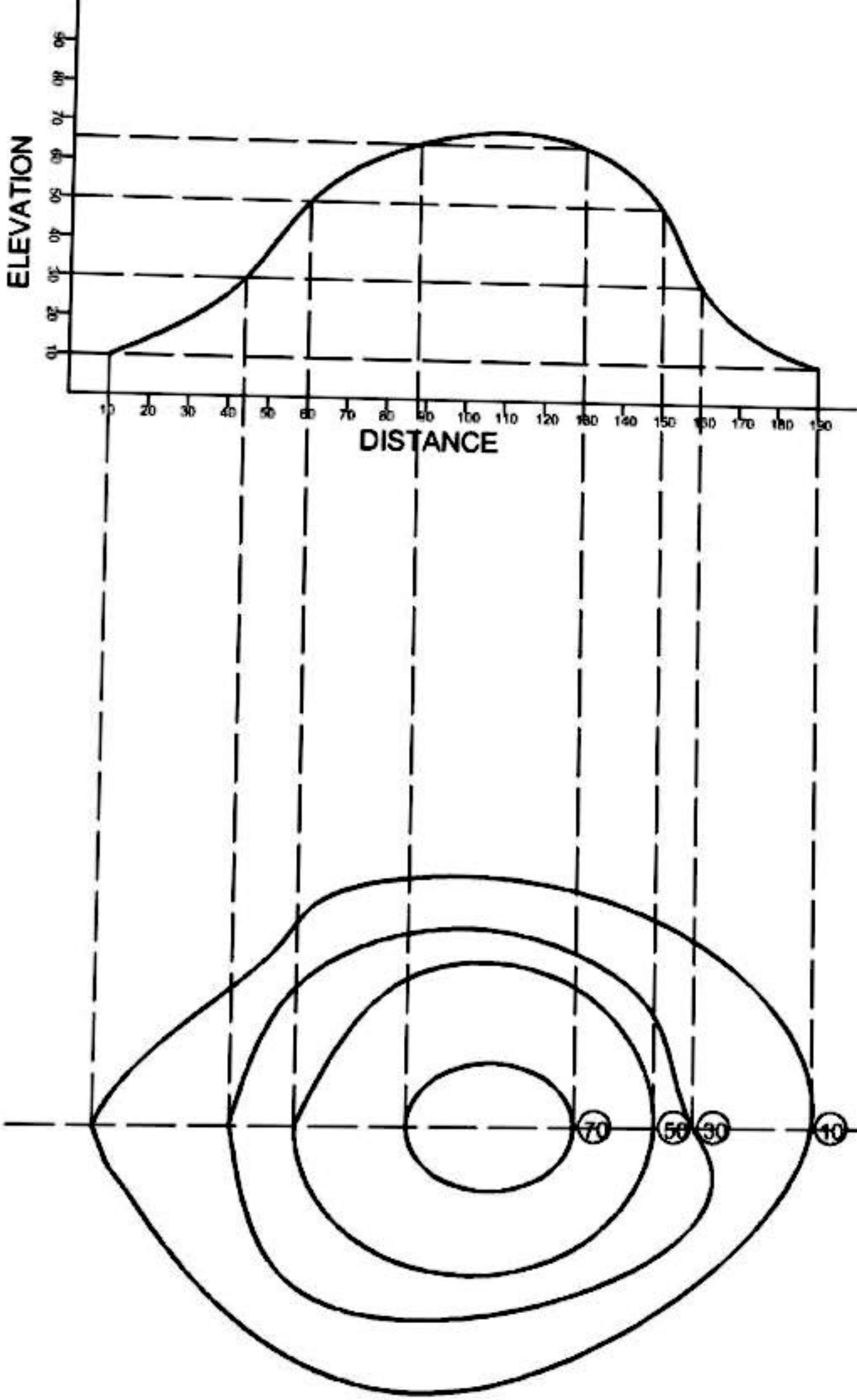
ELEVATION
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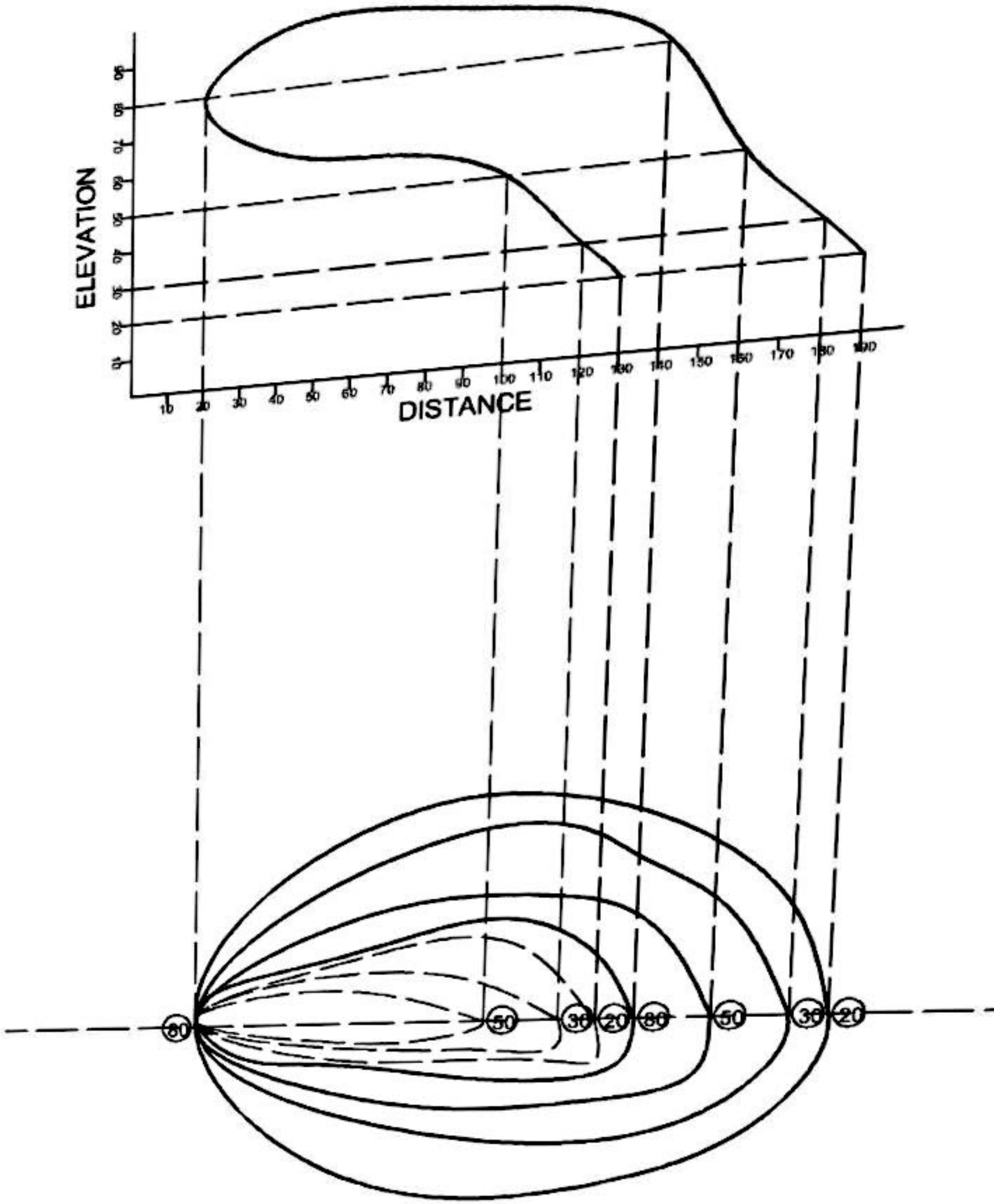
ELEVATION
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