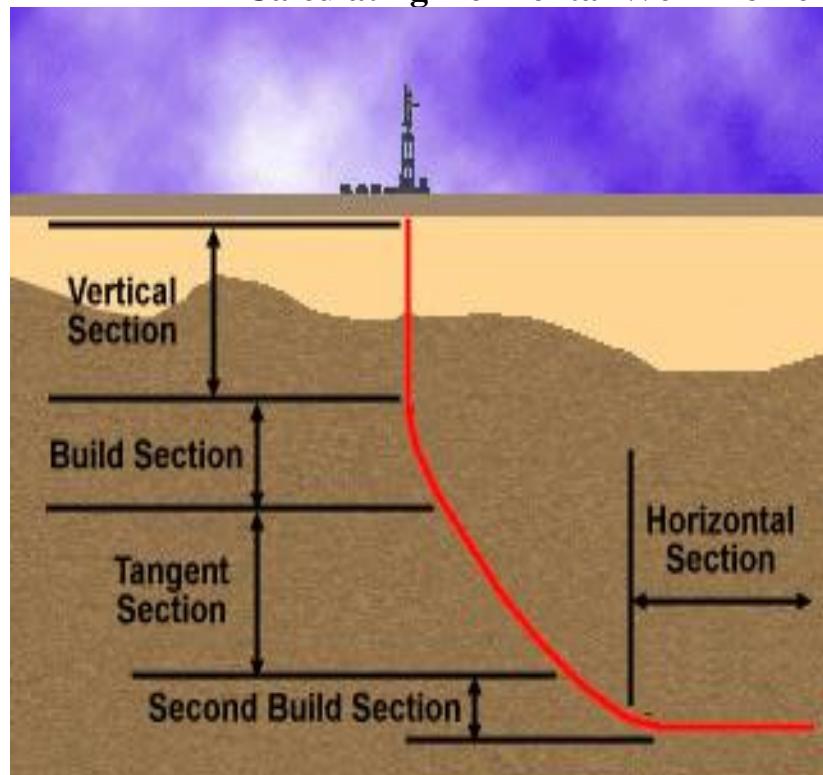


المحاضرة الحادية عشرة تصميم البروفيل الثالث

3-6. حساب البروفيل الأفقي:

Calculating Horizontal Well Profile Variables



المجاهيل المطلوب ايجادها:

1. Profile drawing
2. Well coordinate
3. Build radius
4. MAX hold angle
5. End of Build 1 (EOB1) True Vertical Depth (TVD)
6. EOB1 Measured Depth (MD)
7. EOB1 Displacement
8. Start of Second Build MD
9. Total Measured Depth to the Target

المعلومات المعطاة:

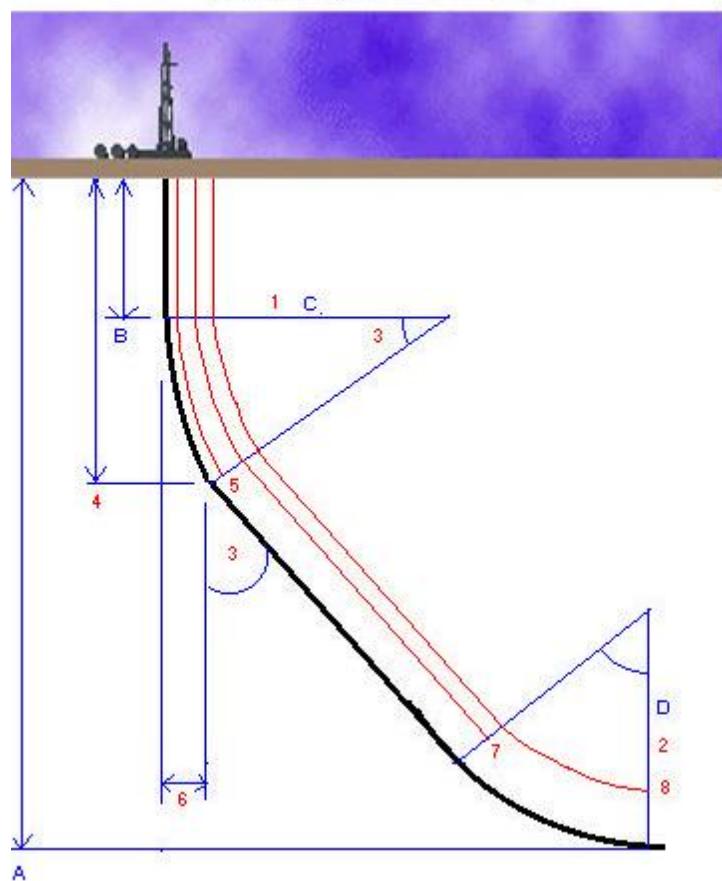
- Target location = 1800 ft @ 135° AZM
- Target's TVD (V4) = 3800 ft
- KOP (V1) = 2000 ft
- Build up rate 1 (BUR1) = 5.73° / 100 ft
- Build up rate 2 (BUR2) = 9.55° / 100 ft

١. مخطط البروفيل: يبين شكل البروفيل والقوانين الخاصة بحساب المساقط الشاقولية والأفقية
لل المجالات والمساقط و زوايا الانحراف وشدة الانحراف

Horizontal Well Profile Worksheet

<u>Plan View</u>		<u>Given Information</u>											
		<table border="1"> <tr><td>Target Location</td><td>1800 ft @ 135°AZM</td></tr> <tr><td>KOP (V₁)</td><td>2000 ft</td></tr> <tr><td>Target TVD (V₄)</td><td>3800 ft</td></tr> <tr><td>BUR 1</td><td>5.73°</td></tr> <tr><td>BUR 2</td><td>9.55°</td></tr> </table>		Target Location	1800 ft @ 135°AZM	KOP (V ₁)	2000 ft	Target TVD (V ₄)	3800 ft	BUR 1	5.73°	BUR 2	9.55°
Target Location	1800 ft @ 135°AZM												
KOP (V ₁)	2000 ft												
Target TVD (V ₄)	3800 ft												
BUR 1	5.73°												
BUR 2	9.55°												
		<u>Unknown Profile Variables</u>											
Variables	Answer												
Coordinate													
R ₁ & R ₂	R ₁ = R ₂ =												
MAX Hold Angle (Θ)													
EOB TVD (V ₂)													
EOB MD													
EOB Displacement(D ₁)													
SOD MD (V ₃)													
SOD TVD													
SOD Displacement(D ₂)													
Total MD to Target													
<u>Calculations</u>													
Formula	Answer												
<u>Coordinate</u>													
E Distance: b = sin $\angle B \times a$	b =												
S Distance: c = cos $\angle B \times a$	c =												
<u>Build Radius</u>													
R ₁ = 5729.58 / BUR ₁	R ₁ =												
R ₂ = 5729.58 / BUR ₂	R ₂ =												
<u>MAX Hold Angle (Θ)</u>													
EG = (V ₄ - V ₁) - R ₂	EG =												
EO = D ₃ - R ₁	EO =												
GOE = tan ⁻¹ (EG/EO)	GOE =												
OG = $\sqrt{(EG^2 + EO^2)}$	OG =												
OF = R ₁ + R ₂	OF =												
GOF = cos ⁻¹ (OF/OG)	GOF =												
$\Theta = 180^\circ - GOE - GOF$	$\Theta =$												
<u>EOB TVD (V₂)</u>													
V ₂ = V ₁ + R ₁ x sin Θ	V ₂ =												
<u>EOB MD</u>													
$EOB_1 = V_1 + \frac{\Theta}{BUR_1} \times 100$	EOB ₁ = MD =												
<u>EOB Displacement (D₁)</u>													
D ₁ = R ₁ - (R ₁ cos Θ)	D ₁ =												
<u>Start of 2nd Build MD</u>													
FG = $\sqrt{OG^2 - OF^2}$	FG =												
SOD ₂ = $V_2 + \frac{\Theta}{BUR_2} \times 100 + BC$	SOD ₂ = MD =												
<u>Total MD to Target</u>													
Total MD = $V_1 + \frac{\Theta}{BUR_1} \times 100 + BC + \frac{\Theta}{BUR_2}$	Total MD =												

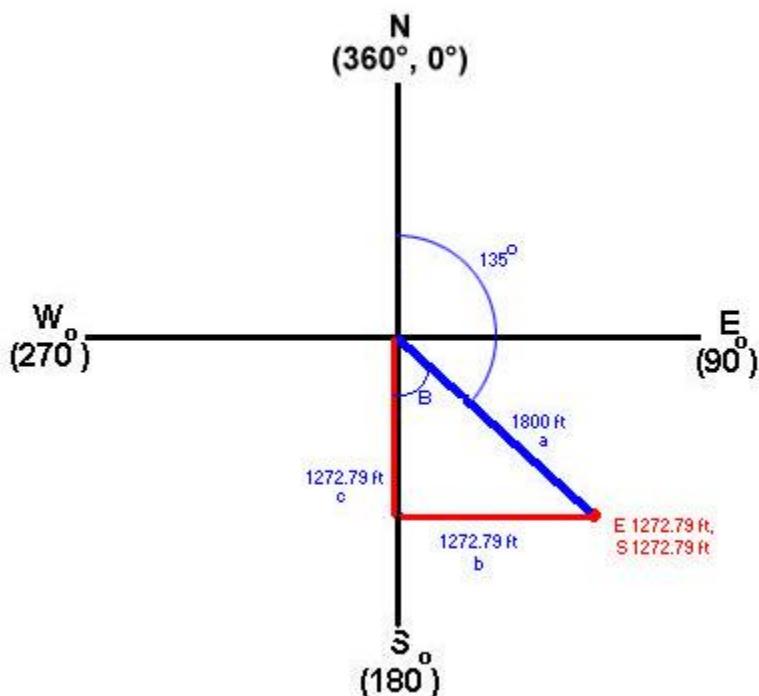
Vertical Section View



2. حساب العناصر المحددة للوضع الفراغي للبئر:

2-1. حساب موقع الهدف:

Plan View



- Formula: $\sin \angle B = \frac{b}{a}$

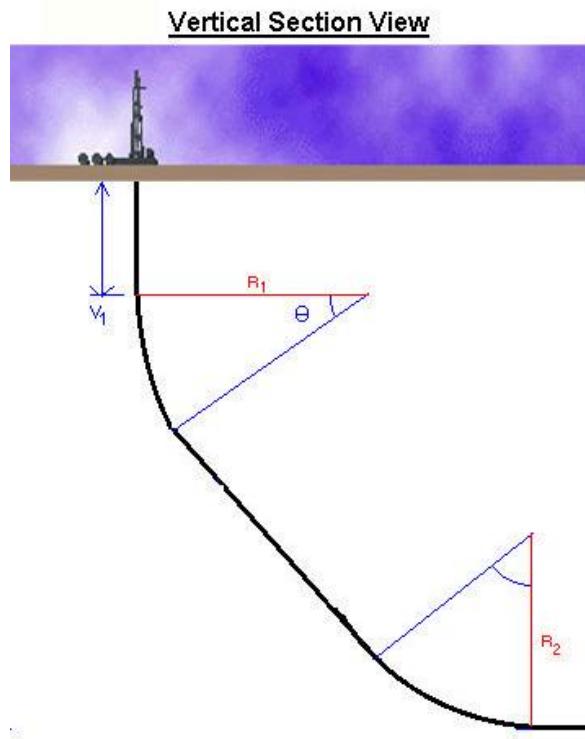
- $b = \sin \angle B \times a$
- $b = \sin 45^\circ \times 1800$
- $b = 0.707106 \times 1800$
- $b = 1272.79 \text{ ft}$
- Answer for the east distance = 1272.79 ft

- Formula: $\cos \angle B = \frac{c}{a}$

- $c = \cos \angle B \times a$
- $c = \cos 45^\circ \times 1800$
- $c = 0.707106 \times 1800$
- $c = 1272.79 \text{ ft}$
- Answer for the south distance = 1272.79 ft

2-2. حساب نصف قطر الانحراف:

Calculating Build Radius



- Formula: Build radius 1 (R_1) = $\frac{180}{\pi} \times \frac{100}{BUR1}$ or $R_1 = \frac{5729.58}{BUR1}$

$$\bullet R_1 = \frac{5729.58}{BUR1}$$

$$\bullet R_1 = \frac{5729.58}{5.73^\circ}$$

$$\bullet R_1 = 999.93 \text{ ft}$$

• Answer for the build radius 1 (R_1) = 999.93 ft

- Formula: Build radius 2 (R_2) = $\frac{180}{\pi} \times \frac{100}{BUR2}$ or $R_2 = \frac{5729.58}{BUR2}$

$$\bullet R_2 = \frac{5729.58}{BUR2}$$

$$\bullet R_2 = \frac{5729.58}{9.55^\circ}$$

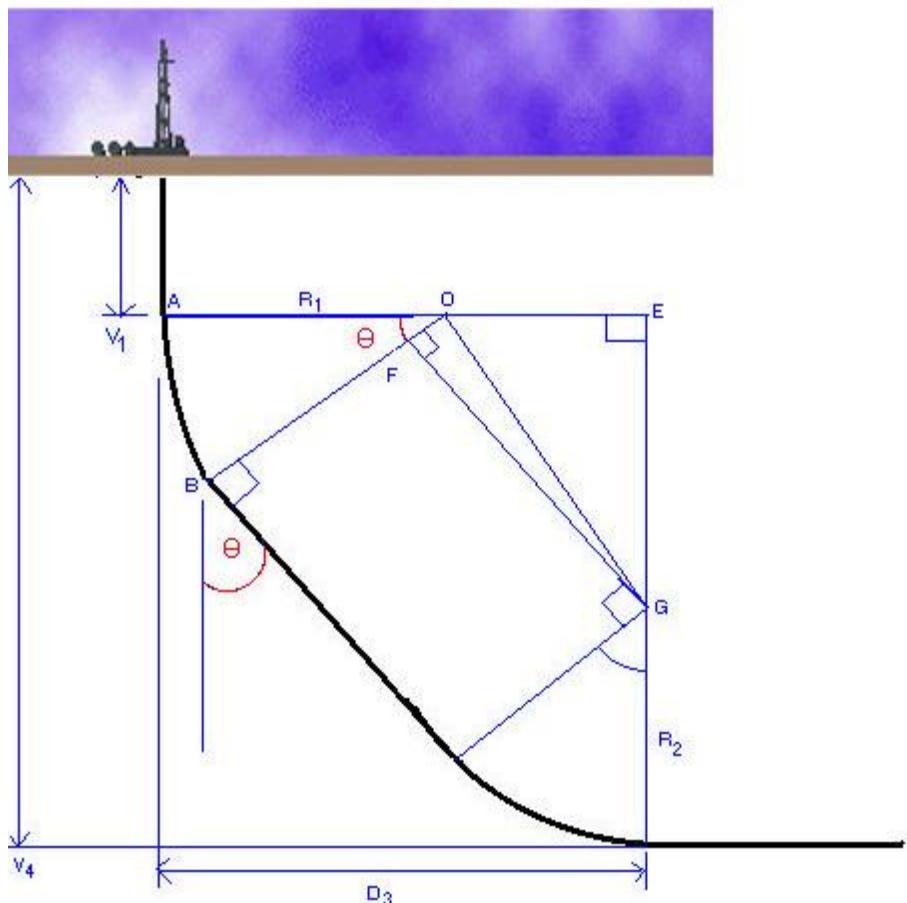
$$\bullet R_2 = 599.96 \text{ ft}$$

• Answer for the build radius 2 (R_2) = 599.96 ft

2-3. حساب زاوية الميل العظمى:

Calculating MAX Hold Angle

Vertical Section View



- First, find line EG = $(V_4 - V_1) - R_2$
 - Second, find line EO = $D_3 - R_1$
 - Third, find angle GOE = $\tan^{-1} \frac{EG}{EO}$
 - Fourth, find line OG = $\sqrt{EG^2 + EO^2}$
 - Fifth, find line OF = $R_1 - R_2$
 - Sixth, find angle GOF = $\cos^{-1} \frac{OF}{OG}$
 - Seventh, find the MAX hold angle (θ or AOB) = $180^\circ - GOE - GOF$
 - Formula: $EG = (V_4 - V_1) - R_2$
 - $EG = (3800 - 2000) - 599.96$
 - $EG = (1800) - 599.96$
 - $EG = 1200.04 \text{ ft}$
- (This answer will be used with the third and fourth steps.)

- Formula: $EO = D_3 - R_1$

- $EO = 1800 - 999.93$

- $EO = 800.07 \text{ ft}$

(This answer will be used with the third and fourth steps.)

- Formula: $\tan \angle GOE = \frac{EG}{EO}$

- $\angle GOE = \tan^{-1} \frac{EG}{EO}$

- $\angle GOE = \tan^{-1} \frac{1200.04}{800.07}$

- $\angle GOE = \tan^{-1} 1.4999$

- $\angle GOE = 56.31$

(This answer will be used with the seventh step.)

- Formula: $OG^2 = EG^2 + EO^2$

- $OG = \sqrt{EG^2 + EO^2}$

- $OG = \sqrt{1200.04^2 + 800.07^2}$

- $OG = \sqrt{20,801,208.01}$

- $OG = 1,442.29 \text{ ft}$

(This answer will be used with the sixth step.)

- Formula: $OF = R_1 - R_2$

- $OF = 999.93 - 599.96$

- $OF = 399.97 \text{ ft}$

(This answer will be used with the sixth step.)

- Formula: $\cos \angle GOF = \frac{OF}{OG}$

- $\angle GOF = \cos^{-1} \frac{OF}{OG}$

- $\angle GOF = \cos^{-1} \frac{399.97}{1442.29}$

- $\angle GOF = \cos^{-1} 0.2773$

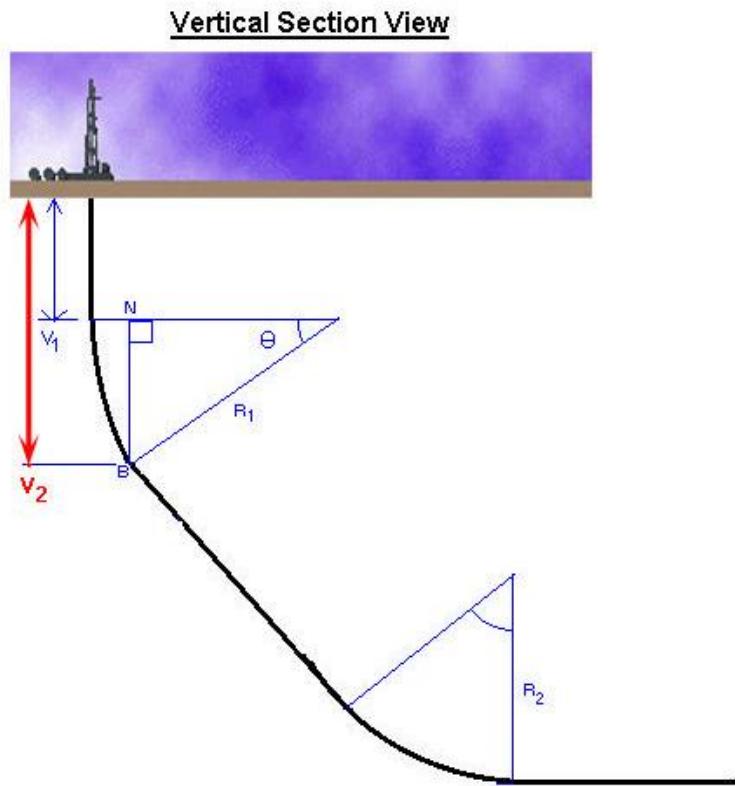
- $\angle GOF = 73.90^\circ$

(This answer will be used with the seventh step.)

- Formula: MAX hold angle (θ or AOB) = $180^\circ - \text{GOE} - \text{GOF}$
 - MAX hold angle (θ) = $180^\circ - 56.31^\circ - 73.90^\circ$
 - MAX hold angle (θ) = 49.79°

2-4. حساب نهاية مجال بناء الزاوية العمق الشاقولي الحقيقي :

Calculating End of Build 1 (EOB) True Vertical Depth (TVD)

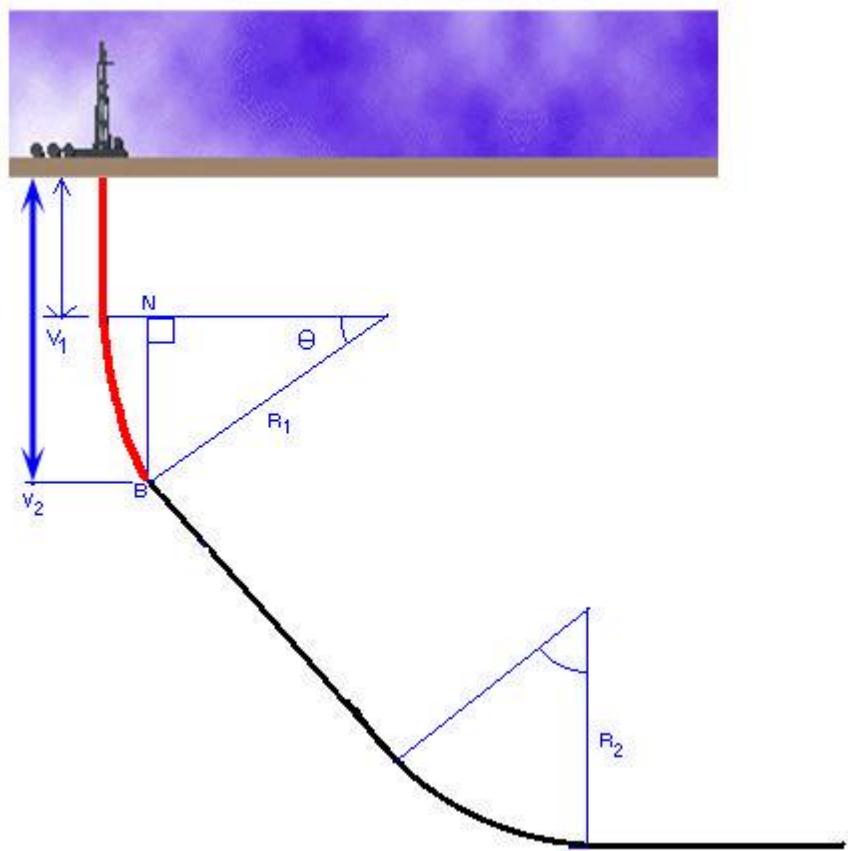


- Formula: EOB1 TVD (V_2) = $V_1 + [R_1 \times (\sin \theta)]$
 - $V_2 = 2000 + [999.93 \times (\sin 49.79^\circ)]$
 - $V_2 = 2000 + [999.93 \times (0.7637)]$
 - $V_2 = 2000 + [763.63]$
 - $V_2 = 2763.63 \text{ ft}$

2-5. حساب نهاية مجال بناء الزاوية العمق المقاس :

Calculating End of Build 1 (EOB) Measured Depth (MD)

Vertical Section View



- Formula: $EOB\ 1\ MD = V_1 + \frac{\theta}{BUR\ 1} \times 100$

- $EOB\ 1\ MD = 2000 + \frac{49.79^\circ}{5.73^\circ} \times 100$

- $EOB\ 1\ MD = 2000 + (8.6894 \times 100)$

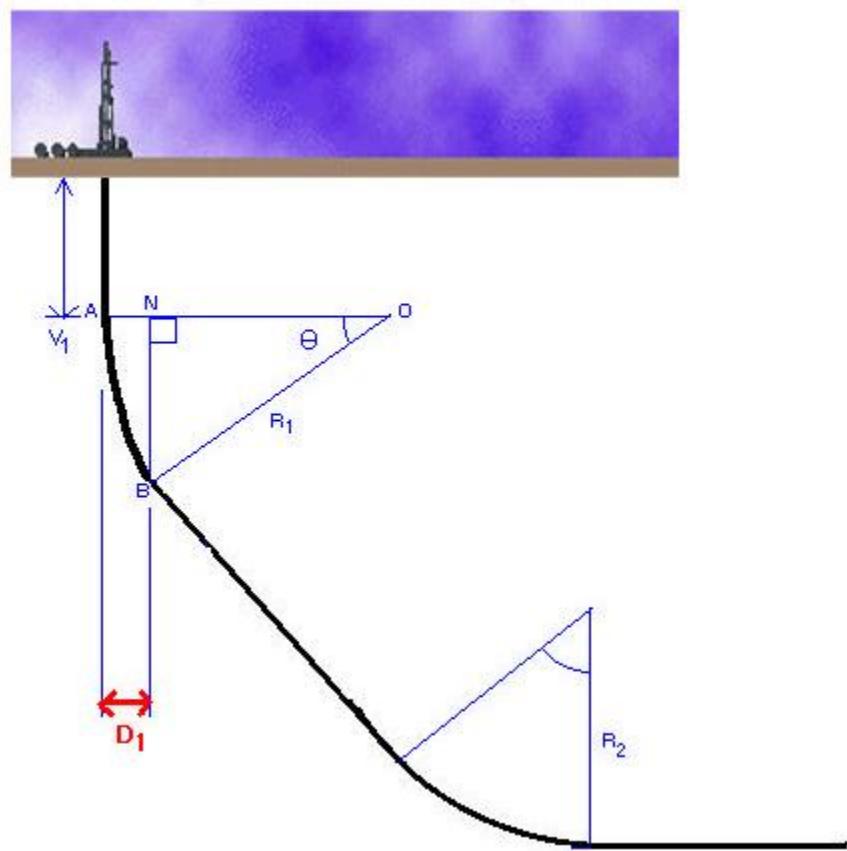
- $EOB\ 1\ MD = 2000 + (868.94)$

- $EOB\ 1\ MD = 2868.94\ ft$

2-6. حساب الانزياح الأفقي للمجال المائل الأول:

Calculating End of Build 1 (EOB) Displacement

Vertical Section View



- Formula: EOB1 displacement (D_1) = $R_1 - [R_1 \times (\cos \theta)]$

$$\bullet D_1 = 999.93 - [999.93 \times (\cos 49.79^\circ)]$$

$$\bullet D_1 = 999.93 - [999.93 \times (0.6463904)]$$

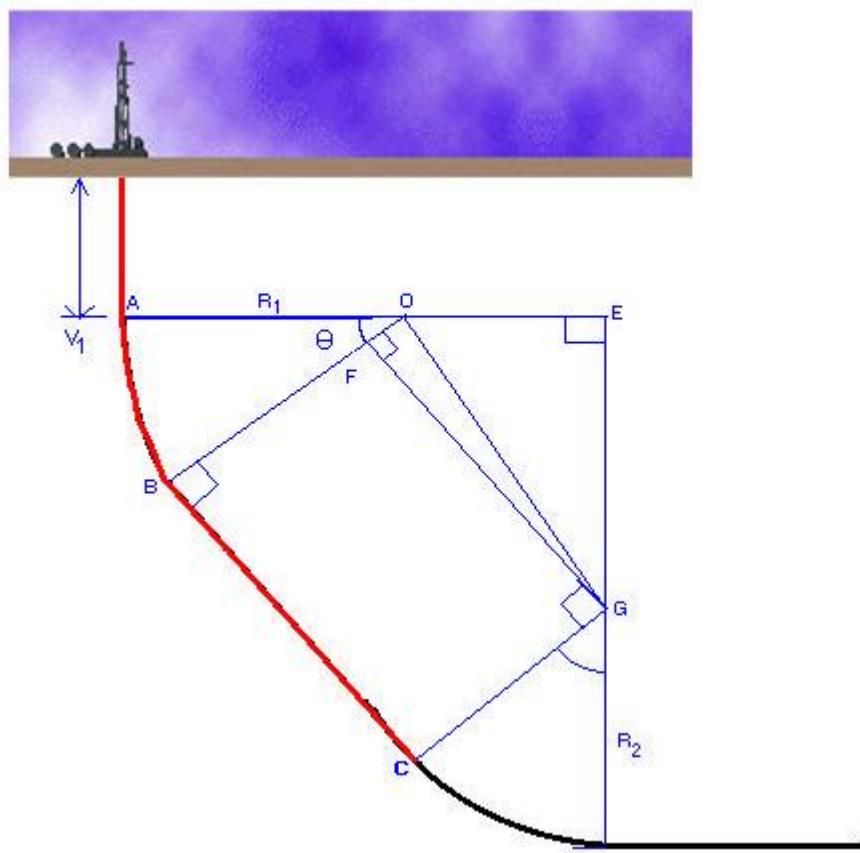
$$\bullet D_1 = 999.93 - [646.39]$$

$$\bullet D_1 = 353.54 \text{ ft}$$

7- حساب عمق بداية بناء المجال الثاني:

Calculating Start of Second Build Measured Depth (MD)

Vertical Section View



- Formula: $OG^2 = FG^2 + OF^2$

- $• FG = \sqrt{OG^2 - OF^2}$

- $• FG = \sqrt{1,442.29^2 - 399.97^2}$

- $• FG = \sqrt{1,920,224.44}$

- $• FG (BC) = 1,385.72 \text{ ft}$

(This answer will be used in the second step.)

- Formula: Start of 2nd build MD = $V_1 + \frac{\theta}{\text{BUR1}} \times 100 + BC$

- $• \text{Start of 2nd build MD} = 2,000 + \frac{49.79^\circ}{5.73^\circ} \times 100 + 1,387.46$

- $• \text{Start of 2nd build MD} = 2,000 + (8.6894 \times 100) + 1,385.72$

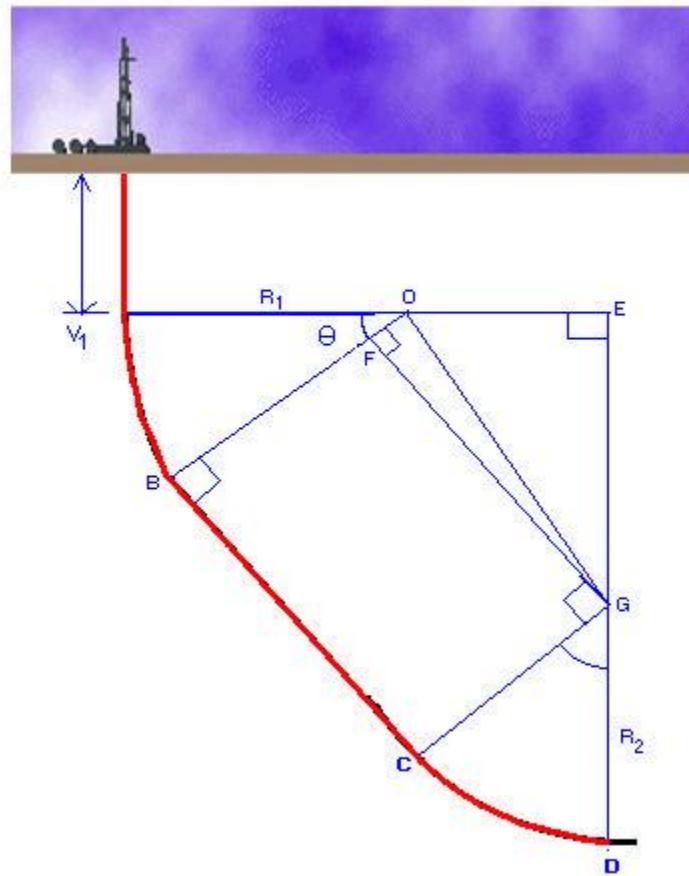
- $• \text{Start of 2nd build MD} = 2,000 + (868.94) + 1,385.72$

- $• \text{Start of 2nd build MD} = 4,254.66 \text{ ft}$

2-9. حساب العمق الكلي حتى الوصول للهدف

Calculating Total Measured Depth to the Target

Vertical Section View



- **Formula:** Total measured depth = $V_1 + \frac{\theta}{\text{BUR1}} \times 100 + BC + \frac{\text{CGD}}{\text{BUR2}} \times 100$
 - Total measured depth = $2000 + \frac{49.79^\circ}{5.73^\circ} \times 100 + 1385.72 + \frac{90^\circ - 49.79^\circ}{9.55^\circ} \times 100$
 - Total measured depth = $2000 + (8.6894 \times 100) + 1385.72 + (4.21675 \times 100)$
 - Total measured depth = $2000 + (868.94) + 1385.72 + (421.05)$
 - Total measured depth = **4675.71 ft**

Summary

The calculations performed in this module are usually done on the computer. Even though technological advancements have led to improved and more effective calculation methods, the directional driller must know how to perform well planning calculations independent of computer assistance. The driller needs to be able to perform these calculations if the client asks for an explanation of how the value is obtained.

In this module you have learned to do the following:

- Given all but one of the variables for a well profile, calculate the values of the missing variables for a build-hold ("J" or Slant) well.

- Given all but one of the variables for a well profile, calculate the values of the missing variables for a "S"-type well.
- Given all but one of the variables for a well profile, calculate the values of the missing variables for a horizontal well.