

Grades & Stakes Formulas



For more Grades and Stakes info scan the QR code.

<p>CONVERT INCHES TO DECIMAL FEET</p> <p>8" - 8/12 = 0.666 = 0.67' 1/4" - 1/4 = /12 = 0.020 = 0.02' 8-1/4" - 1/4 = +8 = /12 = 0.687 = 0.69'</p>	<p>"GOLD"EN RULES</p> <p>RISE / RUN = FT/FT (NEVER ROUND) % / 100 = FT/FT (NEVER ROUND) FT/FT X 100 = % RUN / RISE = SLOPE RATIO</p>																					
<p>CONVERT DECIMAL FEET TO INCHES</p> <p>0.25' = 0.25 X 12 = 3"</p>	<p>STATIONING</p> <p>EXAMPLES - 16+45 & 14+50 1645.00 - 1450.00 = 195.00' APART NEGATIVE OFFSET = LEFT & POSITIVE OFFSET = RIGHT</p>																					
<p>BASIC QUANTITIES</p> <p>FEET X FEET = SQUARE FEET (SQ FT) SQ FT / 9 = SQUARE YARDS (SQ YDS) FEET X FEET X FEET = CUBIC FEET (CU FT) CU FT / 27 = CUBIC YARDS (CU YDS)</p>	<p>FG CUT/FILLS TO SUBGRADE</p> <p>SECTION + CUT = TOTAL CUT SECTION - FILL = POSITIVE # = CUT NEGATIVE # = FILL</p>																					
<p>A² + B² = C²</p> <div style="display: flex; align-items: center;"> <div style="margin-right: 20px;"> <p>A=28' C B=30'</p> </div> <div> <p>(28 X 28) + (30 X 30) 784 + 900 = 1684 $\sqrt{1684} = C = 41.04'$</p> </div> </div>	<p>SURVEYING</p> <p>1 ACRE = 43560 SQ FT (66' X 660') 640 ACRES IN A SECTION SECTION DIMENSION - 1 MILE X 1 MILE 36 SECTIONS PER TOWNSHIP TOWNSHIP DIMENSION - 6 MILE X 6 MILE</p>																					
<p>INCHES & DECIMAL FEET</p> <p>12 INCHES OR 96 EIGHTHS PER FOOT 10 TENTHS OR 100 HUNDREDTHS PER FOOT 5280 FEET - 1 MILE</p>	<p>BENCHMARK (BM) + BACKSIGHT (BS) = HEIGHT OF INSTRUMENT (HI) HI - FORESIGHT (FS) = ELEVATION (EL) HI - EL = FORESIGHT ROD READING</p>																					
<p>LEVEL LOOPING</p>																						
<p>Stake Reading with Section-Grade Rod</p> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th style="width:15%;"></th> <th style="width:15%;">STAKE INFO</th> <th style="width:15%;">SECTION THICKNESS</th> <th style="width:10%;">ROD READING ON HUB (RR)</th> <th style="width:10%;">RR+CUT RR-FILL = FG RR</th> <th style="width:10%;">FG RR + Section = SG RR</th> <th style="width:15%;">SG RR - GROUND RR = (-) = Fill (+) = Cut</th> </tr> </thead> <tbody> <tr> <td>Example</td> <td>F-1.56 To FG</td> <td>4" Concrete 4" Sand</td> <td>5.06</td> <td>(5.06-1.56) 3.50</td> <td>(3.50+0.67) 4.17</td> <td>(4.17-5.25) F-1.08 SG</td> </tr> <tr> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>		STAKE INFO	SECTION THICKNESS	ROD READING ON HUB (RR)	RR+CUT RR-FILL = FG RR	FG RR + Section = SG RR	SG RR - GROUND RR = (-) = Fill (+) = Cut	Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06-1.56) 3.50	(3.50+0.67) 4.17	(4.17-5.25) F-1.08 SG								
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<p>PRORATION</p>																						
<p>SOLVING FOR STEPS = $\frac{35 \text{ (STEPS)} \times \text{(STEPS)}}{100'} = \frac{\text{X (STEPS)}}{60'}$ = 35 X 60 = /100 = 21 STEPS</p>																						
<p>SOLVING FOR RISE = $\frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{\text{X (RISE)}}{14' \text{ (RUN)}}$ = 14 X 1 = /4 = X = 3.5' RISE</p>																						
<p>SOLVING FOR RUN = $\frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{5' \text{ (RISE)}}{\text{X (RUN)}}$ = 5 X 4 = /1 = X = 20' RUN 20 X 2 (SIDES) = + DITCH BOTTOM = TOTAL TRENCH</p>																						

Common Abbreviations

•	BC/PC	Begin Curve	•	⊙ or O/S	Offset
•	BM	Bench Mark	•	PI	Point of Intersection
•	℄	Centerline	•	PL	Property Line
•	C	Cut	•	RAD	Radius Point
•	CP	<u>Catch Point</u>	•	R/W	Right-of-Way
•	EC/PT	End Curve	•	SG	Sub Grade
•	EL	Elevation	•	SS	Slope Stake
•	F	Fill	•	STA	Station
•	FG	Finished Grade	•	TBM	Temporary Bench Mark
•	FL	Flow Line	•	TC	Top of Curb
•	HP	<u>High Point</u>	•	TOE	Toe of Slope
•	INV	Invert of Drain	•	TOP	Top of Slope
•	L/O	Line Only	•	TP	Turning Point
•	MH	Manhole	•	TBC	Top Back of Curb



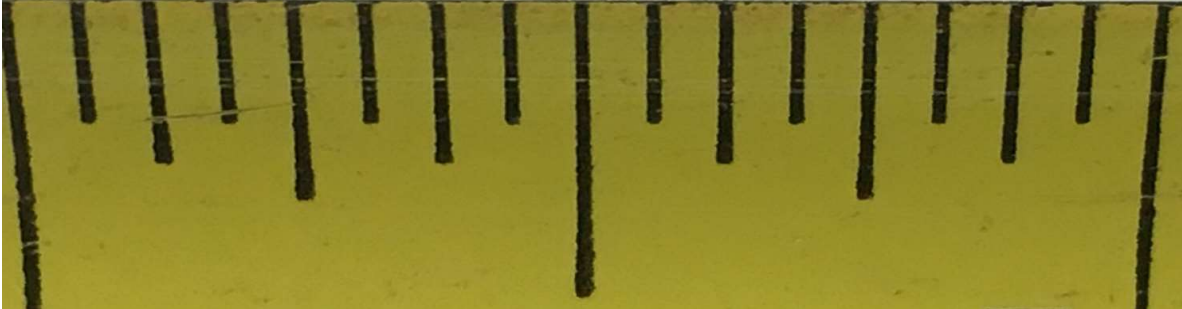
READING INCHES OF A FOOT

0" ZERO FEET 1" 2" 3" 4" 5" 6" 7" 8" 9" 10" 11" 12" ONE FOOT

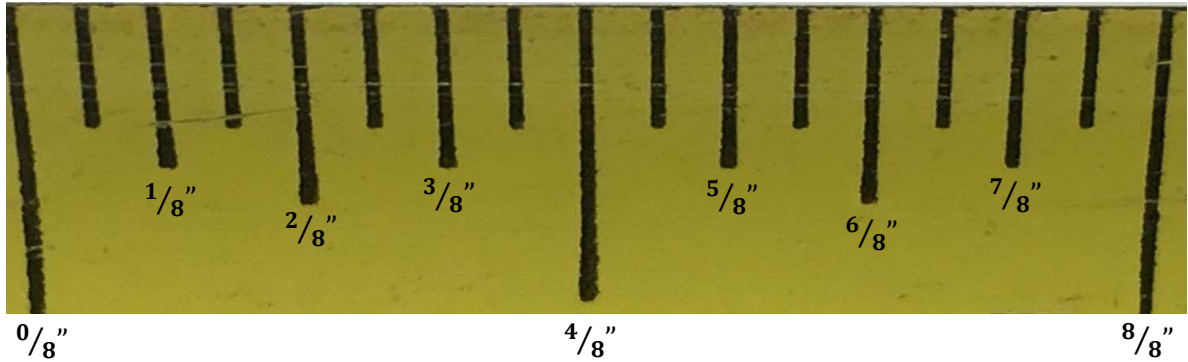


READING SIXTEENTHS OF AN INCH

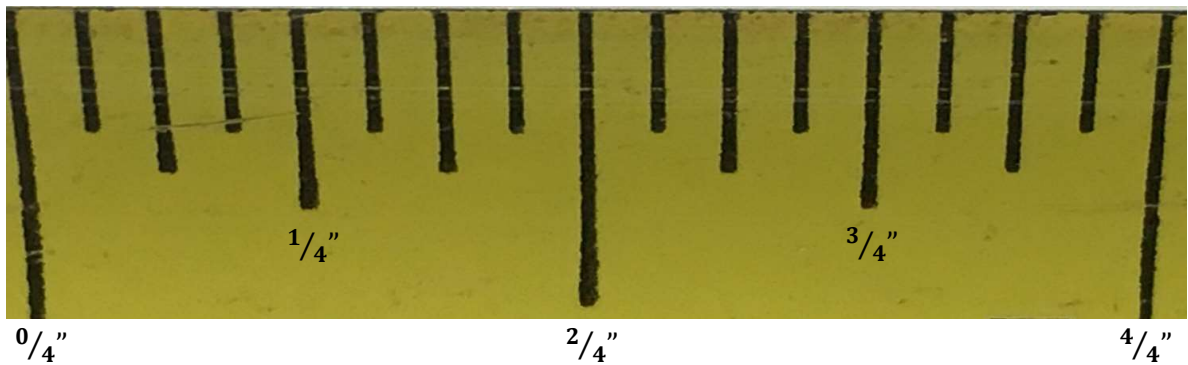
0/16" 1/16" 2/16" 3/16" 4/16" 5/16" 6/16" 7/16" 8/16" 9/16" 10/16" 11/16" 12/16" 13/16" 14/16" 15/16" 16/16"



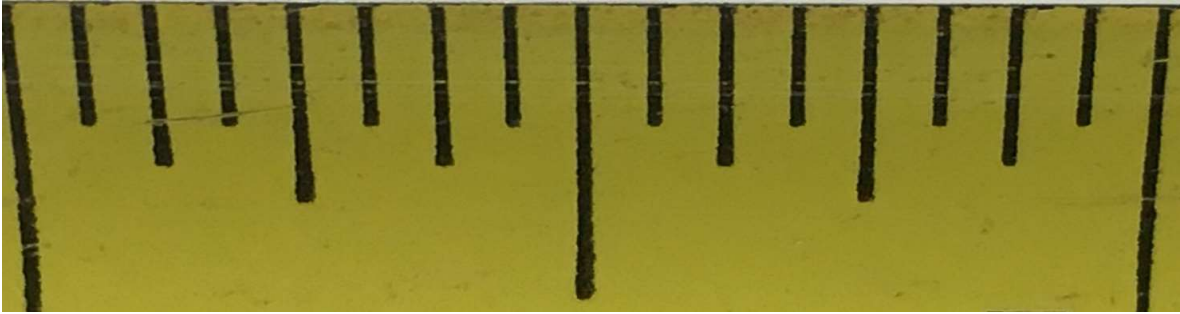
READING EIGHTHS OF AN INCH



READING QUARTERS OF AN INCH



READING HALVES OF AN INCH



0"
0/2"

1/2"

1"
2/2"

REDUCING FRACTIONS

- $\frac{8}{16}$ " • $\frac{10}{16}$ "
- $\frac{8}{8} = 1$ • $\frac{10}{2} = 5$
- $\frac{16}{8} = 2$ • $\frac{16}{2} = 8$
- $\frac{8}{16}$ " = $\frac{1}{2}$ " • $\frac{10}{16}$ " = $\frac{5}{8}$ "

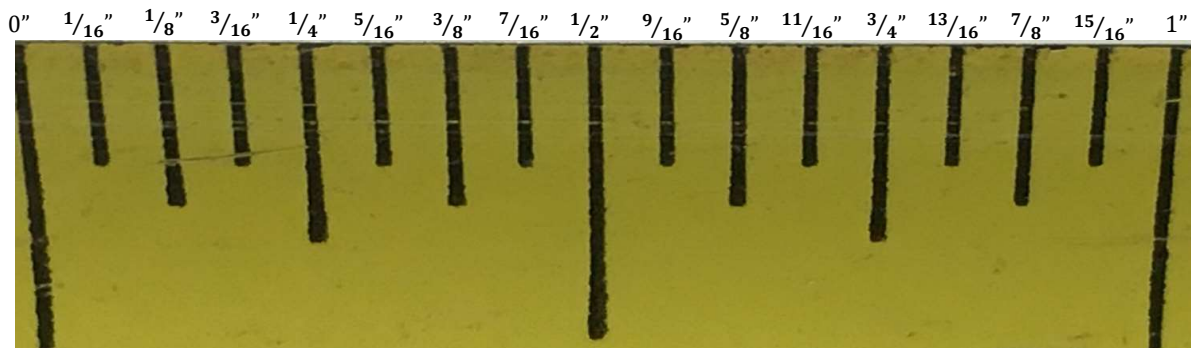
$$\frac{6}{12} \div 6 = \frac{1}{2} \div 6$$

$$\frac{24 \div 8}{32 \div 8} = \frac{3}{4}$$

$$\frac{24}{32} = \frac{3}{4}$$

wild Hor

PROPERLY REDUCED FRACTIONS OF AN INCH



DETERMINING DECIMAL FEET

In the number 6.42...

The **6** represents **Feet (F)**

The **4** represents **Tenth (T)**

The **2** represents **Hundredth (H)**

Its 6 Feet, 4 Tenths and 2 Hundredths

Or commonly said in the field as

6 Feet and 42 Hundredths

Proper way to read a tape or grade rod:

Find your Feet first

Then the Tenth you are at or above

And then count how many hundredths above the tenth

Remember, F/T/H

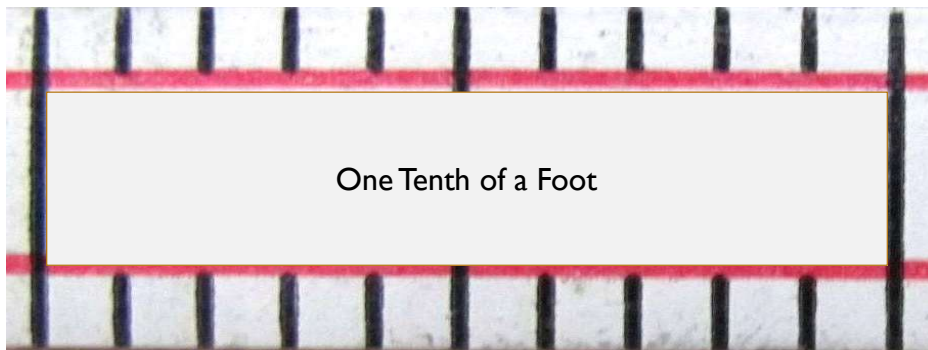
For elevations or converting inches, round to the nearest hundredth of a foot.

READING TENTHS OF A FOOT

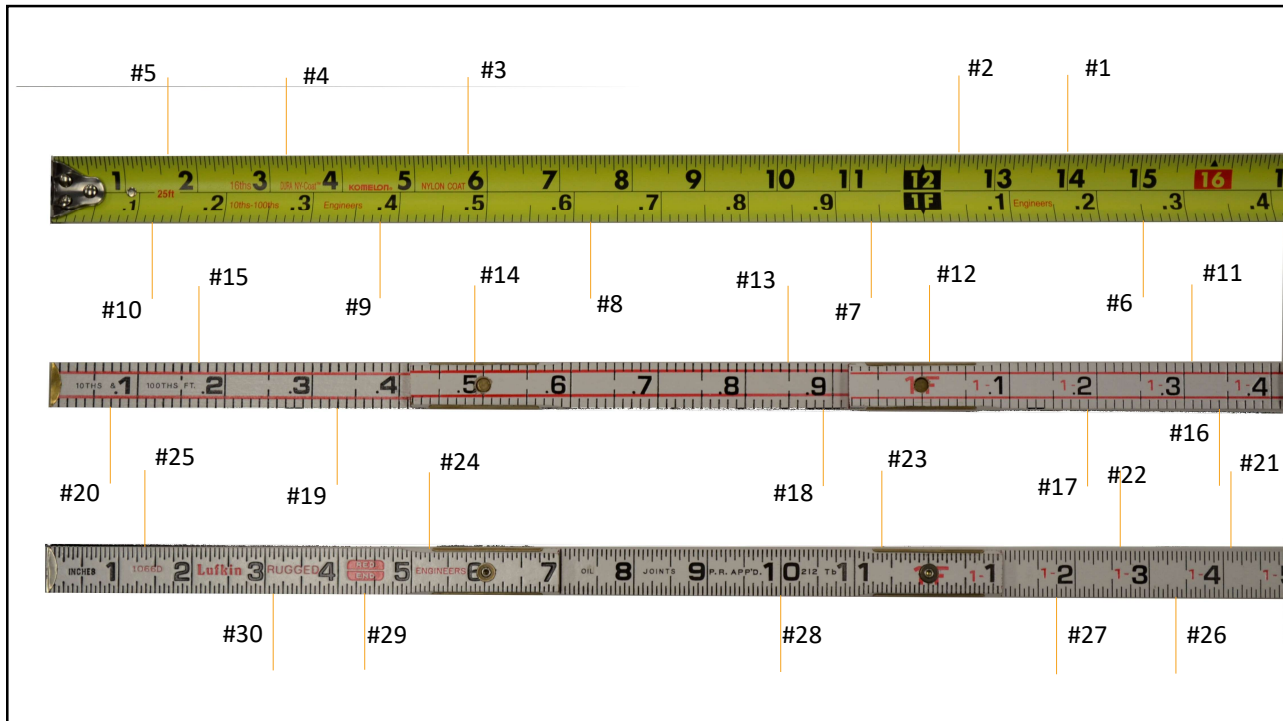


0.00'	0.10'	0.20'	0.30'	0.40'	0.50'	0.60'	0.70'	0.80'	0.90'	1.00'
ZERO	ONE	TWO	THREE	FOUR	FIVE	SIX	SEVEN	EIGHT	NINE	ONE
FEET	TENTH	TENTHS	TENTHS	TENTHS	TENTHS	TENTHS	TENTHS	TENTHS	TENTHS	FOOT

HUNDREDTHS OF A TENTH



0.00' 0.01' 0.02' 0.03' 0.04' 0.05' 0.06' 0.07' 0.08' 0.09' 0.10'



FOLDING RULER

- | | |
|-----------------------|------------------------|
| $8\frac{1}{4}"$ _____ | $\frac{1}{2}"$ _____ |
| $7\frac{1}{2}"$ _____ | $\frac{7}{8}"$ _____ |
| $6\frac{1}{2}"$ _____ | $4\frac{1}{2}"$ _____ |
| $5"$ _____ | $2\frac{3}{4}"$ _____ |
| $3\frac{3}{4}"$ _____ | $10"$ _____ |
| $9\frac{1}{8}"$ _____ | $25\frac{1}{2}"$ _____ |

Feet, Inch and Fractions



Decimal Feet

CONVERTING A BASIC INCH TO TENTHS

Formula inch / 12 =

Let's do the first one together...

- 12"
- $12/12 =$
- 1.00'

Let's do the second one together...

- 11"
- $11 / 12 =$
- 0.916
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 0.92'

**Basic Inch Converted
Inch / 12 =**

INCHES	DECIMALS
12"	
11"	
10"	
9"	
8"	
7"	
6"	
5"	
4"	
3"	
2"	
1"	
0"	

PRACTICE CONVERTING FRACTIONS

Let's do the first one together...

- $1/8 =$
- $/12 =$
- 0.010'
- Round to the nearest hundredth
- 0.01'

Conversion Chart

FRACTIONS	DECIMALS
$1/8$ "	
$1/4$ "	
$3/8$ "	
$1/2$ "	
$5/8$ "	
$3/4$ "	
$7/8$ "	
$8/8$ "	
$1/16$ "	

Let's do the first one together...

• $1/8 =$

• $+9 =$

• $/12 =$

• $0.7604'$

• Round to the nearest hundredth

• $0.76'$

CONVERTING INCH & FRACTIONS

Conversion Chart

FRACTIONS	DECIMALS
$9 \frac{1}{8}''$	
$2 \frac{1}{4}''$	
$3 \frac{3}{8}''$	
$4 \frac{1}{2}''$	
$1 \frac{5}{8}''$	
$6 \frac{3}{4}''$	
$15 \frac{7}{8}''$	
$7 \frac{8}{8}''$	
$10 \frac{1}{16}''$	

PRACTICE CONVERTING

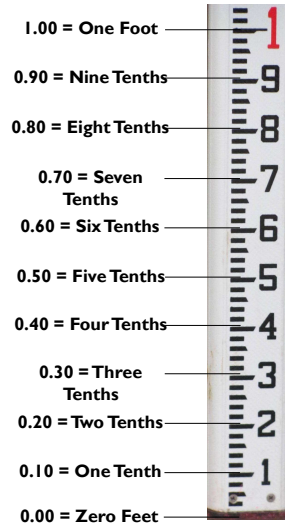
- 8 inches = _____
- 2 inches = _____
- 23 inches = _____
- 32 inches = _____
- 12 feet 11 inches = _____
- $6 \frac{1}{2}$ inches = _____
- 53 feet 9 inches = _____
- 13 inches = _____
- 1 foot 10 inches = _____
- 63 inches = _____
- 17 inches = _____
- 30 inches = _____
- 40 inches = _____
- 7 inches = _____
- 39 inches = _____
- $\frac{3}{4}$ inch = _____
- $8 \frac{1}{4}$ inches = _____
- 9 feet 10 inches = _____
- 100 inches = _____
- $82 \frac{1}{2}$ inches = _____

READING A GRADE ROD - TENTHS

1.00' foot and divide it into:

10 equal parts

We call each one of those parts a Tenth

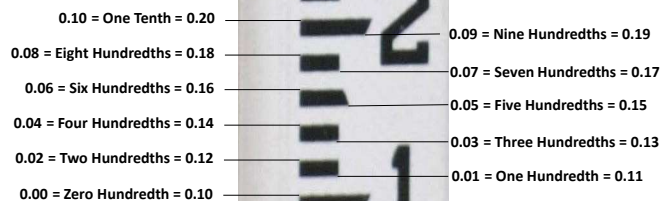


Each Tenth is divided into **10 equal parts.**

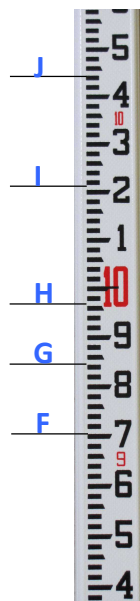
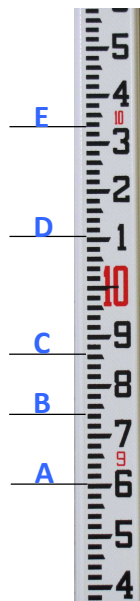
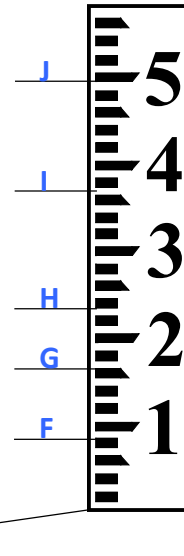
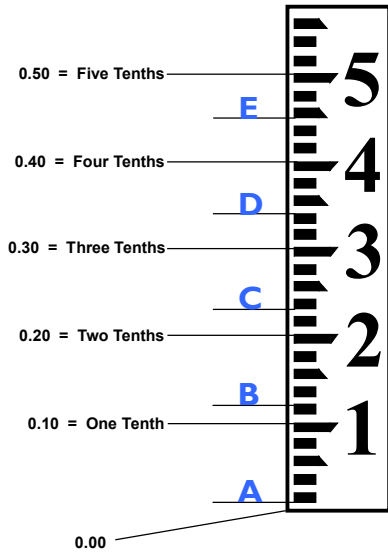
We call each one of those parts a Hundredth

Notice a Pattern?

READING A GRADE ROD - HUNDREDTHS

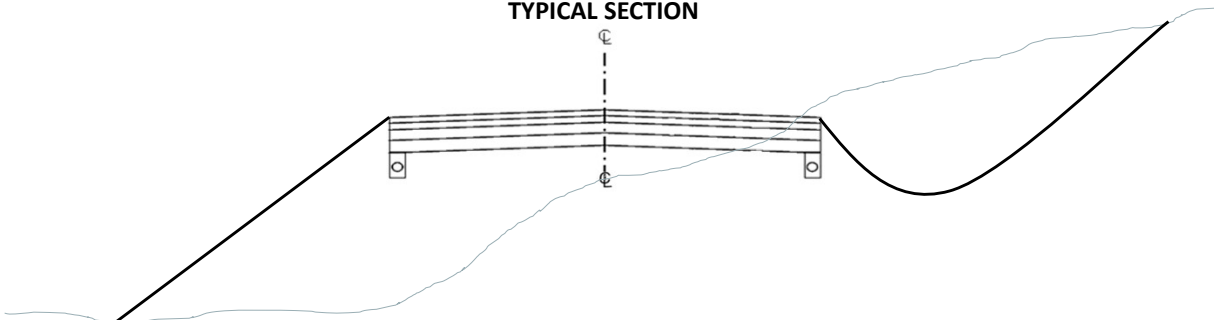


PRACTICE



COMMON ROADWAY SECTION

TYPICAL SECTION

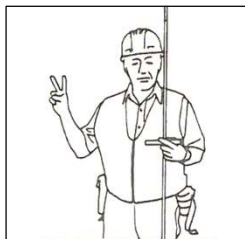
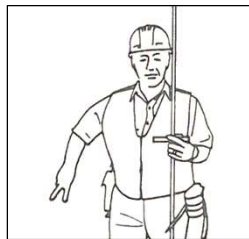


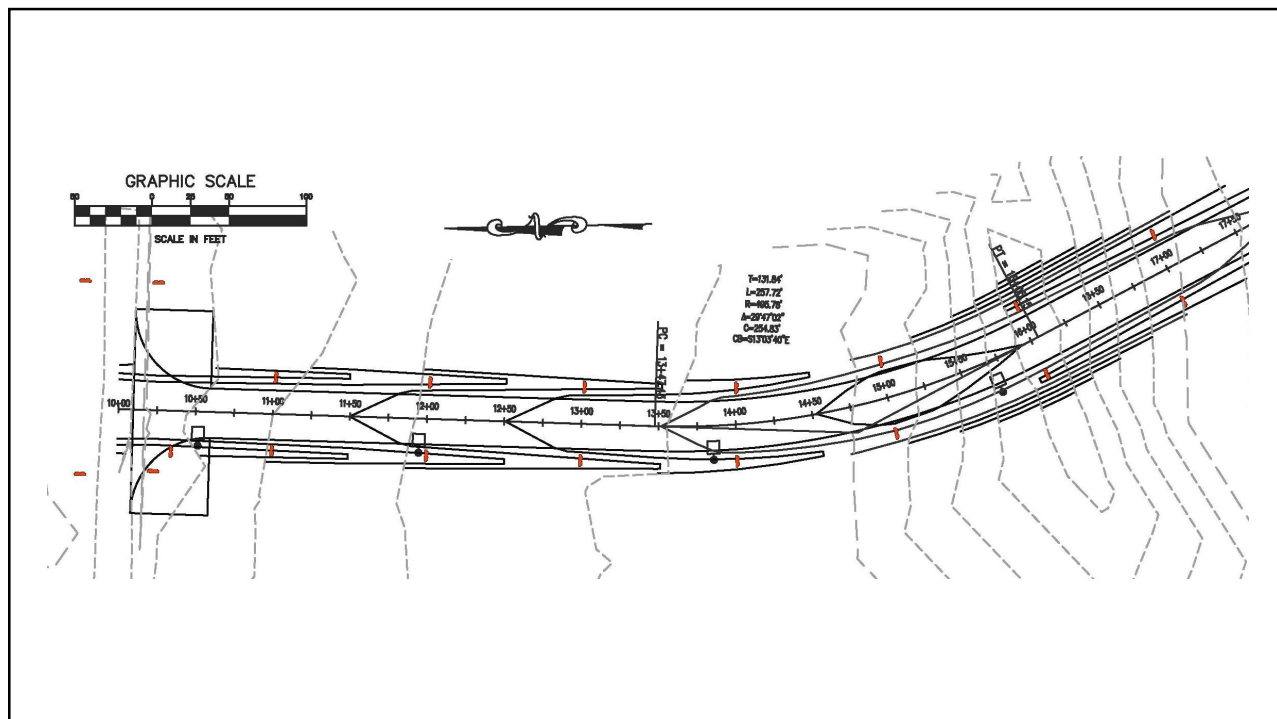
Finish Grade: The final grade required by the plans and specifications.

Sub Grade: The surface produced by grading native earth, or cheap imported materials, which serves as a base for a more expensive paving.

Existing Grade: The natural surface of the earth before being disturbed.

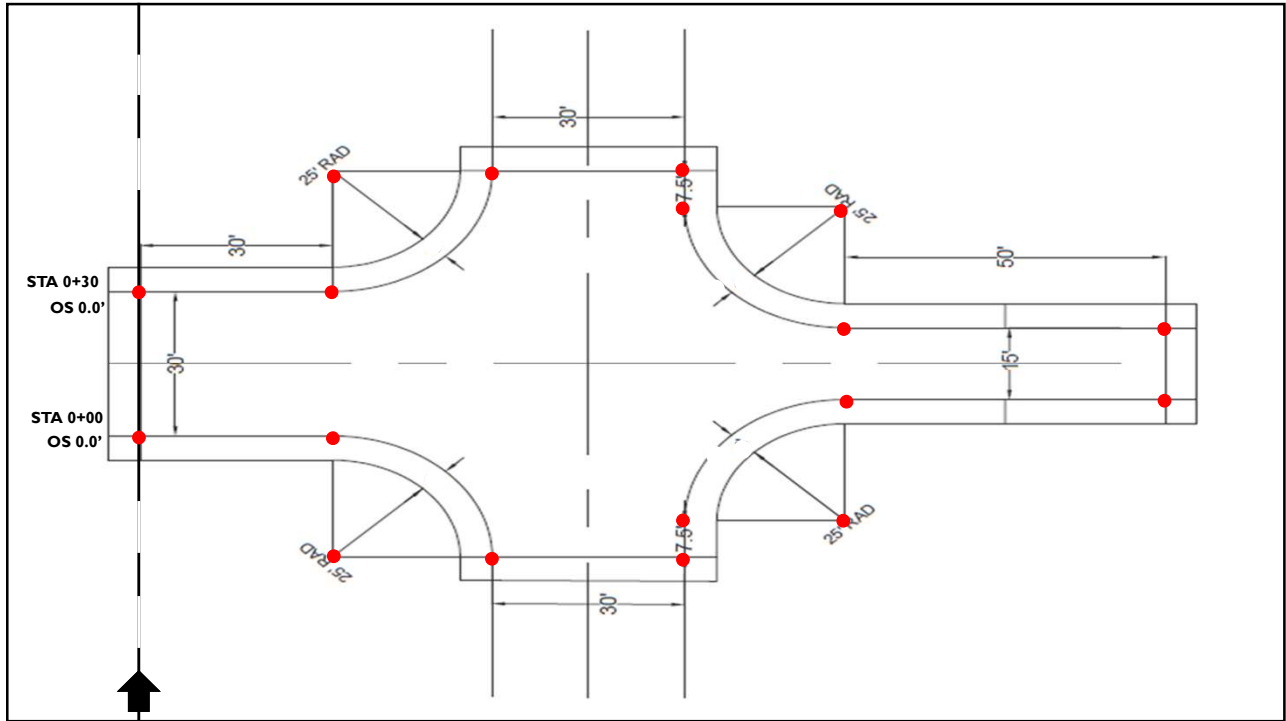
COMMON HAND SIGNALS



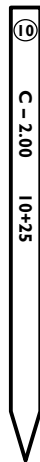


STATIONING QUIZ

1. Begin Station is 10+00 and you are standing at Centerline of Sta 16+45, how many feet are you along the alignment?
2. If you are standing -16.5' offset of Sta 20+10, are you left or right of Centerline?
3. How many feet apart are Stations 12+48.35 and 21+98.68?
4. If you are at Sta 21+00 Offset -25.52', how far is it to Centerline?



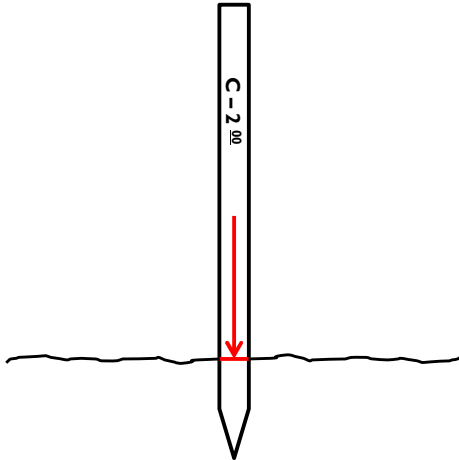
WHAT INFORMATION CAN BE FOUND ON STAKES?



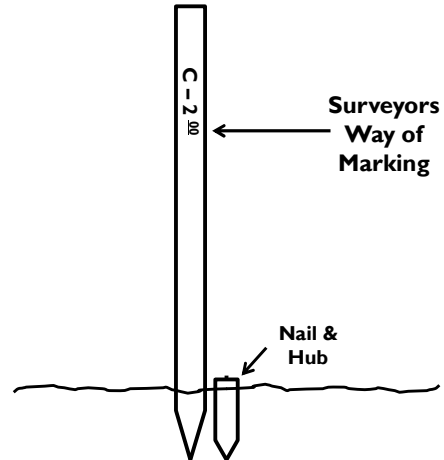
[More Info](#) 

DIFFERENT TYPES OF GRADE STAKES

One type is set by the grade person in your company



The other type of grade stake is set by a surveyor.

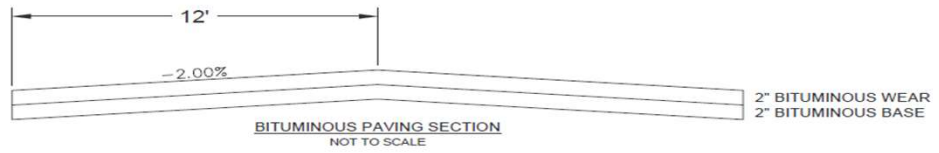
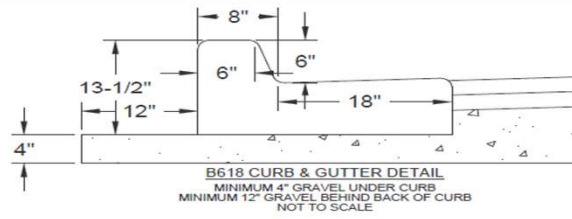
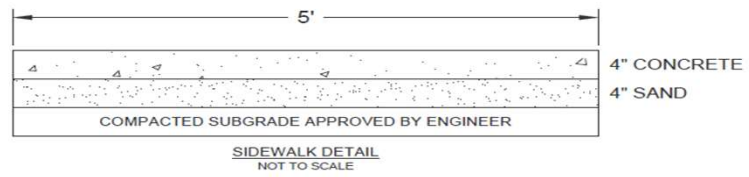


STAKE READING QUIZ

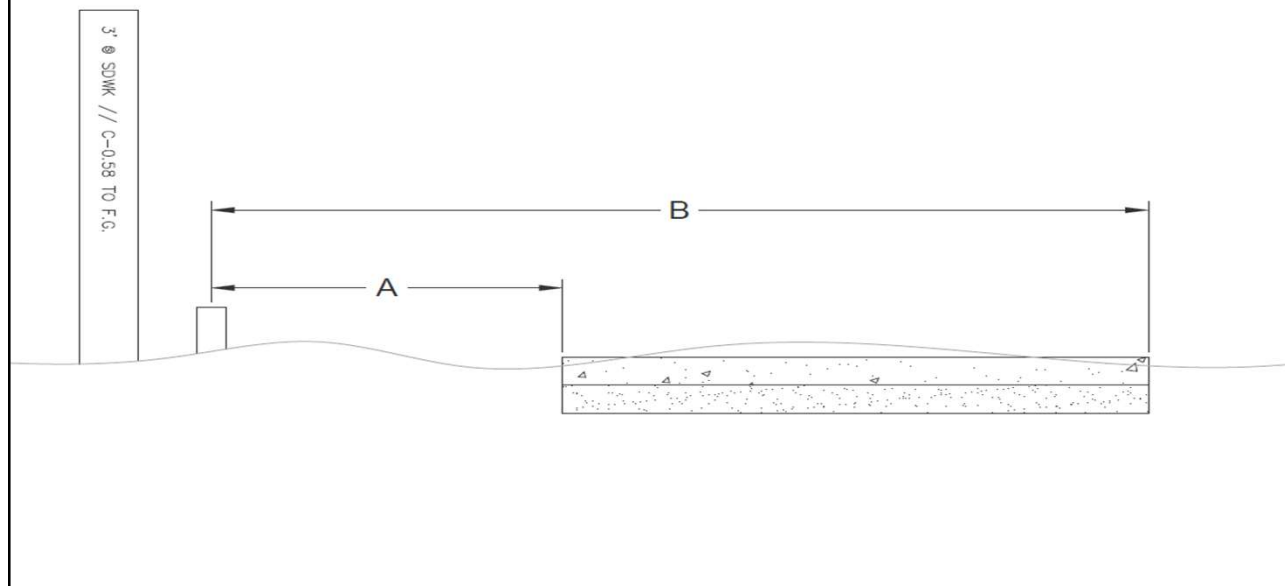
1. 4 Feet equals how many Tenths? _____
2. 100 Hundredths equals how many Tenths? _____
3. 0.5 Feet is how many Inches? _____
4. 2 Feet & 2 Tenths is how many Tenths? _____
5. How many Hundredths is that? _____
6. 3⁴ is how many Tenths? _____
7. 3⁴⁵ is how many Hundredths? _____
8. 30 Tenths is how many feet? _____
9. What is the symbol for Cut? _____ Fill? _____
10. What does this Stake mean?



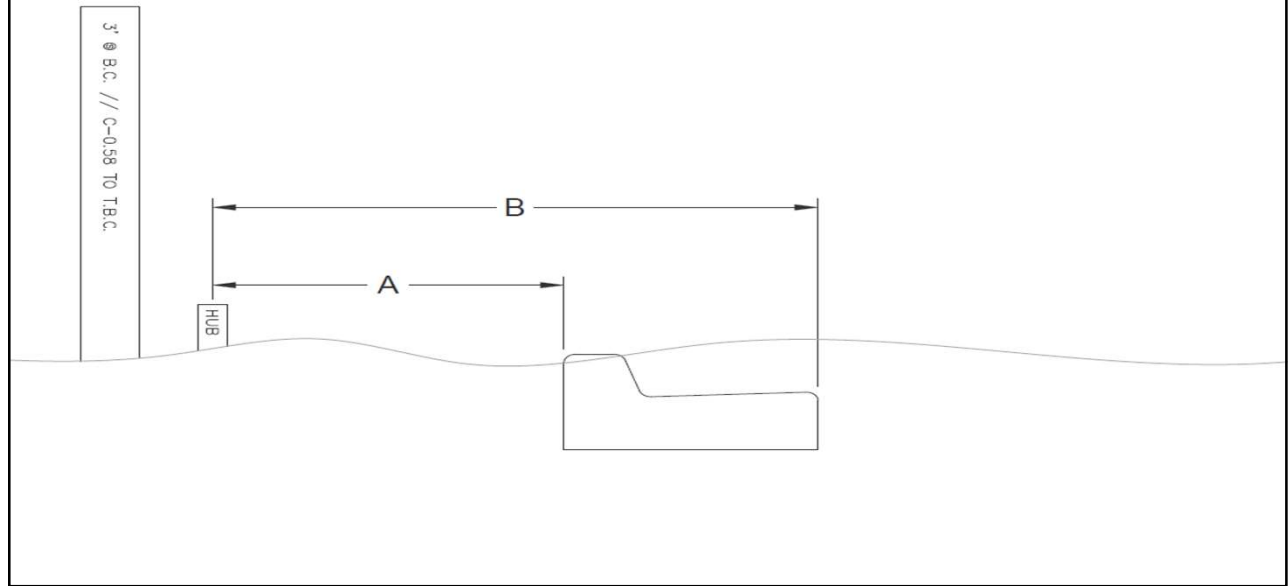
CONSTRUCTION STAKING - DETAILS



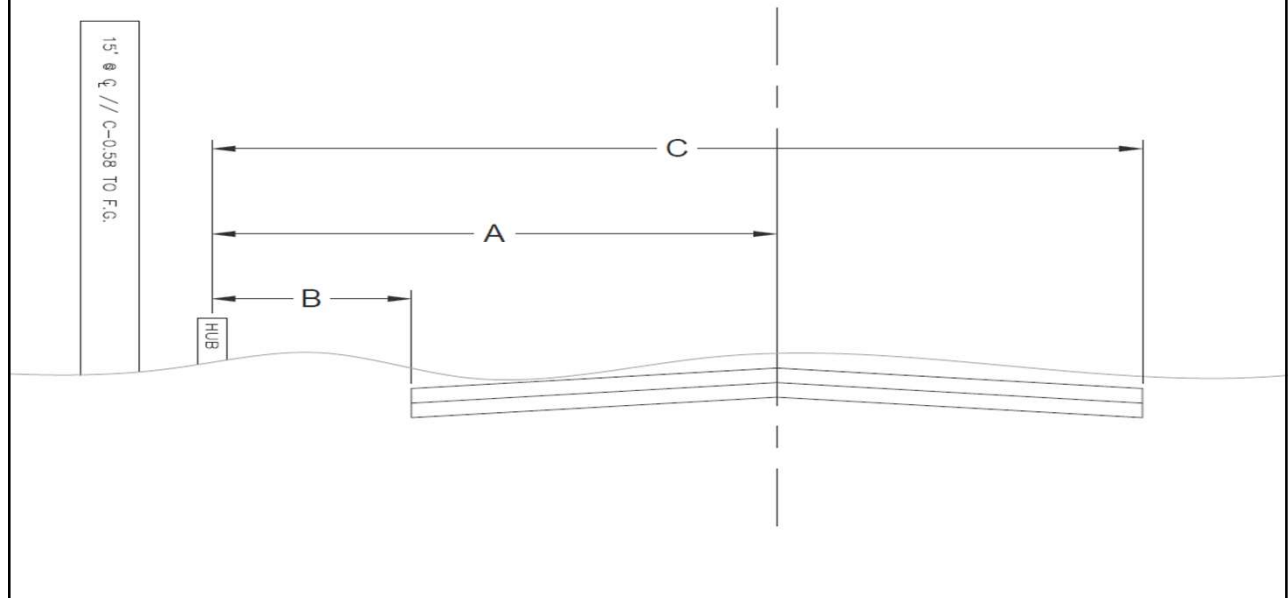
CONSTRUCTION STAKING - SIDEWALK

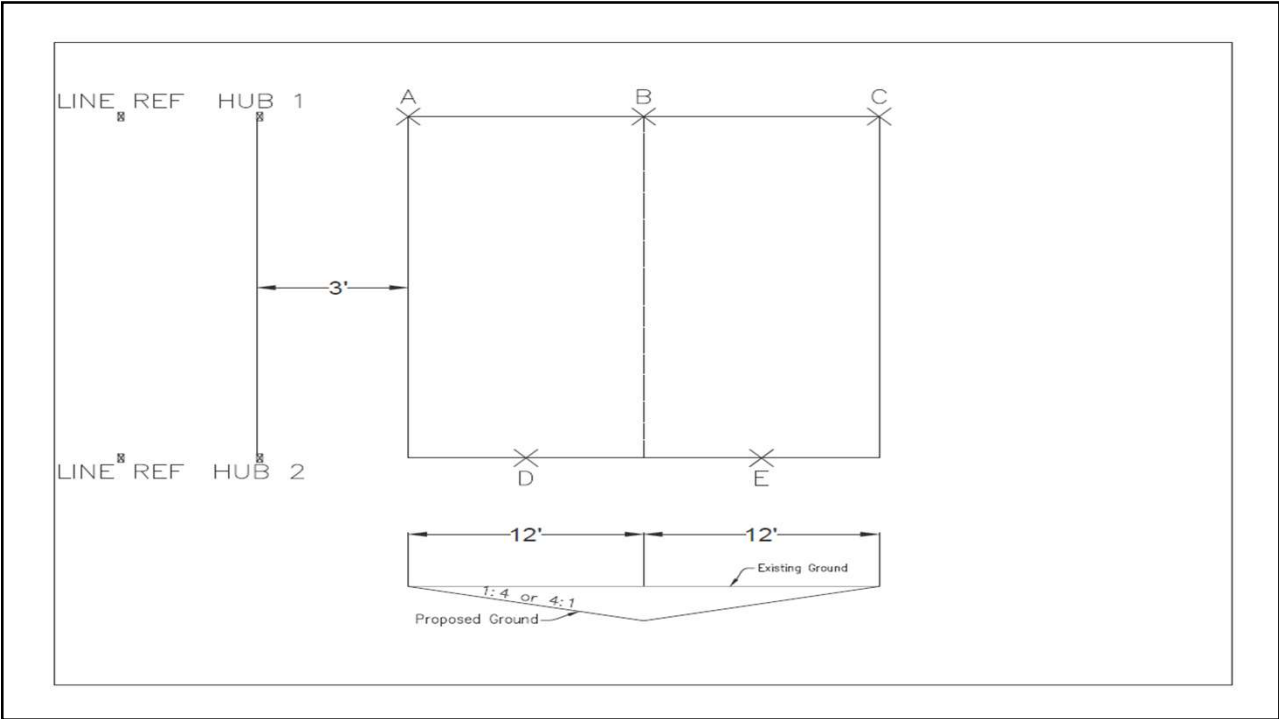
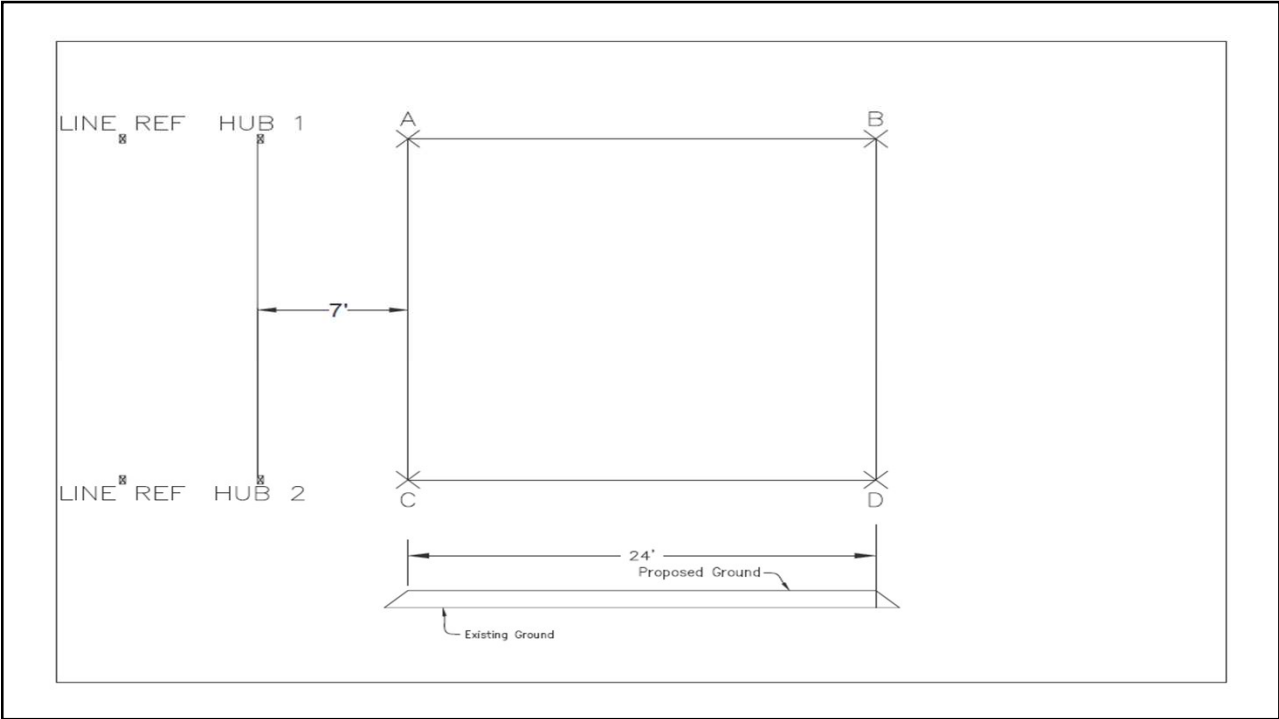


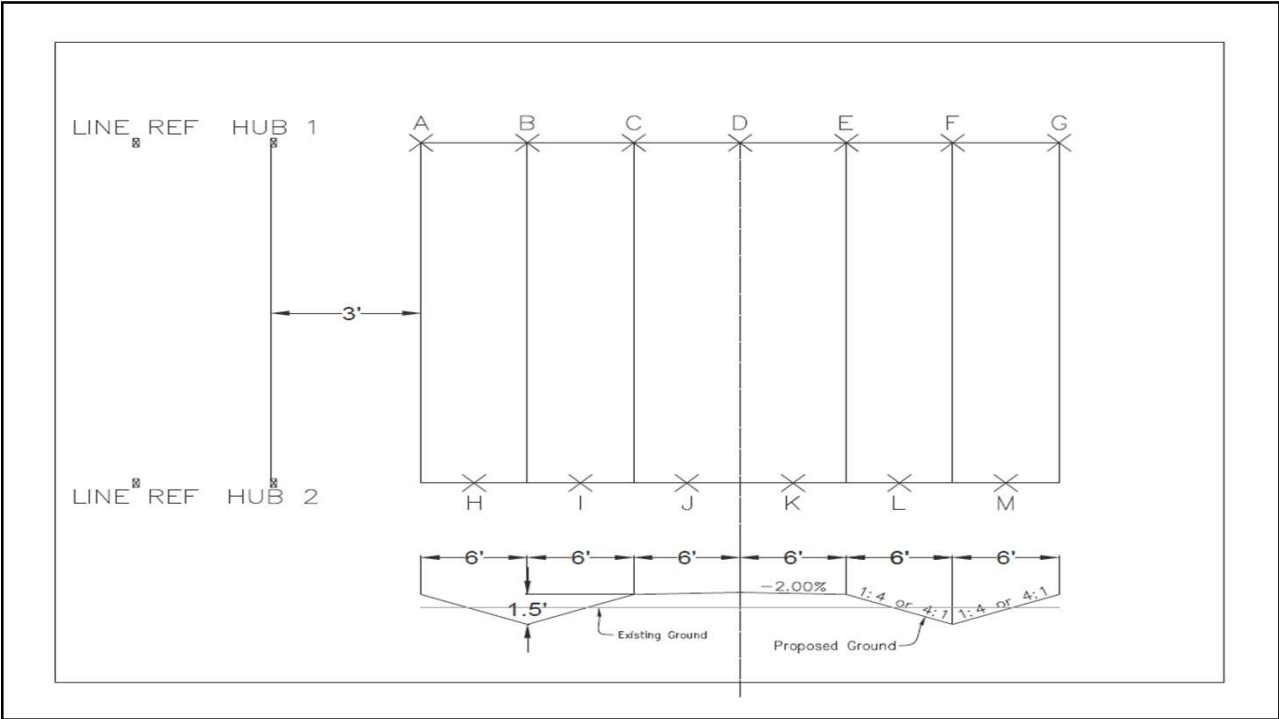
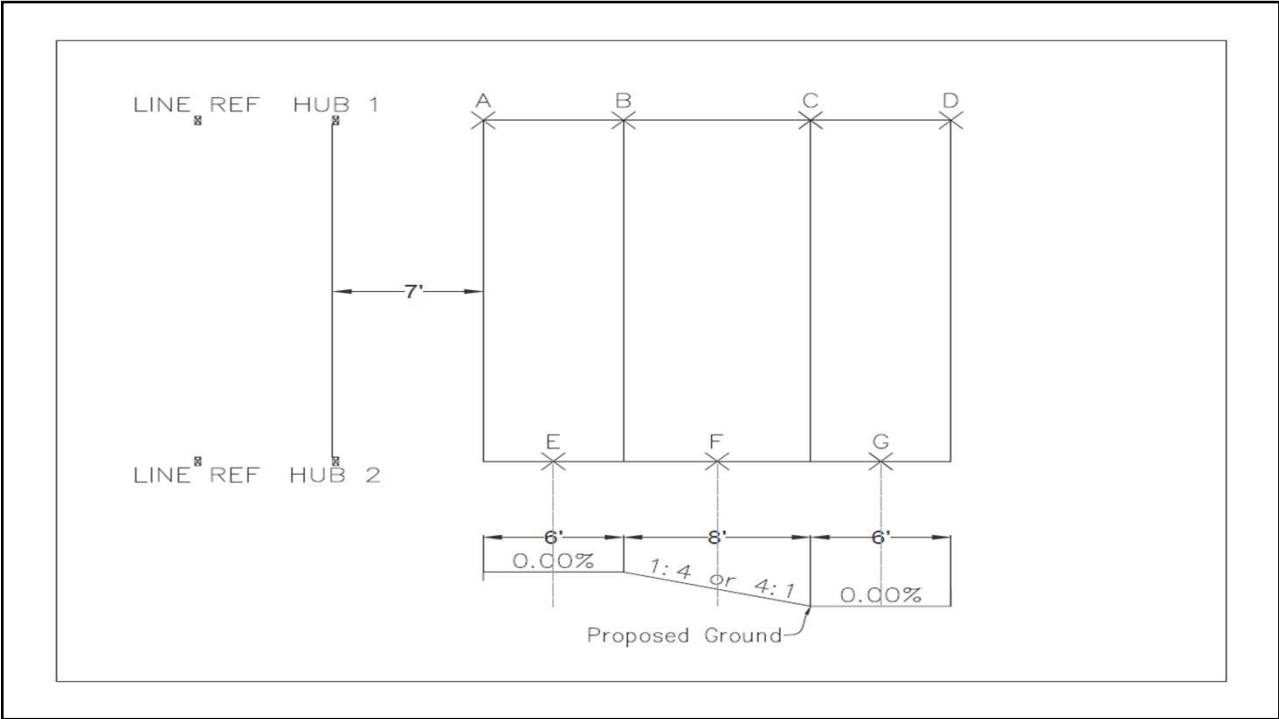
CONSTRUCTION STAKING - CURB & GUTTER



CONSTRUCTION STAKING - ROADWAY SECTION

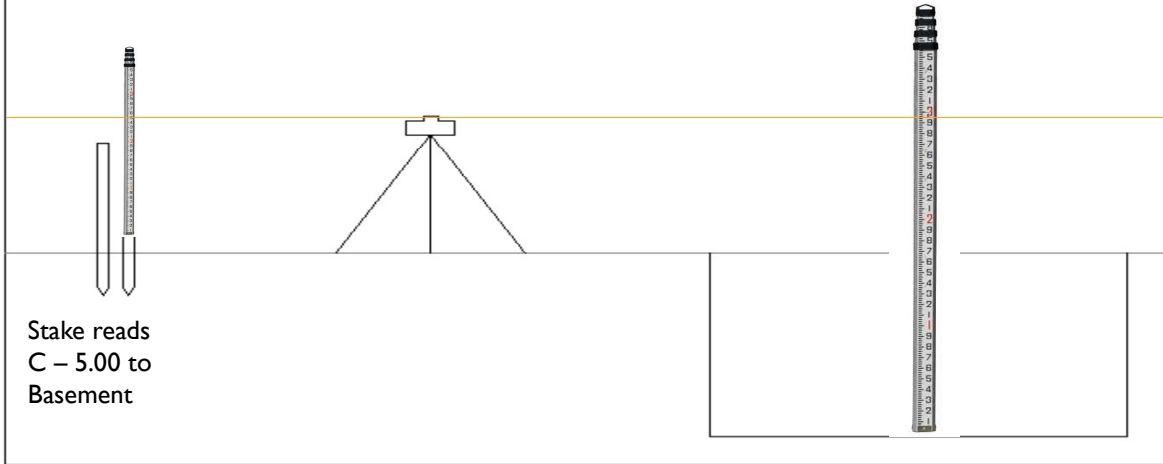






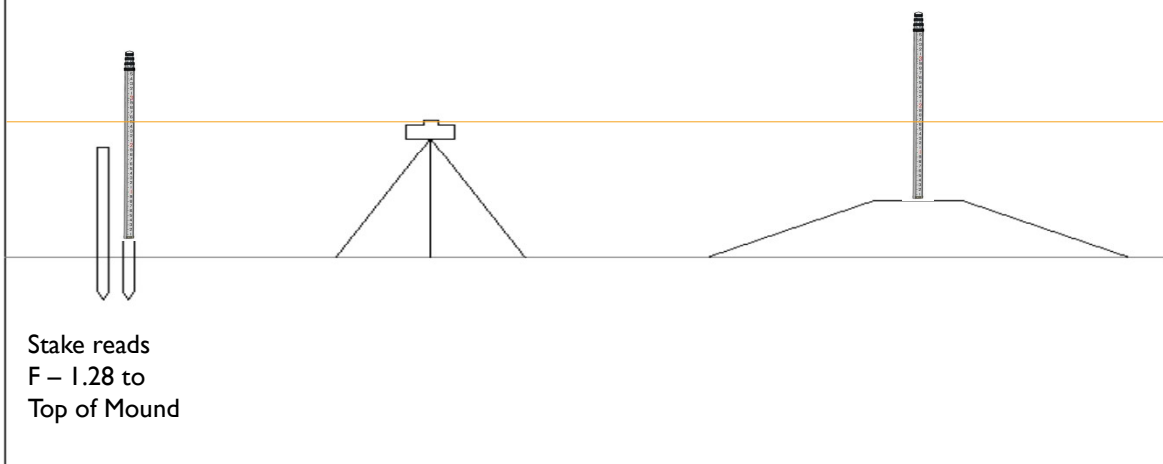
CONSTRUCTION STAKING – GRADE ROD

What is your Rod Reading (RR) to excavate this Basement?



CONSTRUCTION STAKING – GRADE ROD

What is your Rod Reading (RR) to Top of Mound?



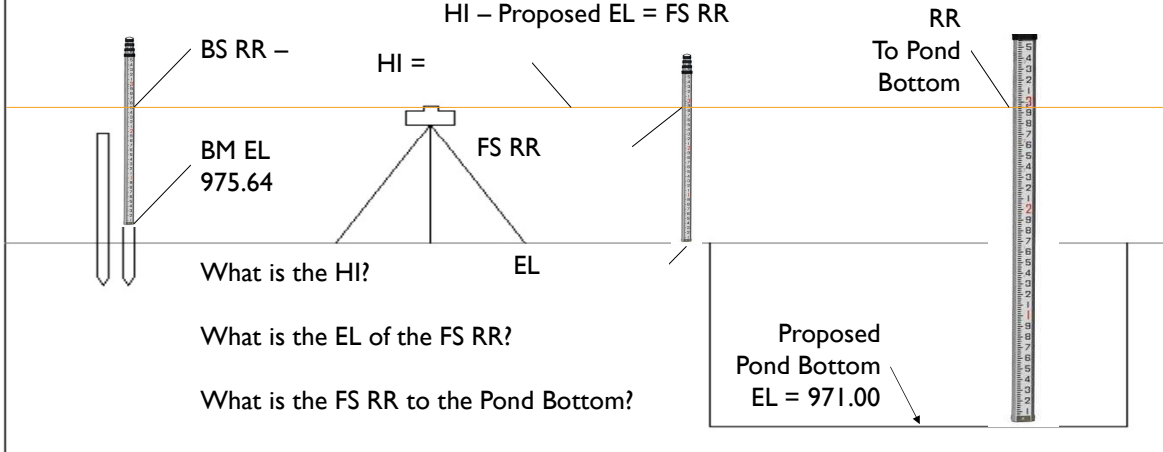
CONSTRUCTION STAKING USING BM – GRADE ROD

Equations

Benchmark (BM) + Backsight (BS) = Height/Elevation of Instrument (HI)

HI – Foresight (FS) = Elevation (EL)

HI – Proposed EL = FS RR



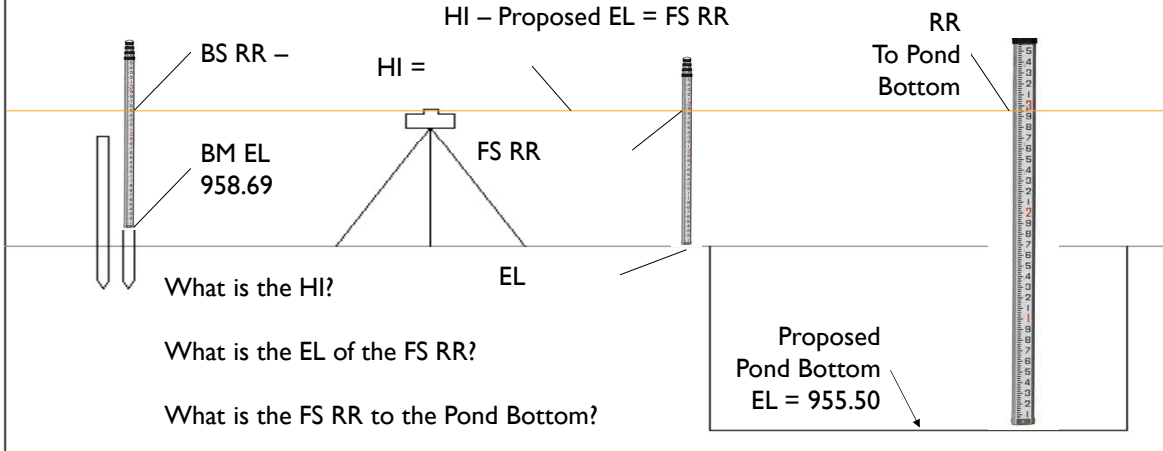
CONSTRUCTION STAKING USING BM – GRADE ROD

Equations

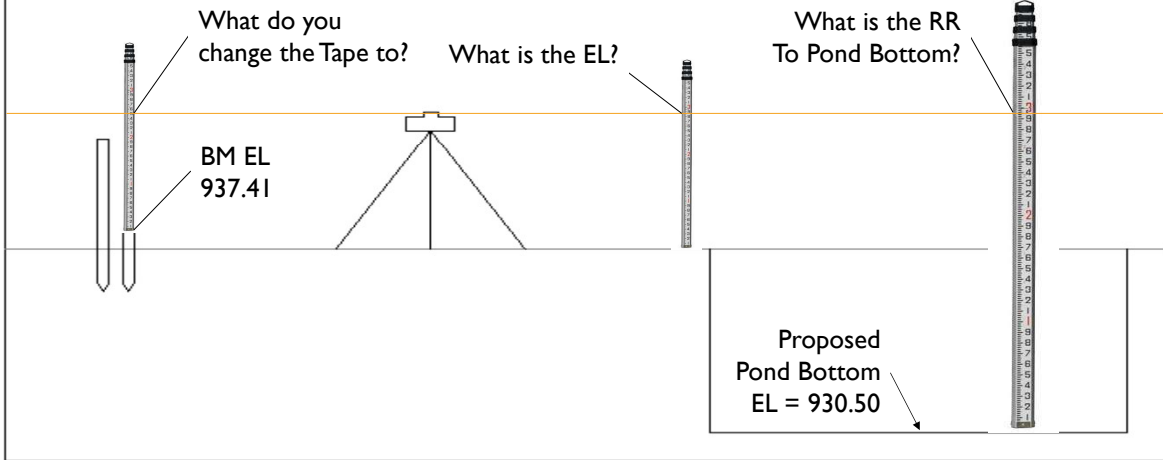
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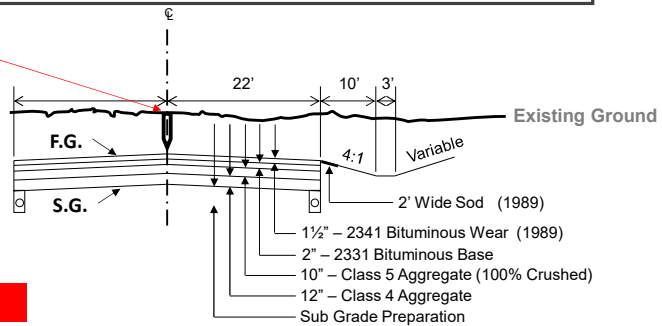


CONSTRUCTION STAKING USING BM – LENKER ROD



STAKE READING WITH SECTION USING 4' LEVEL AND TAPE

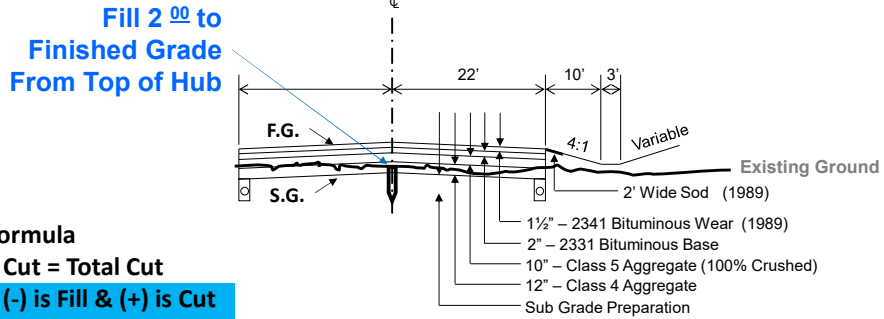
**Cut 2.00 to
Finished Grade
From Top of Hub**



Formula

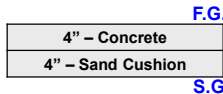
Section + Cut = Total Cut
Section - Fill = (-) is Fill & (+) is Cut

STAKE READING WITH SECTION USING 4' LEVEL AND TAPE



SECTION EXERCISE – SIDEWALK USING 4' LEVEL AND TAPE

Concrete Sidewalk Section



Add all thicknesses. Convert inches to decimal feet, properly rounded. Answer in the space provided.

Formula

Section + Cut = Total Cut

Section - Fill = (-) is Fill & (+) is Cut

Total inches of all section thicknesses = _____ Inches

Inches divided by 12 = _____ Decimal Feet

C - 1.00
Cut _____ or Fill _____

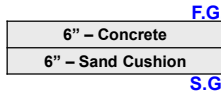
C - 0.83
Cut _____ or Fill _____

F - 0.50
Cut _____ or Fill _____

F - 1.00
Cut _____ or Fill _____

SECTION EXERCISE – BUILDING SLAB USING 4' LEVEL AND TAPE

Concrete Building Slab Section



Add all thicknesses. Convert inches to decimal feet, properly rounded. Answer in the space provided.

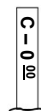
Formula
Section + Cut = Total Cut
Section - Fill = (-) is Fill & (+) is Cut

Total inches of all section thicknesses = _____ Inches

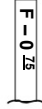
Inches divided by 12 = _____ Decimal Feet



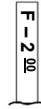
Cut _____ or Fill _____



Cut _____ or Fill _____



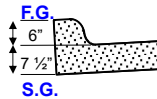
Cut _____ or Fill _____



Cut _____ or Fill _____

SECTION EXERCISE – B618 CURB & GUTTER USING 4' LEVEL AND TAPE

Concrete Curb Section – B618 Curb & Gutter



Add all thicknesses. Convert inches to decimal feet, properly rounded. Answer in the space provided.

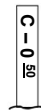
Formula
Section + Cut = Total Cut
Section - Fill = (-) is Fill & (+) is Cut

Total inches of all section thicknesses = _____ Inches

Inches divided by 12 = _____ Decimal Feet



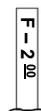
Cut _____ or Fill _____



Cut _____ or Fill _____



Cut _____ or Fill _____



Cut _____ or Fill _____

SECTION EXERCISE – ROADWAY USING 4' LEVEL AND TAPE

Blacktop Road Section

1 ½" - 2341 Bituminous Wear Course
2" - 2331 Bituminous Base Course
10" - Class 5 Aggregate
12" - Class 4 Aggregate

F.G.

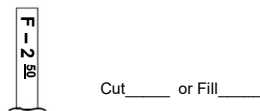
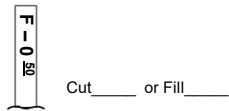
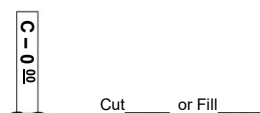
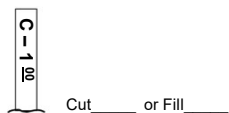
S.G.

Add all thicknesses. Convert inches to decimal feet, properly rounded. Answer in the space provided.

Formula
Section + Cut = Total Cut
Section - Fill = (-) is Fill & (+) is Cut

Total inches of all section thicknesses = _____ Inches

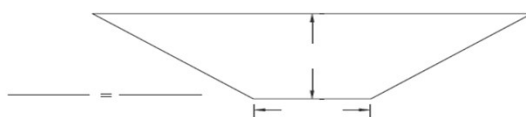
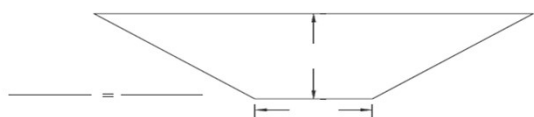
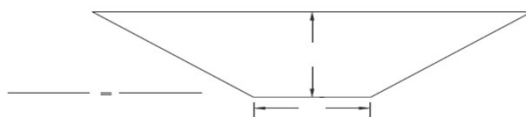
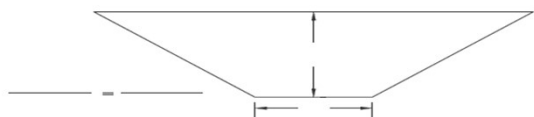
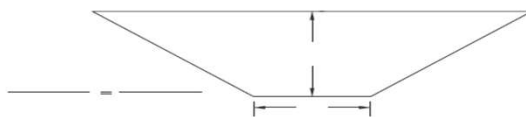
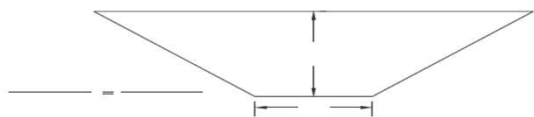
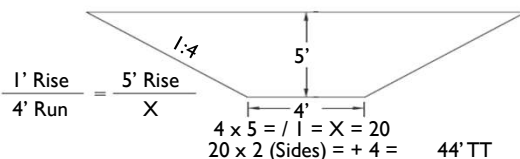
Inches divided by 12 = _____ Decimals Feet



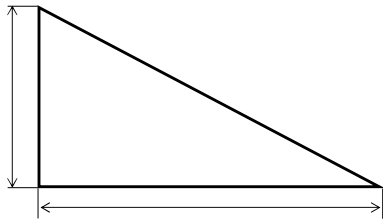
Total Trench Exercise

SOLVING FOR RISE = $\frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{X \text{ (RISE)}}{14' \text{ (RUN)}}$
= $14 \times 1 = 14 / 4 = X = 3.5'$

SOLVING FOR RUN = $\frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{5' \text{ (RISE)}}{X \text{ (RUN)}}$
= $5 \times 4 = 20 / 1 = X = 20'$



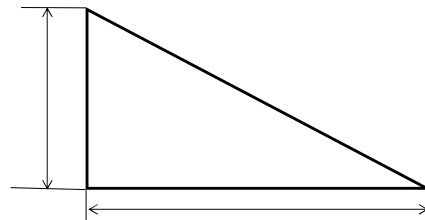
DETERMINING SLOPE RATIOS



How is slope ratio arrived at?

The formula is:

$$\frac{\text{Run}}{\text{Rise}} = \text{Slope Ratio}$$

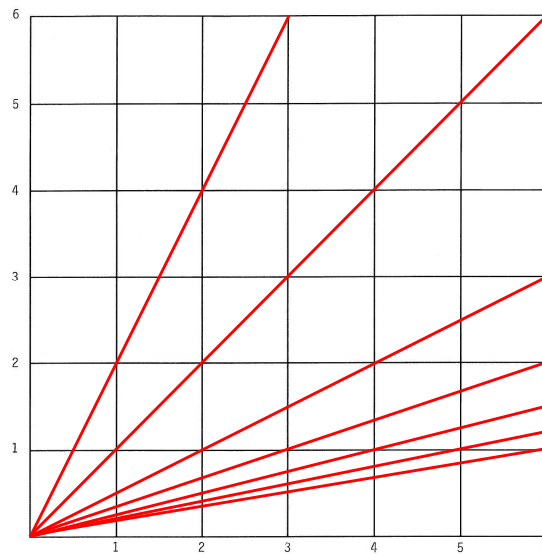


What is this slope ratio?

$$\frac{\text{Run}}{\text{Rise}} = \text{Slope Ratio}$$

COMMON SLOPE RATIOS AND PERCENTAGES

Slope Ratio	Vertical	Horizontal
1:1	1	1
1:2	1	2
1:3	1	3
1:4	1	4
1:5	1	5



CALCULATING PERCENTAGES



Formula

$$\frac{\text{Rise}}{\text{Run}} = \text{FT/FT} \times 100 = \%$$

$$2,552 \text{ Miles} \times 5,280 \text{ (Ft./Mile)} = 13,474,560 \text{ Ft.}$$

$$\frac{\text{Rise}}{1475 \text{ Ft.}} \div \frac{\text{Run}}{13,474,560 \text{ Ft.}} = \text{FT/FT}$$

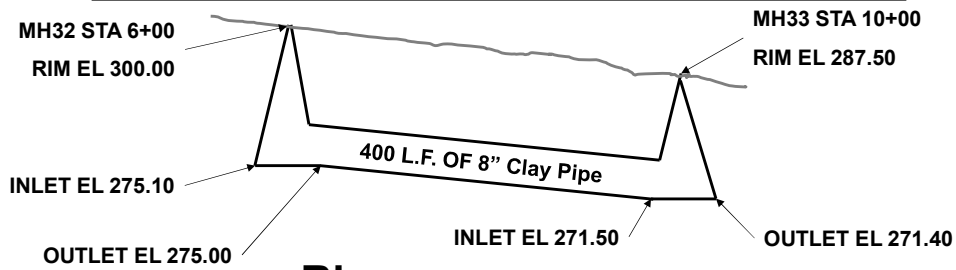
$$\text{FT/FT} \times 100 = \% =$$

COMMON SENSE PERCENTAGES

Percent	Rise/Fall	Distance
1%		
2%		
3%		
4%		
5%		

Percent	Rise/Fall	Distance
6%		
7%		
8%		
9%		
10%		

DETERMINING FT/FT (GOLD)



$$\frac{\text{Rise}}{\text{Run}} = \text{FT/FT}$$

Outlet Elevation @ MH32 Station 6+00 = 275.00'

Inlet Elevation @ MH33 Station 10+00 = 271.50'

DETERMINE INVERT ELEVATIONS

Station #	Distance	X	FT/FT	=	Rise or Fall	+	Elevation	Station #	Distance	X	FT/FT	=	Rise or Fall	+	Elevation
10+00							271.50	10+00							271.50
9+50			0.00875					9+56			0.00875				
9+00			0.00875					9+21			0.00875				
8+50			0.00875					8+90			0.00875				
8+00			0.00875					8+36			0.00875				
7+50			0.00875					7+65			0.00875				
7+00			0.00875					7+32			0.00875				
6+50			0.00875					6+85			0.00875				
6+00			0.00875					6+00			0.00875				

Tie back to station 10+00 for all.

Tie back to station 10+00 for all.

DETERMINING PERCENTAGES

- Determining or double-checking plan percentages
 - Formula
 - $\text{Rise} / \text{Run} = \text{Ft/Ft}$
 - $\text{Ft/Ft} \times 100 = \text{Percent } \%$
 - Round off to the nearest hundredth
- Example: You have a 3' rise and 250' run
 -
 -
 -
 -

MH 32
RIM EL = 980.56
INV IN = 972.52
INV OUT = 972.42

What percent is this Pipe run?

MH 31
RIM EL = 979.56
INV IN = 970.12
INV OUT = 970.02

400 LF OF 18" RCP @ %

CONVERTING PERCENTAGES INTO GOLD

- Formula to convert
- $\% / 100 = \text{Gold} = \text{Ft}/\text{Ft}$ (never round off)
- Once you know how much rise or fall you have in 1 foot, you can now determine the rise or fall for any horizontal distance
- Example: +2% slope for 256'
-
-
-

MH 32
RIM EL = 980.56
INV IN =
INV OUT =

What is the invert out of MH 32?

MH 31
RIM EL = 979.56
INV IN = 970.12
INV OUT = 970.02

400 LF OF 18" RCP @ 0.88 %

CALCULATING SQUARE FEET (SQ FT)

Square Feet or Area

- Two-Dimensional
- Feet x Feet = SQ FT
- Must convert inches to decimal feet
- Use it to find the square foot of your house
- One square foot is nothing more than a square that is 1 foot wide by 1 foot long.



CALCULATING SQ FT

Formula – FT x FT =

Let's do the first one together...

- $80 \times 10 =$
- 800 SQ FT

Let's do the next one together...

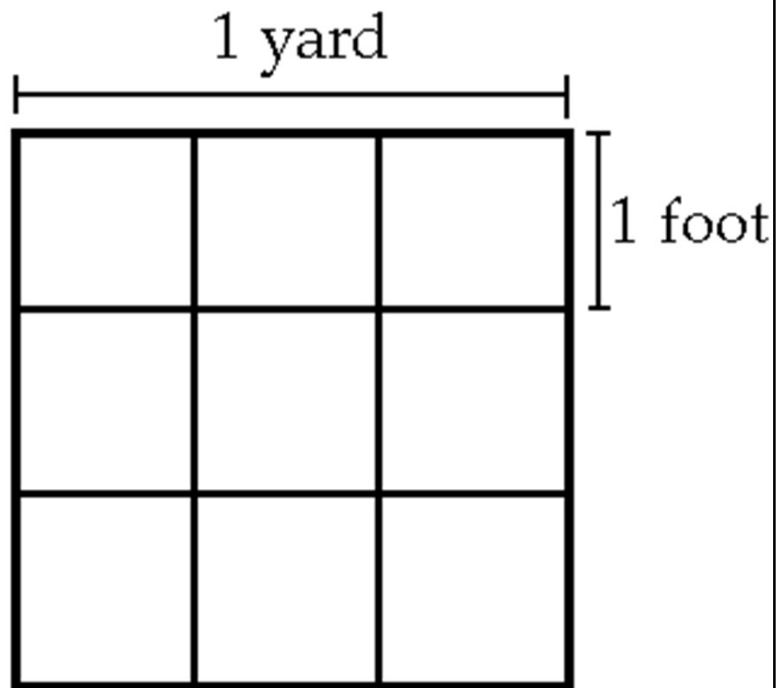
- Must convert inches to decimal feet
- $16 / 12 = x 42 =$
- 55.999
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 56.00 SQ FT

FT x FT =	SQ FT
80' x 10'	
42' x 16"	
75' x 12'	
64' x 16"	
112' x 13"	
52' x 32'	
18" x 16"	
86' x 8"	
42' x 20"	
32' x 120"	
48' x 22"	
75' x 22'	
84' x 10"	

CALCULATING SQUARE YARDS (SQ YD)

Once we determine Sq Ft, it can then be converted to Sq Yds

- Very few pay items are in Sq Ft
- Most pay items are in Sq Yds
- Must multiply Feet x Feet, converting inches first.
- Feet x Feet = / 9 = Sq Yds



CALCULATING SQ YDS

Formula – FT x FT = / 9 =

Let's do the first one together...

- $80 \times 10 = / 9 =$
- 88.89 SQ YDS

Let's do the next one together...

- Must convert inches to decimal feet
- $16 / 12 = x 42 = / 9 =$
- 6.222
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 6.22 SQ YDS

FT x FT = / 9 =	SQ YDS
80' x 10'	
42' x 16"	
75' x 12'	
64' x 16"	
112' x 13"	
52' x 32'	
18" x 16"	
86' x 8"	
42' x 20"	
32' x 120"	
48' x 22"	
75' x 22'	
84' x 10"	

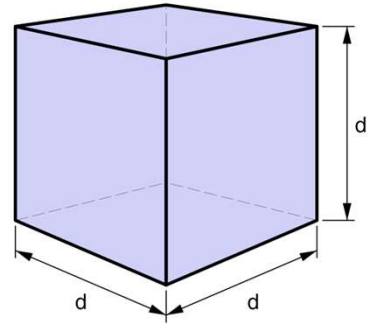
CALCULATING CUBIC FEET (CU FT)

Onto cubic feet and Three-Dimensional Volumes...

- A cubic foot is 3-D
- A cubic foot is 1 foot high by 1 foot long by 1 foot deep

Multiply Feet x Feet x Feet = CU FT

- Must convert inches to decimal feet
- Not feet times inches or feet times yards



CALCULATING CU FT

Formula – FT x FT x FT=

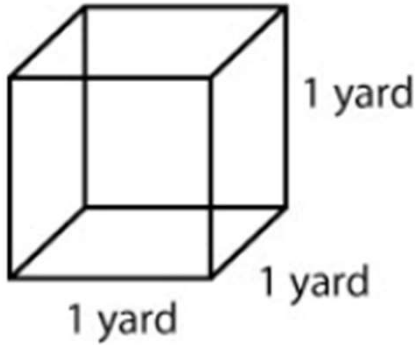
Let's do the first one together...

- $80 \times 10 \times 8 =$
- 6400.00 CU FT

Let's do the next one together...

- Must convert inches to decimal feet
- $10 / 12 = .833$ $150 \times 24 =$
- 2999.999
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 3000.00 CU FT

FT x FT x FT =	CU FT
80' x 10' x 8'	
150' x 24' x 10"	
75' x 12' x 6'	
64' x 16' x 16"	
112' x 13' x 20'	
52' x 32' x 10"	
18' x 16' x 14"	
86' x 8' x 20"	
42' x 20' x 13"	
32' x 120' x 5"	
48' x 22' x 32"	
75' x 22' x 12'	
84' x 10' x 16'	



CALCULATING CUBIC YARDS (CU YDS)

Now to convert cubic feet to cubic yards...

- Cubic yards are how most of earth quantities are measured and paid for.
- A cubic yard is 3 foot by 3 foot by 3 foot.
- There are 27 cubic feet in one cubic yard ($3 \times 3 \times 3 = 27$)
- Find Cubic Feet and then $/ 27 =$ Cubic Yards (Cu Yds)

CALCULATING CU YDS

Formula – FT x FT x FT = / 27 =

Let's do the first one together...

- $80 \times 10 \times 8 = / 27 =$
- 237.04 CUYDS

Let's do the next one together...

- Must convert inches to decimal feet
- $10 / 12 = .833$ $150 \times 24 = / 27 =$
- 111.111
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 111.11 CUYDS

FT x FT x FT = / 27 =	CU YDS
80' x 10' x 8'	
150' x 24' x 10"	
75' x 12' x 6'	
64' x 16' x 16"	
112' x 13' x 20'	
52' x 32' x 10"	
18' x 16' x 14"	
86' x 8' x 20"	
42' x 20' x 13"	
32' x 120' x 5"	
48' x 22' x 32"	
75' x 22' x 12'	
84' x 10' x 16'	

BASIC QUANTITY EXERCISE

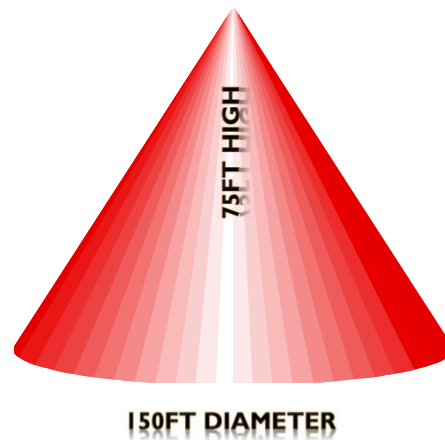
- 1- 44' x 26' = _____ Sq Yds
- 2- 112' x 12' x 20" = _____ Cu Yds
- 3- 36' x 22" = _____ Sq Ft
- 4- 41' x 15' = _____ Sq Ft
- 5- 120' x 12" x 26" = _____ Cu Ft
- 6- 51' x 8' x 6' = _____ Cu Ft
- 7- 52' x 20" = _____ Sq Yds
- 8- 35' x 12' = _____ Sq Yds
- 9- 154' x 32" = _____ Sq Yds
- 10- 85' x 22" = _____ Sq Ft
- 11- 48' x 20" = _____ Sq Ft
- 12- 33' x 56" = _____ Sq Yds

- 13- 48" x 32" = _____ Sq Yds
- 14- 83' x 42" = _____ Sq Ft
- 15- 140' x 64' x 64" = _____ Cu Yds
- 16- 140' x 64' x 64" = _____ Cu Ft
- 17- 72' x 56' x 10' = _____ Cu Yds
- 18- 44' x 22" = _____ Sq Yds
- 19- 24" x 16" = _____ Sq Ft
- 20- 24' x 32' x 10' = _____ Cu Ft
- 21- 60" x 72" x 48" = _____ Cu Ft
- 22- 60' x 72' x 48' = _____ Cu Yds
- 23- 6 3/4" x 15 1/4" = _____ Sq Ft
- 24- 27 cu. Ft. = _____ Cu Yds

BASIC QUANTITIES - PILE

Volume of a crusher pile.

- This pile is shaped like a cone.
- The formula for a cone is:
 - $(1/3) \times \pi \times \text{radius}^2 \times \text{height}$
 - Radius is half the diameter $150 / 2 = 75$
 - $(75 \times 75) = \times 75 =$
 - $421,875 \times 3.14 =$
 - $1,324,687.50 / 3 =$
 - $441,562.50 / 27 =$



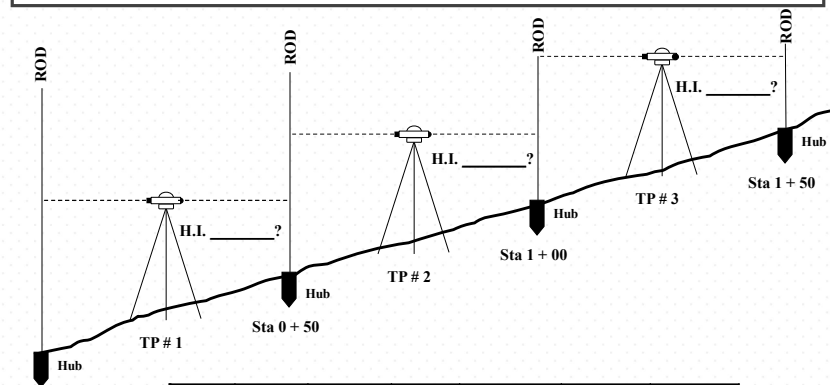
GALLONS OF WATER PER INCH OF RAINFALL

How many gallons of water fall on one acre of land that receives 1" of rain?

- An acre of land is 66' x 660'
- Convert inches first – $1 / 12 = \times 66 \times 660 =$
- There are 7.481 gallons of water in a cubic foot – $\times 7.481 =$
- There are 640 acres/section of land – $\times 640 =$
- There are 36 sections/township – $\times 36 =$



ESTABLISHING AN ELEVATION - STUDENT



BM
El 100.00
Sta 0 + 00

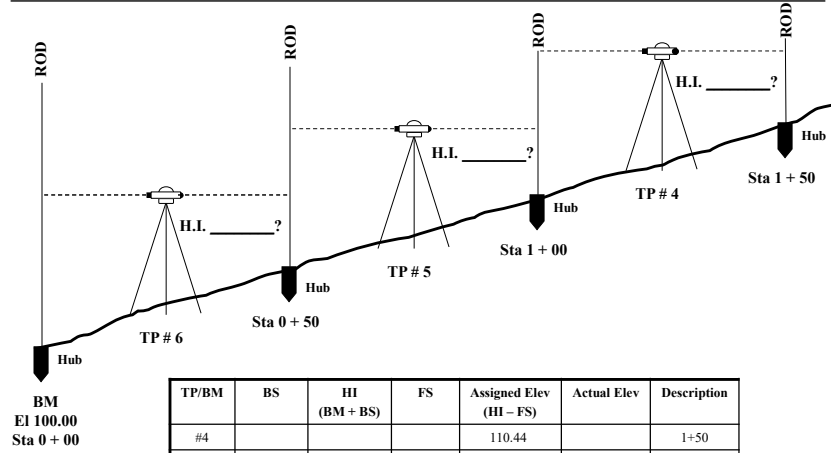
Formulas

$BM + BS = HI$

$HI - FS = \text{Elevation}$

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI - FS)	Actual Elev BM	Description
#1					100.00	0+00
#2						0+50
#3						1+00
						1+50

CONFIRMING THE ELEVATION - STUDENT



BM
EI 100.00
Sta 0 + 00

Formulas

BM + BS = HI

HI - FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI - FS)	Actual Elev	Description
#4				110.44		1+50
#5						1+00
#6						0+50
					100.00	0+00

Cut/Fill Stakes - 4' Level

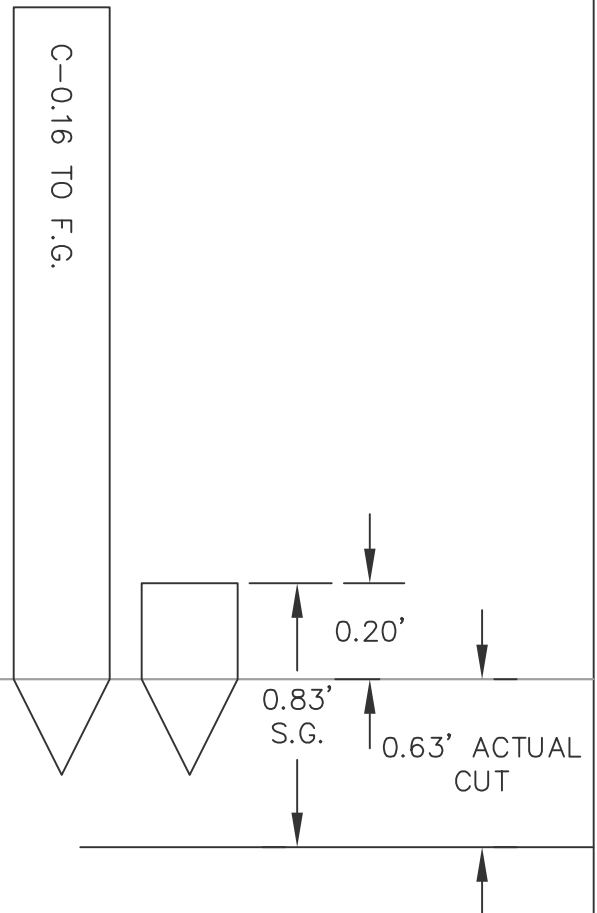
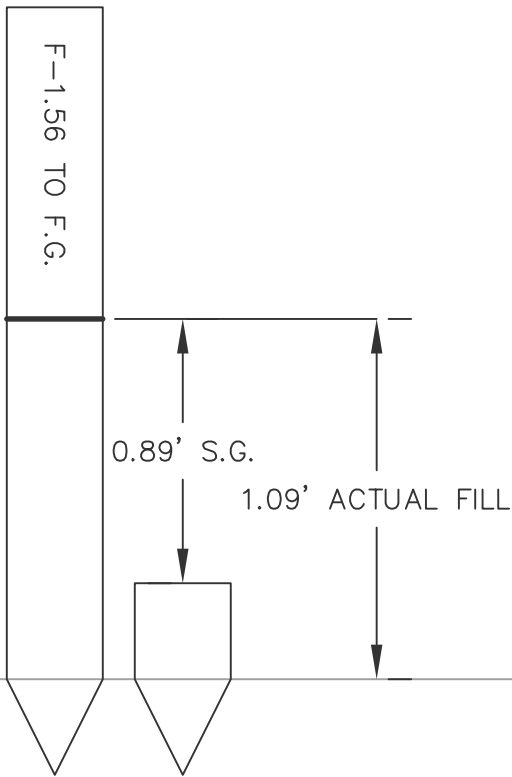
SECTION + CUT = TOTAL CUT
 SECTION - FILL = POSITIVE # = CUT
 SECTION - FILL = NEGATIVE # = FILL

FILL STAKE EXAMPLE

SECTION - 4" CONC & 4" SAND = 8" = 0.67'
 FILL OF 1.56' TO F.G. (TOP OF CONCRETE)
 $0.67' - 1.56 = -0.89 = F-0.89$
 MEASURE UP FROM THE TOP OF THE HUB
 0.89', MARK THE LATH WITH A BLACK LINE.
 USING THE 4' LEVEL, PLACE THE BOTTOM OF
 THE LEVEL ON THE BLACK LINE AND MEASURE
 DOWN TO THE GROUND, THIS IS YOUR
 ACTUAL FILL - F-1.09

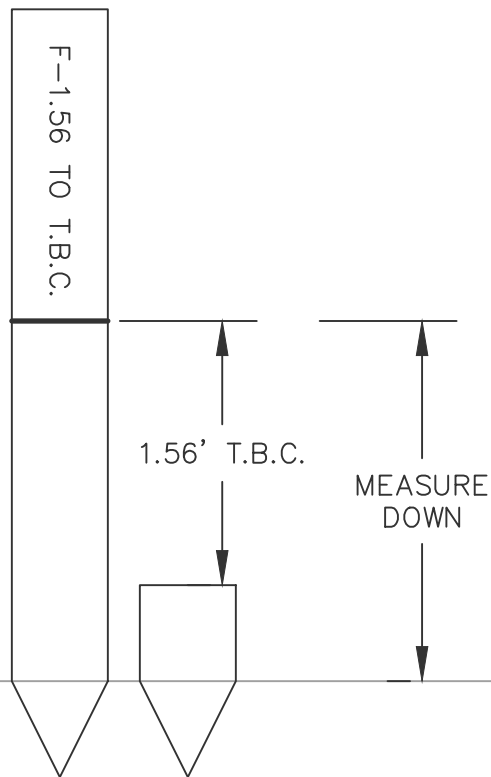
CUT STAKE EXAMPLE

SECTION - 4" CONC & 4" SAND = 8" = 0.67'
 CUT OF 0.16' TO F.G. (TOP OF CONCRETE)
 $0.67' + 0.16' = +0.83 = C-0.83$
 PLACE THE LEVEL ON THE HUB AND MEASURE
 THE DISTANCE TO THE GROUND.
 $0.83' - 0.20' = \text{ACTUAL CUT} = C-0.63'$



Curb Stakes - 4' Level

FILL STAKE EXAMPLE
GENERALLY, CURB STAKES SHOULD ALL BE FILLS
FILL OF 1.56' TO T.B.C. (TOP BACK CURB)
MEASURE UP FROM THE HUB 1.56' AND DRAW
A BLACK LINE DENOTING T.B.C. FIND OUT WHAT
CURB DIMENSIONS ARE INCLUDING GRAVEL IF NEEDED.
PLACE THE TOP OF YOUR LEVEL ON THE BLACK LINE
AND MEASURE DOWN TO THE GROUND. IF YOUR TOTAL
SECTION SHOULD HAVE BEEN 1.42' AND YOU MEASURE
1.52', ITS A FILL OF 0.10'. IF YOU MEASURE 1.12, ITS
A CUT OF 0.30'. KEEP MEASURING UNTIL YOU MEASURE
THE 1.42 OR WHATEVER YOUR SECTION IS.



Stake Reading with Section - Grade Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR+CUT RR-FILL = FG RR	FG RR + Section = SG RR	$\frac{SG\ RR -}{GROUND\ RR} =$ (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06-1.56) 3.50	(3.50+0.67) 4.17	(4.17-5.25) F-1.08 SG
1	C-0.16 To FG	4" Concrete 4" Sand				
2	F-1.56 To FG	4" Concrete 4" Sand				
3	C-0.34 To FG	4" Concrete 4" Sand				
4	F-1.08 To FG	4" Concrete 4" Sand				
5	C-0.67 To FG	6" Concrete 6" Sand				
6	F-0.96 To FG	6" Concrete 6" Sand				
7	C-1.43 To FG	6" Concrete 6" Sand				
8	F-0.56 To FG	6" Concrete 6" Sand				
9	C-1.21 To FG	Curb & Gutter 13 1/2" Section				
10	F-0.85 To FG	Curb & Gutter 13 1/2" Section				
11	C-0.01 To FG	Curb & Gutter 13 1/2" Section				
12	F-2.02 To FG	Curb & Gutter 13 1/2" Section				
13	C-0.85 To FG	Roadway 25 1/2" Section				
14	F-1.11 To FG	Roadway 25 1/2" Section				
15	C-2.44 To FG	Roadway 25 1/2" Section				
16	F-0.24 To FG	Roadway 25 1/2" Section				

Stake Reading with Section - Grade Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR+CUT RR-FILL = FG RR	FG RR + Section = SG RR	$\frac{SG\ RR -}{GROUND\ RR} =$ (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06-1.56) 3.50	(3.50+0.67) 4.17	(4.17-5.25) F-1.08 SG
1	C-0.16 To FG	4" Concrete 4" Sand				
2	F-1.56 To FG	4" Concrete 4" Sand				
3	C-0.34 To FG	4" Concrete 4" Sand				
4	F-1.08 To FG	4" Concrete 4" Sand				
5	C-0.67 To FG	6" Concrete 6" Sand				
6	F-0.96 To FG	6" Concrete 6" Sand				
7	C-1.43 To FG	6" Concrete 6" Sand				
8	F-0.56 To FG	6" Concrete 6" Sand				
9	C-1.21 To FG	Curb & Gutter 13 1/2" Section				
10	F-0.85 To FG	Curb & Gutter 13 1/2" Section				
11	C-0.01 To FG	Curb & Gutter 13 1/2" Section				
12	F-2.02 To FG	Curb & Gutter 13 1/2" Section				
13	C-0.85 To FG	Roadway 25 1/2" Section				
14	F-1.11 To FG	Roadway 25 1/2" Section				
15	C-2.44 To FG	Roadway 25 1/2" Section				
16	F-0.24 To FG	Roadway 25 1/2" Section				

Stake Reading with Section - Grade Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR+CUT RR-FILL = FG RR	FG RR + Section = SG RR	$\frac{SG\ RR -}{GROUND\ RR} =$ (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06-1.56) 3.50	(3.50+0.67) 4.17	(4.17-5.25) F-1.08 SG
1	To FG					
2	To FG					
3	To FG					
4	To FG					
5	To FG					
6	To FG					
7	To FG					
8	To FG					
9	To FG					
10	To FG					
11	To FG					
12	To FG					
13	To FG					
14	To FG					
15	To FG					
16	To FG					

Stake Reading with Section - Grade Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR+CUT RR-FILL = FG RR	FG RR + Section = SG RR	$\frac{SG\ RR -}{GROUND\ RR} =$ (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06-1.56) 3.50	(3.50+0.67) 4.17	(4.17-5.25) F-1.08 SG
1	To FG					
2	To FG					
3	To FG					
4	To FG					
5	To FG					
6	To FG					
7	To FG					
8	To FG					
9	To FG					
10	To FG					
11	To FG					
12	To FG					
13	To FG					
14	To FG					
15	To FG					
16	To FG					

Stake Reading with Section - Lenker Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR-CUT RR+FILL = FG RR	FG RR - Section = SG RR	GROUND RR - SG RR = (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06+1.56) 6.62	(6.62-0.67) 5.95	(4.87-5.95) F-1.08 SG
1	C-0.16 To FG	4" Concrete 4" Sand				
2	F-1.56 To FG	4" Concrete 4" Sand				
3	C-0.34 To FG	4" Concrete 4" Sand				
4	F-1.08 To FG	4" Concrete 4" Sand				
5	C-0.67 To FG	6" Concrete 6" Sand				
6	F-0.96 To FG	6" Concrete 6" Sand				
7	C-1.43 To FG	6" Concrete 6" Sand				
8	F-0.56 To FG	6" Concrete 6" Sand				
9	C-1.21 To FG	Curb & Gutter 13 1/2" Section				
10	F-0.85 To FG	Curb & Gutter 13 1/2" Section				
11	C-0.01 To FG	Curb & Gutter 13 1/2" Section				
12	F-2.02 To FG	Roadway 25 1/2" Section				
13	C-0.85 To FG	Roadway 25 1/2" Section				
14	F-1.11 To FG	Roadway 25 1/2" Section				
15	C-2.44 To FG	Roadway 25 1/2" Section				
16	F-0.24 To FG	Roadway 25 1/2" Section				

Stake Reading with Section - Lenker Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR-CUT RR+FILL = FG RR	FG RR - Section = SG RR	GROUND RR - SG RR = (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06+1.56) 6.62	(6.62-0.67) 5.95	(4.87-5.95) F-1.08 SG
1	C-0.16 To FG	4" Concrete 4" Sand				
2	F-1.56 To FG	4" Concrete 4" Sand				
3	C-0.34 To FG	4" Concrete 4" Sand				
4	F-1.08 To FG	4" Concrete 4" Sand				
5	C-0.67 To FG	6" Concrete 6" Sand				
6	F-0.96 To FG	6" Concrete 6" Sand				
7	C-1.43 To FG	6" Concrete 6" Sand				
8	F-0.56 To FG	6" Concrete 6" Sand				
9	C-1.21 To FG	Curb & Gutter 13 1/2" Section				
10	F-0.85 To FG	Curb & Gutter 13 1/2" Section				
11	C-0.01 To FG	Curb & Gutter 13 1/2" Section				
12	F-2.02 To FG	Roadway 25 1/2" Section				
13	C-0.85 To FG	Roadway 25 1/2" Section				
14	F-1.11 To FG	Roadway 25 1/2" Section				
15	C-2.44 To FG	Roadway 25 1/2" Section				
16	F-0.24 To FG	Roadway 25 1/2" Section				

Stake Reading with Section - Lenker Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR-CUT RR+FILL = FG RR	FG RR - Section = SG RR	GROUND RR - SG RR = (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06+1.56) 6.62	(6.62-0.67) 5.95	(4.87-5.95) F-1.08 SG
1	To FG					
2	To FG					
3	To FG					
4	To FG					
5	To FG					
6	To FG					
7	To FG					
8	To FG					
9	To FG					
10	To FG					
11	To FG					
12	To FG					
13	To FG					
14	To FG					
15	To FG					
16	To FG					

Stake Reading with Section - Lenker Rod

Stake #	Stake Info	Section Thickness	ROD READING ON HUB(RR)	RR-CUT RR+FILL = FG RR	FG RR - Section = SG RR	GROUND RR - SG RR = (-) = Fill (+) = Cut
Example	F-1.56 To FG	4" Concrete 4" Sand	5.06	(5.06+1.56) 6.62	(6.62-0.67) 5.95	(4.87-5.95) F-1.08 SG
1	To FG					
2	To FG					
3	To FG					
4	To FG					
5	To FG					
6	To FG					
7	To FG					
8	To FG					
9	To FG					
10	To FG					
11	To FG					
12	To FG					
13	To FG					
14	To FG					
15	To FG					
16	To FG					

Straight Grade - 2 Elev/RR & Dist Grade Rod

BM	BS RR	HI	FS RR	Elevation	Distance	
BM-980.32	3.24	983.56				
			LP 9.87	973.69	132.50	
			HP 6.54	977.02		
Highest RR - Lowest RR			3.33	$3.33/132.50 = \text{FT/FT} = 0.02513 \text{ FT/FT}$		
Want it staked in 4 equal Segments				$132.50 / 4 = D = 33.125$		
DIST (D) X		FT/FT =	RISE	LP RR-Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)	33.125	0.02513	0.83	9.87-0.83	9.04	9.04 + 1.00 = 10.04
(DX2)	66.25	0.02513	1.66	9.87-1.66	8.21	8.21 + 1.00 = 9.21
(DX3)	99.375	0.02513	2.50	9.87-2.50	7.37	7.37 + 1.00 = 8.37
(DX4)	132.50	0.02513	3.33	9.87-3.33	6.54	6.54 + 1.00 = 7.54

BM	BS RR	HI	FS RR	Elevation	Distance	
			LP			
			HP			
Highest RR - Lowest RR						
Want it staked in 4 equal Segments						
DIST (D) X		FT/FT =	RISE	LP RR-Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)						
(DX2)						
(DX3)						
(DX4)						

Try Some Random Distances

Straight Grade - 2 Elev/RR & Dist Grade Rod

BM	BS RR	HI	FS RR	Elevation	Distance	
BM-980.32	3.24	983.56				
			LP 9.87	973.69	132.50	
			HP 6.54	977.02		
Highest RR - Lowest RR			3.33	$3.33/132.50 = \text{FT/FT} = 0.02513 \text{ FT/FT}$		
Want it staked in 4 equal Segments				$132.50 / 4 = D = 33.125$		
DIST (D) X		FT/FT =	RISE	LP RR-Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)	33.125	0.02513	0.83	9.87-0.83	9.04	$9.04 + 1.00 = 10.04$
(DX2)	66.25	0.02513	1.66	9.87-1.66	8.21	$8.21 + 1.00 = 9.21$
(DX3)	99.375	0.02513	2.50	9.87-2.50	7.37	$7.37 + 1.00 = 8.37$
(DX4)	132.50	0.02513	3.33	9.87-3.33	6.54	$6.54 + 1.00 = 7.54$

BM	BS RR	HI	FS RR	Elevation	Distance	
			LP			
			HP			
Highest RR - Lowest RR						
Want it staked in 4 equal Segments						
DIST (D) X		FT/FT =	RISE	LP RR-Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)						
(DX2)						
(DX3)						
(DX4)						

Try Some Random Distances

Straight Grade - 2 Elev/RR & Dist Lenker Rod

BM	BS RR	HI	FS RR	Elevation	Distance	
BM-980.32		0.32				
			LP 3.69	973.69	132.50	
			HP 7.02	977.02		
Highest RR - Lowest RR			3.33	3.33/132.50=FT/FT=0.02513 FT/FT		
Want it staked in 4 equal Segments				132.50 / 4 = D = 33.125		
DIST (D) X		FT/FT =	RISE	LP RR+Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR - Section =SG RR
(DX1)	33.125	0.02513	0.83	3.69+0.83	4.52	4.52 - 1.00 = 3.52
(DX2)	66.25	0.02513	1.66	3.69+1.66	5.35	5.35 - 1.00 = 4.35
(DX3)	99.375	0.02513	2.50	3.69+2.50	6.19	6.19 - 1.00 = 5.19
(DX4)	132.50	0.02513	3.33	3.69+3.33	7.02	7.02 - 1.00 = 6.02

BM	BS RR	HI	FS RR	Elevation	Distance	
			LP			
			HP			
Highest RR - Lowest RR						
Want it staked in 4 equal Segments						
DIST (D) X		FT/FT =	RISE	LP RR+Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR - Section =SG RR
(DX1)						
(DX2)						
(DX3)						
(DX4)						

Try Some Random Distances

Straight Grade - 2 Elev/RR & Dist Lenker Rod

BM	BS RR	HI	FS RR	Elevation	Distance	
BM-980.32		0.32				
			LP 3.69	973.69	132.50	
			HP 7.02	977.02		
Highest RR - Lowest RR			3.33	3.33/132.50=FT/FT=0.02513 FT/FT		
Want it staked in 4 equal Segments				132.50 / 4 = D = 33.125		
DIST (D) X		FT/FT =	RISE	LP RR+Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR - Section =SG RR
(DX1)	33.125	0.02513	0.83	3.69+0.83	4.52	4.52 - 1.00 = 3.52
(DX2)	66.25	0.02513	1.66	3.69+1.66	5.35	5.35 - 1.00 = 4.35
(DX3)	99.375	0.02513	2.50	3.69+2.50	6.19	6.19 - 1.00 = 5.19
(DX4)	132.50	0.02513	3.33	3.69+3.33	7.02	7.02 - 1.00 = 6.02

BM	BS RR	HI	FS RR	Elevation	Distance	
			LP			
			HP			
Highest RR - Lowest RR						
Want it staked in 4 equal Segments						
DIST (D) X		FT/FT =	RISE	LP RR+Rise =	FG RR	Section-4"Bit + 8"CL-5 FG RR - Section =SG RR
(DX1)						
(DX2)						
(DX3)						
(DX4)						

Try Some Random Distances

Straight Grade - 1 Elev/RR, Dist & Rise/Fall Grade Rod

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32	3.24	983.56					
			9.87	973.69	20.00	+2.00%	
Want Rise/Fall in Feet per Foot				$+2.00\% / 100 = \text{FT/FT} = +0.02$			
Want it staked in 4 equal Segments				$20.00 / 4 = D = 5.00$			
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR-Rise RR+Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)	5	+0.02		+0.10	9.87-0.10	9.77	9.77 + 1.00 = 10.77
(DX2)	10	+0.02		+0.20	9.87-0.20	9.67	9.67 + 1.00 = 10.67
(DX3)	15	+0.02		+0.30	9.87-0.30	9.57	9.57 + 1.00 = 10.57
(DX4)	20	+0.02		+0.40	9.87-0.40	9.47	9.47 + 1.00 = 10.47

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32							
Want Rise/Fall in Feet per Foot							
Want it staked in 4 equal Segments							
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR-Rise RR+Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)							
(DX2)							
(DX3)							
(DX4)							

Try Some Random Distances

Straight Grade - 1 Elev/RR, Dist & Rise/Fall Grade Rod

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32	3.24	983.56					
			9.87	973.69	20.00	+2.00%	
Want Rise/Fall in Feet per Foot				$+2.00\% / 100 = \text{FT/FT} = +0.02$			
Want it staked in 4 equal Segments				$20.00 / 4 = D = 5.00$			
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR-Rise RR+Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)	5	+0.02		+0.10	9.87-0.10	9.77	9.77 + 1.00 = 10.77
(DX2)	10	+0.02		+0.20	9.87-0.20	9.67	9.67 + 1.00 = 10.67
(DX3)	15	+0.02		+0.30	9.87-0.30	9.57	9.57 + 1.00 = 10.57
(DX4)	20	+0.02		+0.40	9.87-0.40	9.47	9.47 + 1.00 = 10.47

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32							
Want Rise/Fall in Feet per Foot							
Want it staked in 4 equal Segments							
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR-Rise RR+Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR + Section =SG RR
(DX1)							
(DX2)							
(DX3)							
(DX4)							

Try Some Random Distances

Straight Grade - 1 Elev/RR, Dist & Rise/Fall Lenker Rod

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32		0.32					
			3.69	973.69	20.00	+2.00%	
Want Rise/Fall in Feet per Foot				$+2.00\% / 100 = \text{FT/FT} = +0.02$			
Want it staked in 4 equal Segments				$20.00 / 4 = D = 5.00$			
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR+Rise RR-Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR - Section = SG RR
(DX1)	5	+0.02		+0.10	3.69+0.10	3.79	3.79 - 1.00 = 2.79
(DX2)	10	+0.02		+0.20	3.69+0.20	3.89	3.89 - 1.00 = 2.89
(DX3)	15	+0.02		+0.30	3.69+0.30	3.99	3.99 - 1.00 = 2.99
(DX4)	20	+0.02		+0.40	3.69+0.40	4.09	4.09 - 1.00 = 3.09

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32							
Want Rise/Fall in Feet per Foot							
Want it staked in 4 equal Segments							
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR+Rise RR-Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR - Section = SG RR
(DX1)							
(DX2)							
(DX3)							
(DX4)							

Try Some Random Distances

Straight Grade - 1 Elev/RR, Dist & Rise/Fall Lenker Rod

BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32		0.32					
			3.69	973.69	20.00	+2.00%	
Want Rise/Fall in Feet per Foot				$+2.00\% / 100 = \text{FT/FT} = +0.02$			
Want it staked in 4 equal Segments				$20.00 / 4 = D = 5.00$			
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR+Rise RR-Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR - Section = SG RR
(DX1)	5	+0.02		+0.10	3.69+0.10	3.79	3.79 - 1.00 = 2.79
(DX2)	10	+0.02		+0.20	3.69+0.20	3.89	3.89 - 1.00 = 2.89
(DX3)	15	+0.02		+0.30	3.69+0.30	3.99	3.99 - 1.00 = 2.99
(DX4)	20	+0.02		+0.40	3.69+0.40	4.09	4.09 - 1.00 = 3.09

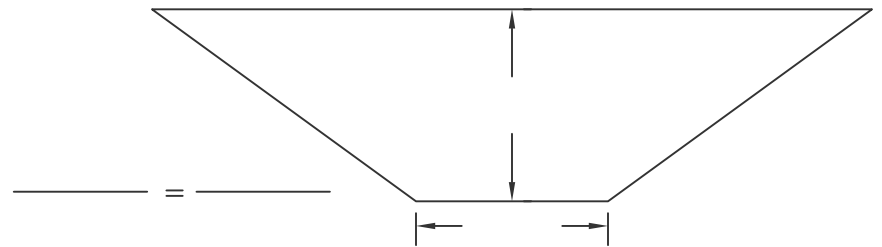
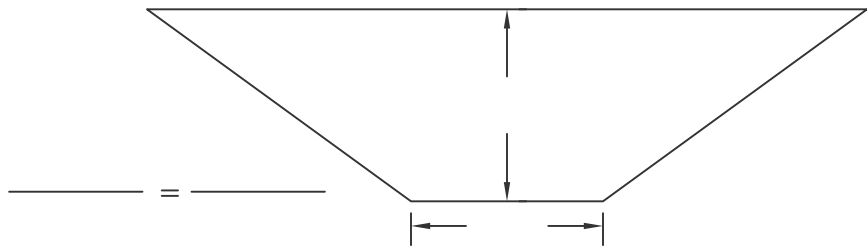
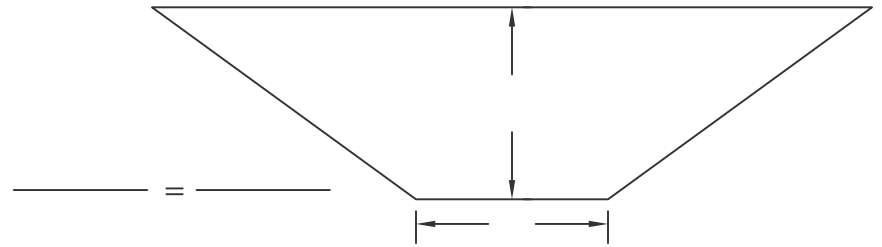
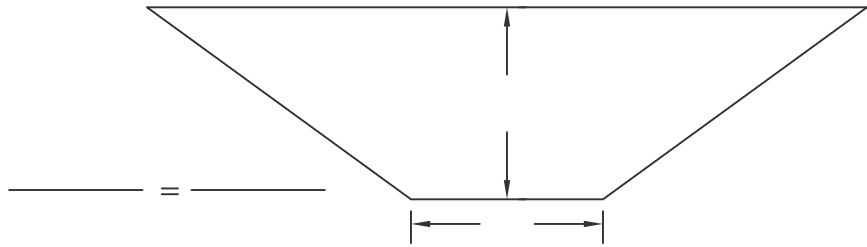
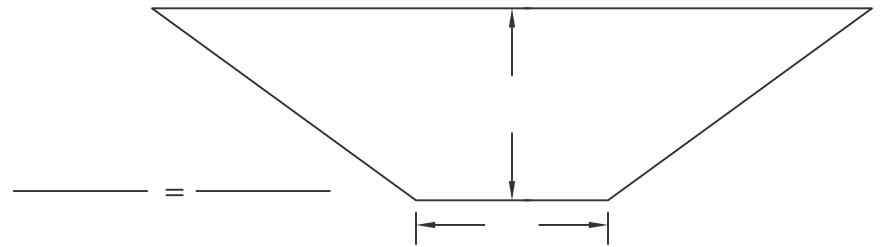
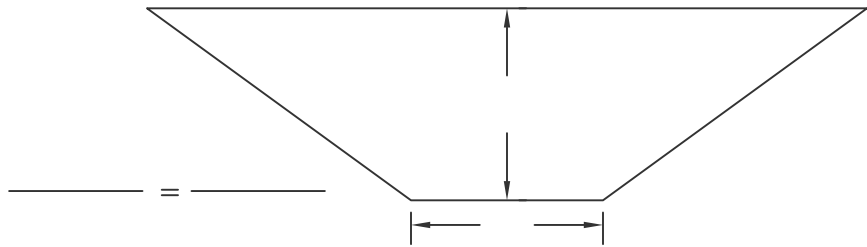
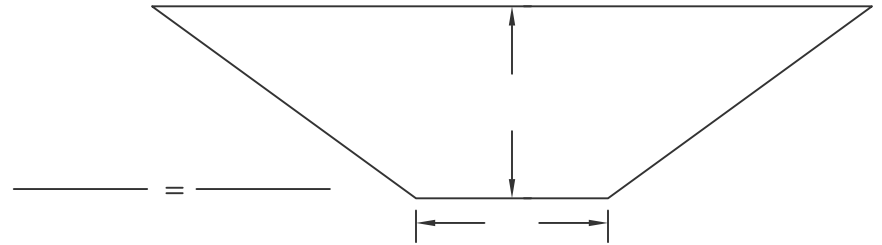
BM	BS RR	HI	FS RR	Elevation	Distance	Rise (+) Fall (-)	
BM-980.32							
Want Rise/Fall in Feet per Foot							
Want it staked in 4 equal Segments							
DIST (D)	X	FT/FT	=	+ = Rise - = Fall	RR+Rise RR-Fall	= FG RR	Section-4"Bit + 8"CL-5 FG RR - Section = SG RR
(DX1)							
(DX2)							
(DX3)							
(DX4)							

Try Some Random Distances

Total Trench Exercise

$$\begin{aligned} \text{SOLVING FOR RISE} &= \frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{X \text{ (RISE)}}{14' \text{ (RUN)}} \\ &= 14 \times 1 = 14 / 4 = X = 3.5' \end{aligned}$$

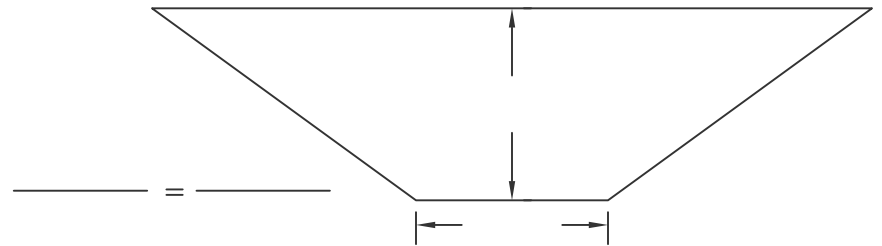
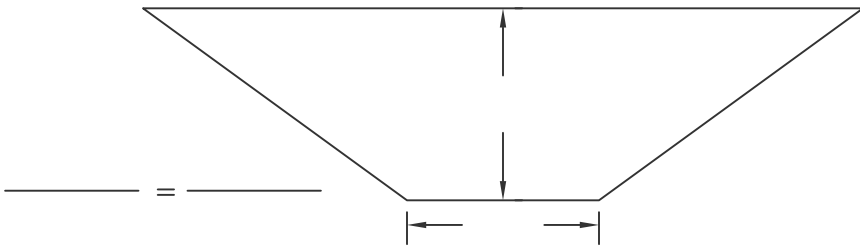
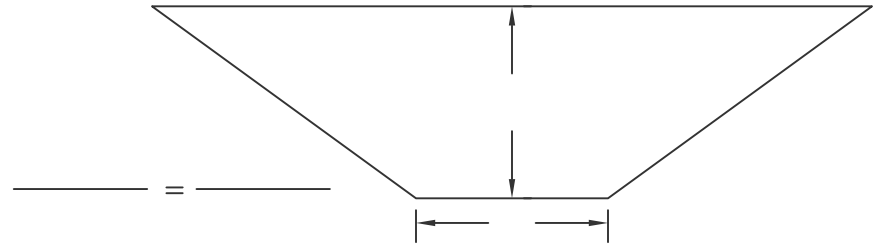
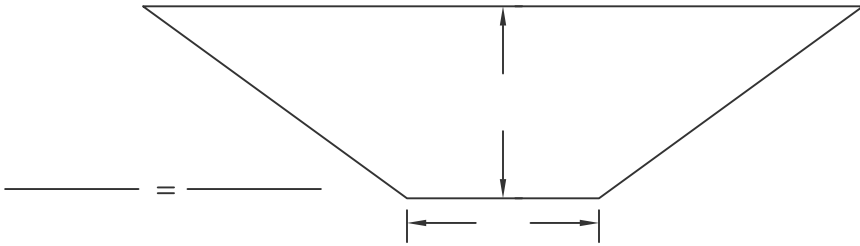
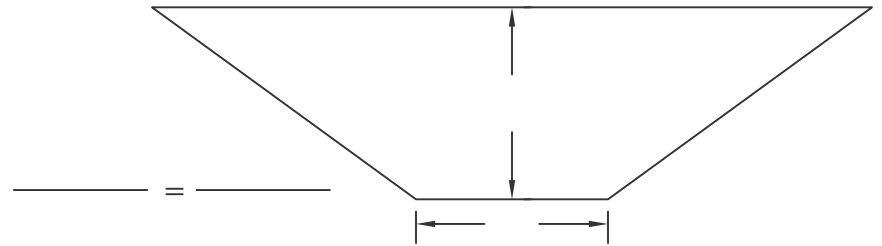
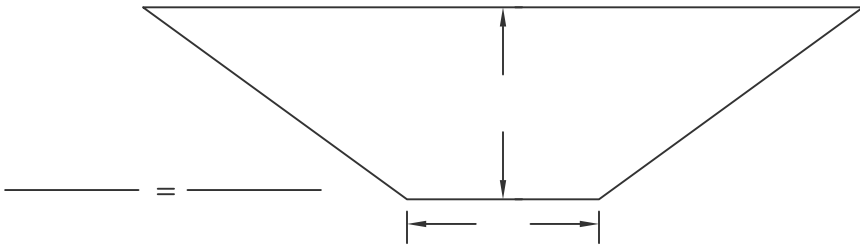
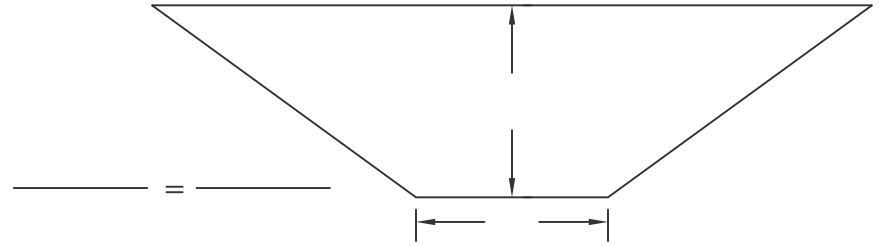
$$\begin{aligned} \text{SOLVING FOR RUN} &= \frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{5' \text{ (RISE)}}{X \text{ (RUN)}} \\ &= 5 \times 4 = 20 / 1 = X = 20' \\ 20 \times 2 \text{ (Sides)} &= + \text{Ditch Bottom} = \text{Total Trench} \end{aligned}$$



Total Trench Exercise

$$\begin{aligned} \text{SOLVING FOR RISE} &= \frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{X \text{ (RISE)}}{14' \text{ (RUN)}} \\ &= 14 \times 1 = 14 / 4 = X = 3.5' \end{aligned}$$

$$\begin{aligned} \text{SOLVING FOR RUN} &= \frac{1' \text{ (RISE)}}{4' \text{ (RUN)}} = \frac{5' \text{ (RISE)}}{X \text{ (RUN)}} \\ &= 5 \times 4 = 20 / 1 = X = 20' \\ 20 \times 2 \text{ (Sides)} &= + \text{Ditch Bottom} = \text{Total Trench} \end{aligned}$$



TYPICAL SECTION EXERCISES

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#5

#6

#1
Rise/Fall _____

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Rise/Fall _____

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Rise/Fall _____

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Rise/Fall _____

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TYPICAL SECTION EXERCISES

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TYPICAL SECTION EXERCISES

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TYPICAL SECTION EXERCISES

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