I.U.O.E. LOCAL 49

GRADE STAKES, LAYOUT AND PLAN READING

INTERNET SEARCH

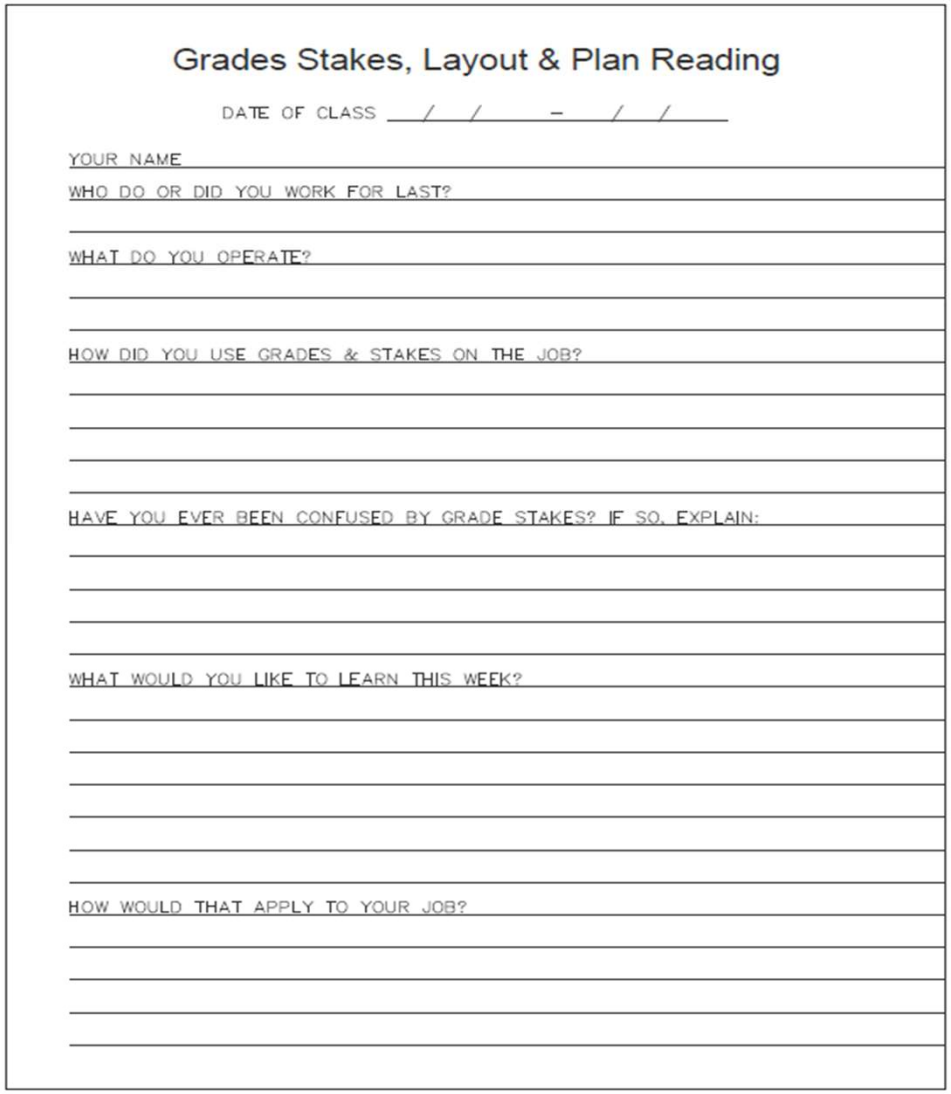
KAHOOT.IT

ENTER CODE SHOWN ON SCREEN

CLASSROOM APPROPRIATE NAME

GOOD MORNING

- Introduction of Instructor
  - Al Bernhardt
- Student Questionnaire
  - Let's find out about you



Grades Stakes, Layout & Plan Reading

DATE OF CLASS __/__/__ – __/__/__

YOUR NAME

WHO DO OR DID YOU WORK FOR LAST?

WHAT DO YOU OPERATE?

HOW DID YOU USE GRADES & STAKES ON THE JOB?

HAVE YOU EVER BEEN CONFUSED BY GRADE STAKES? IF SO, EXPLAIN:

WHAT WOULD YOU LIKE TO LEARN THIS WEEK?

HOW WOULD THAT APPLY TO YOUR JOB?

IN CASE YOU ARE NERVOUS

- Here is an anonymous quote from a previous student who took the class online..
- "AI was able to teach someone like me who has never had any experience the basics, and more. I am a hands-on learner with a need for visuals. AI was able to give the fundamentals and then paint a picture of the whole process. Providing visual examples and real-world examples made it so much easier to understand. Even with being over Zoom AI made the class feel hands on. By having us follow each step, showing the details in the process, and what to do with that information. Made it that much easier to understand the subject. AI also made it a very fun class. Some of the zoom courses get boring, but AI kept us all engaged and laughing. 10/10"

IDEAS TO FOLLOW FOR THE WEEK

- Have fun while learning
- Organize your thinking by taking notes
- Follow the Formula
- Try! Show me the effort and I will help you succeed!
- Double check your work

Grades & Stakes Formulas

CONVERT INCHES TO DECIMAL FEET

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'

CONVERT DECIMAL FEET TO INCHES

0.25' = 0.25 X 12 = 3"

BASIC QUANTITIES

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)

$A^2 + B^2 = C^2$

A=28' B=30' C

(28 X 28) + (30 X 30)
784 + 900 = 1684
$\sqrt{1684}$ = C = 41.04'

INCHES & DECIMAL FEET

12 INCHES OR 96 EIGHTHS PER FOOT
10 TENTHS OR 100 HUNDREDTHS PER FOOT
5280 FEET – 1 MILE

"GOLD"EN RULES

RISE / RUN = FT/FT (NEVER ROUND)
% / 100 = FT/FT (NEVER ROUND)
FT/FT X 100 = %
RUN / RISE = SLOPE RATIO

STATIONING

EXAMPLES – 16+45 & 14+50
1645.00 – 1450.00 = 195.00' APART
NEGATIVE OFFSET – LEFT & POSITIVE OFFSET – RIGHT

FG CUT/FILLS TO SUBGRADE

SECTION + CUT = TOTAL CUT
SECTION – FILL = POSITIVE # = CUT / NEGATIVE # = FILL

SURVEYING

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

LEVEL LOOPING

BENCHMARK (BM) + BACKSIGHT (BS) = HEIGHT OF INSTRUMENT (HI)
HI – FORESIGHT (FS) = ELEVATION (EL)
HI – EL = FORESIGHT ROD READING

Stake Reading with Section-Grade Rod			ROD READING ON HUB (RR)	RR+CUT RR–FILL = FG RR	FG RR + Section = SG RR	SG RR – GROUND RR = (–) = Fill (+) = Cut
Example	STAKE INFO F–1.56 To FG	SECTION THICKNESS 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

Stake Reading with Section-Lenker Rod			ROD READING ON HUB (RR)	RR–CUT RR+FILL = FG RR	FG RR – Section = SG RR	GROUND RR – SG RR = (–) = Fill (+) = Cut
Example	STAKE INFO F–1.56 To FG	SECTION THICKNESS 4" Concrete 4" Sand	3.72	(3.72+1.56) 5.28	(5.28–0.67) 4.61	(3.51–4.61) F–1.10 SG

PRORATION

SOLVING FOR STEPS = $\frac{35\ (\text{STEPS})}{100'} = \frac{X\ (\text{STEPS})}{60'}$ = 35 X 60 = /100 = 21 STEPS

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

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

20 X 2 (SIDES) – + DITCH BOTTOM – TOTAL TRENCH

Common Abbreviations

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

SECTION 1

Tape Reading, Conversions and Grade Rod Reading

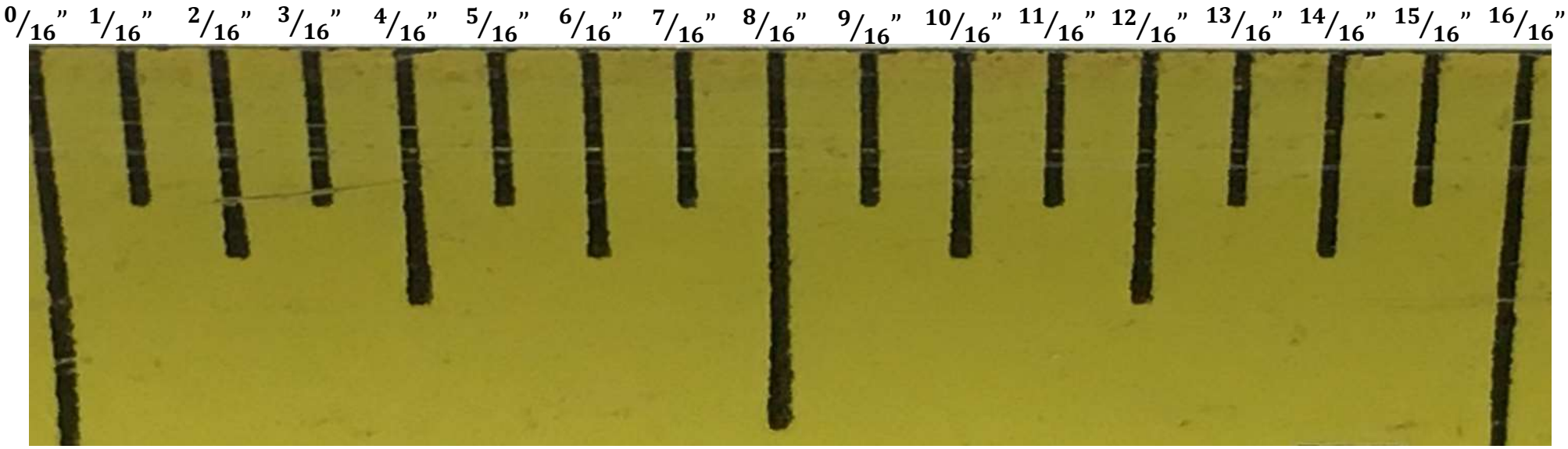
READING INCHES OF A FOOT

0”
ZERO
FEET

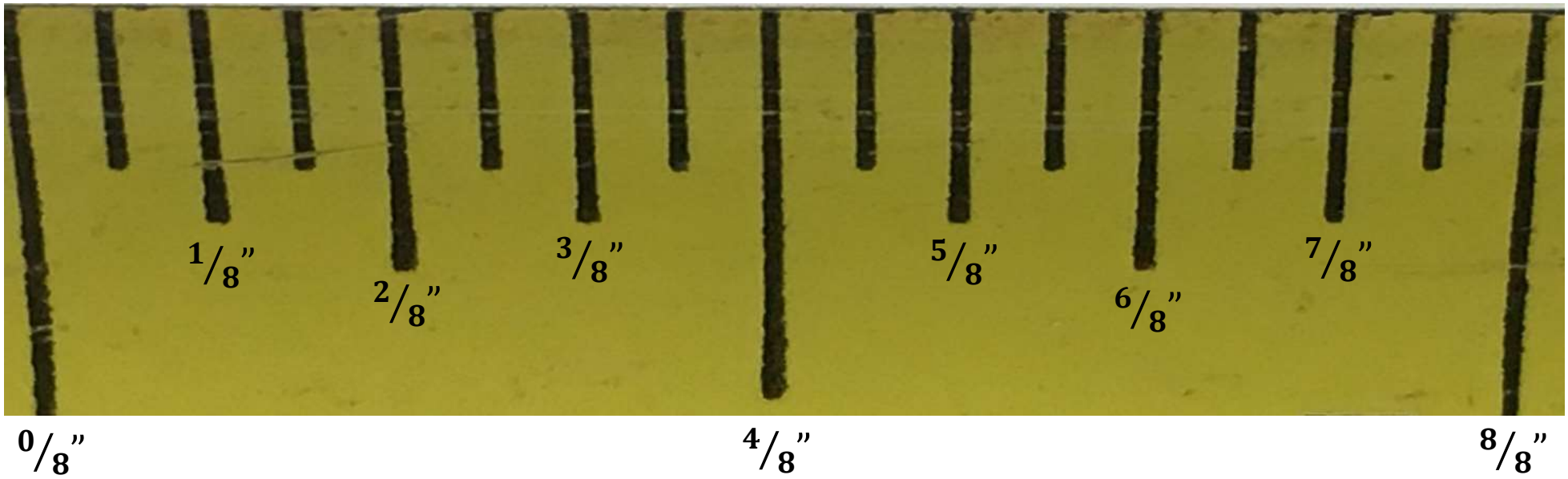
1” 2” 3” 4” 5” 6” 7” 8” 9” 10” 11”

12”
ONE
FOOT

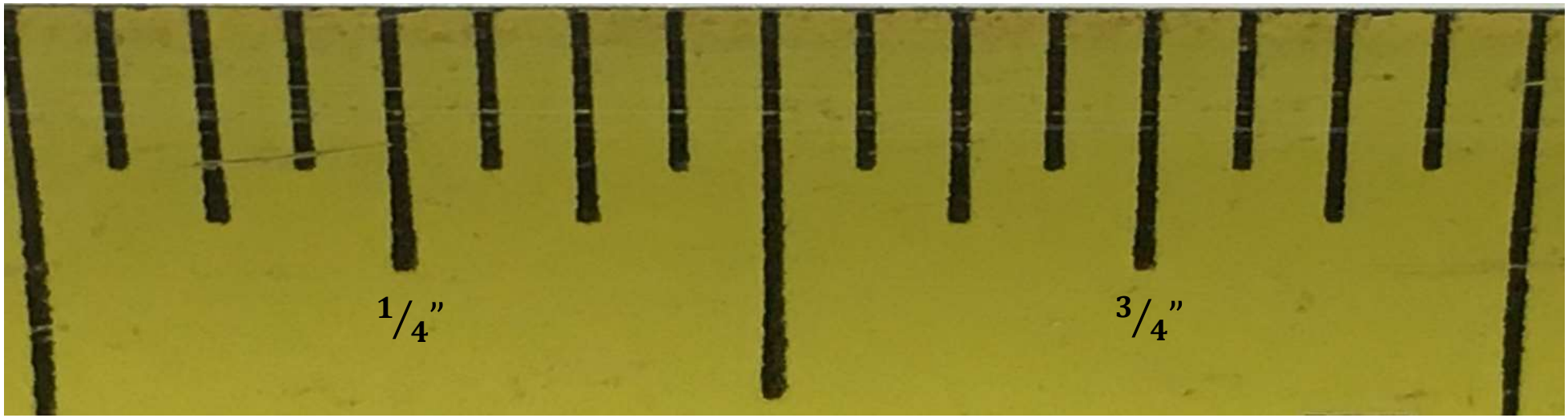
READING SIXTEENTHS OF AN INCH



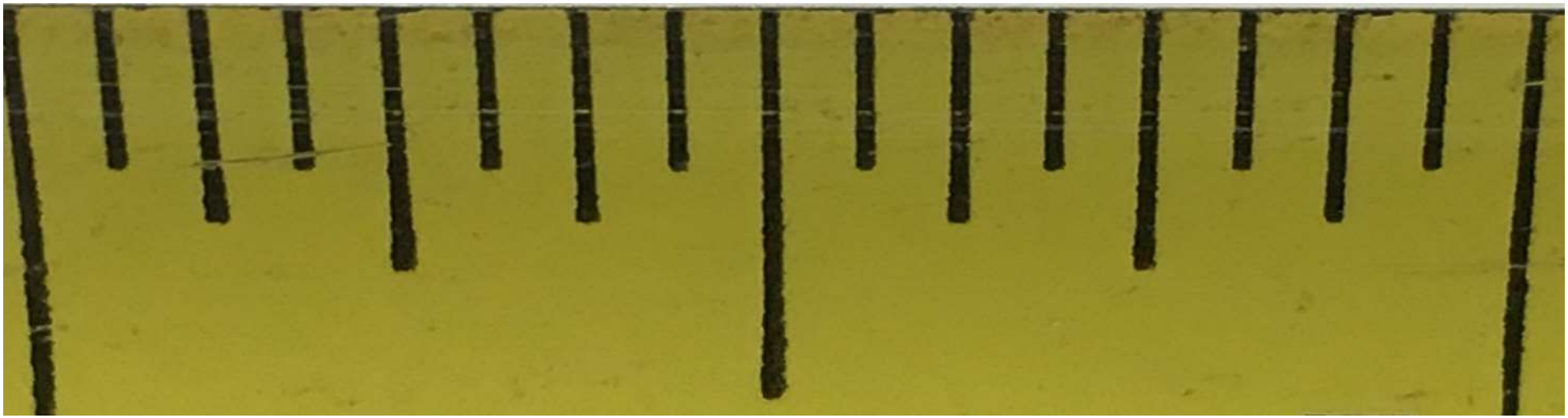
READING EIGHTHS OF AN INCH



READING QUARTERS OF AN INCH



READING HALVES OF AN INCH



0”
$^{0}/_{2}$”

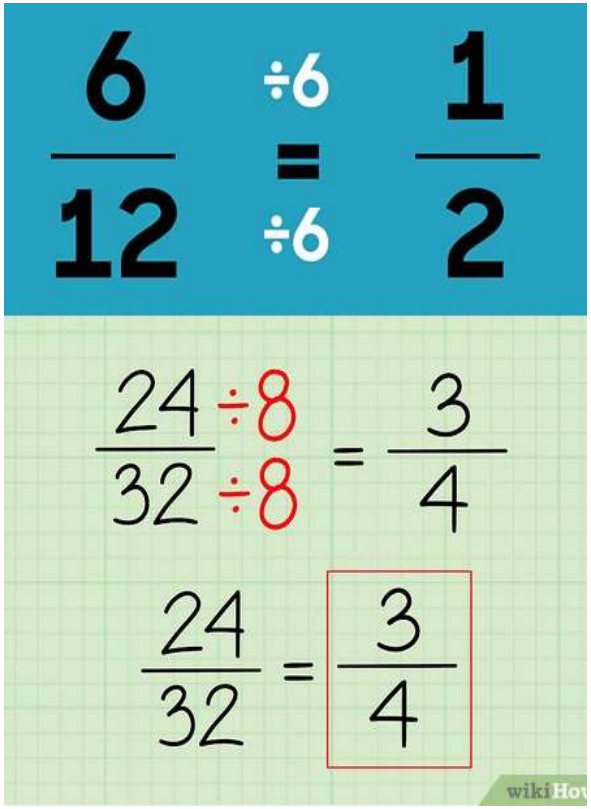
$^{1}/_{2}$”

1”
$^{2}/_{2}$”

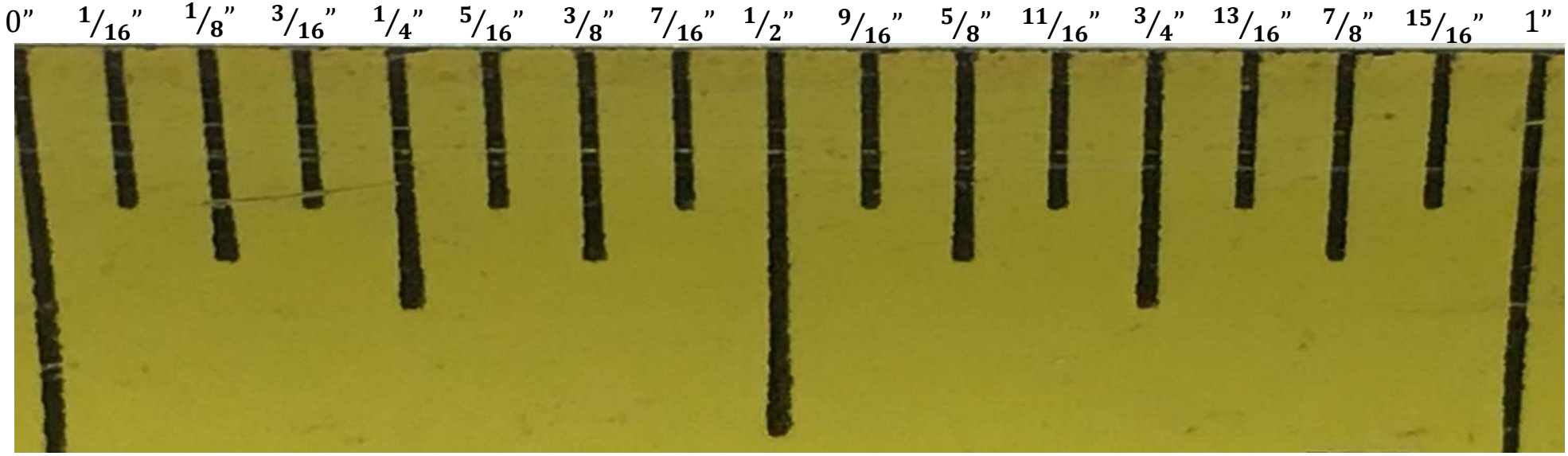
REDUCING FRACTIONS

- $^{8}/_{16}$”
- $^{8}/_{16}$” = $^{1}/_{2}$”
- 8 / 8 = 1
- 16 / 8 = 2

- $^{10}/_{16}$”
- $^{10}/_{16}$” = $^{5}/_{8}$”
- 10 / 2 = 5
- 16 / 2 = 8



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

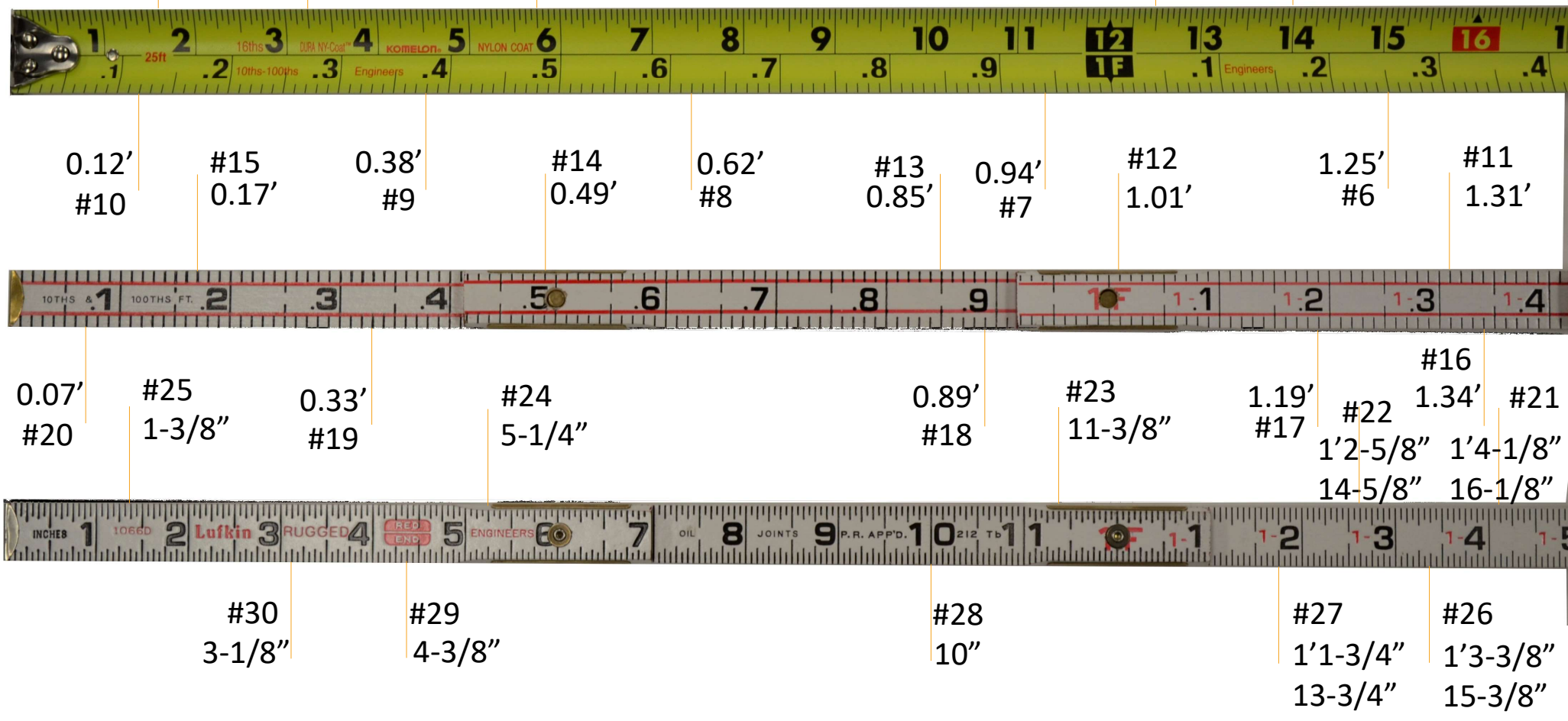
Remember, F/T/H

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

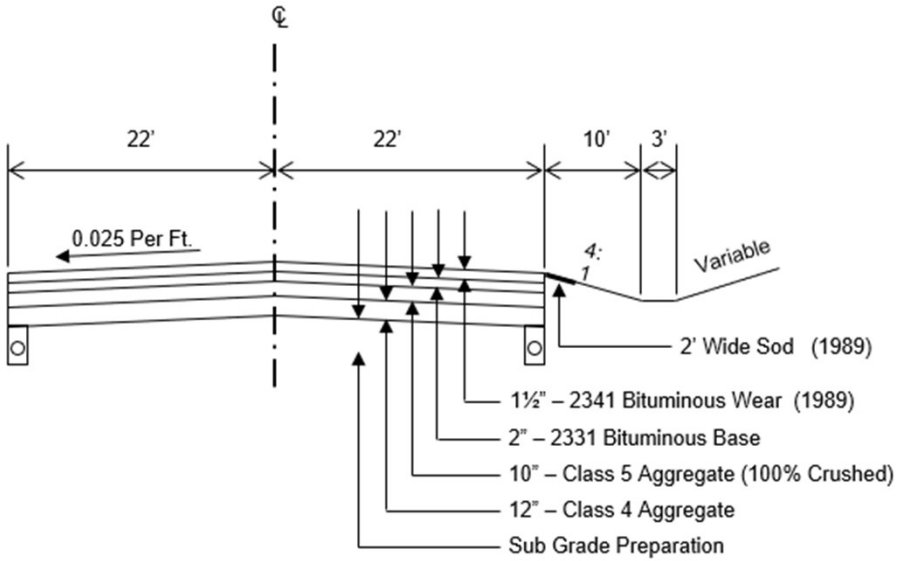
READING TENTHS OF A FOOT

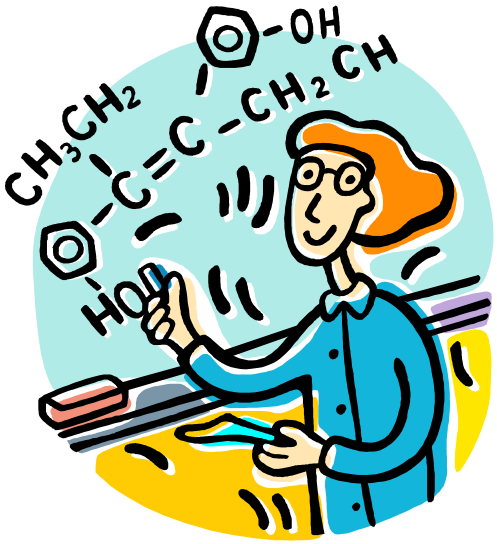
0.00’	0.10’	0.20’	0.30’	0.40’	0.50’	0.60’	0.70’	0.80’	0.90’	1.00’
ZERO FEET	ONE TENTH	TWO TENTHS	THREE TENTHS	FOUR TENTHS	FIVE TENTHS	SIX TENTHS	SEVEN TENTHS	EIGHT TENTHS	NINE TENTHS	ONE FOOT

HUNDREDTHS OF A TENTH


#5
1-5/8”
#4
3-1/4”
#3
5-3/4”
#2
1’-1/2”
12-1/2”
#1
1’2”
14”
0.12’
#10
#15
0.17’
0.38’
#9
#14
0.49’
0.62’
#8
#13
0.85’
0.94’
#7
#12
1.01’
1.25’
#6
#11
1.31’
0.07’
#20
#25
1-3/8”
0.33’
#19
#24
5-1/4”
0.89’
#18
#23
11-3/8”
1.19’
#17
#22
1’2-5/8”
14-5/8”
#16
1.34’
#21
1’4-1/8”
16-1/8”
#30
3-1/8”
#29
4-3/8”
#28
10”
#27
1’1-3/4”
13-3/4”
#26
1’3-3/8”
15-3/8”

CONVERTING INCHES TO DECIMAL FEET





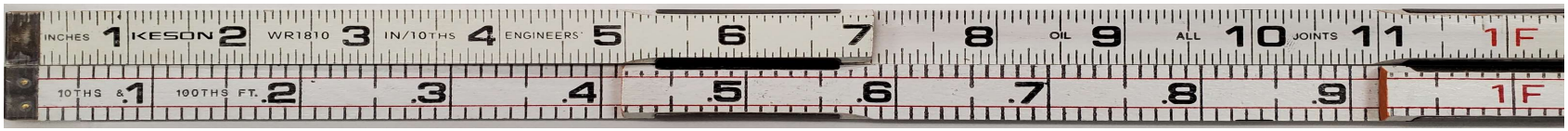
WAYS TO CONVERT

- Folding Ruler
- Formula

FOLDING RULER

$8\,1/4$"	0.69’	$1/2$"	0.04’
$7\,1/2$"	0.62’	$7/8$"	0.07’
$6\,1/2$"	0.54’	$4\,1/2$"	0.37’
5"	0.42’	$2\,3/4$"	0.23’
$3\,3/4$"	0.31’	10"	0.83’
$9\,1/8$"	0.76’	$25\,1/2$"	2.13’

Feet, Inch and Fractions



Decimal Feet

CONVERTING A BASIC INCH TO TENTHS

Formula inch / 12 =

Let's do the first one together…

- 12 /12 =
- 1.00'

Let's do the next 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"	**1.00'**	
11"	**0.916'**	**0.92'**
10"	**0.833'**	**0.83'**
9"	**0.75'**	
8"	**0.666'**	**0.67'**
7"	**0.583'**	**0.58'**
6"	**0.50'**	
5"	**0.416'**	**0.42'**
4"	**0.333'**	**0.33'**
3"	**0.25'**	
2"	**0.166'**	**0.17'**
1"	**0.083'**	**0.08'**
0"	**0.00'**	

PRACTICE CONVERTING FRACTIONS

Let's do the second one together…

- 1/4 =
- /12 =
- 0.0208333’
- Round to the nearest hundredth
- 0.02’

Conversion Chart

FRACTIONS	DECIMALS
$^{1}/_{8}$”	0.01’
$^{1}/_{4}$”	0.02’
$^{3}/_{8}$”	0.03’
$^{1}/_{2}$”	0.04’
$^{5}/_{8}$”	0.05’
$^{3}/_{4}$"	0.06’
$^{7}/_{8}$”	0.07’
$^{8}/_{8}$”	0.08’
$^{1}/_{16}$”	0.005’

CONVERTING INCH & FRACTIONS

Let's do the second one together…

- 1/4 =
- +2 =
- /12 =
- 0.1875’
- Round to the nearest hundredth
- 0.19’

Conversion Chart

FRACTIONS	DECIMALS
$9\,1/8$”	0.76’
$2\,1/4$”	0.19’
$3\,3/8$”	0.28’
$4\,1/2$”	0.38’
$1\,5/8$”	0.14’
$6\,3/4$”	0.56’
$15\,7/8$”	1.32’
$7\,8/8$”	0.67’
$10\,1/16$”	0.84’

PRACTICE CONVERTING

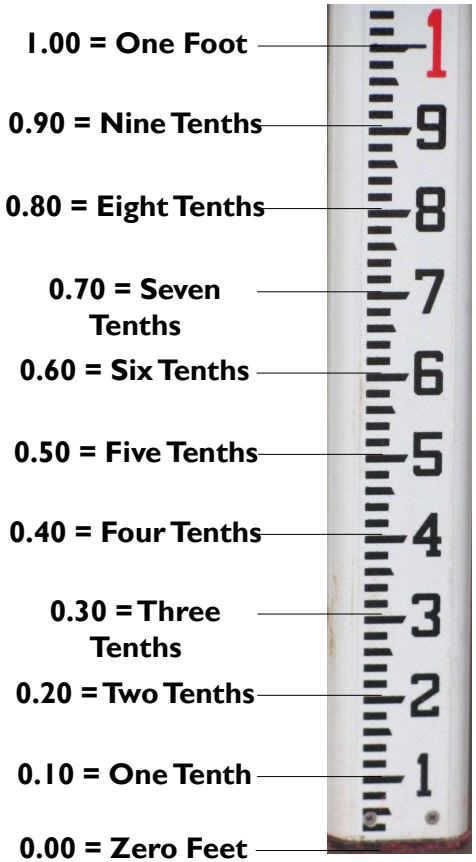
1. 8 inches = 0.67’
2. 2 inches = 0.17’
3. 23 inches = 1.92’
4. 32 inches = 2.67’
5. 12 feet 11 inches = 12.92’
6. 6 ½ inches= 0.54’
7. 53 feet 9 inches = 53.75’
8. 13 inches = 1.08’
9. 1 foot 10 inches = 1.83’
10. 63 inches = 5.25’
11. 17 inches = 1.42’
12. 30 inches = 2.50’
13. 40 inches = 3.33’
14. 7 inches = 0.58’
15. 39 inches = 3.25’
16. ¾ inch = 0.06’
17. 8 ¼ inches = 0.69’
18. 9 feet 10 inches = 9.83’
19. 100 inches = 8.33’
20. 82 ½ inches = 6.88’

READING A GRADE ROD - TENTHS

1.00' foot and divide it into:

10 equal parts

We call each one of those parts a *Tenth*



READING A GRADE ROD - HUNDREDTHS

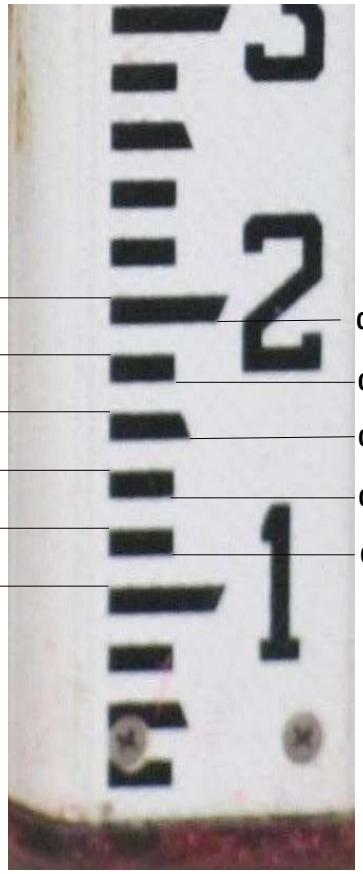
Each Tenth is divided into **10 equal parts.**

We call each one of those parts a **Hundredth**

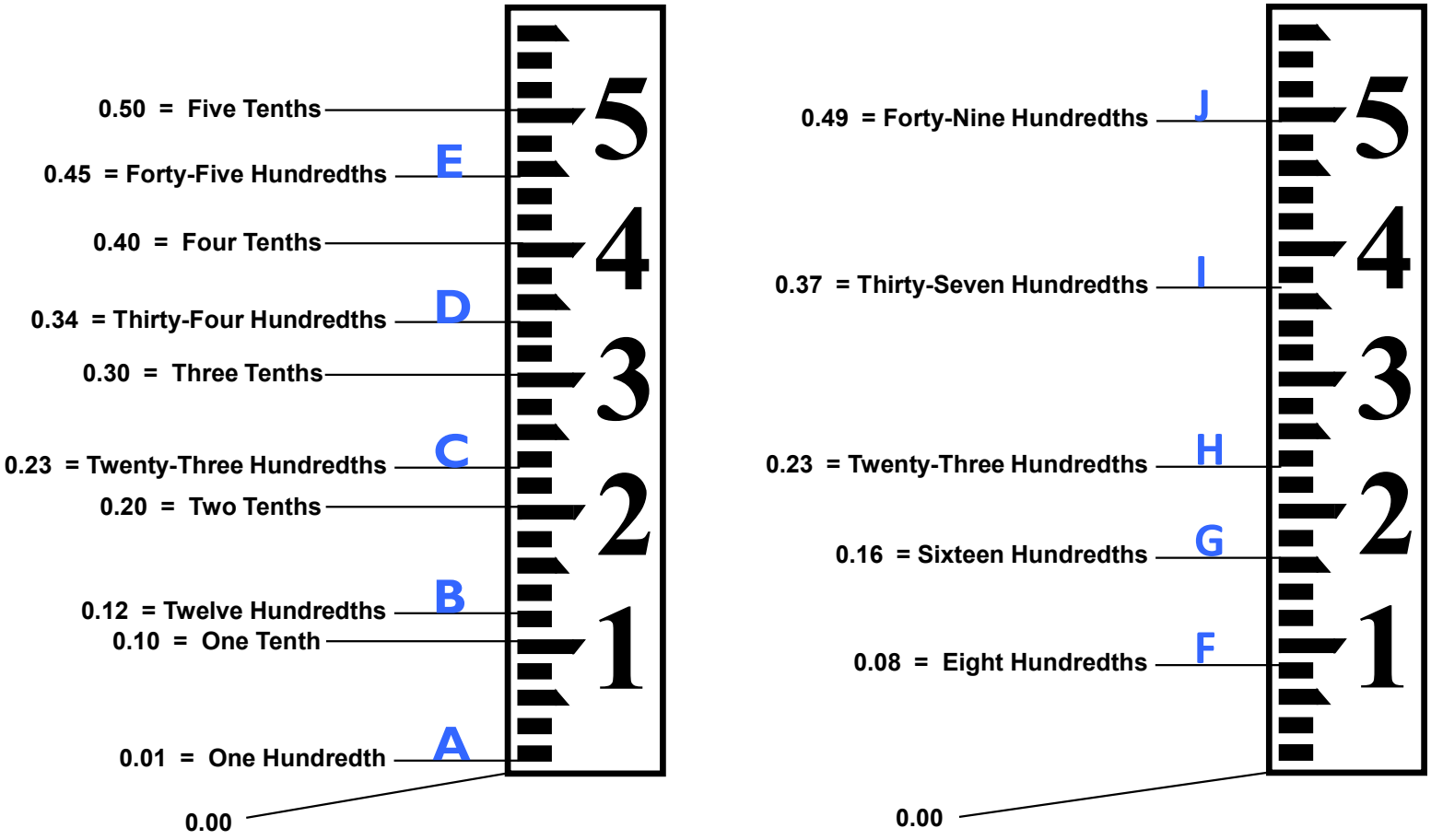
Notice a Pattern?

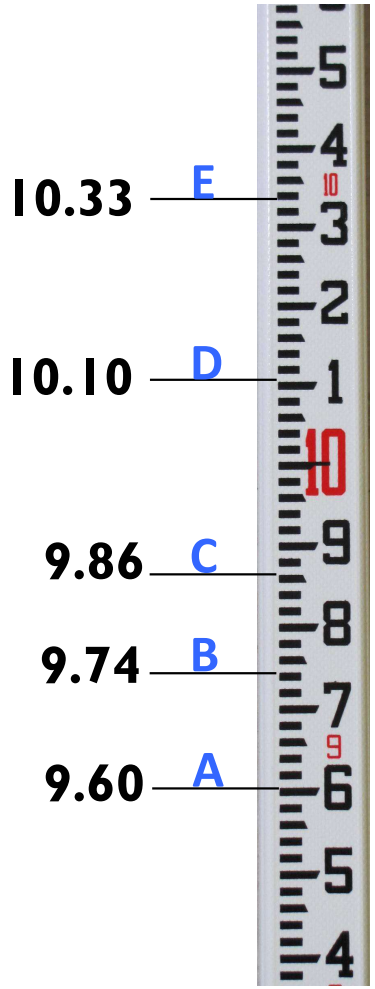
The Top of every Black Bar is an Even Number

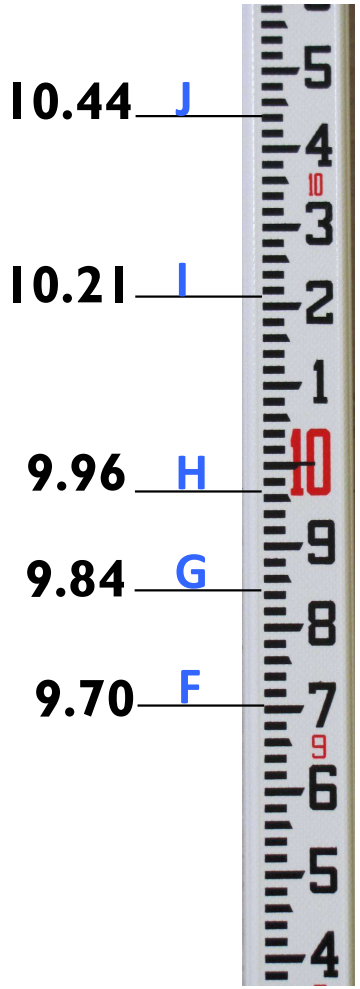
The Bottom of every Black Bar is an Odd Number



PRACTICE


0.50 = Five Tenths
0.45 = Forty-Five Hundredths
E
0.40 = Four Tenths
0.34 = Thirty-Four Hundredths
D
0.30 = Three Tenths
0.23 = Twenty-Three Hundredths
C
0.20 = Two Tenths
0.12 = Twelve Hundredths
B
0.10 = One Tenth
0.01 = One Hundredth
A
0.00
5
4
3
2
1
0.49 = Forty-Nine Hundredths
J
0.37 = Thirty-Seven Hundredths
I
0.23 = Twenty-Three Hundredths
H
0.16 = Sixteen Hundredths
G
0.08 = Eight Hundredths
F
0.00


10.33
E
10.10
D
9.86
C
9.74
B
9.60
A


10.44
J
10.21
I
9.96
H
9.84
G
9.70
F

SECTION 2

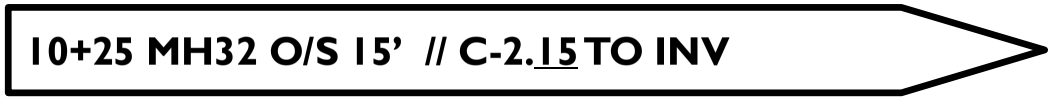
General Information

- BC/PC Begin Curve
- BM Benchmark
- ℄ Centerline
- C Cut
- CP Catch Point
- EC/PT End Curve
- EL Elevation
- F Fill
- FG Finished Grade
- FL Flow Line
- HP High Point
- INV Invert of Drain
- L/O Line Only
- MH Manhole
- Ⓢ or 0/S Offset
- PI Point of Intersection
- PL Property Line
- RAD Radius Point
- R/W Right-of-Way
- SG Sub Grade
- SS Slope Stake
- STA Station
- TBM Temporary Benchmark
- TC Top of Curb
- TOE Toe of Slope
- TOP Top of Slope
- TP Turning Point
- TBC Top Back of Curb


20’ O/S BLDG COR // C-3.50 TO FFE


10+25 MH32 L/O

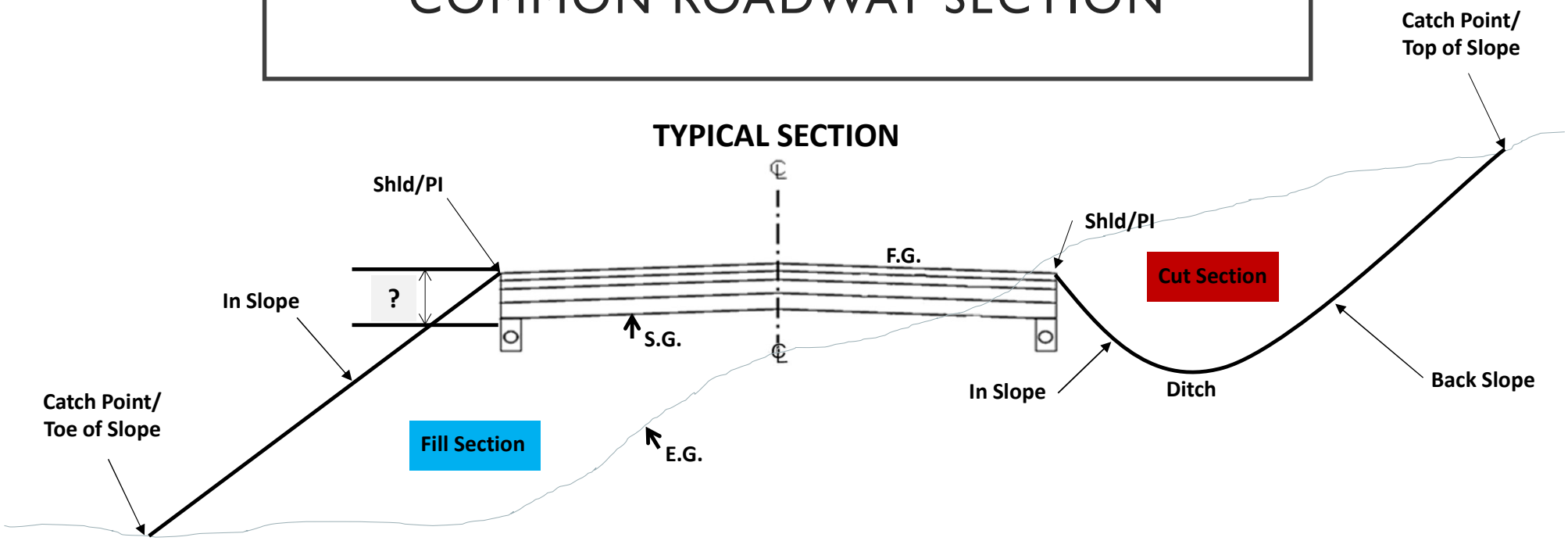

3’ O/S TBC @ PC // F-1.45 TO FL // F-1.95 TO TC


10+25 MH32 O/S 15’ // C-2.15 TO INV

GENERAL DEFINITIONS

- ***Bench Mark:*** A point of known elevation, used as a reference in determining and recording other elevations.
- ***Blue Tops:*** Grade hubs whose tops indicate finish or sub grade.
- ***Catch Point:*** Where Proposed construction meets Existing ground
- ***Center Line:*** The middle or crown of a roadway, dividing separate sections of a roadway, usually where station labels are attached to.
- ***Cut:*** Lowering the elevation of the ground, marked C on a stake, plus the number of feet (and tenths) of earth to be removed.
- ***Fill****:* Raising the elevation of the ground. Marked F on the lath plus the number of feet (and tenths) of earth to be added.
- ***Elevation:*** An established point that is a definite vertical distance above sea level
- ***Fall or Rise/Ft***. The vertical fall or rise for each horizontal foot.
- **Slope Ratio:** The ratio of the horizontal run distance to the vertical rise distance.
- ***Super:*** A continuous slope in one direction of a road.

COMMON ROADWAY 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.

STANDARD DIRT TOLERANCES

Dirt

0.10’ plus (+) or minus (-)

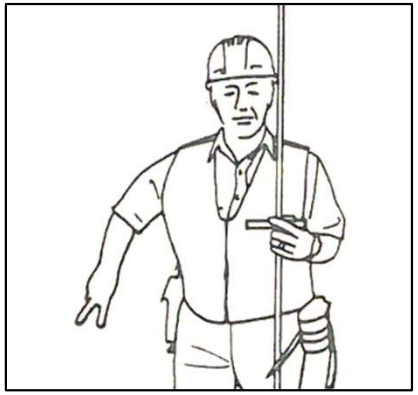
Gravel

0.05’ plus (+) or minus (-)

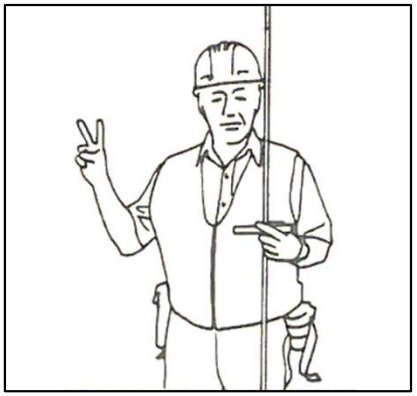
Black Top

0.01’ plus (+) or minus (-)

COMMON HAND SIGNALS

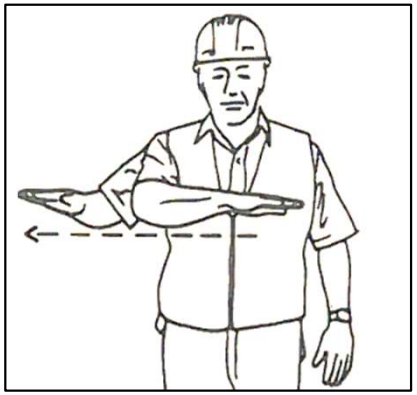


Cut Two Tenths



Fill Two Tenths

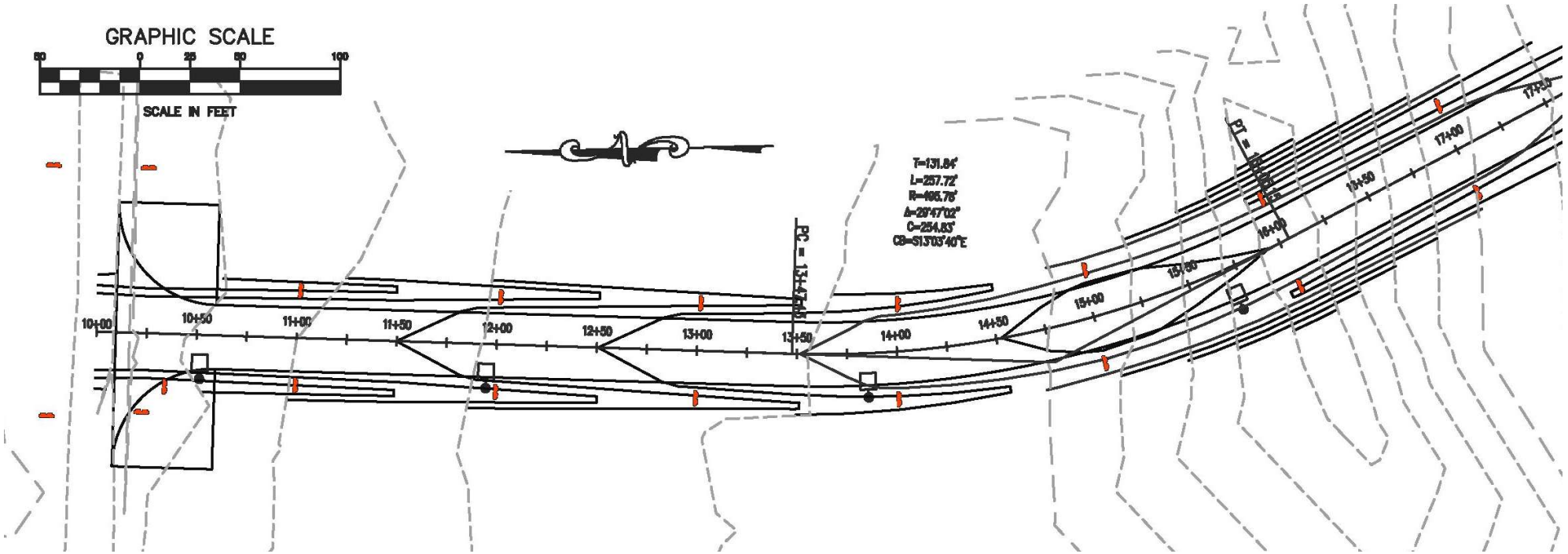
Cut One Foot



Grade

SECTION 3

Stationing



- For this alignment, Sta 10+00 is the begin station and station values increase as you head South.
- Once you know which way the station values are increasing, you now can determine which side is left and right of the Centerline. Left and right of station are determined with you back toward the begin station and with you facing up station.
- Remember, negative offsets are left, and positive offsets are right of the baseline

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?

   1645.00 – 1000.00 = 645.00'

2. If you are standing -16.5' offset of Sta 20+10, are you left or right of Centerline?

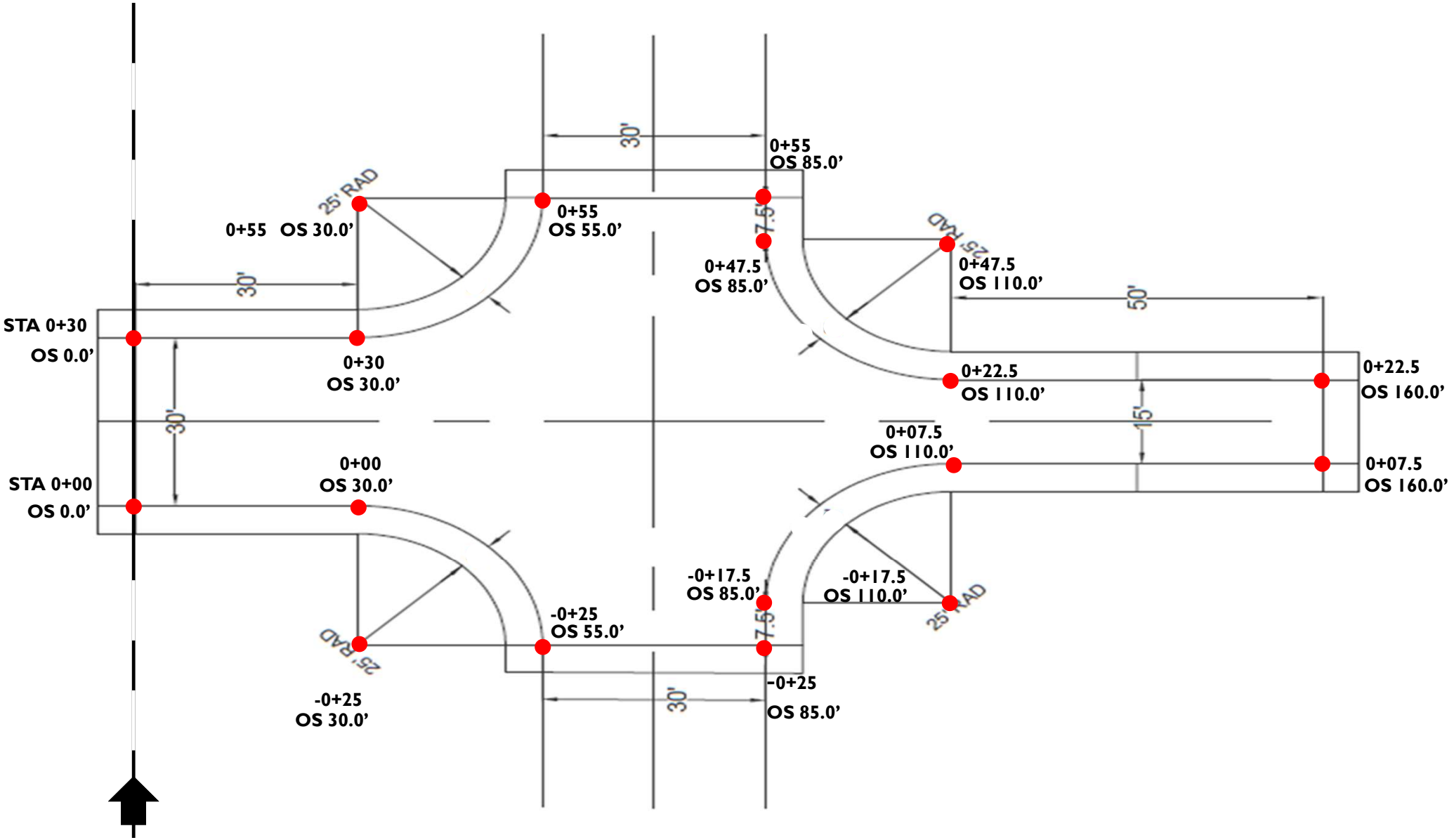
   Negative Offset = Left & Positive Offset = Right

3. How many feet apart are Stations 12+48.35 and 21+98.68?

   2198.68 – 1248.35 = 950.33'

4. If you are at Sta 21+00 Offset -25.52', how far is it to Centerline?

   25.52'


30'
0+55
OS 85.0'
25' RAD
0+55 OS 30.0'
0+55
OS 55.0'
7.5'
0+47.5
OS 85.0'
25' RAD
0+47.5
OS 110.0'
50'
30'
STA 0+30
OS 0.0'
0+30
OS 30.0'
0+22.5
OS 110.0'
0+22.5
OS 160.0'
30'
15'
0+07.5
OS 110.0'
STA 0+00
OS 0.0'
0+00
OS 30.0'
0+07.5
OS 160.0'
-0+17.5
OS 85.0'
-0+17.5
OS 110.0'
7.5'
25' RAD
-0+25
OS 55.0'
25' RAD
-0+25
OS 30.0'
30'
-0+25
OS 85.0'

SECTION 4

Stake Reading

Least Expendable Stakes

– Horizontal Control

– Vertical Control

More Expendable Stakes

– Reference

– Temporary

Expendable Stakes

– Centerline

Do Not Run Any Stake Over Anytime!

The integrity of the stake and its location must be maintained at all times!

WHAT INFORMATION CAN BE FOUND ON STAKES?

Horizontal - Offset

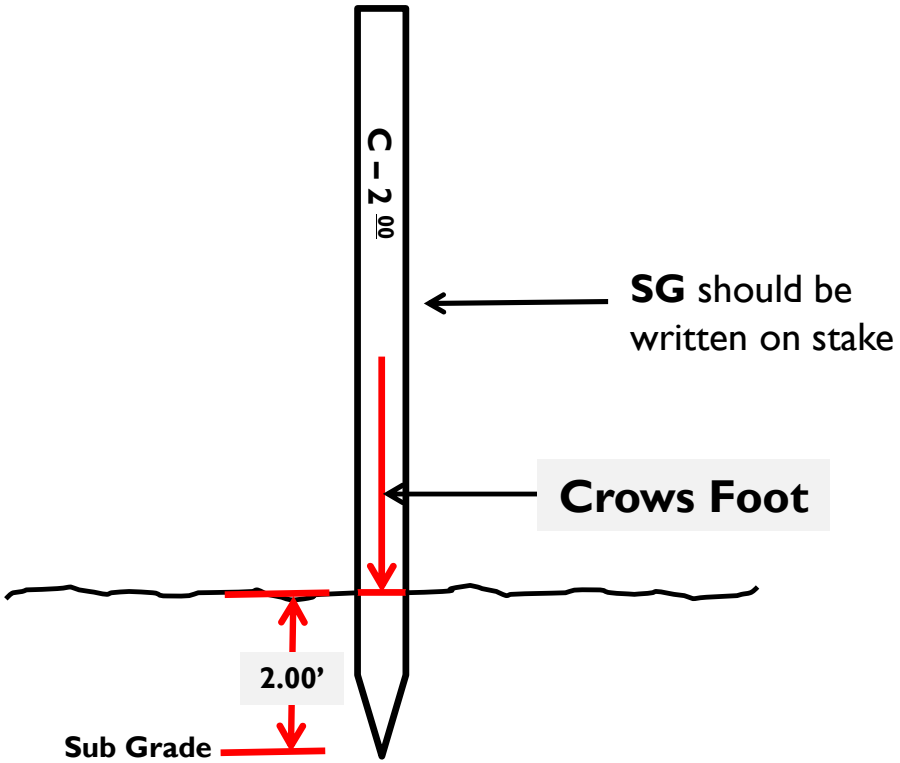
Vertical – Cut or Fill

Location - Stationing

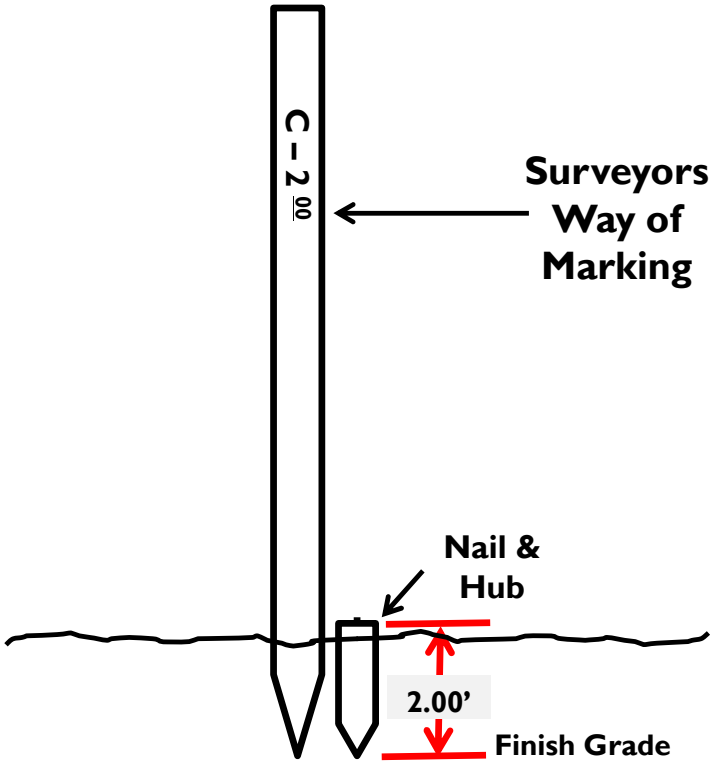
More Info

DIFFERENT TYPES OF GRADE STAKES

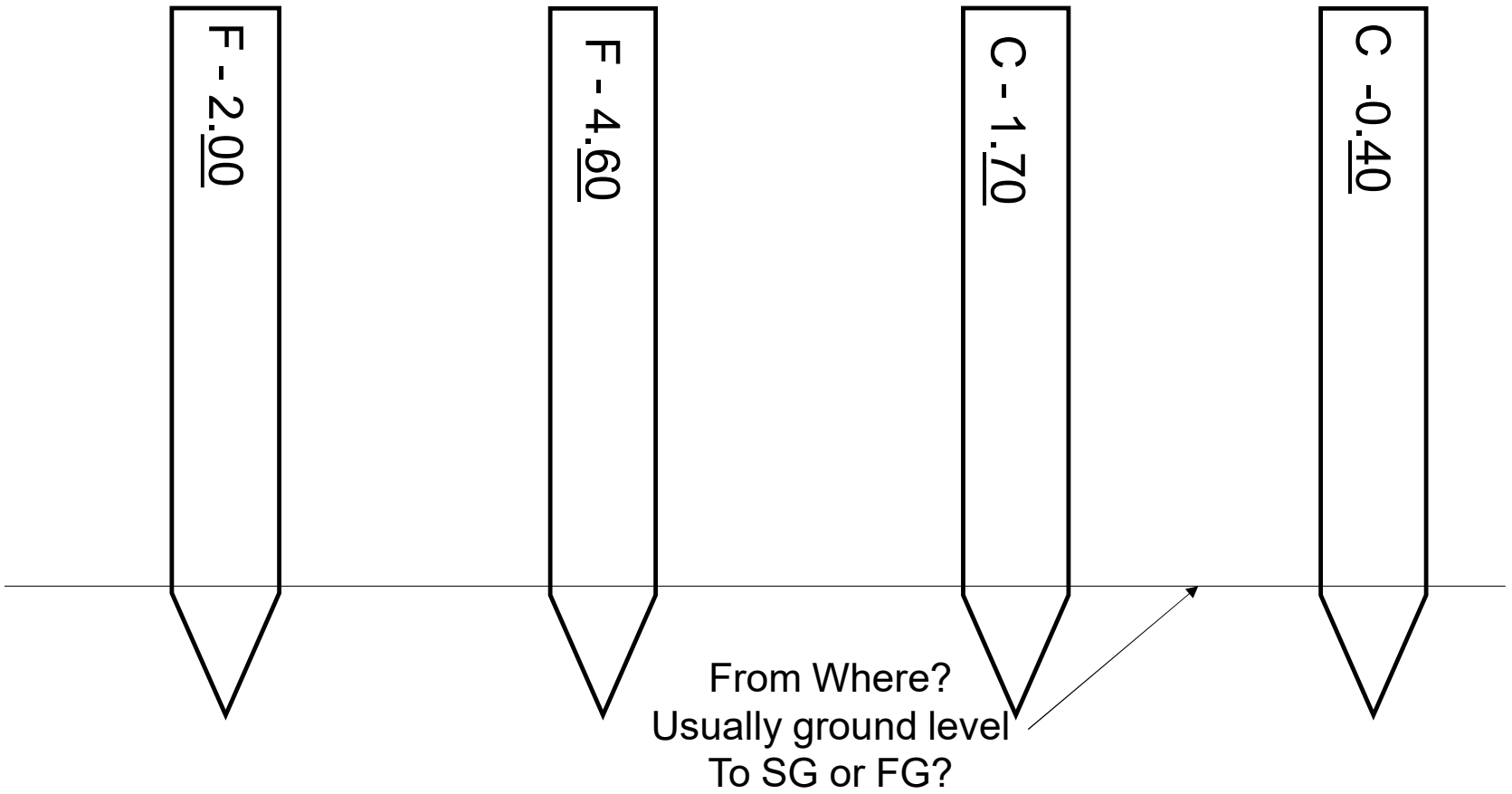
One type is set by the grade person in your company



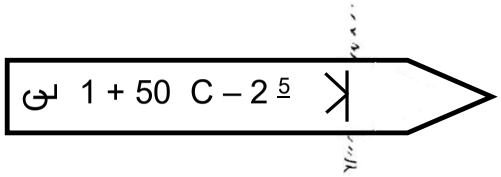
The other type of grade stake is set by a surveyor.

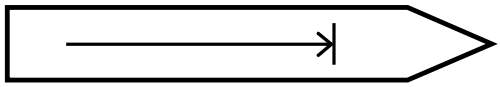


STAKE READING QUESTIONS

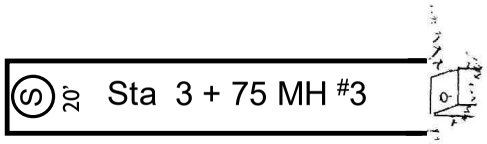


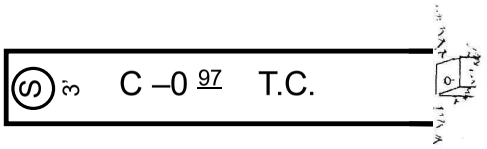
STAKE READING QUESTIONS

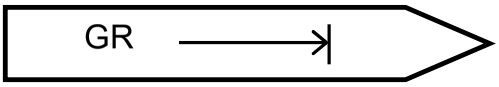




MH #3 Line Only







F – 3 8

F – 3.08

C – 2 56

C – 2.56

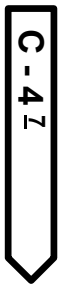
F – 4.6

C – 2.0

STAKE READING QUIZ

1. 4 Feet equals how many Tenths? 40
2. 100 Hundredths equals how many Tenths? 10
3. 0.5 Feet is how many Inches? 6”
4. 2 Feet & 2 Tenths is how many Tenths? 22
5. How many Hundredths is that? 220
6. $3\frac{4}{}$’ is how many Tenths? 34
7. $3\frac{45}{}$’ is how many Hundredths? 345
8. 30 Tenths is how many feet? 3’
9. What is the symbol for Cut? C Fill? F

10. What does this Stake mean?



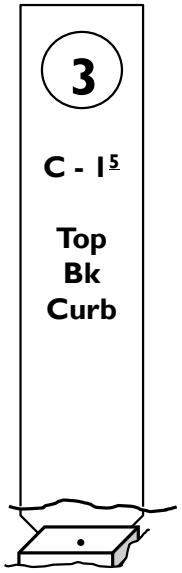
Cut 4.70’

11. What does this Stake mean?

Fill 0.85’

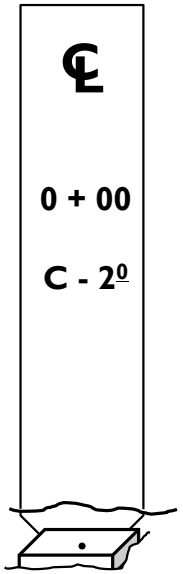
STAKE READING WITH VISUALIZATION

Curb Stake



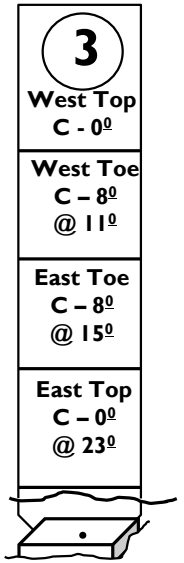
Hub

Street Stake



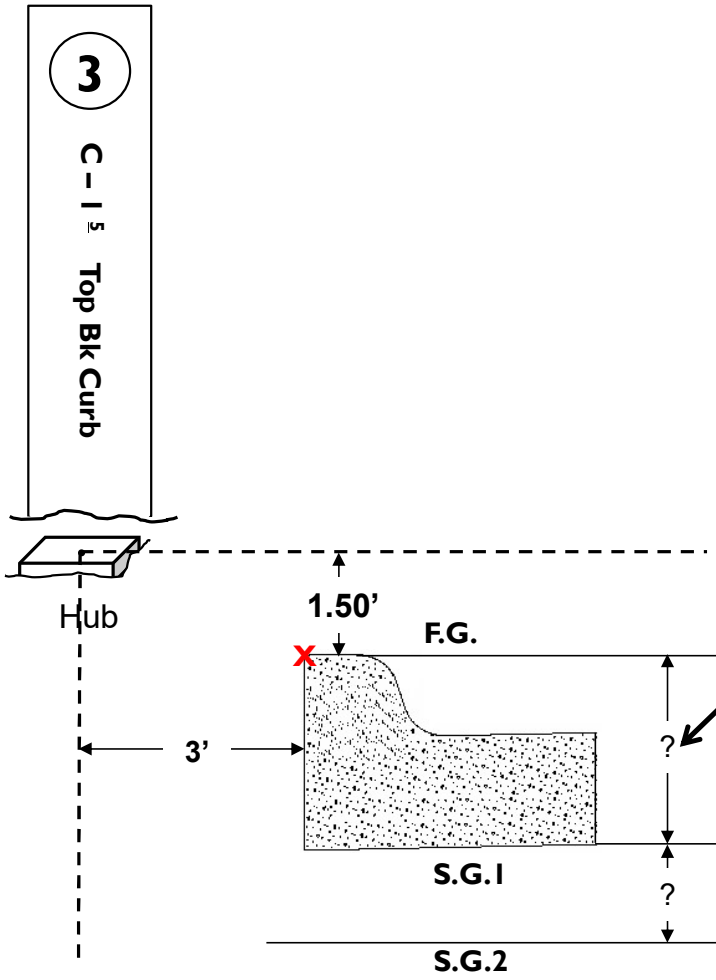
Hub

Ditch Channel Stake



Hub

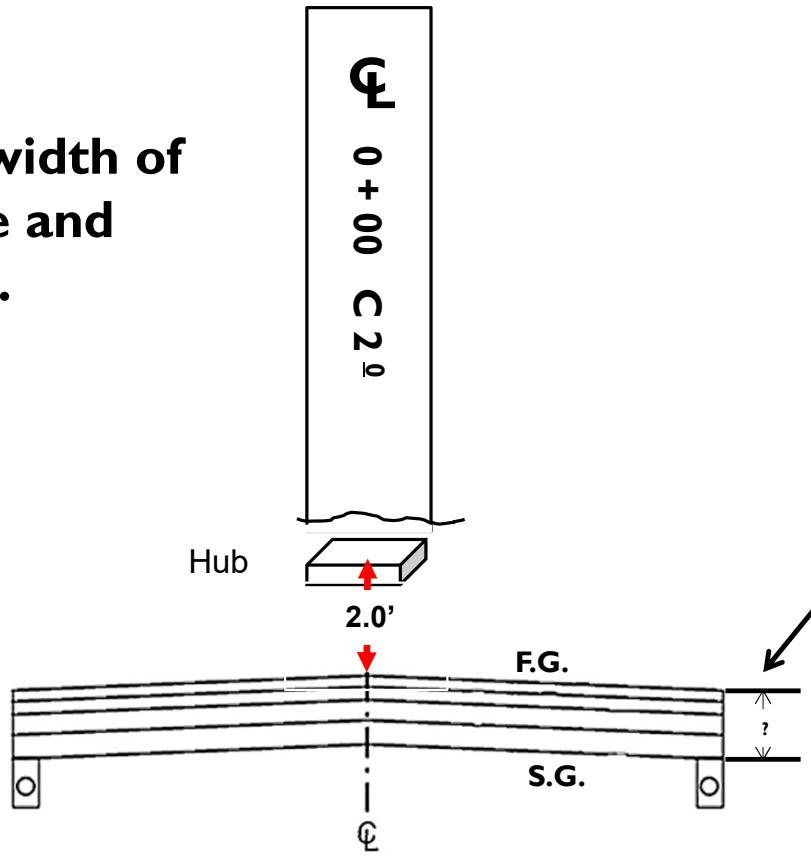
CURB STAKE VISUAL



What is the section thicknesses?

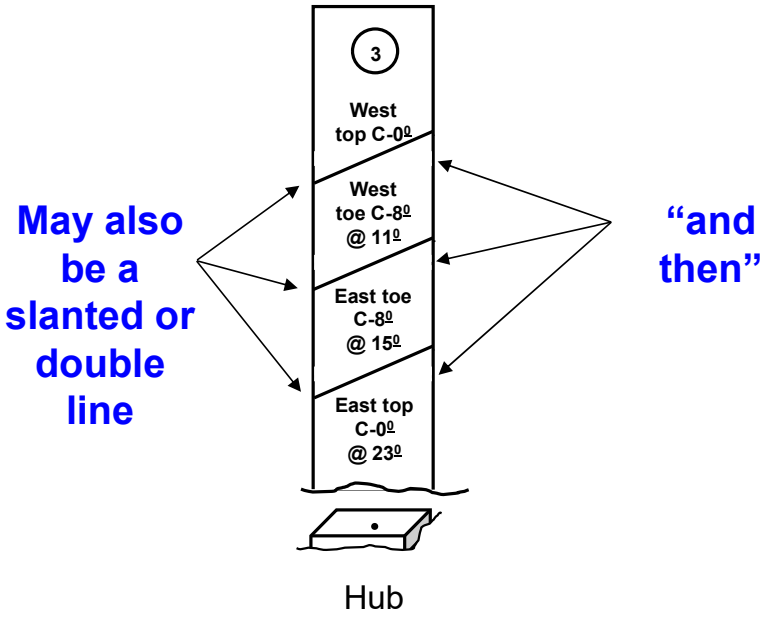
ROAD STAKE VISUAL

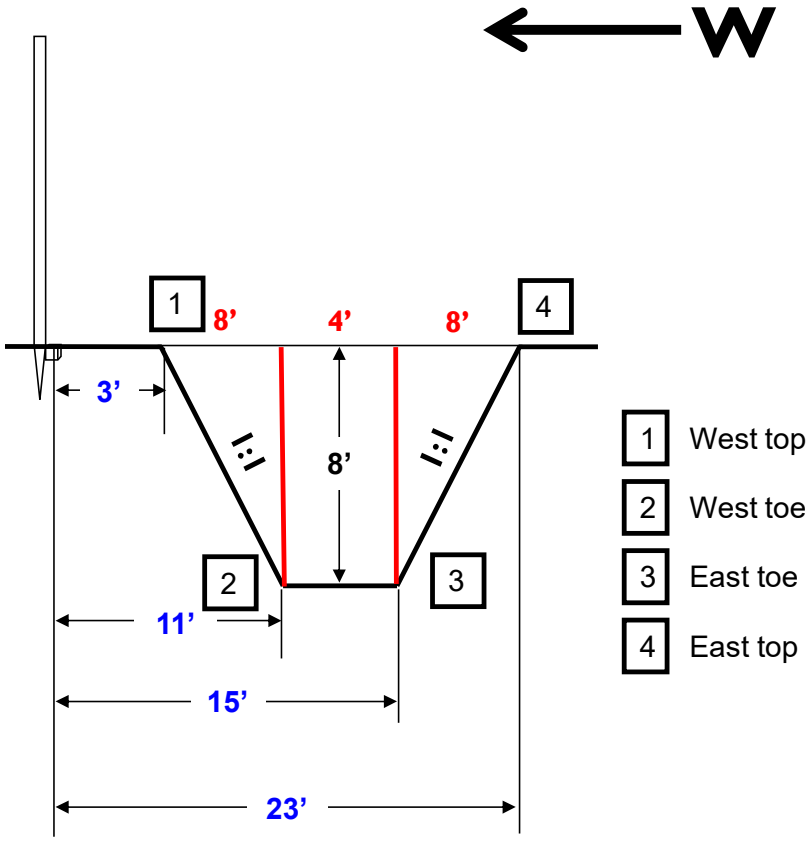
You need to know the width of road from centerline and percent of slope.



What is the section thickness for SG?

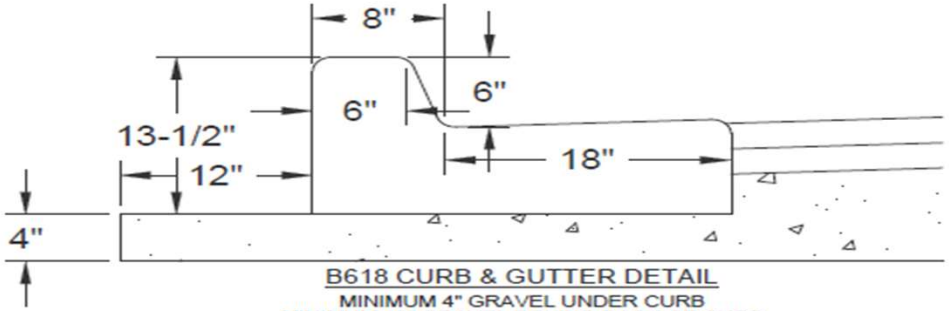
DITCH CHANNEL STAKE VISUAL



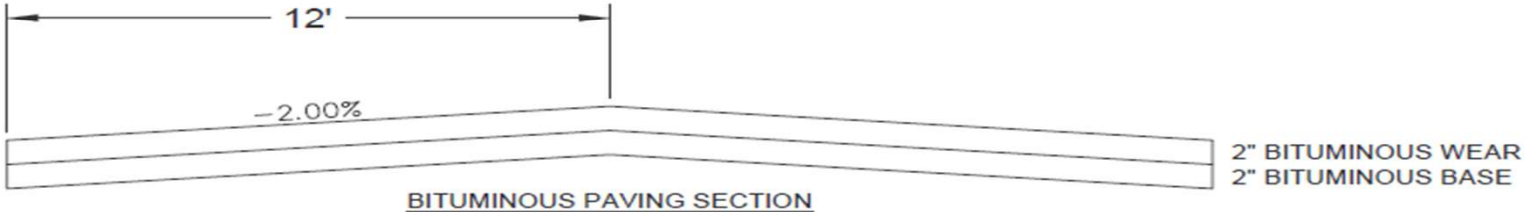


CONSTRUCTION STAKING - DETAILS

SIDEWALK DETAIL
NOT TO SCALE

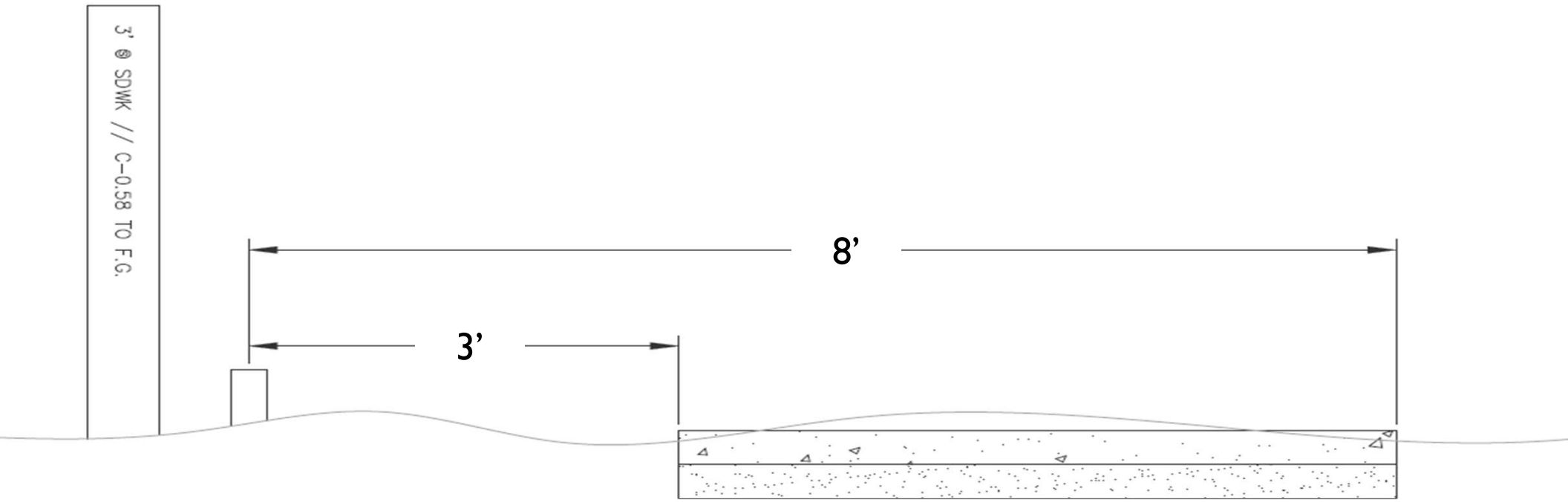


B618 CURB & GUTTER DETAIL
MINIMUM 4" GRAVEL UNDER CURB
MINIMUM 12" GRAVEL BEHIND BACK OF CURB
NOT TO SCALE

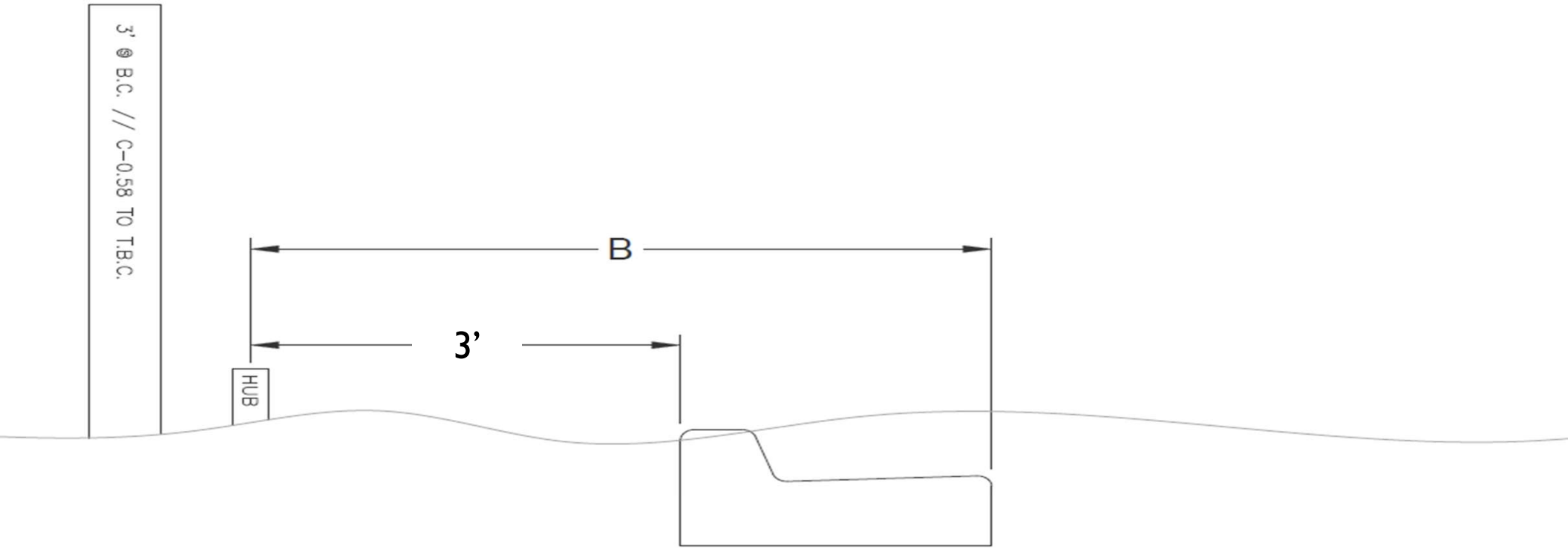


BITUMINOUS PAVING SECTION
NOT TO SCALE

CONSTRUCTION STAKING - SIDEWALK

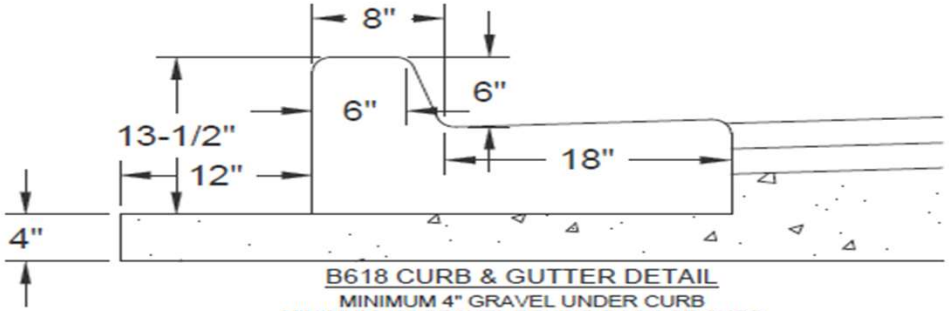


CONSTRUCTION STAKING - CURB & GUTTER

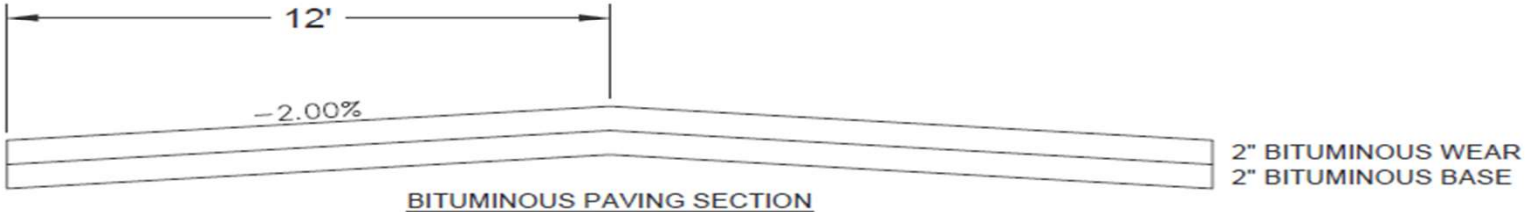


CONSTRUCTION STAKING - DETAILS

SIDEWALK DETAIL
NOT TO SCALE

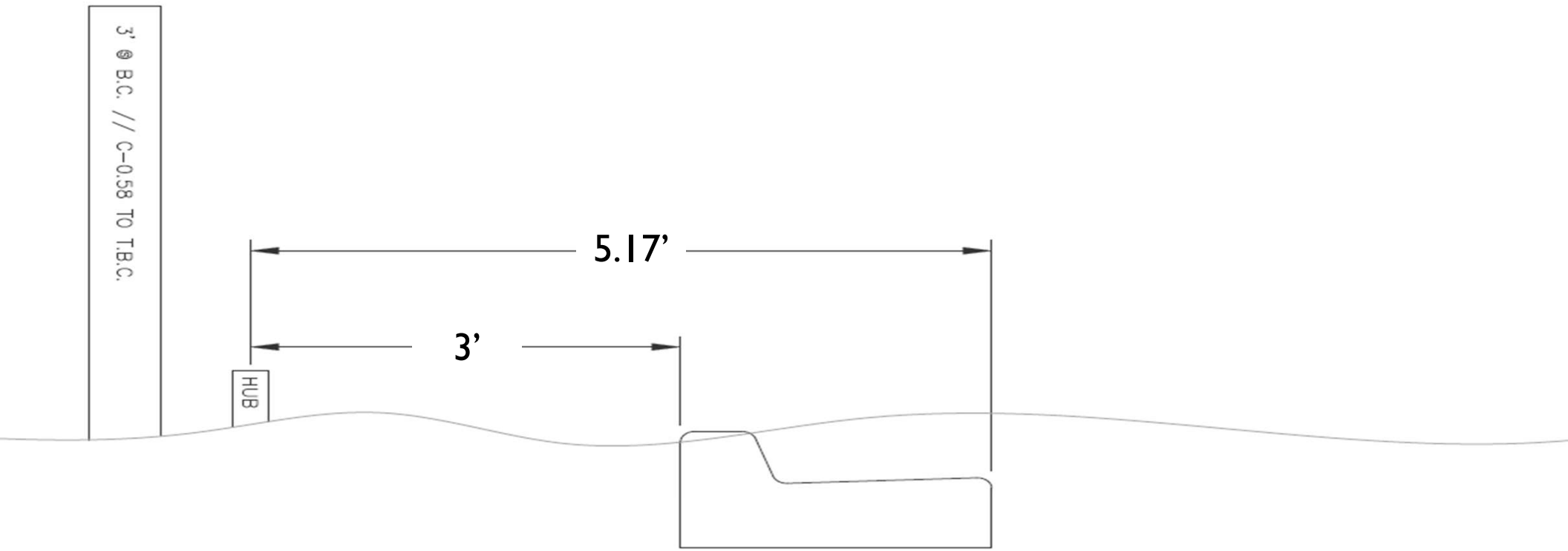


B618 CURB & GUTTER DETAIL
MINIMUM 4" GRAVEL UNDER CURB
MINIMUM 12" GRAVEL BEHIND BACK OF CURB
NOT TO SCALE

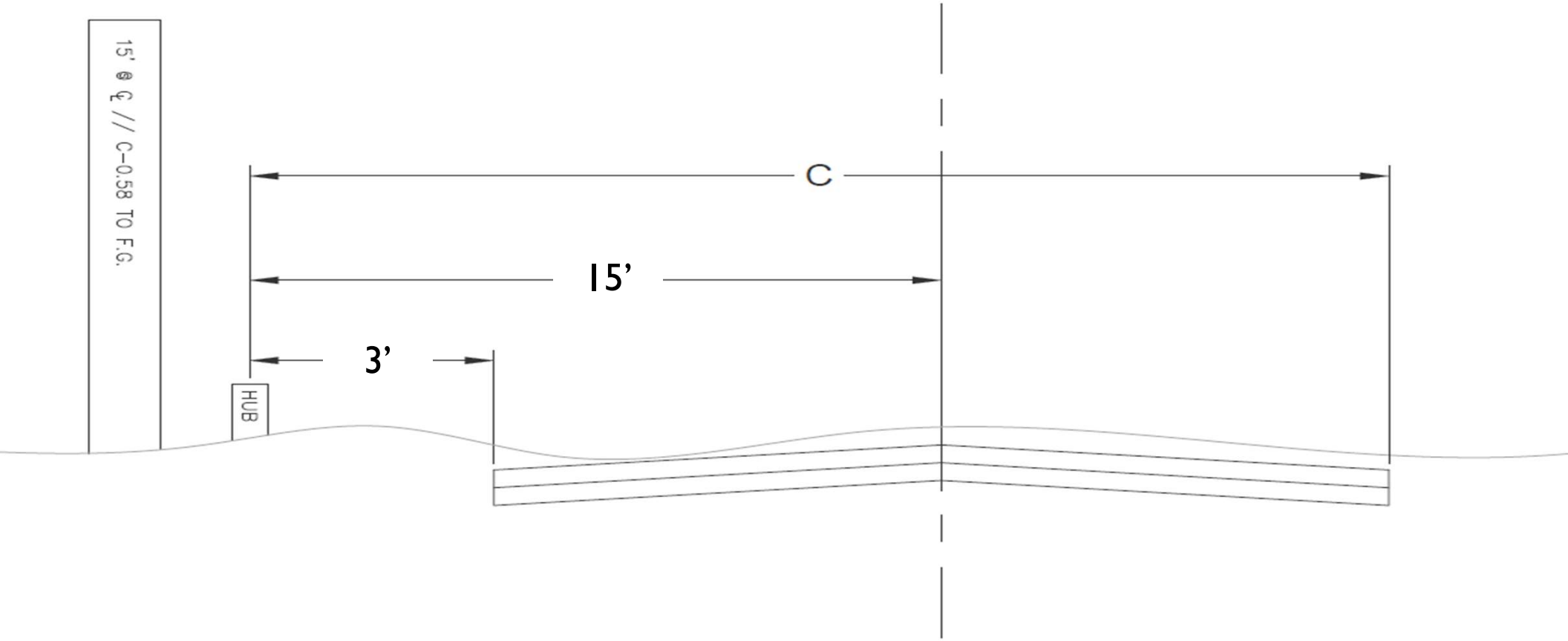


BITUMINOUS PAVING SECTION
NOT TO SCALE

CONSTRUCTION STAKING - CURB & GUTTER

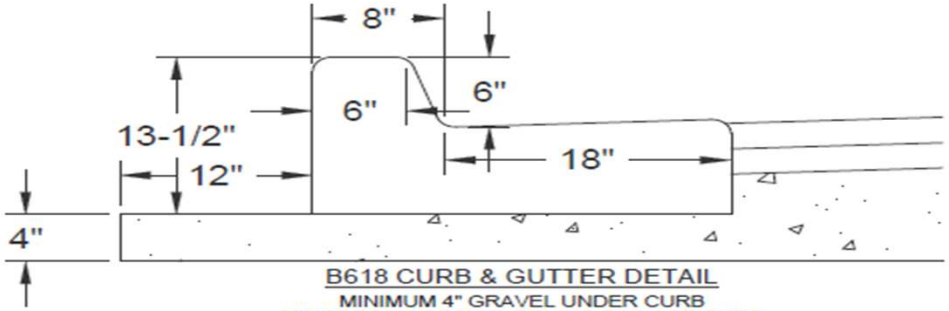


CONSTRUCTION STAKING - ROADWAY SECTION

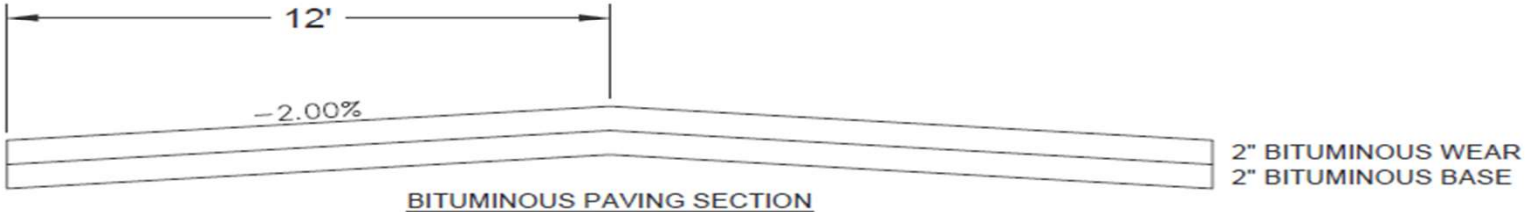


CONSTRUCTION STAKING - DETAILS

SIDEWALK DETAIL
NOT TO SCALE

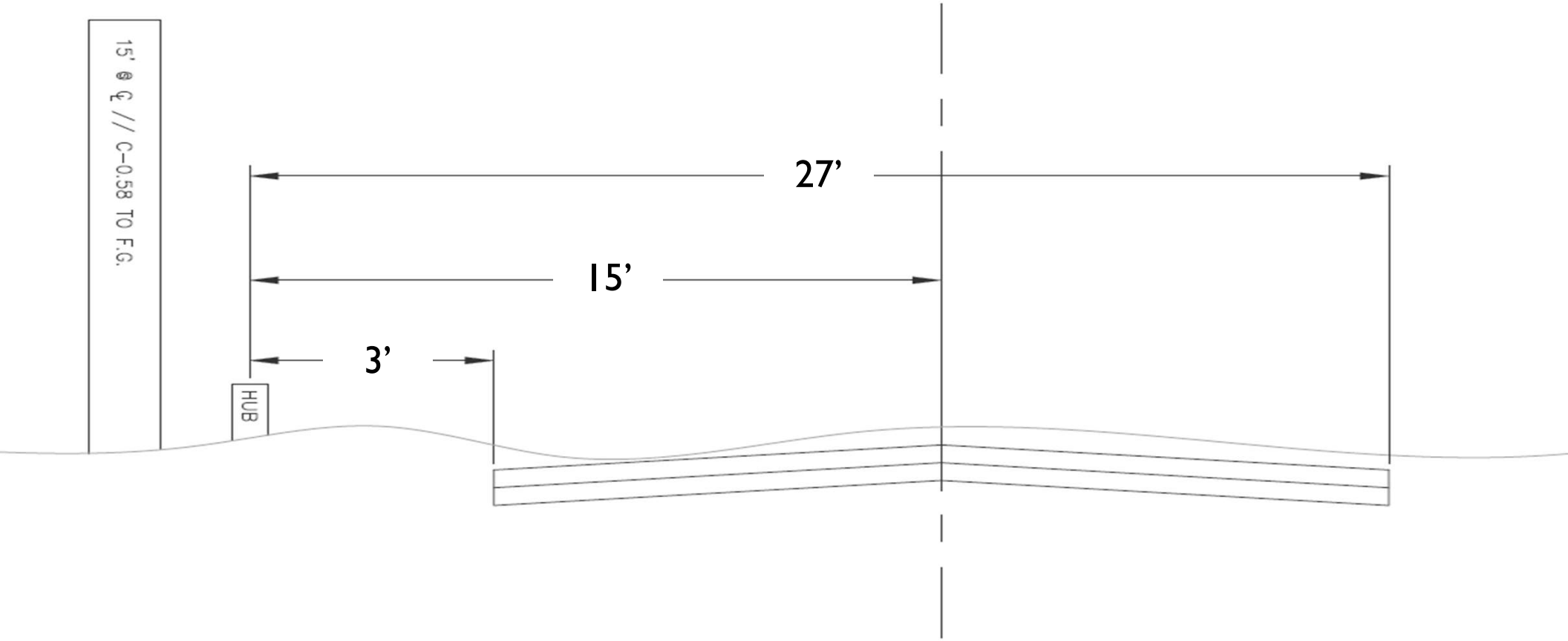


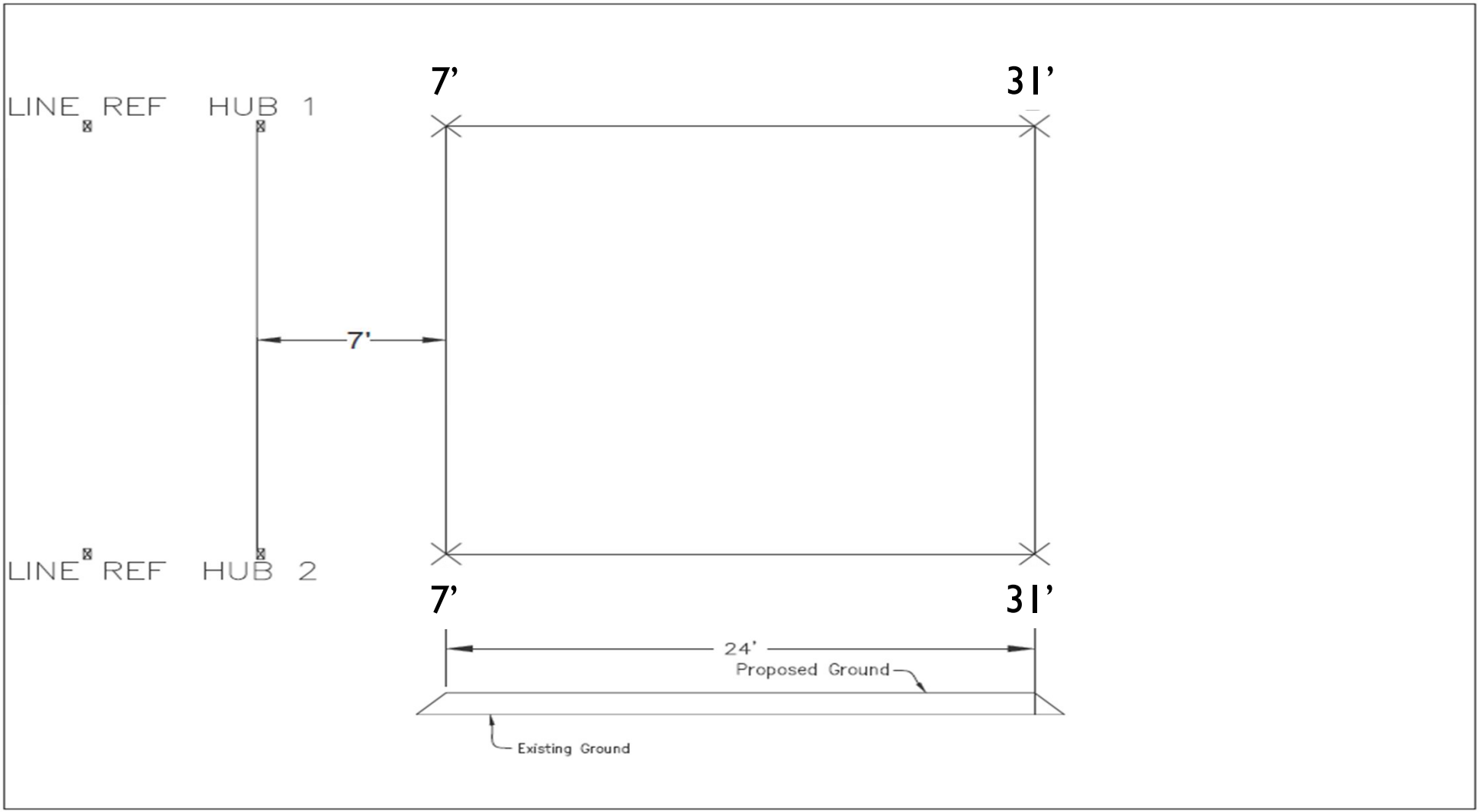
B618 CURB & GUTTER DETAIL
MINIMUM 4" GRAVEL UNDER CURB
MINIMUM 12" GRAVEL BEHIND BACK OF CURB
NOT TO SCALE

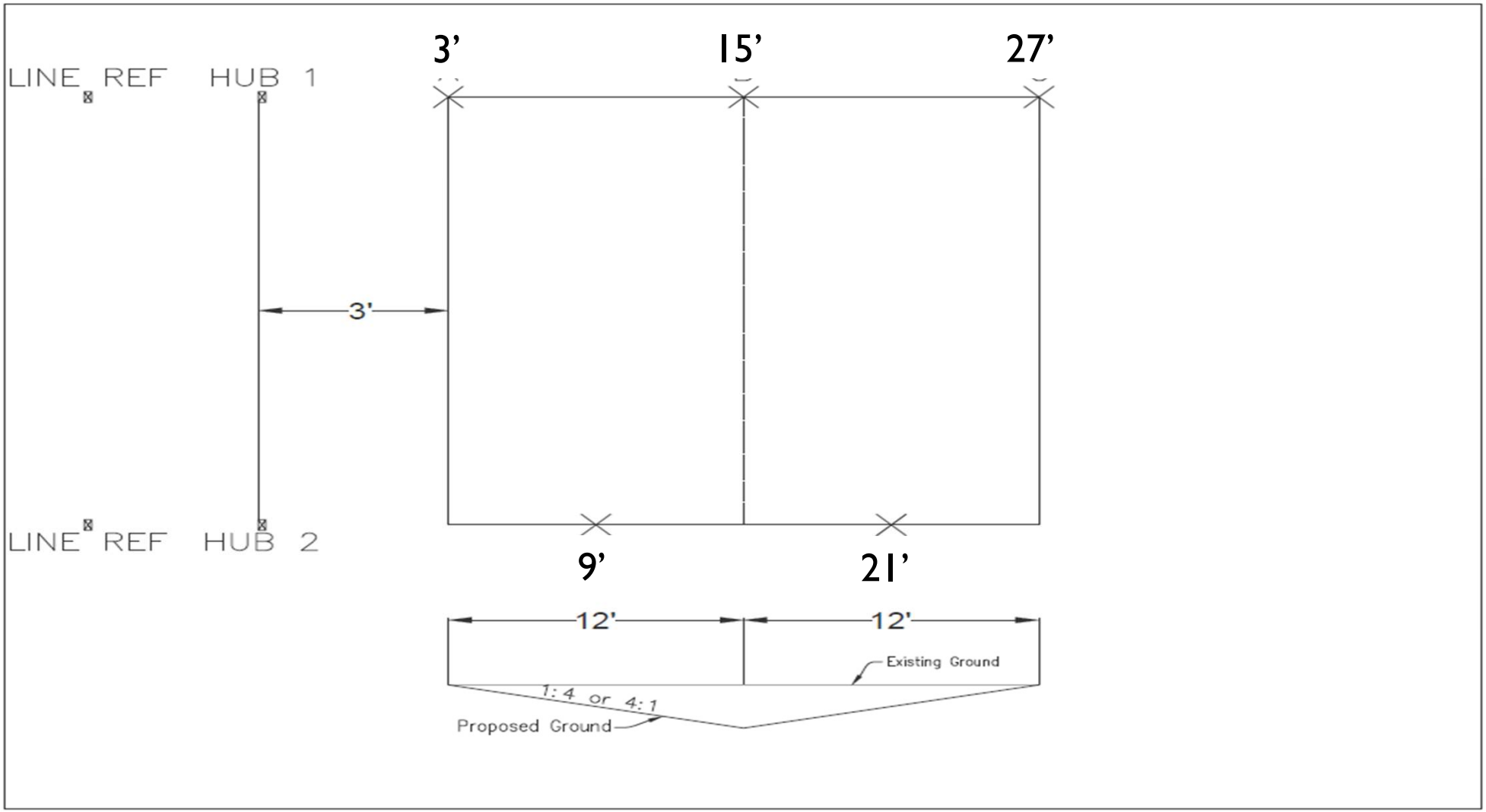


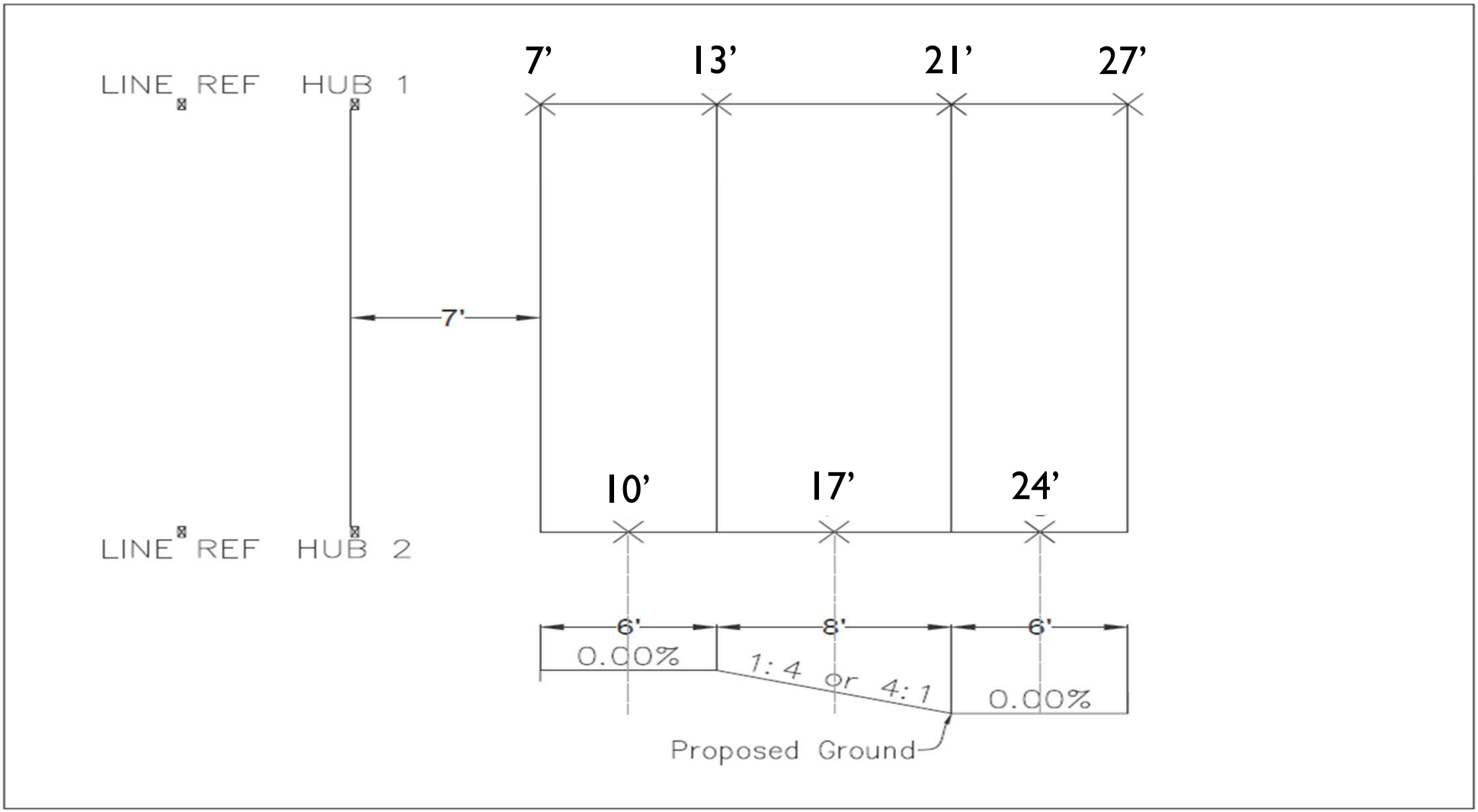
BITUMINOUS PAVING SECTION
NOT TO SCALE

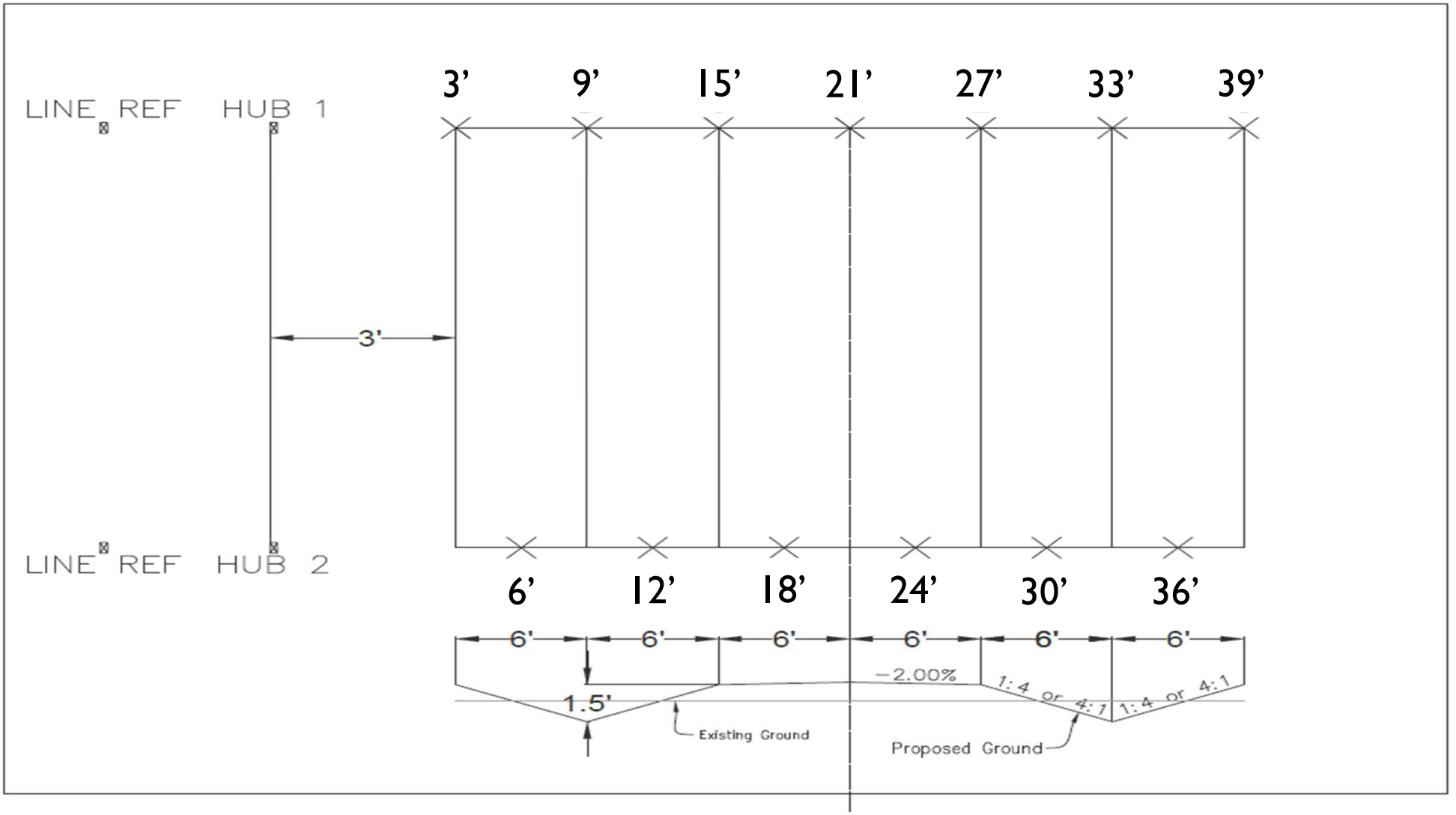
CONSTRUCTION STAKING - ROADWAY SECTION




LINE REF HUB 1
LINE REF HUB 2
7'
7'
31'
7'
31'
24'
Proposed Ground
Existing Ground

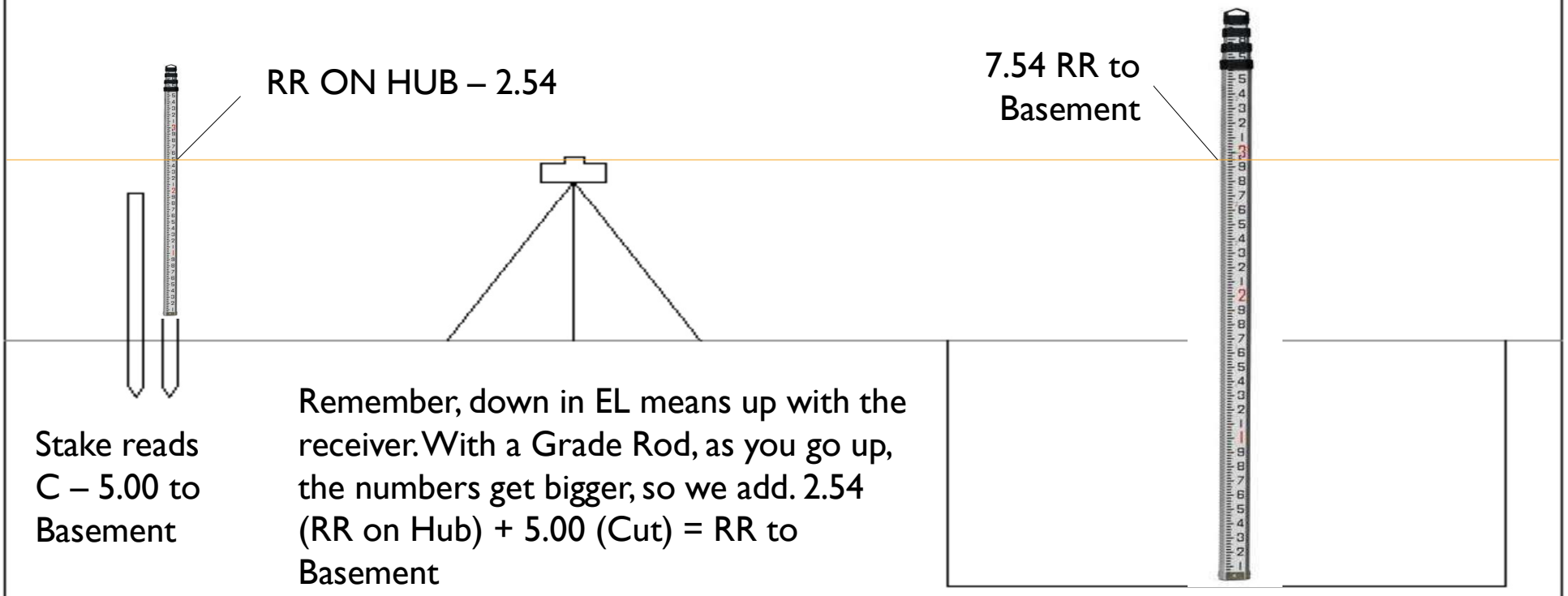

3'
15'
27'
LINE REF HUB 1
3'
LINE REF HUB 2
9'
21'
12'
12'
Existing Ground
1:4 or 4:1
Proposed Ground


LINE REF HUB 1
LINE REF HUB 2
7'
7'
13'
21'
27'
10'
17'
24'
6'
8'
6'
0.00%
1:4 or 4:1
0.00%
Proposed Ground


LINE REF HUB 1
LINE REF HUB 2
3'
3'
9'
15'
21'
27'
33'
39'
6'
12'
18'
24'
30'
36'
6'
6'
6'
6'
6'
6'
-2.00%
1.5'
1:4 or 4:1
1:4 or 4:1
Existing Ground
Proposed Ground

CONSTRUCTION STAKING – GRADE ROD

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

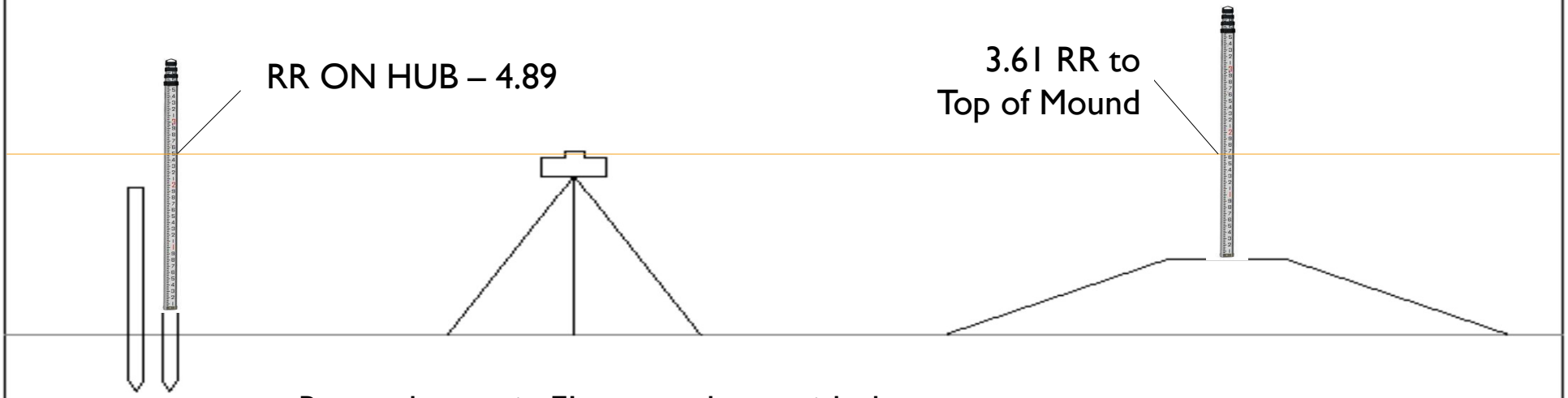


Stake reads C – 5.00 to Basement

Remember, down in EL means up with the receiver. With a Grade Rod, as you go up, the numbers get bigger, so we add. 2.54 (RR on Hub) + 5.00 (Cut) = RR to Basement

CONSTRUCTION STAKING – GRADE ROD

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



Stake reads
F – 1.28 to
Top of Mound

Remember, up in EL means down with the receiver. With a Grade Rod, as you go down, the numbers get smaller, so we subtract. 4.89 (RR on Hub) – 1.28 (Fill) = RR to Top of Mound

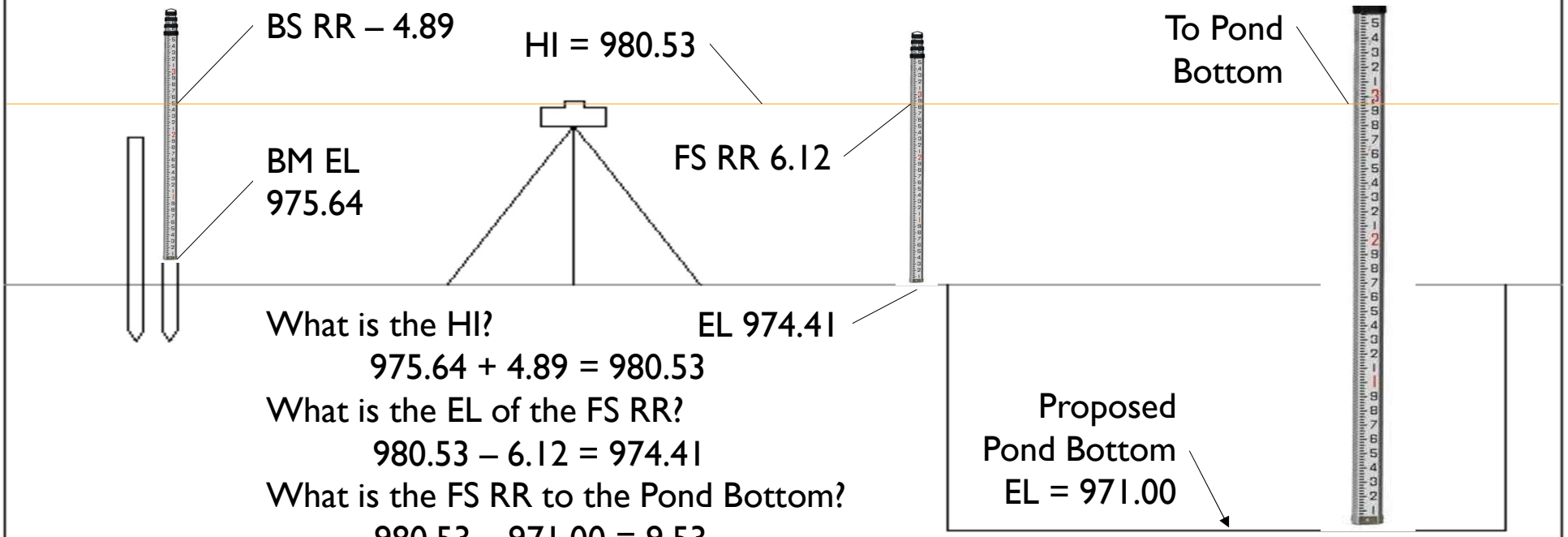
CONSTRUCTION STAKING USING BM – GRADE ROD

Equations

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

HI – Foresight (FS) = Elevation (EL)

HI – Proposed EL = FS RR



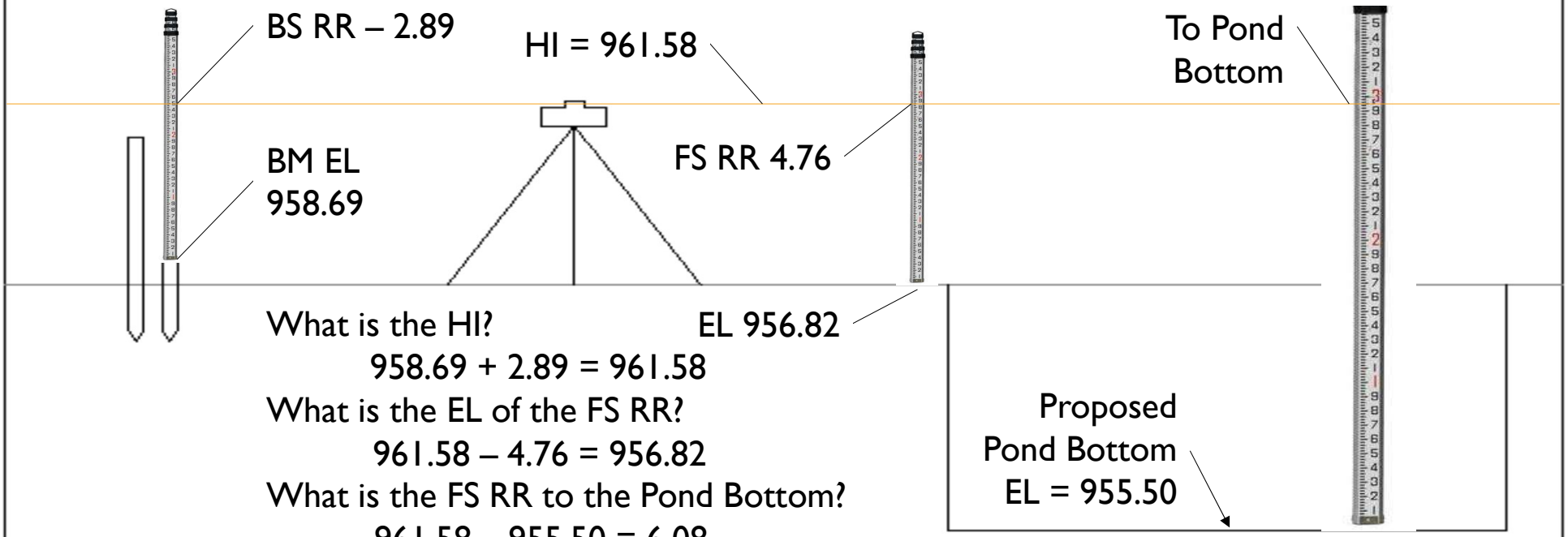
CONSTRUCTION STAKING USING BM – GRADE ROD

Equations

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

HI – Foresight (FS) = Elevation (EL)

HI – Proposed EL = FS RR



What is the HI?

958.69 + 2.89 = 961.58

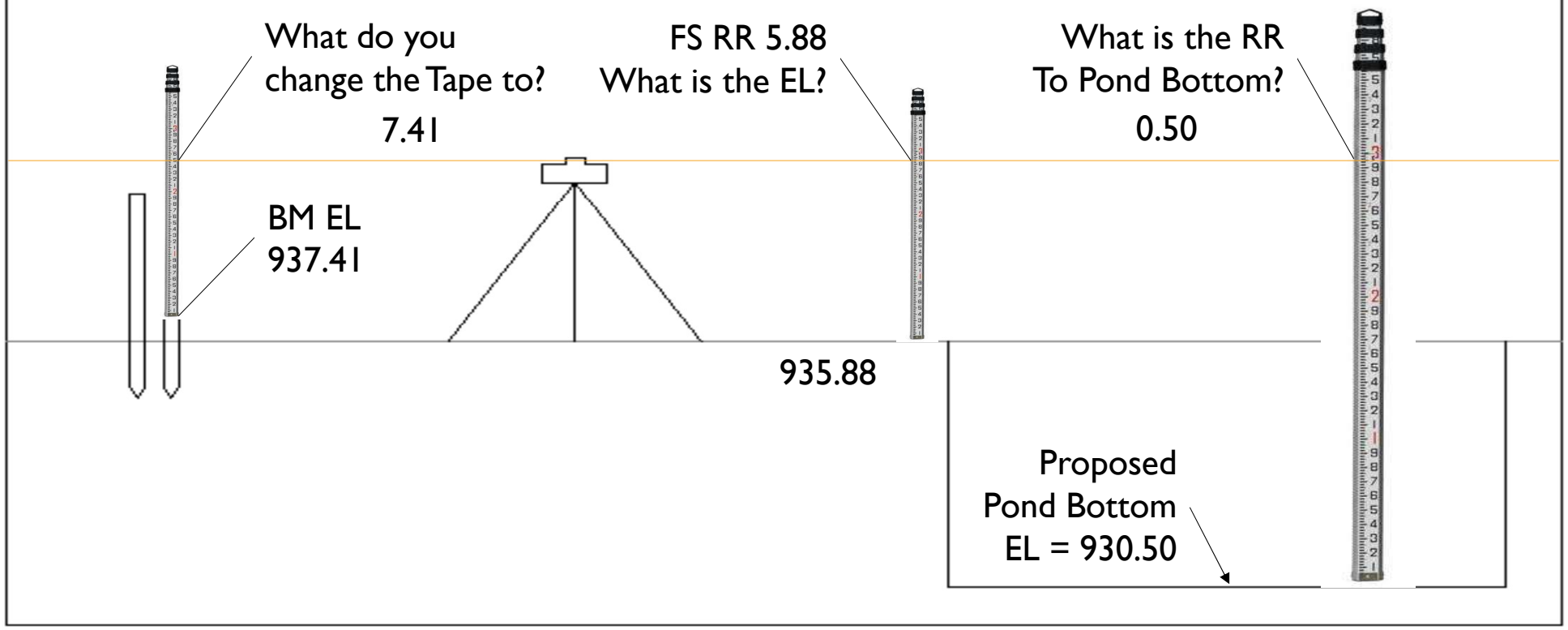
What is the EL of the FS RR?

961.58 – 4.76 = 956.82

What is the FS RR to the Pond Bottom?

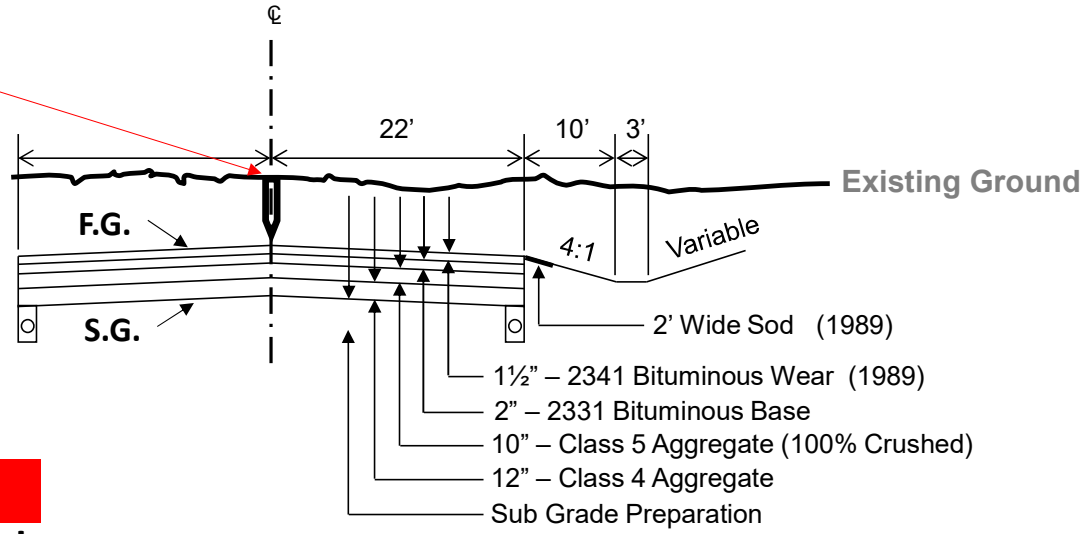
961.58 – 955.50 = 6.08

CONSTRUCTION STAKING USING BM – LENKER ROD



STAKE READING WITH SECTION USING 4' LEVEL AND TAPE

Cut 2 $\frac{00}{}$ to Finished Grade From Top of Hub



Formula

Section + Cut = Total Cut

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

Can we figure out the Cut to SG @ Centerline?

Yes, we can! How?

Add up all the Sections, converting to Decimal Feet and properly rounded = 2.13'

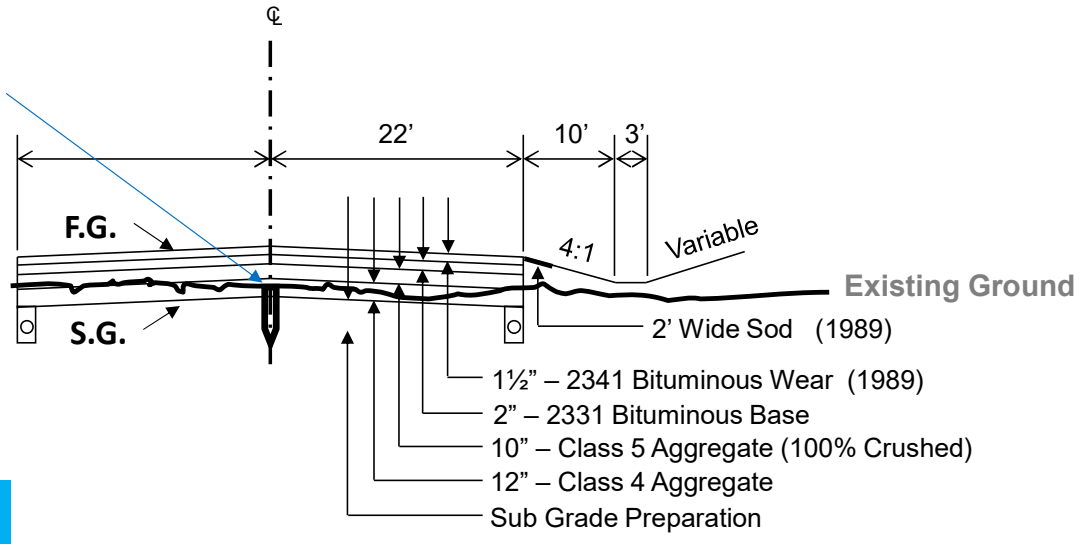
We know it's a Cut of 2.00' to FG @ Centerline and the formula says we add the Cut

Section Converted = 2.13' + Cut of 2.00' = 4.13' Total Cut

From the Top of the Hub, it's a C – 4.13' to S.G. @ Centerline

STAKE READING WITH SECTION USING 4' LEVEL AND TAPE

Fill 2 $\frac{00}{}$ to Finished Grade From Top of Hub



Formula

Section + Cut = Total Cut

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

Can we figure out the Cut to SG @ Centerline?

Yes, we can! How?

Add up all the Sections, converting to Decimal Feet and properly rounded = 2.13'

We know it's a Fill of 2.00' to FG @ Centerline and the formula says we subtract the Fill

Section Converted = 2.13' - Fill of 2.00' = 0.13' is a positive number

From the Top of the Hub, it's a C – 0.13' to S.G. @ Centerline

SECTION EXERCISE – SIDEWALK USING 4' LEVEL AND TAPE

Concrete Sidewalk Section

F.G.

4" – Concrete
4" – Sand Cushion

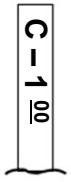
S.G.

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

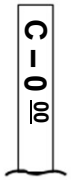
Total inches of all section thicknesses = **8"** Inches

Inches divided by 12 = **0.67'** Decimal Feet



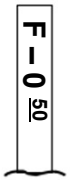
0.67 + 1.00 = 1.67'

Cut **1.67'** or Fill_____



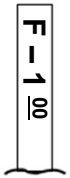
0.67 + 0.00 = 0.67'

Cut **0.67'** or Fill_____



0.67 – 0.50 = 0.17'

Cut **0.17'** or Fill_____

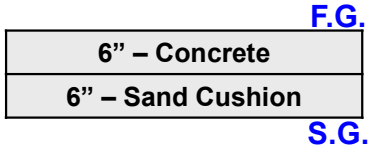


0.67 – 1.00 = -0.33'

Cut_____ or Fill **0.33'**

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.

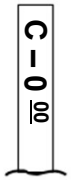
Formula
Section + Cut = Total Cut
Section - Fill = (-) is Fill & (+) is Cut

Total inches of all section thicknesses = **12"** Inches

Inches divided by 12 = **1.00'** Decimal Feet

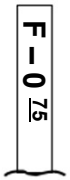
1.00 + 1.00 = 2.00'

Cut **2.00'** or Fill_____



1.00 + 0.00 = 1.00'

Cut **1.00'** or Fill_____



1.00 – 0.75 = 0.25'

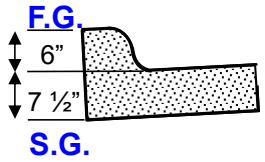
Cut **0.25'** or Fill_____

1.00 – 2.00 = -1.00'

Cut_____ or Fill **1.00'**

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 = **13-1/2"** Inches

Inches divided by 12 = **1.13'** Decimal Feet

C – 1 00

1.13 + 1.00 = 2.13'

Cut **2.13'** or Fill_____

C – 0 50

1.13 + 0.50 = 1.63'

Cut **1.63'** or Fill_____

F – 1 00

1.13 – 1.00 = 0.13'

Cut **0.13'** or Fill_____

F – 2 00

1.13 - 2.00 = -0.87'

Cut_____ or Fill **0.87'**

SECTION EXERCISE – ROADWAY USING 4' LEVEL AND TAPE

Blacktop Road Section

F.G.

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

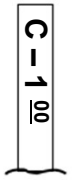
S.G.

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

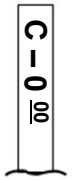
Total inches of all section thicknesses = **25-1/2"** Inches

Inches divided by 12 = **2.13'** Decimals Feet



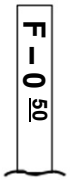
2.13 + 1.00 = 3.13'

Cut **3.13'** or Fill_____



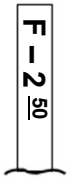
2.13 + 0.00 = 2.13'

Cut **2.13'** or Fill_____



2.13 – 0.50 = 1.63'

Cut **1.63'** or Fill_____



2.13 -2.50 = -0.37'

Cut_____ or Fill **0.37'**

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	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**	7.12	**(7.12 + 0.16) FG RR = 7.28**	**(7.28 + 0.67) SG RR = 7.95**	**(7.95 - 7.37) C – 0.58**
2	**F – 1.56 TO FG**	**4" CONCRETE 4" SAND**	6.22	**(6.22 - 1.56) FG RR = 4.66**	**(4.66 + 0.67) SG RR = 5.33**	**(5.33 - 6.42) F – 1.09**
3	**C – 0.34 TO FG**	**4" CONCRETE 4" SAND**	4.19	**(4.19 + 0.34) FG RR = 4.53**	**(4.53 + 0.67) SG RR = 5.20**	**(5.20 - 4.39) C – 0.81**
4	**F – 1.08 TO FG**	**4" CONCRETE 4" SAND**	10.22	**(10.22 - 1.08) FG RR = 9.14**	**(9.14 + 0.67) SG RR = 9.81**	**(9.81 - 10.52) F – 0.71**
5	**C – 0.67 TO FG**	**6" CONCRETE 6" SAND**	2.17	**(2.17 + 0.67) FG RR = 2.84**	**(2.84 + 1.00) SG RR = 3.84**	**(3.84 - 2.42) C – 1.42**
6	**F – 0.96 TO FG**	**6" CONCRETE 6" SAND**	3.02	**(3.02 - 0.96) FG RR = 2.06**	**(2.06 + 1.00) SG RR = 3.06**	**(3.06 - 3.52) F – 0.46**
7	**C – 1.43 TO FG**	**6" CONCRETE 6" SAND**	8.12	**(8.12 + 1.43) FG RR = 9.55**	**(9.55 + 1.00) SG RR = 10.55**	**(10.55 - 8.37) C – 2.18**
8	**F – 0.56 TO FG**	**6" CONCRETE 6" SAND**	9.13	**(9.13 - 0.56) FG RR = 8.57**	**(8.57 + 1.00) SG RR = 9.57**	**(9.57 - 9.28) C – 0.29**
9	**C – 1.21 TO FG**	**CURB & GUTTER 13 ½" SECTION**	6.27	**(6.27 + 1.21) FG RR = 7.48**	**(7.48 + 1.13) SG RR = 8.61**	**(8.61 - 6.53) C – 2.08**
10	**F – 0.85 TO FG**	**CURB & GUTTER 13 ½" SECTION**	5.74	**(5.74 - 0.85) FG RR = 4.89**	**(4.89 + 1.13) SG RR = 6.02**	**(6.02 - 6.00) C – 0.02**
11	**C – 0.01 TO FG**	**CURB & GUTTER 13 ½" SECTION**	9.24	**(9.24 + 0.01) FG RR = 9.25**	**(9.25 + 1.13) SG RR = 10.38**	**(10.38 - 9.43) C – 0.95**
12	**F – 2.02 TO FG**	**CURB & GUTTER 13 ½" SECTION**	6.22	**(6.22 - 2.02) FG RR = 4.20**	**(4.20 + 1.13) SG RR = 5.33**	**(5.33 - 6.52) F – 1.19**
13	**C – 0.85 TO FG**	**ROADWAY 25 ½" SECTION**	5.74	**(5.74 + 0.85) FG RR = 6.59**	**(6.59 + 2.13) SG RR = 8.72**	**(8.72 - 6.00) C – 2.72**
14	**F – 1.11 TO FG**	**ROADWAY 25 ½" SECTION**	3.52	**(3.52 - 1.11) FG RR = 2.41**	**(2.41 + 2.13) SG RR = 4.54**	**(4.54 - 3.79) C – 0.75**
15	**C – 2.44 TO FG**	**ROADWAY 25 ½" SECTION**	6.82	**(6.82 + 2.44) FG RR = 9.26**	**(9.26 + 2.13) SG RR = 11.39**	**(11.39 - 7.08) C – 4.31**
16	**F – 0.24 TO FG**	**ROADWAY 25 ½" SECTION**	4.74	**(4.74 - 0.24) FG RR = 4.50**	**(4.50 + 2.13) SG RR = 6.63**	**(6.63 - 4.98) C – 1.65**

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**	6.75	**(6.75 - 0.16) FG RR = 6.59**	**(6.59 - 0.67) SG RR = 5.92**	**(6.50 - 5.92) C – 0.58**
2	**F – 1.56 TO FG**	**4" CONCRETE 4" SAND**	4.28	**(4.28 + 1.56) FG RR = 5.84**	**(5.84 - 0.67) SG RR = 5.17**	**(4.03 - 5.17) F – 1.14**
3	**C – 0.34 TO FG**	**4" CONCRETE 4" SAND**	3.12	**(3.12 - 0.34) FG RR = 2.78**	**(2.78 - 0.67) SG RR = 2.11**	**(2.87 - 2.11) C – 0.76**
4	**F – 1.08 TO FG**	**4" CONCRETE 4" SAND**	10.10	**(10.10 + 1.08) FG RR = 11.18**	**(11.18 - 0.67) SG RR = 10.51**	**(9.85 - 10.51) F – 0.66**
5	**C – 0.67 TO FG**	**6" CONCRETE 6" SAND**	7.18	**(7.18 - 0.67) FG RR = 6.51**	**(6.51 - 1.00) SG RR = 5.51**	**(6.93 - 5.51) C – 1.42**
6	**F – 0.96 TO FG**	**6" CONCRETE 6" SAND**	5.44	**(5.44 + 0.96) FG RR = 6.40**	**(6.40 - 1.00) SG RR = 5.40**	**(5.19 - 5.40) F – 0.21**
7	**C – 1.43 TO FG**	**6" CONCRETE 6" SAND**	6.13	**(6.13 - 1.43) FG RR = 4.70**	**(4.70 - 1.00) SG RR = 3.70**	**(5.88 - 3.70) C – 2.18**
8	**F – 0.56 TO FG**	**6" CONCRETE 6" SAND**	7.88	**(7.88 + 0.56) FG RR = 8.44**	**(8.44 - 1.00) SG RR = 7.44**	**(7.63 - 7.44) C – 0.19**
9	**C – 1.21 TO FG**	**CURB & GUTTER 13 ½" SECTION**	6.97	**(6.97 - 1.21) FG RR = 5.76**	**(5.76 - 1.13) SG RR = 4.63**	**(6.72 - 4.63) C – 2.09**
10	**F – 0.85 TO FG**	**CURB & GUTTER 13 ½" SECTION**	12.12	**(12.12 + 0.85) FG RR = 12.97**	**(12.97 - 1.13) SG RR = 11.84**	**(11.87 - 11.84) C – 0.03**
11	**C – 0.01 TO FG**	**CURB & GUTTER 13 ½" SECTION**	2.60	**(2.60 - 0.01) FG RR = 2.59**	**(2.59 - 1.13) SG RR = 1.46**	**(2.35 - 1.46) C – 0.89**
12	**F – 2.02 TO FG**	**CURB & GUTTER 13 ½" SECTION**	4.13	**(4.13 + 2.02) FG RR = 6.15**	**(6.15 - 1.13) SG RR = 5.02**	**(3.88 - 5.02) F – 1.14**
13	**C – 0.85 TO FG**	**ROADWAY 25 ½" SECTION**	5.67	**(5.67 - 0.85) FG RR = 4.82**	**(4.82 - 2.13) SG RR = 2.69**	**(5.42 - 2.69) C – 2.73**
14	**F – 1.11 TO FG**	**ROADWAY 25 ½" SECTION**	7.44	**(7.44 + 1.11) FG RR = 8.55**	**(8.55 - 2.13) SG RR = 6.42**	**(7.19 - 6.42) C – 0.77**
15	**C – 2.44 TO FG**	**ROADWAY 25 ½" SECTION**	9.13	**(9.13 - 2.44) FG RR = 6.69**	**(6.69 - 2.13) SG RR = 4.56**	**(8.88 - 4.56) C – 4.32**
16	**F – 0.24 TO FG**	**ROADWAY 25 ½" SECTION**	8.42	**(8.42 + 0.24) FG RR = 8.66**	**(8.66 - 2.13) SG RR = 6.53**	**(8.17 - 6.53) C – 1.64**

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	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**	4.58	(4.58 + 0.16) 4.74	(4.74 + 0.67) 5.41	(5.41 - 4.88) C – 0.53
2	**F – 1.56 TO FG**	**4" CONCRETE 4" SAND**	7.69	(7.69 – 1.56) 6.13	(6.13 + 0.67) 6.80	(6.80 - 7.99) F – 1.19
3	**C – 0.34 TO FG**	**4" CONCRETE 4" SAND**	3.25	(3.25 + 0.34) 3.59	(3.59 + 0.67) 4.26	(4.26 - 3.55) C – 0.71
4	**F – 1.08 TO FG**	**4" CONCRETE 4" SAND**	9.54	(9.54 – 1.08) 8.46	(8.46 + 0.67) 9.13	(9.13 - 9.84) F – 0.71
5	**C – 0.67 TO FG**	**6" CONCRETE 6" SAND**	4.22	(4.22 + 0.67) 4.89	(4.89 + 1.00) 5.89	(5.89 - 4.52) C – 1.37
6	**F – 0.96 TO FG**	**6" CONCRETE 6" SAND**	6.98	(6.98 – 0.96) 6.02	(6.02 + 1.00) 7.02	(7.02 - 7.28) F – 0.26
7	**C – 1.43 TO FG**	**6" CONCRETE 6" SAND**	8.58	(8.58 + 1.43) 10.01	(10.01 + 1.00) 11.01	(11.01 - 8.88) C – 2.13
8	**F – 0.56 TO FG**	**6" CONCRETE 6" SAND**	15.54	(15.54 – 0.56) 14.98	(14.98 + 1.00) 15.98	(15.98 - 15.84) C – 0.14
9	**C – 1.21 TO FG**	**CURB & GUTTER 13 ½" SECTION**	5.24	(5.24 + 1.21) 6.45	(6.45 + 1.13) 7.58	(7.58 - 5.54) C – 2.04
10	**F – 0.85 TO FG**	**CURB & GUTTER 13 ½" SECTION**	6.85	(6.85 – 0.85) 6.00	(6.00 + 1.13) 7.13	(7.13 - 7.15) F – 0.02
11	**C – 0.01 TO FG**	**CURB & GUTTER 13 ½" SECTION**	5.69	(5.69 + 0.01) 5.70	(5.70 + 1.13) 6.83	(6.83 - 5.99) C – 0.84
12	**F – 2.02 TO FG**	**CURB & GUTTER 13 ½" SECTION**	12.69	(12.69 – 2.02) 10.67	(10.67 + 1.13) 11.80	(11.80 - 12.99) F – 1.19
13	**C – 0.85 TO FG**	**ROADWAY 25 ½" SECTION**	10.12	(10.12 + 0.85) 10.97	(10.97 + 2.13) 13.10	(13.10 - 10.42) C – 2.68
14	**F – 1.11 TO FG**	**ROADWAY 25 ½" SECTION**	3.52	(3.52 – 1.11) 2.41	(2.41 + 2.13) 4.54	(4.54 - 3.82) C – 0.72
15	**C – 2.44 TO FG**	**ROADWAY 25 ½" SECTION**	7.26	(7.26 + 2.44) 9.70	(9.70 + 2.13) 11.83	(11.83 - 7.56) C – 4.27
16	**F – 0.24 TO FG**	**ROADWAY 25 ½" SECTION**	8.22	(8.22 – 0.24) 7.98	(7.98 + 2.13) 10.11	(10.11 - 8.52) C – 1.59

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**	4.52	(4.52 – 0.16) 4.36	(4.36 - 0.67) 3.69	(4.22 - 3.69) C – 0.53
2	**F – 1.56 TO FG**	**4" CONCRETE 4" SAND**	3.54	(3.54 + 1.56) 5.10	(5.10 - 0.67) 4.43	(3.24 - 4.43) F – 1.19
3	**C – 0.34 TO FG**	**4" CONCRETE 4" SAND**	6.89	(6.89 – 0.34) 6.55	(6.55 - 0.67) 5.88	(6.59 - 5.88) C – 0.71
4	**F – 1.08 TO FG**	**4" CONCRETE 4" SAND**	5.12	(5.12 + 1.08) 6.20	(6.20 - 0.67) 5.53	(4.82 - 5.53) F – 0.71
5	**C – 0.67 TO FG**	**6" CONCRETE 6" SAND**	4.86	(4.86 - 0.67) 4.19	(4.19 - 1.00) 3.19	(4.56 - 3.19) C – 1.37
6	**F – 0.96 TO FG**	**6" CONCRETE 6" SAND**	6.33	(6.33 + 0.96) 7.29	(7.29 - 1.00) 6.29	(6.03 - 6.29) F – 0.26
7	**C – 1.43 TO FG**	**6" CONCRETE 6" SAND**	5.63	(5.63 - 1.43) 4.20	(4.20 - 1.00) 3.20	(5.33 - 3.20) C – 2.13
8	**F – 0.56 TO FG**	**6" CONCRETE 6" SAND**	3.96	(3.96 + 0.56) 4.52	(4.52 - 1.00) 3.52	(3.66 - 3.52) C – 0.14
9	**C – 1.21 TO FG**	**CURB & GUTTER 13 ½" SECTION**	4.85	(4.85 - 1.21) 3.64	(3.64 - 1.13) 2.51	(4.55 - 2.51) C – 2.04
10	**F – 0.85 TO FG**	**CURB & GUTTER 13 ½" SECTION**	3.77	(3.77 + 0.85) 4.62	(4.62 - 1.13) 3.49	(3.47 - 3.49) F – 0.02
11	**C – 0.01 TO FG**	**CURB & GUTTER 13 ½" SECTION**	6.32	(6.32 - 0.01) 6.31	(6.31 - 1.13) 5.18	(6.02 - 5.18) C – 0.84
12	**F – 2.02 TO FG**	**CURB & GUTTER 13 ½" SECTION**	5.89	(5.89 + 2.02) 7.91	(7.91 - 1.13) 6.78	(5.59 - 6.78) F – 1.19
13	**C – 0.85 TO FG**	**ROADWAY 25 ½" SECTION**	4.63	(4.63 - 0.85) 3.78	(3.78 - 2.13) 1.65	(4.33 - 1.65) C – 2.68
14	**F – 1.11 TO FG**	**ROADWAY 25 ½" SECTION**	3.75	(3.75 + 1.11) 4.86	(4.86 - 2.13) 2.73	(3.45 - 2.73) C – 0.72
15	**C – 2.44 TO FG**	**ROADWAY 25 ½" SECTION**	6.12	(6.12 - 2.44) 3.68	(3.68 - 2.13) 1.55	(5.82 - 1.55) C – 4.27
16	**F – 0.24 TO FG**	**ROADWAY 25 ½" SECTION**	5.41	(5.41 + 0.24) 5.65	(5.65 - 2.13) 3.52	(5.11 - 3.52) C – 1.59

SECTION 5

Pacing & Proration

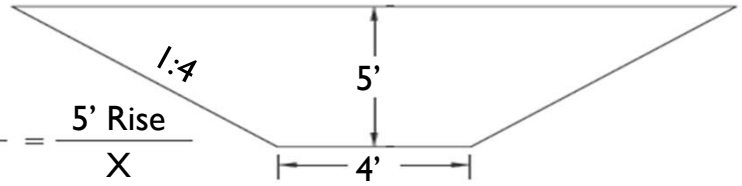
Total Trench Exercise

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

= 14 X 1 = 14 / 4 = X = 3.5'

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

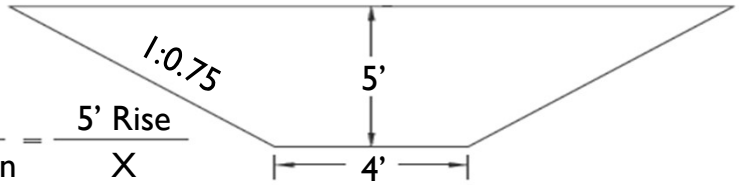
= 5 X 4 = 20 / 1 = X = 20'



1' Rise / 4' Run = 5' Rise / X

4 x 5 = / 1 = X = 20

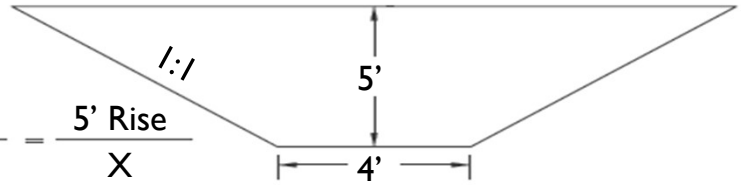
20 x 2 (Sides) = + 4 = 44' TT



1' Rise / 0.75' Run = 5' Rise / X

0.75 x 5 = / 1 = X = 3.75

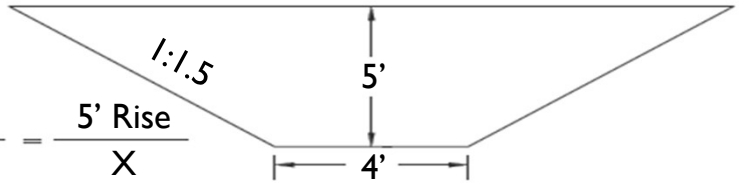
3.75 x 2 (Sides) = + 4 = 11.5' TT



1' Rise / 1' Run = 5' Rise / X

1 x 5 = / 1 = X = 5

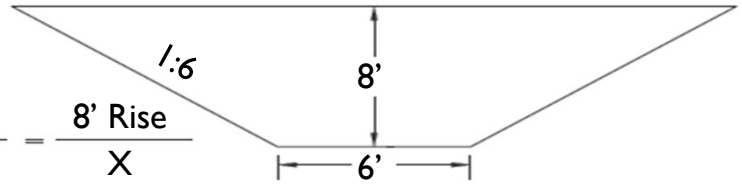
5 x 2 (Sides) = + 4 = 14' TT



1' Rise / 1.5' Run = 5' Rise / X

1.5 x 5 = / 1 = X = 7.5

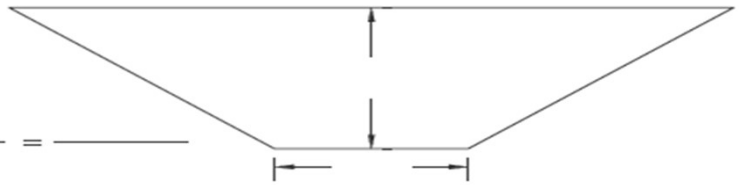
7.5 x 2 (Sides) = + 4 = 19' TT

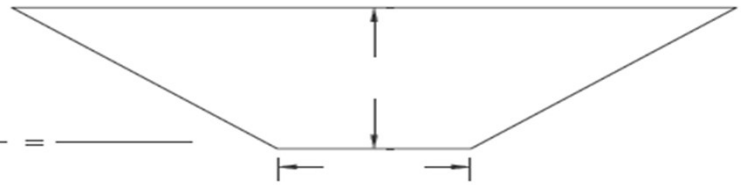


1' Rise / 6' Run = 8' Rise / X

6 x 8 = / 1 = X = 48

48 x 2 (Sides) = + 6 = 102' TT





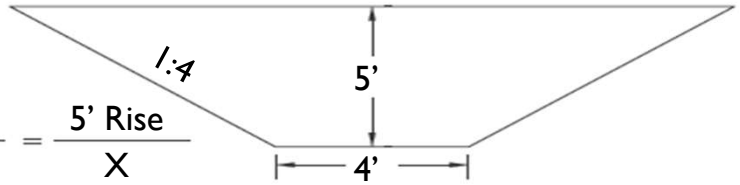
Total Trench Exercise

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

= 14 X 1 = 14 / 4 = X = 3.5'

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

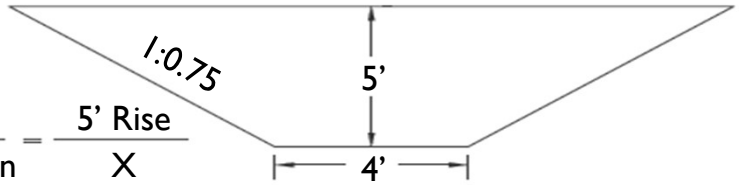
= 5 X 4 = 20 / 1 = X = 20'



1' Rise / 4' Run = 5' Rise / X

4 x 5 = / 1 = X = 20

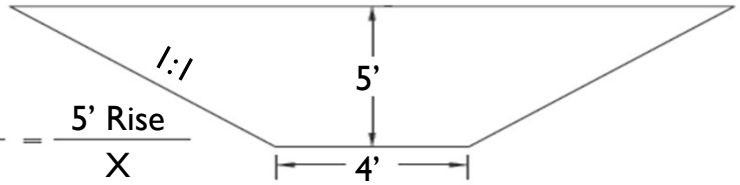
20 x 2 (Sides) = + 4 = 44' TT



1' Rise / 0.75' Run = 5' Rise / X

0.75 x 5 = / 1 = X = 3.75

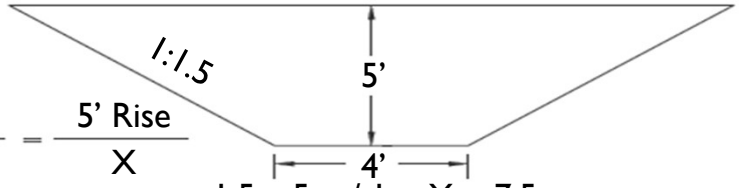
3.75 x 2 (Sides) = + 4 = 11.5' TT



1' Rise / 1' Run = 5' Rise / X

1 x 5 = / 1 = X = 5

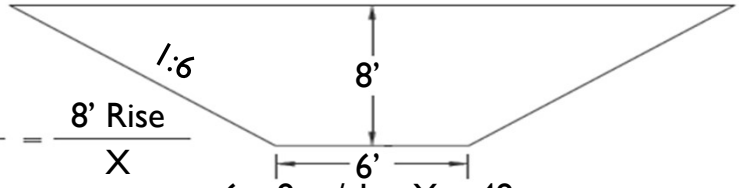
5 x 2 (Sides) = + 4 = 14' TT



1' Rise / 1.5' Run = 5' Rise / X

1.5 x 5 = / 1 = X = 7.5

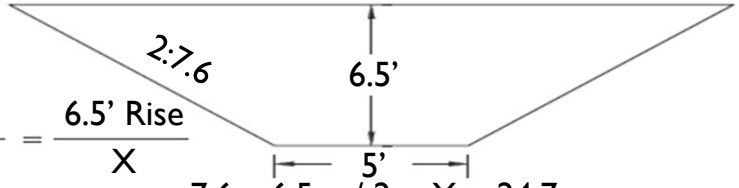
7.5 x 2 (Sides) = + 4 = 19' TT



1' Rise / 6' Run = 8' Rise / X

6 x 8 = / 1 = X = 48

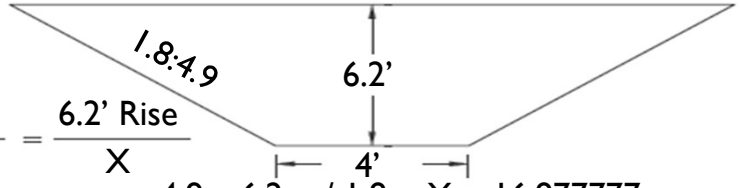
48 x 2 (Sides) = + 6 = 102' TT



2' Rise / 7.6' Run = 6.5' Rise / X

7.6 x 6.5 = / 2 = X = 24.7

24.7 x 2 (Sides) = + 5 = 54.4' TT



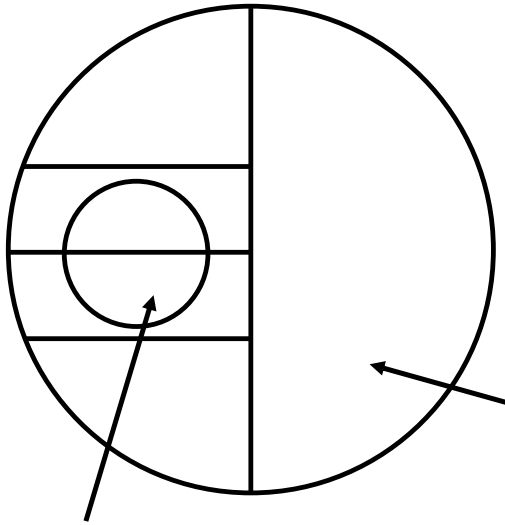
1.8' Rise / 4.9' Run = 6.2' Rise / X

4.9 x 6.2 = / 1.8 = X = 16.877777

16.8777777 x 2 (Sides) = + 4 = 37.76' TT

SECTION 6

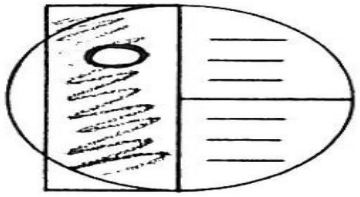
Eye Levels



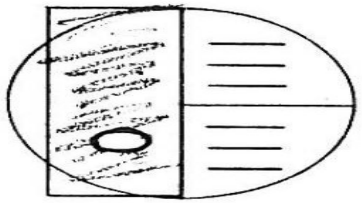
Viewing Area

Bubble in middle is what you want

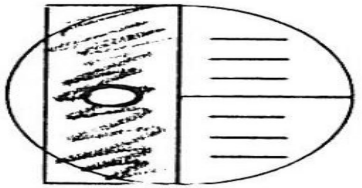
EYE LEVELS – WHAT TO LOOK FOR



LINE OF SIGHT TOO HIGH



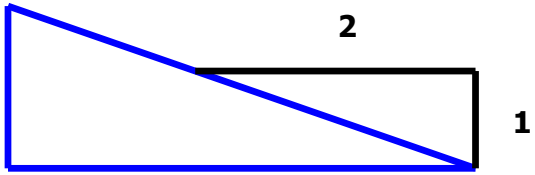
LINE OF SIGHT TOO LOW



LINE OF SIGHT IS LEVEL

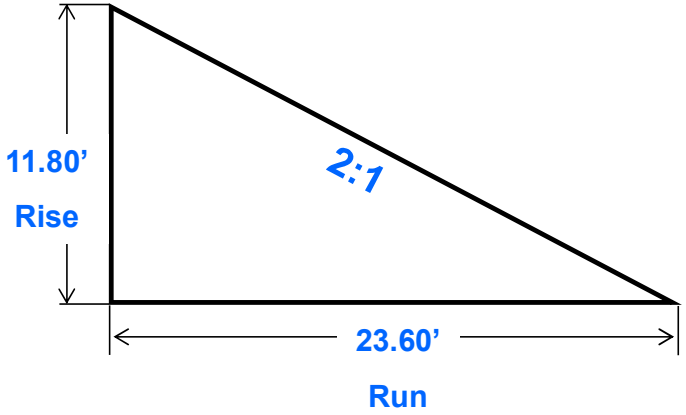
SECTION 7

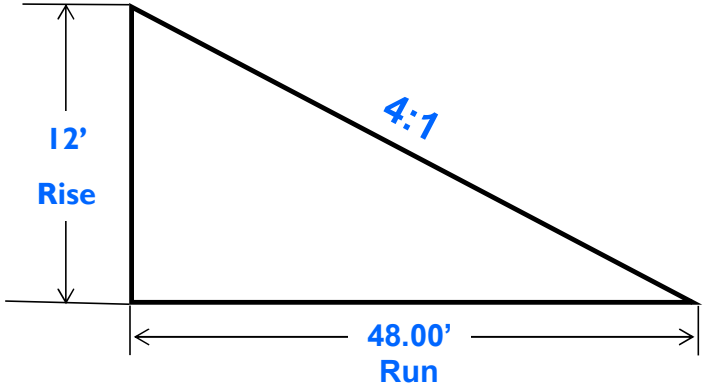
Slope Ratio



2:1 or 1:2

DETERMINING SLOPE RATIOS





How is slope ratio arrived at?

The formula is:

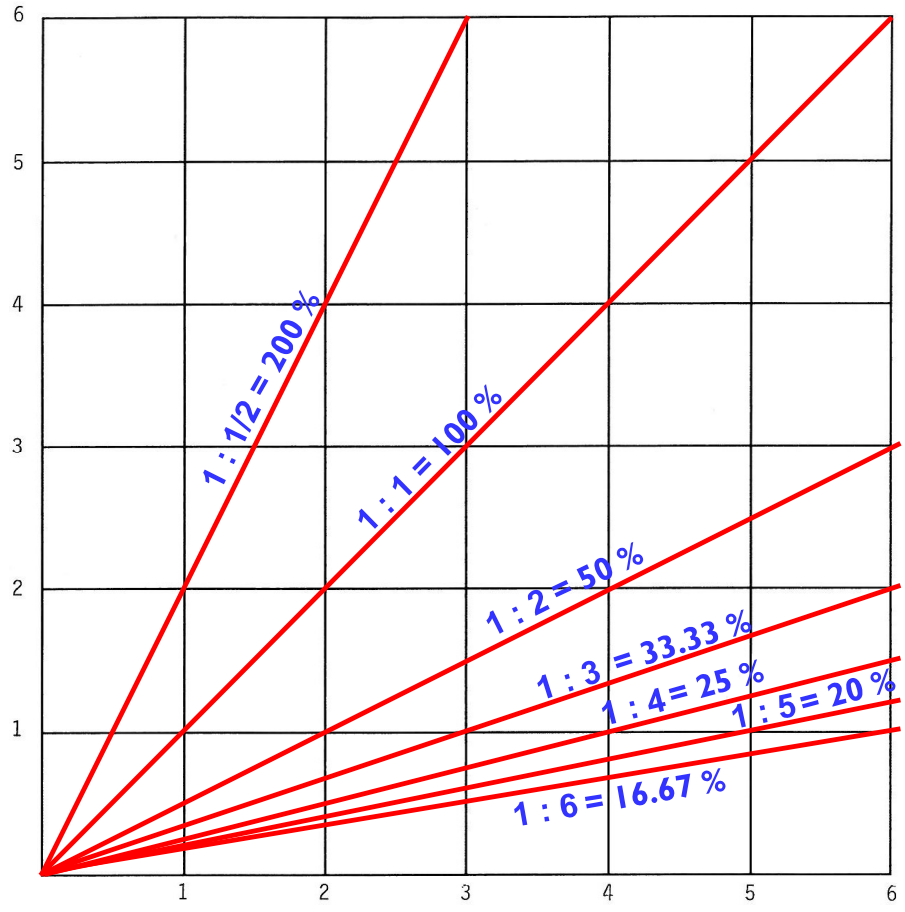
$$\frac{23.60' \text{ Run}}{11.80' \text{ Rise}} = \text{Slope Ratio } 2:1$$

What is this slope ratio?

$$\frac{48 \text{ Run}}{12 \text{ Rise}} = \text{Slope Ratio } 4:1$$

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



SECTION 8

Percentages

PERCENTAGE APPLICATIONS

What applications do we use percentage for?

Roadways and pipes

CALCULATING PERCENTAGES

Formula

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

2,552 Miles x 5,280 (Ft./Mile) = 13,474,560 Ft.

$$\frac{\text{Rise}}{\text{1475 Ft.}} \div \frac{\text{Run}}{\text{13,474,560 Ft.}} = 0.0001094 \text{ FT/FT}$$

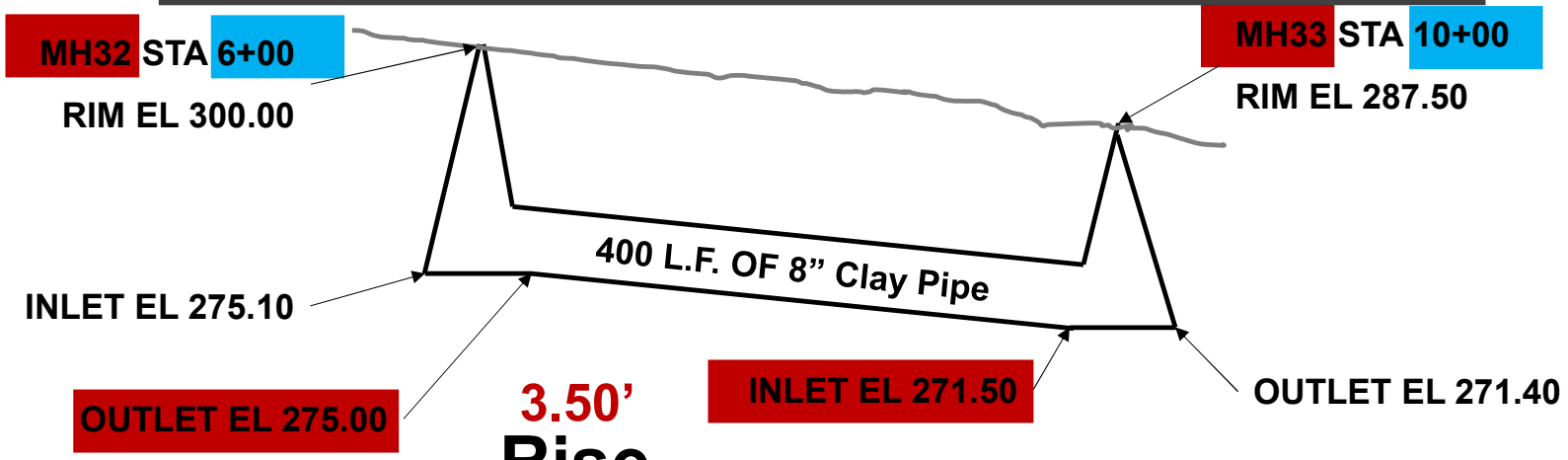
0.0001094 FT/FT x 100 = % = 0.01 %

COMMON SENSE PERCENTAGES

Percent	Rise/Fall	Distance
1%	1’	100’
2%	2’	100’
3%	3’	100’
4%	4’	100’
5%	5’	100’

Percent	Rise/Fall	Distance
6%	6’	100’
7%	7’	100’
8%	8’	100’
9%	9’	100’
10%	10’	100’

DETERMINING FT/FT (GOLD)



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

$$\frac{3.50'}{400'} = 0.00875'$$

Outlet Elevation @ MH32 Station 6+00 = 275.00'

Inlet Elevation @ MH33 Station 10+00 = 271.50'

400' 3.50'

DETERMINE INVERT ELEVATIONS

Station #	Distance	X	FT/FT	=	Rise or Fall	+	Elevation
10+00							271.50
9+50	50.00		0.00875		0.4375		271.94
9+00	100.00		0.00875		0.875		272.38
8+50	150.00		0.00875		1.3125		272.81
8+00	200.00		0.00875		1.75		273.25
7+50	250.00		0.00875		2.1875		273.69
7+00	300.00		0.00875		2.625		274.13
6+50	350.00		0.00875		3.0625		274.56
6+00	400.00		0.00875		3.5		275.00

Tie back to station 10+00 for all.

TIE OUT!

Station #	Distance	X	FT/FT	=	Rise or Fall	+	Elevation
10+00							271.50
9+56	44.00		0.00875		0.385		271.89
9+21	79.00		0.00875		0.69125		272.19
8+90	110.00		0.00875		0.9625		272.46
8+36	164.00		0.00875		1.435		272.94
7+65	235.00		0.00875		2.05625		273.56
7+32	268.00		0.00875		2.345		273.85
6+85	315.00		0.00875		2.75625		274.26
6+00	400.00		0.00875		3.5		275.00

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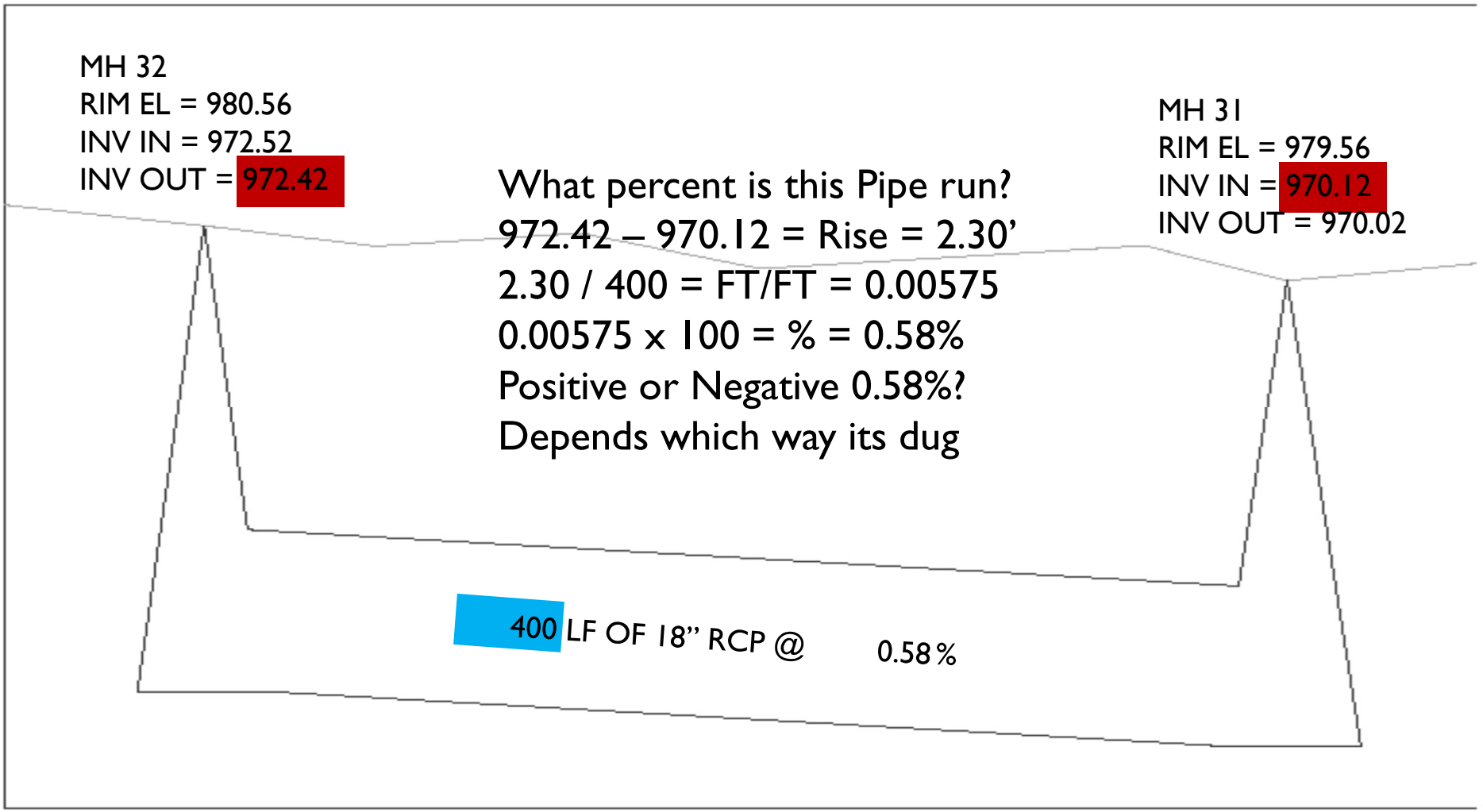
TIE OUT!

DETERMINING PERCENTAGES

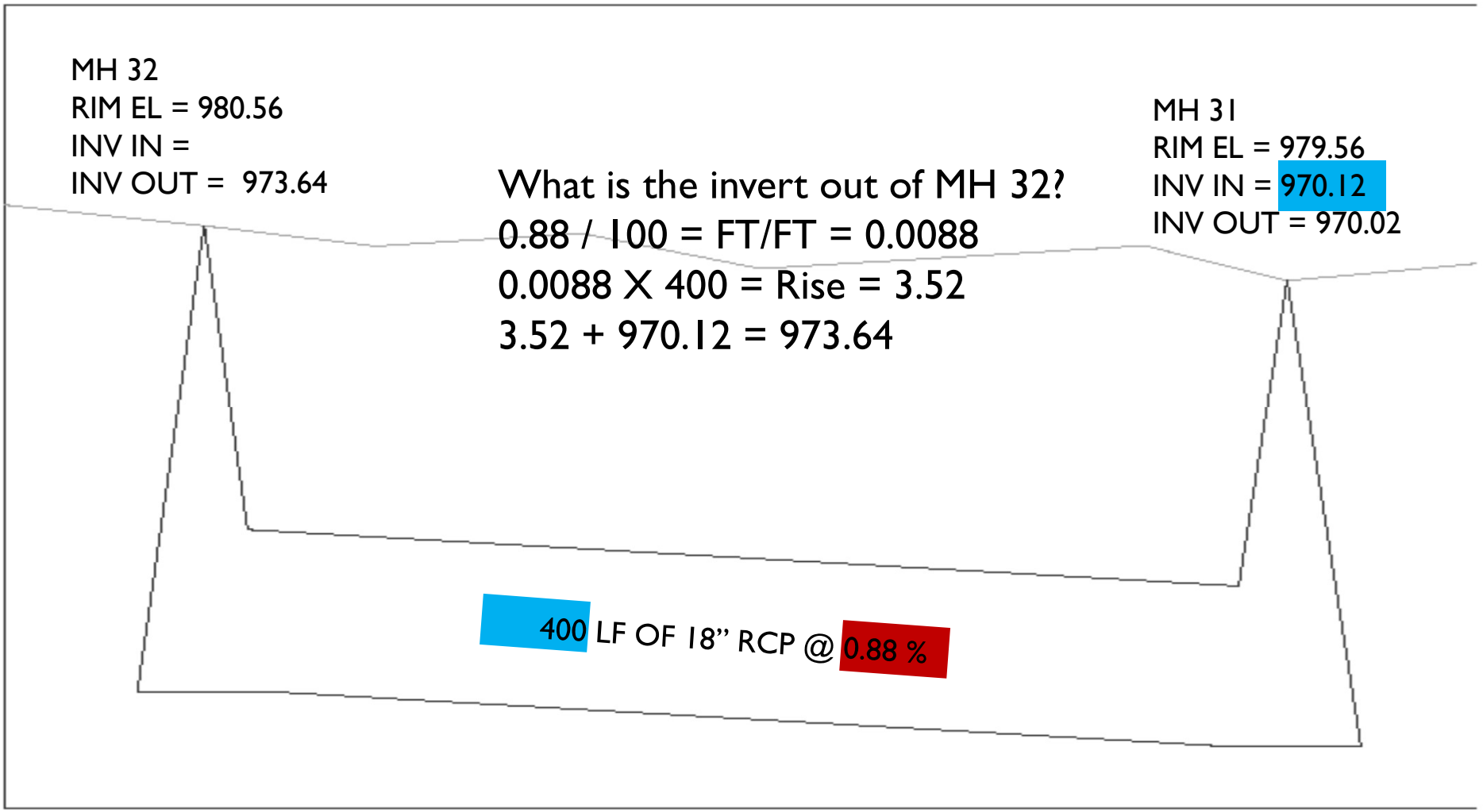
- Determining or double-checking plan percentages
- Formula
- Rise / Run = Ft/Ft
- Ft/Ft x 100 = Percent %
- Round off to the nearest hundredth

- Example: You have a 3’ rise and 250’ run
- 3 / 250 = 0.012
- 0.012 x 100 = %
- 1.20%
- Let's do some more practice

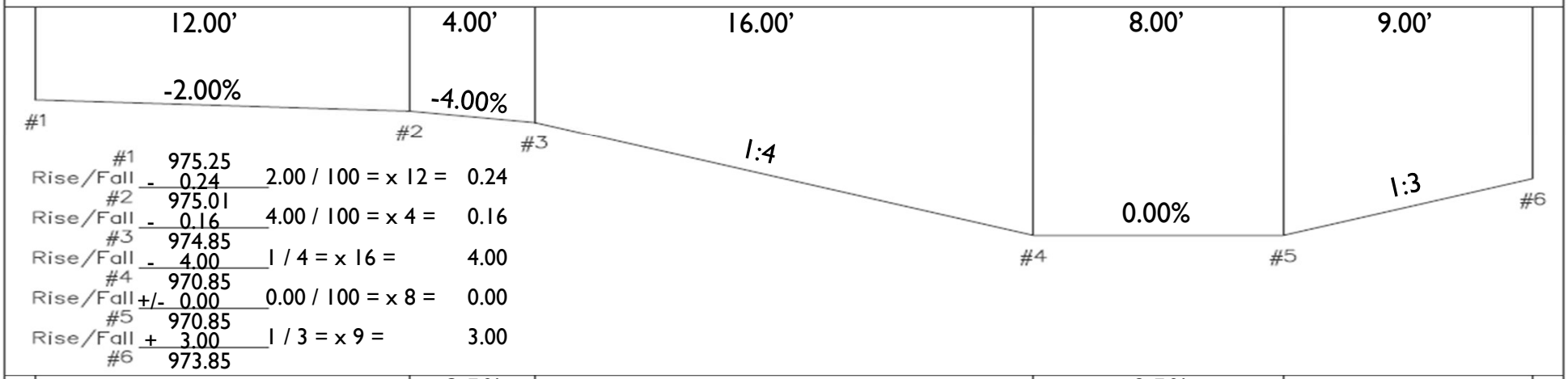

MH 32
RIM EL = 980.56
INV IN = 972.52
INV OUT = 972.42
What percent is this Pipe run?
972.42 – 970.12 = Rise = 2.30'
2.30 / 400 = FT/FT = 0.00575
0.00575 x 100 = % = 0.58%
Positive or Negative 0.58%?
Depends which way its dug
MH 31
RIM EL = 979.56
INV IN = 970.12
INV OUT = 970.02
400 LF OF 18" RCP @ 0.58%

CONVERTING PERCENTAGES INTO GOLD

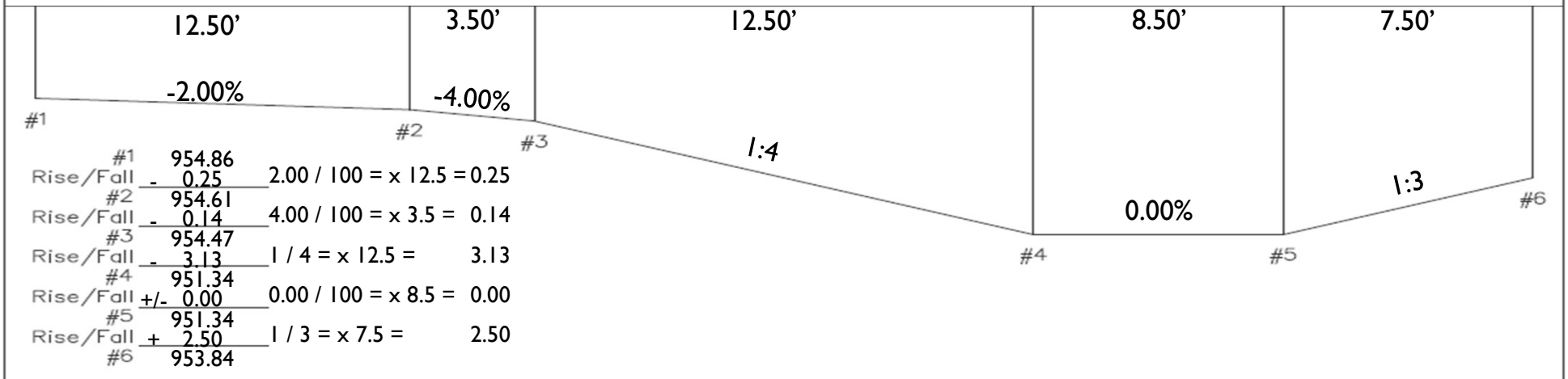
- Formula to convert
- % / 100 = Gold = Ft/Ft (never round off)
- Once you know how much rise or fall you have in 1 foot, you can now determine the rise or fall for any horizontal distance
- Example: +2% slope for 256'
- 2 / 100 = 0.02
- 0.02 x 256 =
- 5.12' of Rise in 256' of Run


MH 32
RIM EL = 980.56
INV IN =
INV OUT = 973.64
What is the invert out of MH 32?
0.88 / 100 = FT/FT = 0.0088
0.0088 X 400 = Rise = 3.52
3.52 + 970.12 = 973.64
MH 31
RIM EL = 979.56
INV IN = 970.12
INV OUT = 970.02
400 LF OF 18" RCP @ 0.88 %

TYPICAL SECTION EXERCISES

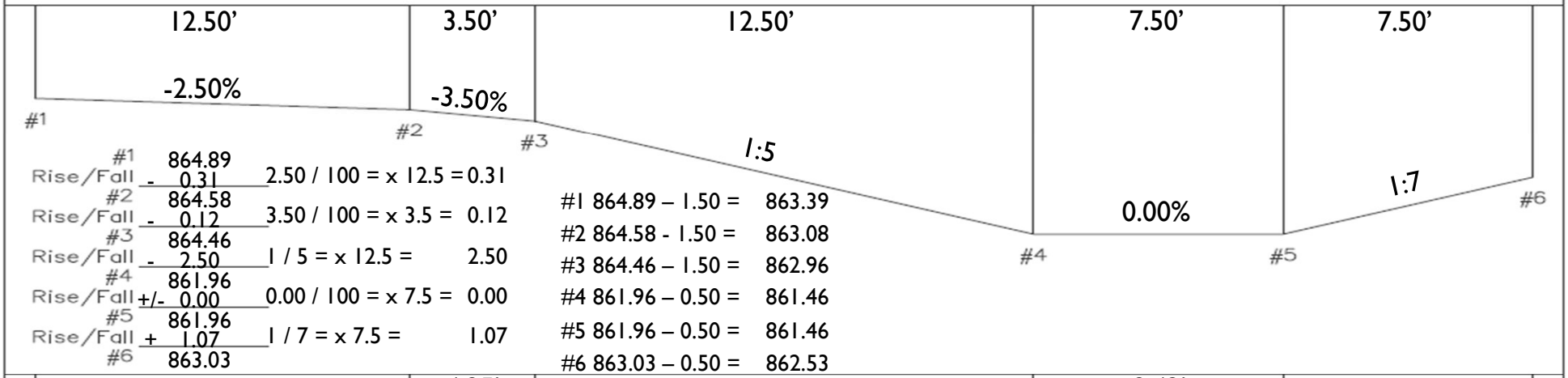


#1	975.25		
Rise/Fall	- 0.24	2.00 / 100 = x 12 =	0.24
#2	975.01		
Rise/Fall	- 0.16	4.00 / 100 = x 4 =	0.16
#3	974.85		
Rise/Fall	- 4.00	1 / 4 = x 16 =	4.00
#4	970.85		
Rise/Fall	+/- 0.00	0.00 / 100 = x 8 =	0.00
#5	970.85		
Rise/Fall	+ 3.00	1 / 3 = x 9 =	3.00
#6	973.85		



#1	954.86		
Rise/Fall	- 0.25	2.00 / 100 = x 12.5 =	0.25
#2	954.61		
Rise/Fall	- 0.14	4.00 / 100 = x 3.5 =	0.14
#3	954.47		
Rise/Fall	- 3.13	1 / 4 = x 12.5 =	3.13
#4	951.34		
Rise/Fall	+/- 0.00	0.00 / 100 = x 8.5 =	0.00
#5	951.34		
Rise/Fall	+ 2.50	1 / 3 = x 7.5 =	2.50
#6	953.84		

TYPICAL SECTION EXERCISES



#1 Rise/Fall - 0.31 = 864.89

#2 Rise/Fall - 0.12 = 864.58

#3 Rise/Fall - 2.50 = 864.46

#4 Rise/Fall +/- 0.00 = 861.96

#5 Rise/Fall + 1.07 = 861.96

#6 = 863.03

2.50 / 100 = x 12.5 = 0.31

3.50 / 100 = x 3.5 = 0.12

1 / 5 = x 12.5 = 2.50

0.00 / 100 = x 7.5 = 0.00

1 / 7 = x 7.5 = 1.07

#1 864.89 – 1.50 = 863.39

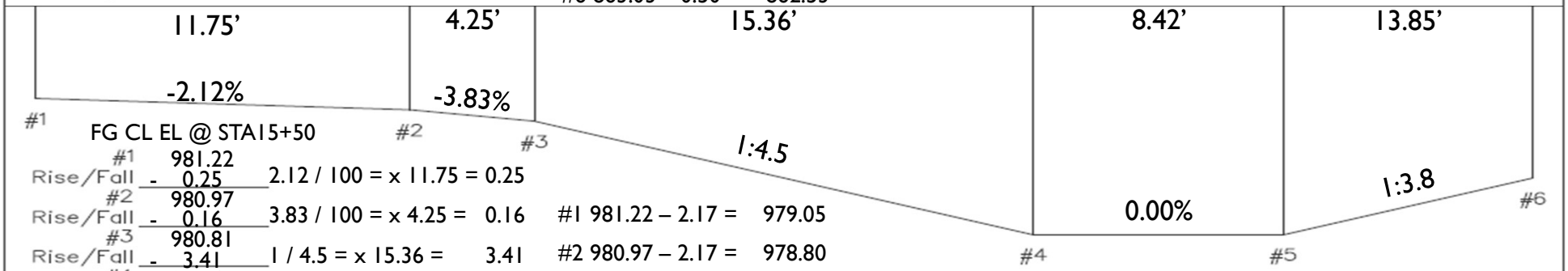
#2 864.58 - 1.50 = 863.08

#3 864.46 – 1.50 = 862.96

#4 861.96 – 0.50 = 861.46

#5 861.96 – 0.50 = 861.46

#6 863.03 – 0.50 = 862.53



FG CL EL @ STA15+50

#1 Rise/Fall - 0.25 = 981.22

#2 Rise/Fall - 0.16 = 980.97

#3 Rise/Fall - 3.41 = 980.81

#4 Rise/Fall +/- 0.00 = 977.40

#5 Rise/Fall + 3.64 = 977.40

#6 = 981.04

2.12 / 100 = x 11.75 = 0.25

3.83 / 100 = x 4.25 = 0.16

1 / 4.5 = x 15.36 = 3.41

0.00 / 100 = x 8.42 = 0.00

1 / 3.8 = x 13.85 = 3.64

#1 981.22 – 2.17 = 979.05

#2 980.97 – 2.17 = 978.80

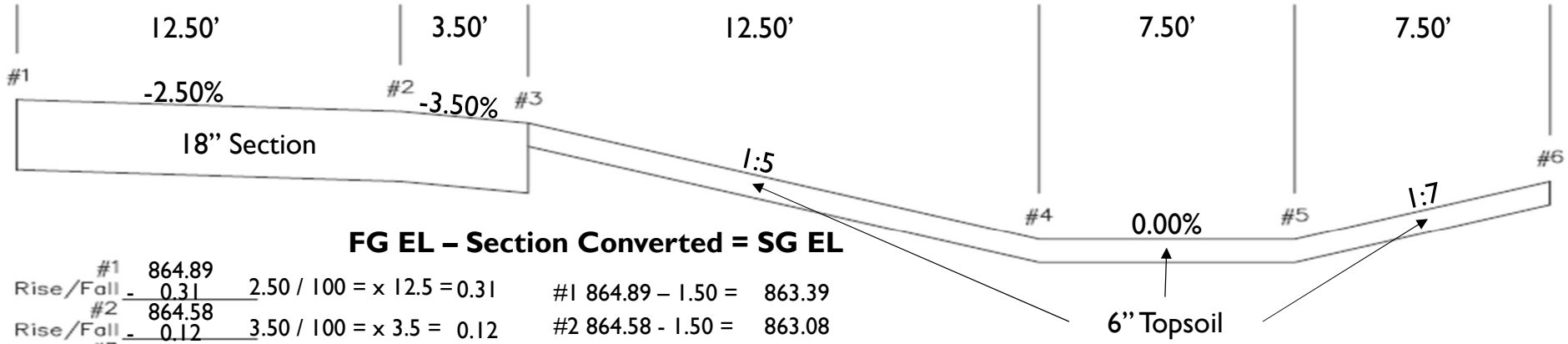
#3 980.81 – 2.17 = 978.64

#4 977.40 – 0.33 = 977.07

#5 977.40 – 0.33 = 977.07

#6 981.04 – 0.33 = 980.71

TYPICAL SECTION EXERCISES

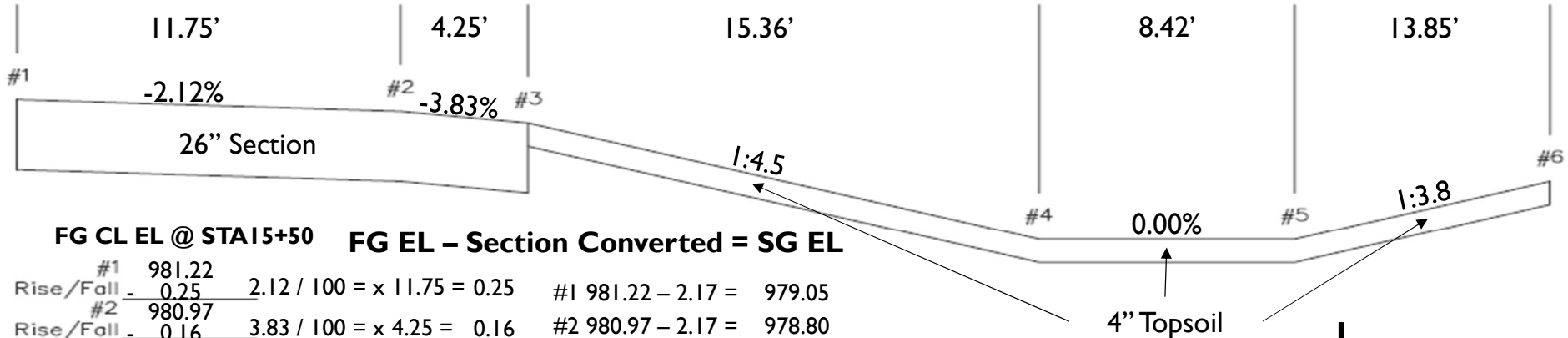


FG EL – Section Converted = SG EL

#1	864.89		
Rise/Fall	- 0.31	2.50 / 100 = x 12.5 =	0.31
#2	864.58		
Rise/Fall	- 0.12	3.50 / 100 = x 3.5 =	0.12
#3	864.46		
Rise/Fall	- 2.50	1 / 5 = x 12.5 =	2.50
#4	861.96		
Rise/Fall	+/- 0.00	0.00 / 100 = x 7.5 =	0.00
#5	861.96		
Rise/Fall	+ 1.07	1 / 7 = x 7.5 =	1.07
#6	863.03		

#1 864.89 – 1.50 = 863.39
#2 864.58 - 1.50 = 863.08
#3 864.46 – 1.50 = 862.96
#4 861.96 – 0.50 = 861.46
#5 861.96 – 0.50 = 861.46
#6 863.03 – 0.50 = 862.53

TYPICAL SECTION EXERCISES

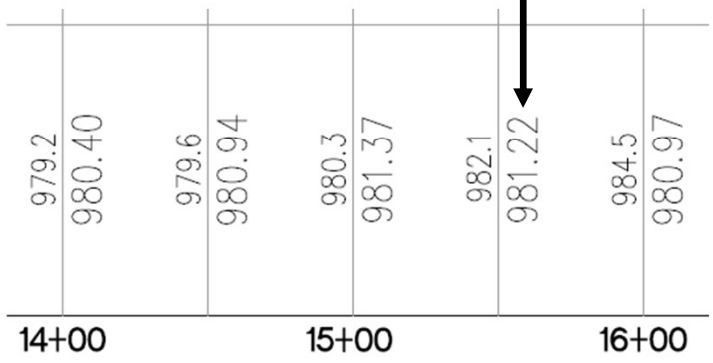


FG CL EL @ STA15+50

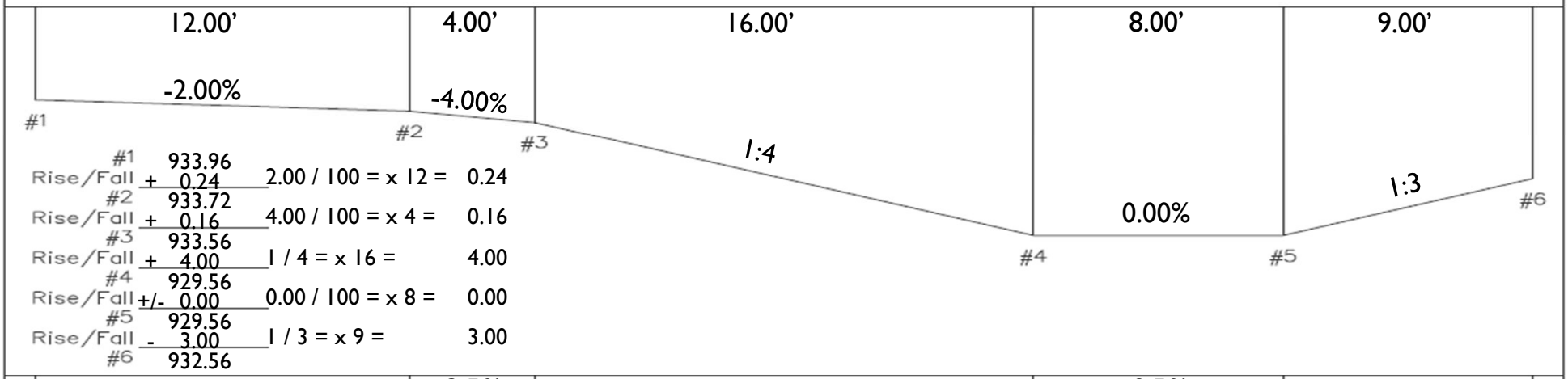
#1	981.22		
Rise/Fall	- 0.25	2.12 / 100 = x 11.75 =	0.25
#2	980.97		
Rise/Fall	- 0.16	3.83 / 100 = x 4.25 =	0.16
#3	980.81		
Rise/Fall	- 3.41	1 / 4.5 = x 15.36 =	3.41
#4	977.40		
Rise/Fall	+/- 0.00	0.00 / 100 = x 8.42 =	0.00
#5	977.40		
Rise/Fall	+ 3.64	1 / 3.8 = x 13.85 =	3.64
#6	981.04		

FG EL – Section Converted = SG EL

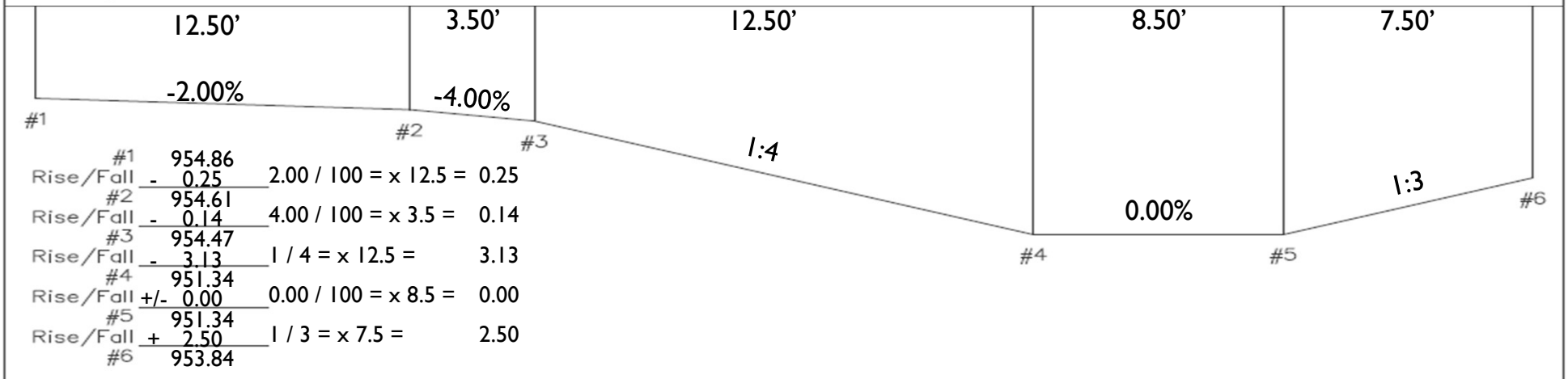
#1 981.22 – 2.17 = 979.05
#2 980.97 – 2.17 = 978.80
#3 980.81 – 2.17 = 978.64
#4 977.40 – 0.33 = 977.07
#5 977.40 – 0.33 = 977.07
#6 981.04 – 0.33 = 980.71



TYPICAL SECTION EXERCISES



#1	933.96		
Rise/Fall	+ 0.24	2.00 / 100 = x 12 =	0.24
#2	933.72		
Rise/Fall	+ 0.16	4.00 / 100 = x 4 =	0.16
#3	933.56		
Rise/Fall	+ 4.00	1 / 4 = x 16 =	4.00
#4	929.56		
Rise/Fall	+/- 0.00	0.00 / 100 = x 8 =	0.00
#5	929.56		
Rise/Fall	- 3.00	1 / 3 = x 9 =	3.00
#6	932.56		



#1	954.86		
Rise/Fall	- 0.25	2.00 / 100 = x 12.5 =	0.25
#2	954.61		
Rise/Fall	- 0.14	4.00 / 100 = x 3.5 =	0.14
#3	954.47		
Rise/Fall	- 3.13	1 / 4 = x 12.5 =	3.13
#4	951.34		
Rise/Fall	+/- 0.00	0.00 / 100 = x 8.5 =	0.00
#5	951.34		
Rise/Fall	+ 2.50	1 / 3 = x 7.5 =	2.50
#6	953.84		

SECTION 9

Basic Quantities

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 x 10 =
- 800 SQ FT

Let's do the next one together…

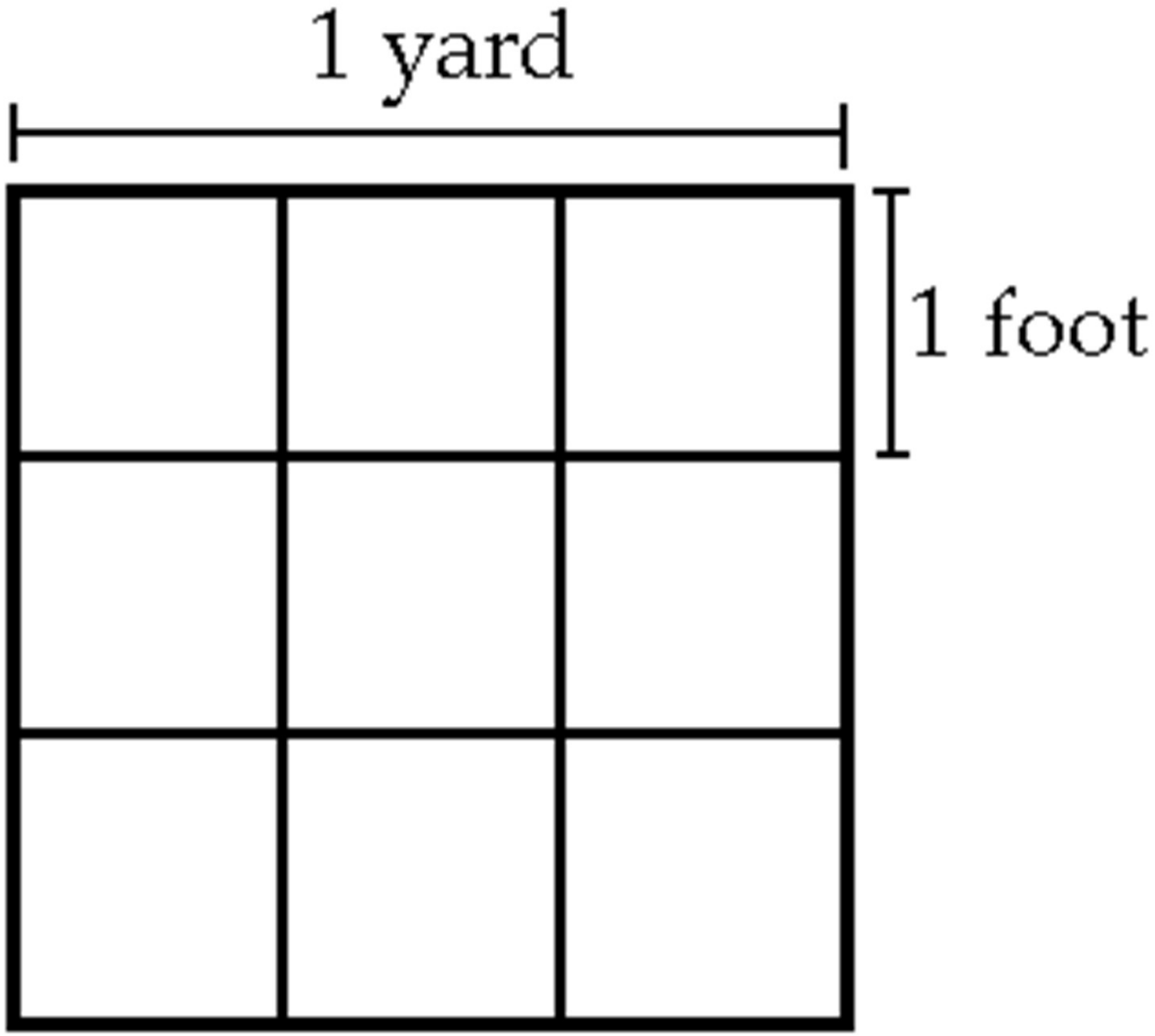
- Must convert inches to decimal feet
- 16 / 12 = x 42 =
- 55.999
- Looking at the 3rd digit after the decimal, 5 or higher we round up and 4 and lower, we keep it the same
- 56.00 SQ FT

FT x FT =	SQ FT
80' x 10'	**800.00**
42' x 16"	**56.00**
75' x 12'	**900.00**
64' x 16"	**85.33**
112' x 13"	**121.33**
52' x 32'	**1664.00**
18" x 16"	**2.00**
86' x 8"	**57.33**
42' x 20"	**70.00**
32' x 120"	**320.00**
48' x 22"	**88.00**
75' x 22'	**1650.00**
84' x 10"	**70.00**

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 x 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'	**88.89**
42' x 16"	**6.22**
75' x 12'	**100.00**
64' x 16"	**9.48**
112' x 13"	**13.48**
52' x 32'	**184.89**
18" x 16"	**0.22**
86' x 8"	**6.37**
42' x 20"	**7.78**
32' x 120"	**35.56**
48' x 22"	**9.78**
75' x 22'	**183.33**
84' x 10"	**7.78**

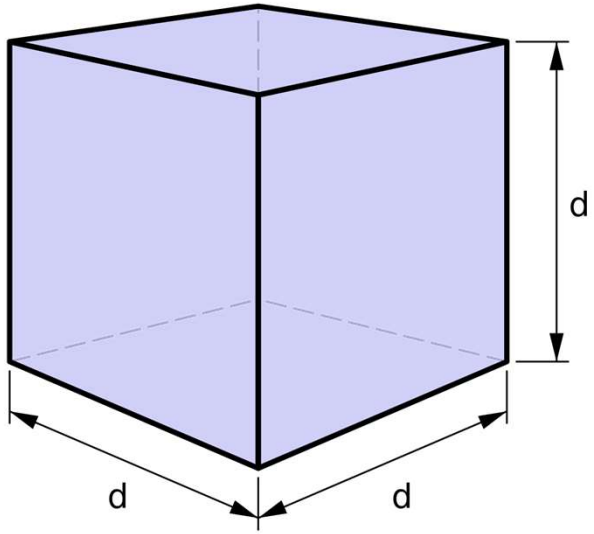
CALCULATING CUBIC FEET (CU FT)

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=

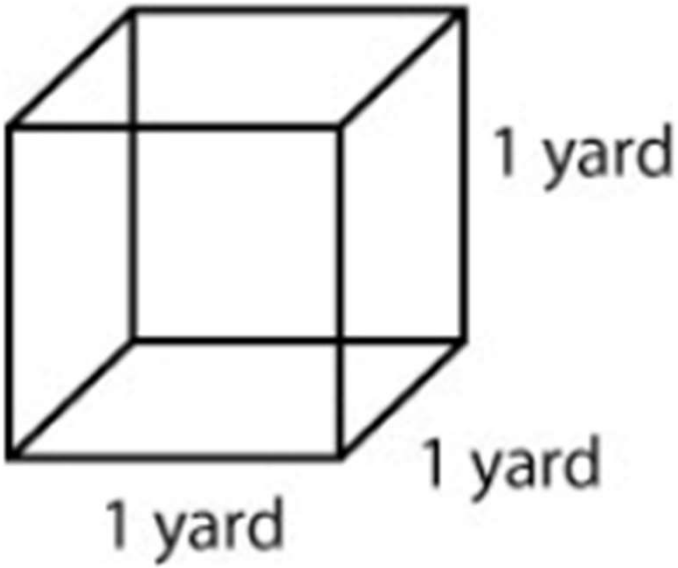
Let's do the first one together…

- 80 x 10 x 8 =
- 6400.00 CU FT

Let's do the next one together…

- Must convert inches to decimal feet
- 10 / 12 = x 150 x 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'	**6400.00**
150' x 24' x 10"	**3000.00**
75' x 12' x 6'	**5400.00**
64' x 16' x 16"	**1365.33**
112' x 13' x 20'	**29120.00**
52' x 32' x 10"	**1386.67**
18' x 16' x 14"	**336.00**
86' x 8' x 20"	**1146.67**
42' x 20' x 13"	**910.00**
32' x 120' x 5"	**1600.00**
48' x 22' x 32"	**2816.00**
75' x 22' x 12'	**19800.00**
84' x 10' x 16'	**13440.00**



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 x 3 x 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 x 10 x 8 = / 27 =
- 237.04 CU YDS

Let's do the next one together…

- Must convert inches to decimal feet
- 10 / 12 = x 150 x 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 CU YDS

FT x FT x FT = / 27 =	CU YDS
80' x 10' x 8'	**237.04**
150' x 24' x 10"	**111.11**
75' x 12' x 6'	**200.00**
64' x 16' x 16"	**50.57**
112' x 13' x 20'	**1078.52**
52' x 32' x 10"	**51.36**
18' x 16' x 14"	**12.44**
86' x 8' x 20"	**42.47**
42' x 20' x 13"	**33.70**
32' x 120' x 5"	**59.26**
48' x 22' x 32"	**104.30**
75' x 22' x 12'	**733.33**
84' x 10' x 16'	**497.78**

BASIC QUANTITY EXERCISE

1- 44' x 26' = 127.11 Sq Yds

2- 112' x 12' x 20" = 82.96 Cu Yds

3- 36' x 22" = 66.00 Sq Ft

4- 41' x 15' = 615.00 Sq Ft

5- 120' x 12" x 26" = 260.00 Cu Ft

6- 51' x 8' x 6' = 2448.00 Cu Ft

7- 52' x 20" = 9.63 Sq Yds

8- 35' x 12' = 46.67 Sq Yds

9- 154' x 32" = 45.63 Sq Yds

10- 85' x 22" = 155.83 Sq Ft

11- 48' x 20" = 80.00 Sq Ft

12- 33' x 56" = 17.11 Sq Yds

13- 48" x 32" = 1.19 Sq Yds

14- 83' x 42" = 290.50 Sq Ft

15- 140' x 64' x 64" = 1769.88 Cu Yds

16- 140' x 64' x 64" = 47786.67 Cu Ft

17- 72' x 56' x 10' = 1493.33 Cu Yds

18- 44' x 22" = 8.96 Sq Yds

19- 24" x 16" = 2.67 Sq Ft

20- 24' x 32' x 10' = 7680.00 Cu Ft

21- 60" x 72" x 48" = 120.00 Cu Ft

22- 60' x 72' x 48' = 7680.00 Cu Yds

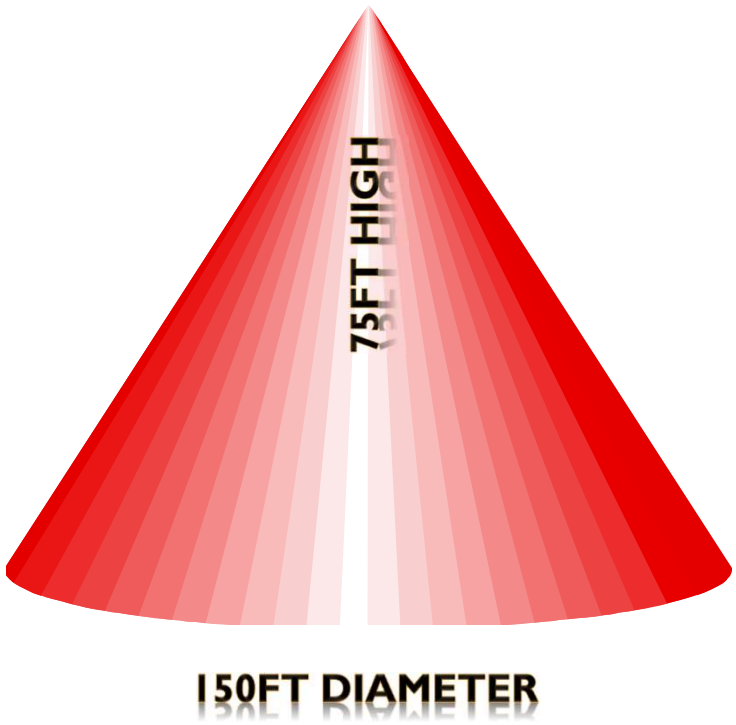
23- 6 ¾ " x 15 ¼ " = 0.71 Sq Ft

24- 27 cu. Ft. = 1.00 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) × pi × radius^2 × height
  - Radius is half the diameter 150 / 2 = 75
  - (75 x 75) = x 75 = 421,875
  - 421,875 x 3.14 = 1,324,687.50
  - 1,324,687.50 / 3 = 441,562.50 Cu Ft
  - 441,562.50 / 27 = 16,354.17 Cu Yds



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 = x 66 x 660 = 3630.00 Cu Ft
- There are 7.481 gallons of water in a cubic foot – x 7.481 = 27,156.03 gallons/acre
- There are 640 acres/section of land –

  x 640 = 17,379,859.19 gallons/section
- There are 36 sections/township –

  x 36 = 625,674,930.95 gallons/township

SECTION 10

Level Looping

To Level Loop you start by:

Setting up the instrument 250' max away from the benchmark. Next have the rod man "Rod" the rod on the Benchmark (BM), this is known as the Back Sight (BS)

The Height of Instrument (HI) is determined by taking a BS rod reading on a known BM or elevation.

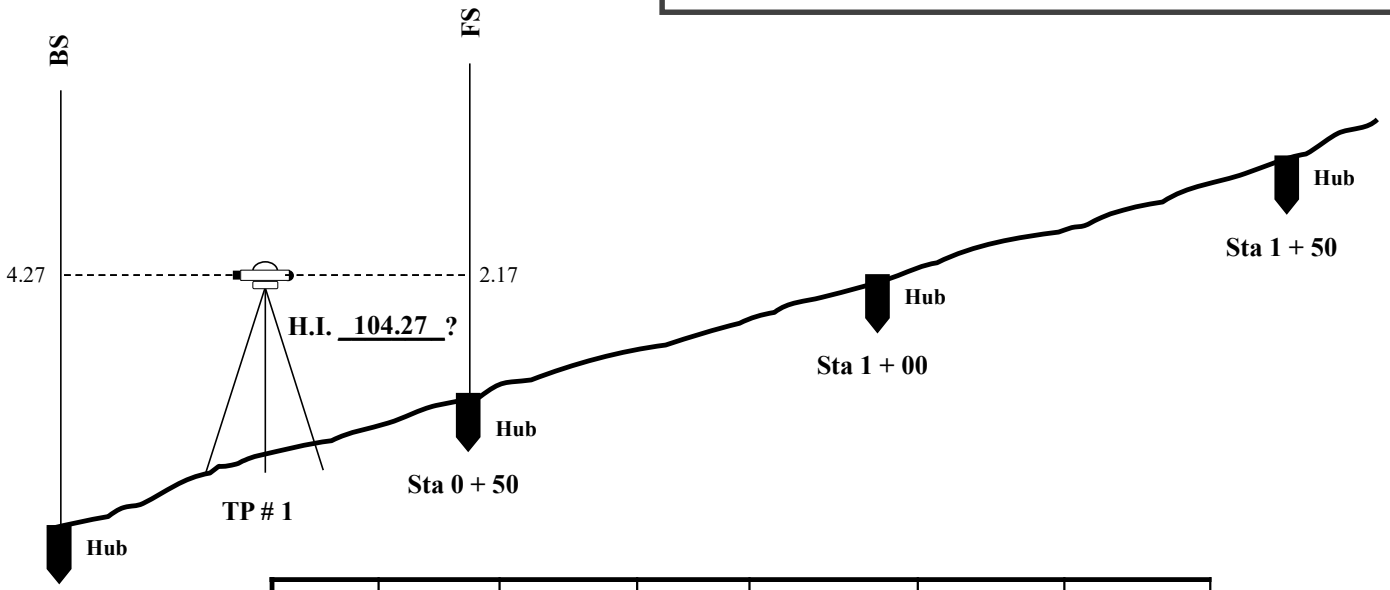
The BS rod reading is added (+) to the BM Elevation to determine the HI.

Once the HI is established, any other Foresight (FS) or Turn Point (TP) rod reading is subtracted from the HI to establish an objects Elevations.

Then continue looping until you come back to the original BM (Around the World) or once you establish an Elevation on the unknown, loop back to the original BM and close within tolerance.

Let's do some practice examples…

ESTABLISHING AN ELEVATION



BM
El 100.00
Sta 0 + 00

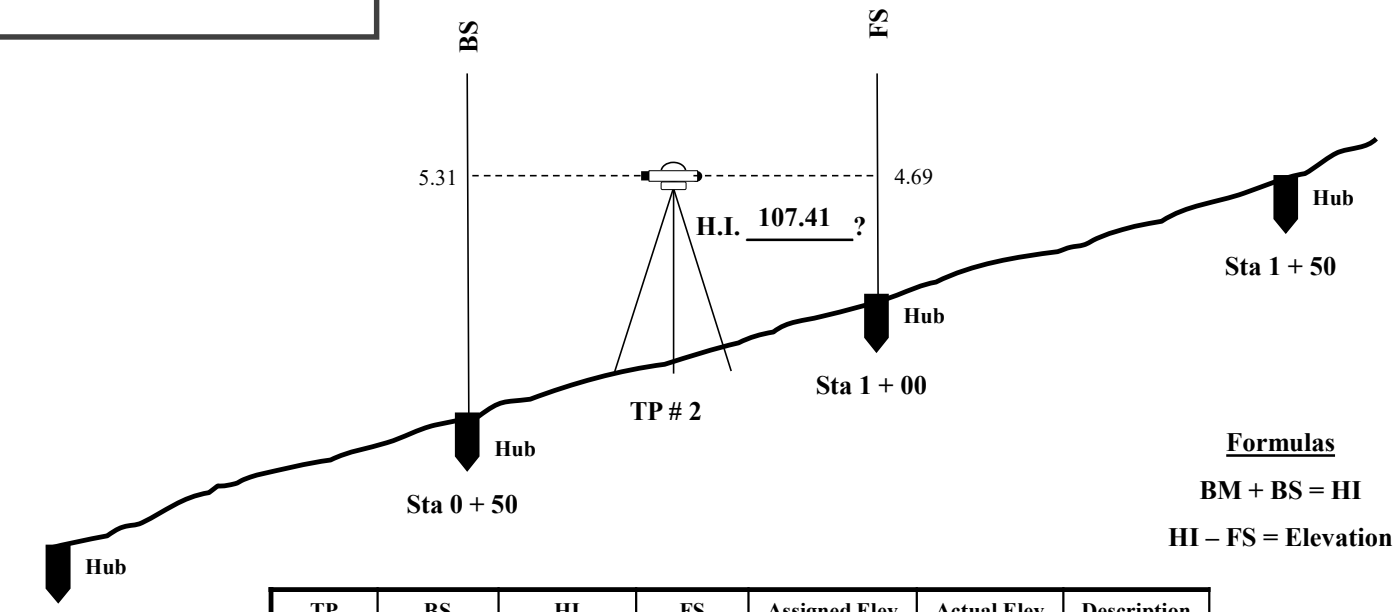
TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	4.27	104.27			100.00	0+00
#2			2.17	102.10		0+50
#3						1+00
						1+50

Formulas

BM + BS = HI

HI – FS = Elevation

ESTABLISHING AN ELEVATION



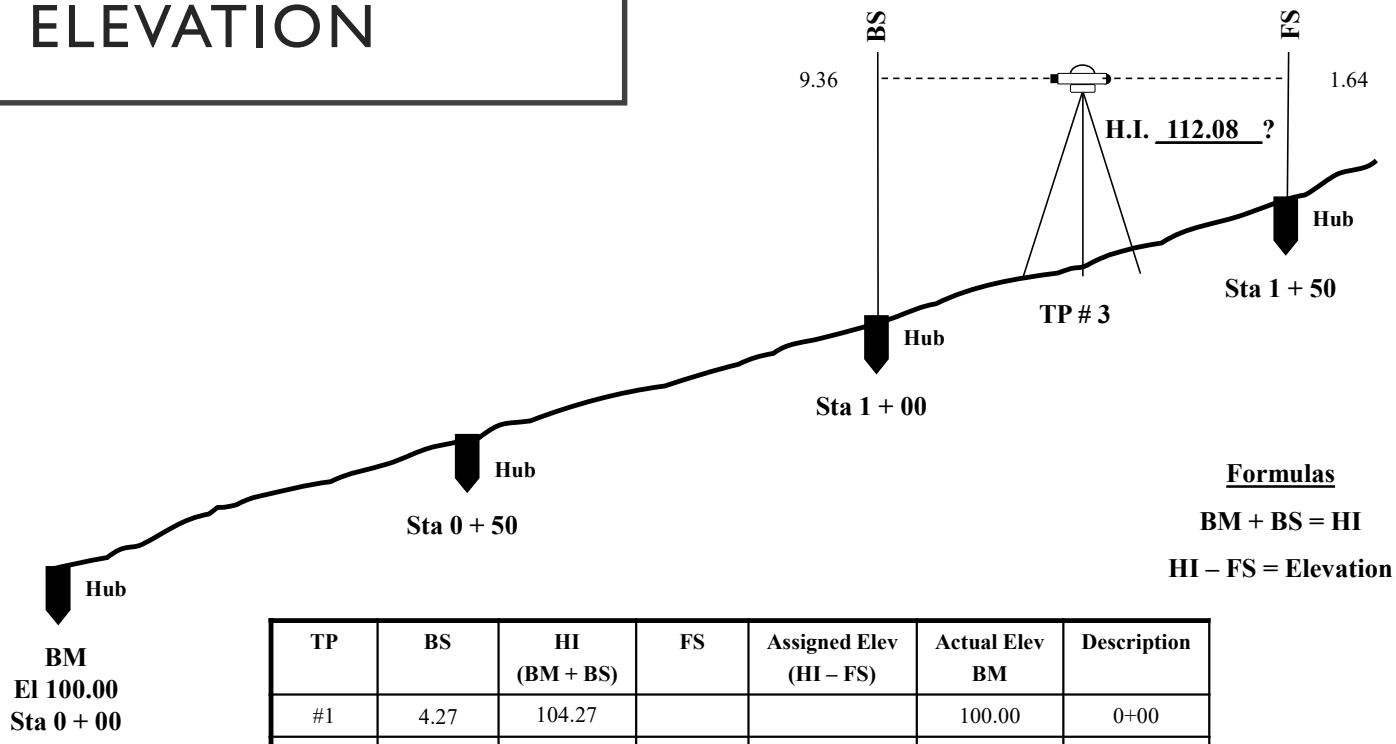
Formulas

BM + BS = HI

HI – FS = Elevation

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	4.27	104.27			100.00	0+00
#2	5.31	107.41	2.17	102.10		0+50
#3			4.69	102.72		1+00
						1+50

ESTABLISHING AN ELEVATION



Formulas

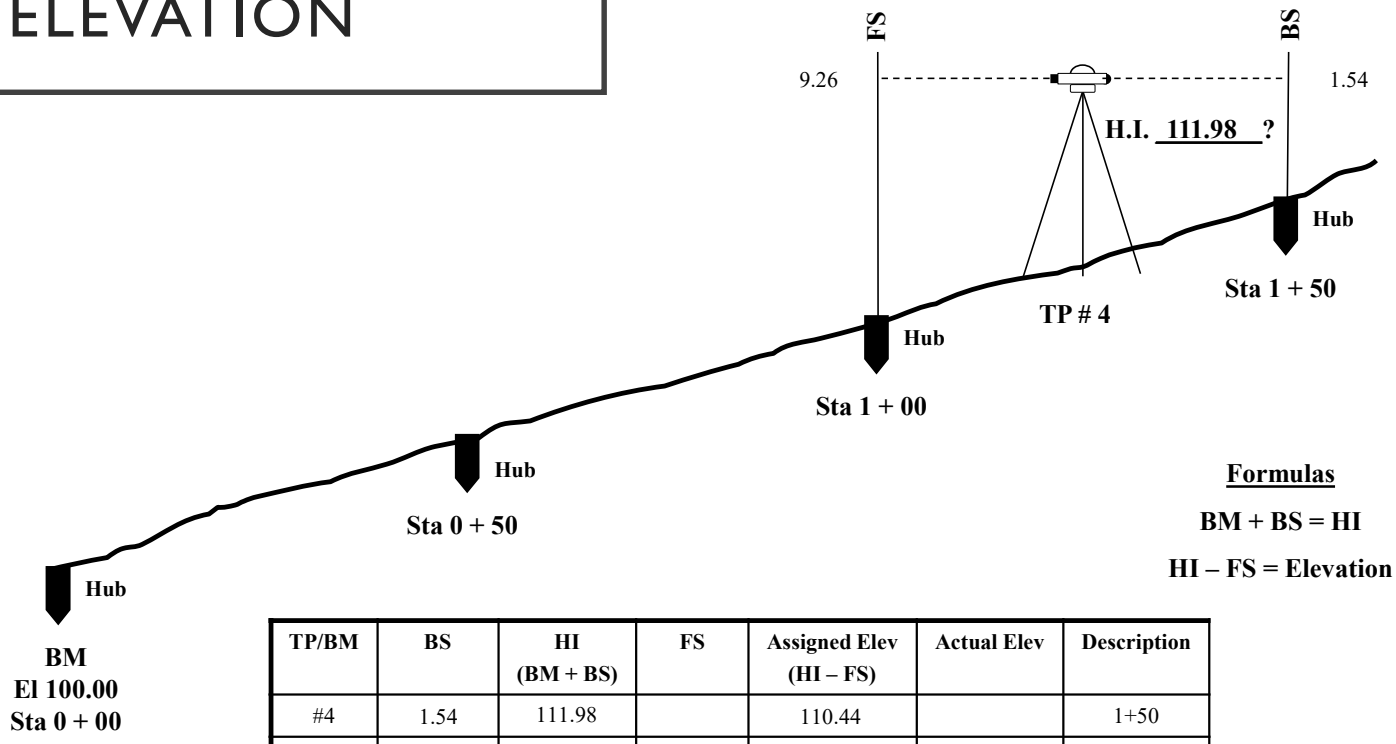
BM + BS = HI

HI – FS = Elevation

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	4.27	104.27			100.00	0+00
#2	5.31	107.41	2.17	102.10		0+50
#3	9.36	112.08	4.69	102.72		1+00
			1.64	110.44		1+50

Difference in Hub elevations between Sta 0 + 00 & Sta 1 + 50 10.44 ?

CONFIRMING THE ELEVATION



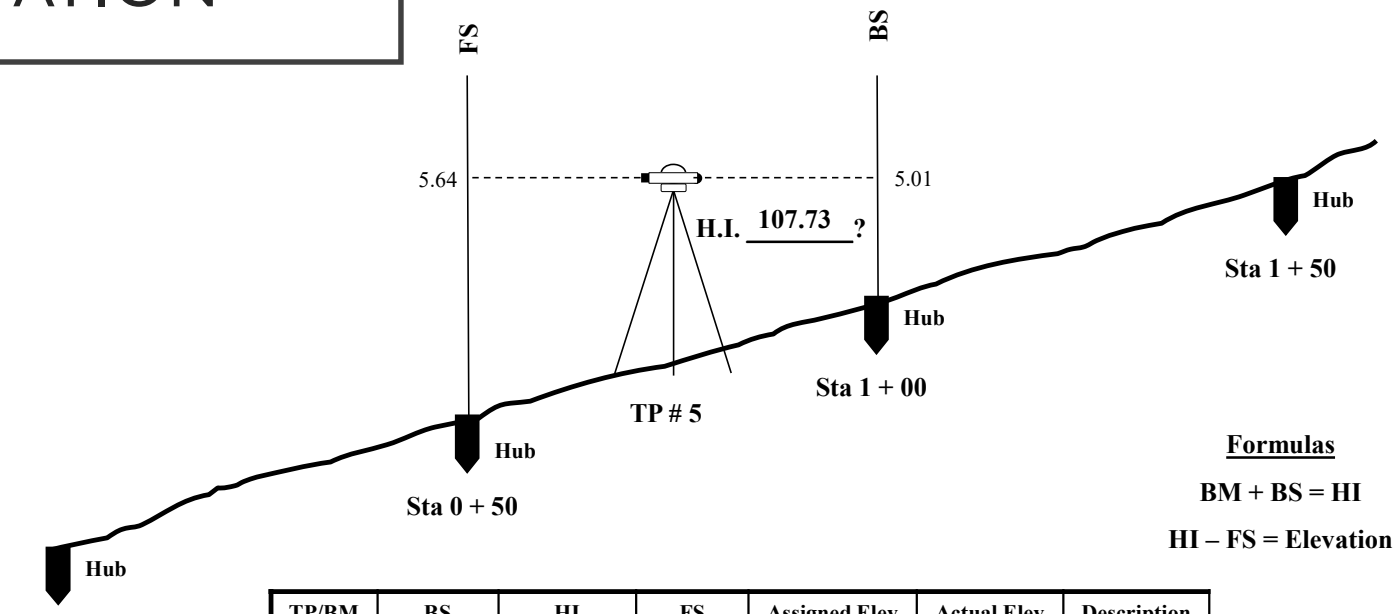
Formulas

BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	1.54	111.98		110.44		1+50
#5			9.26	102.72		1+00
#6						0+50
					100.00	0+00

CONFIRMING THE ELEVATION



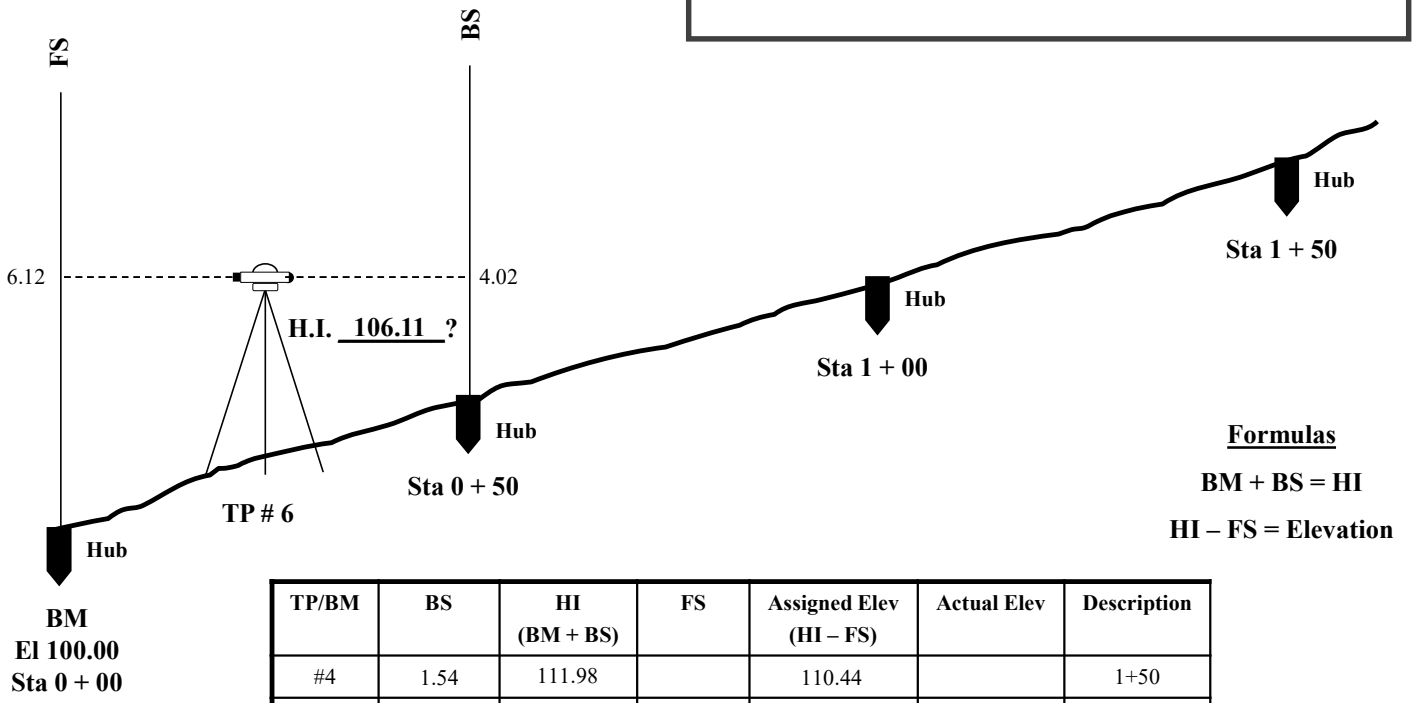
Formulas

BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	1.54	111.98		110.44		1+50
#5	5.01	107.73	9.26	102.72		1+00
#6			5.64	102.09		0+50
					100.00	0+00

CONFIRMING THE ELEVATION



Formulas

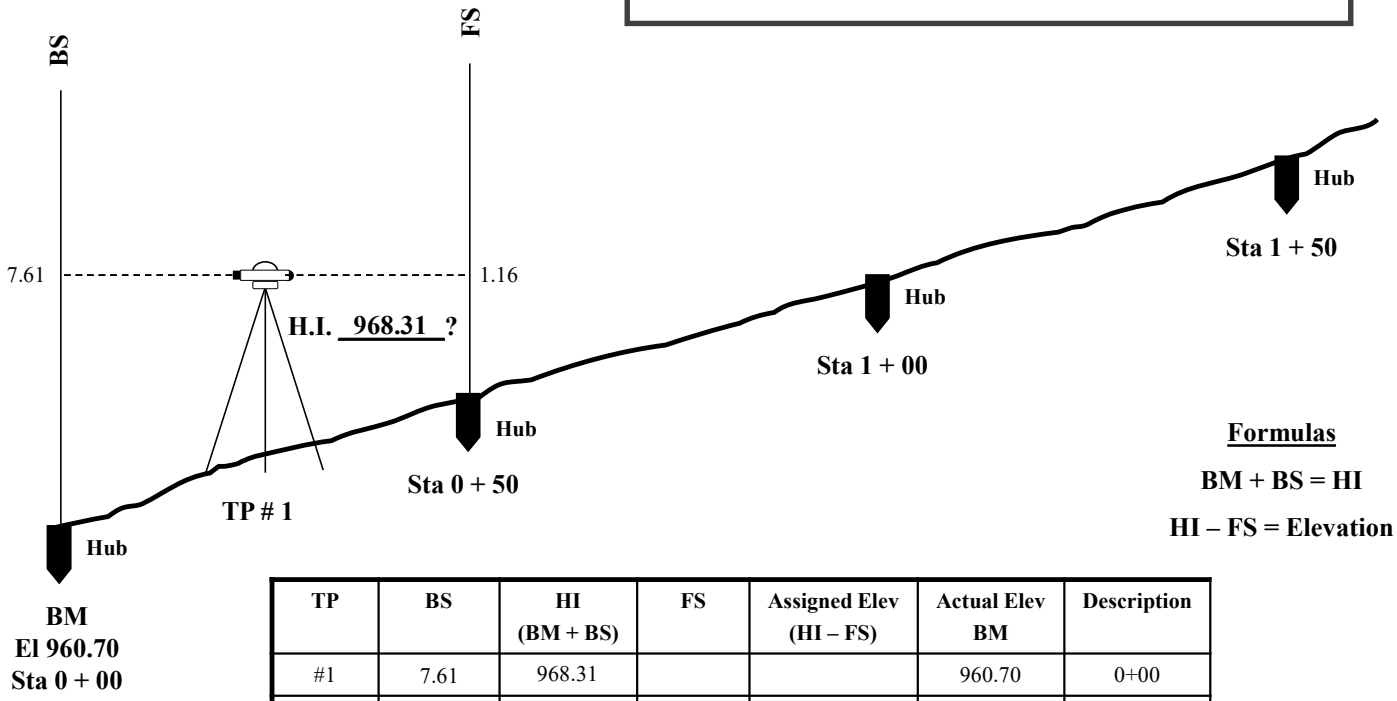
BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	1.54	111.98		110.44		1+50
#5	5.01	107.73	9.26	102.72		1+00
#6	4.02	106.11	5.64	102.09		0+50
			6.12	99.99	100.00	0+00

Does this close within Tolerance? Yes

ESTABLISHING AN ELEVATION



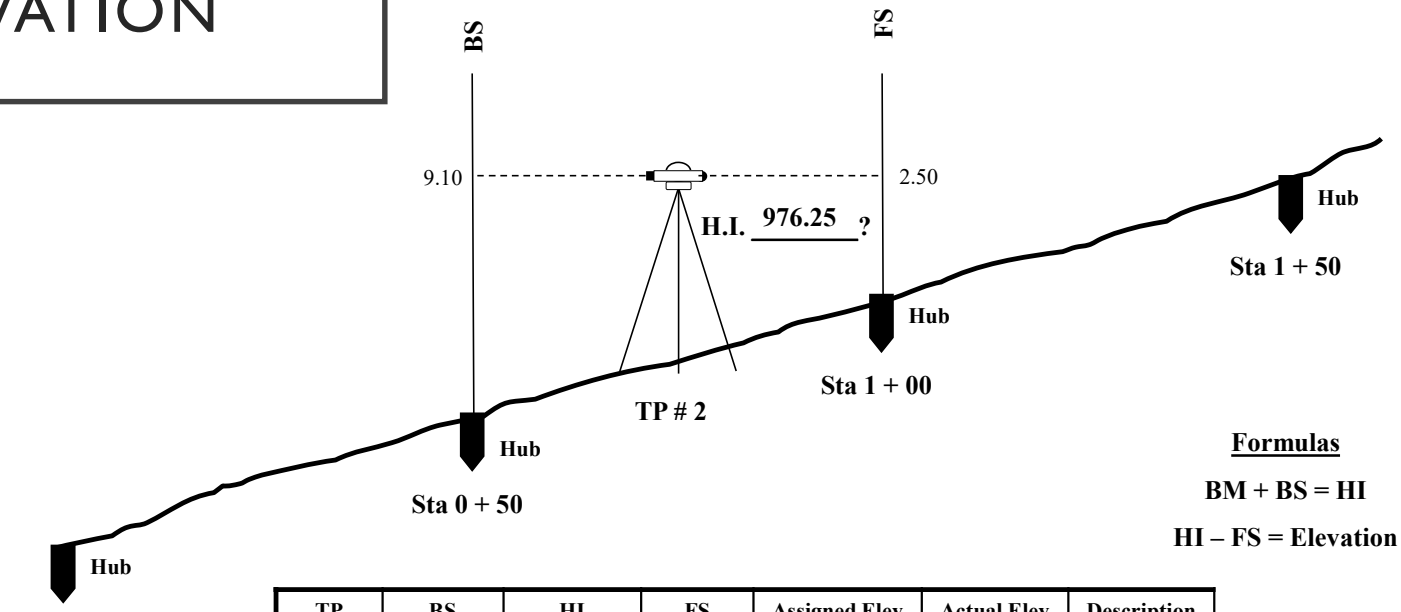
Formulas

BM + BS = HI

HI – FS = Elevation

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	7.61	968.31			960.70	0+00
#2			1.16	967.15		0+50
#3						1+00
						1+50

ESTABLISHING AN ELEVATION



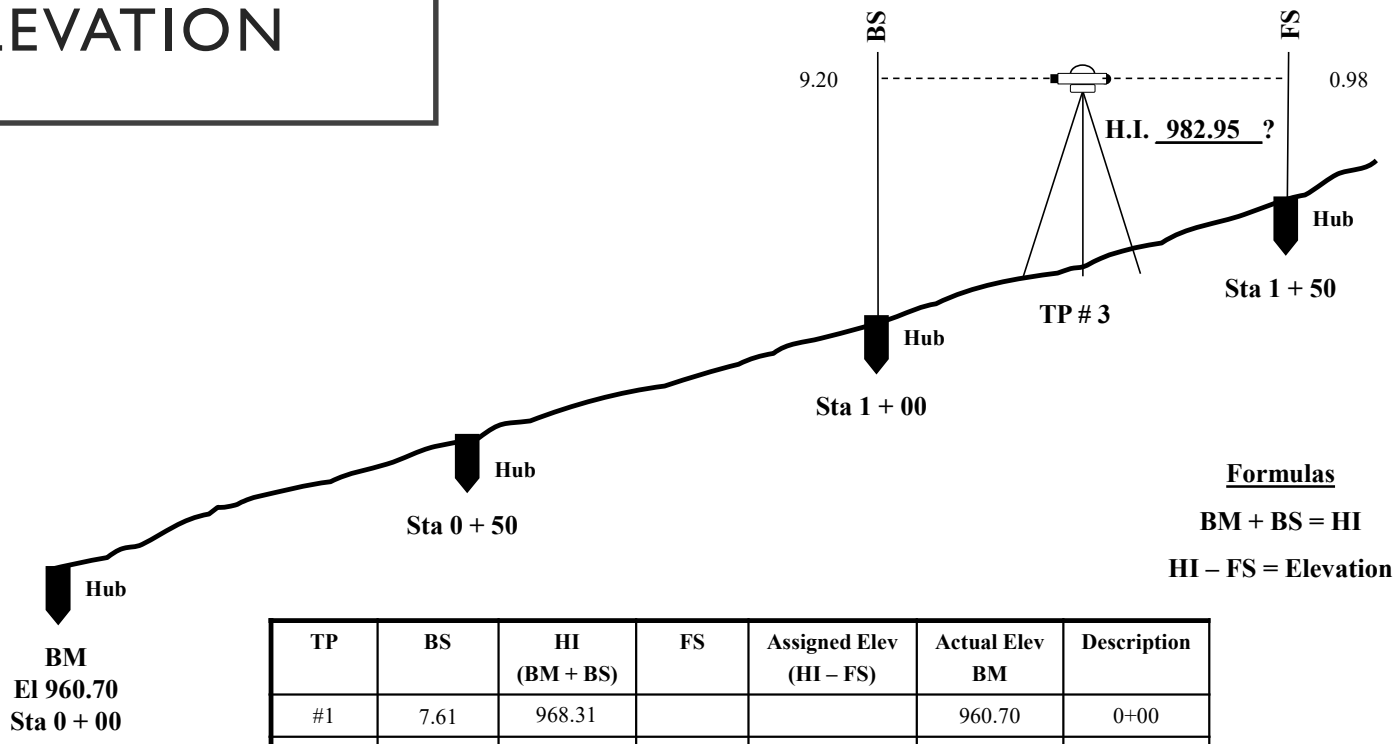
Formulas

BM + BS = HI

HI – FS = Elevation

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	7.61	968.31			960.70	0+00
#2	9.10	976.25	1.16	967.15		0+50
#3			2.50	973.75		1+00
						1+50

ESTABLISHING AN ELEVATION



Formulas

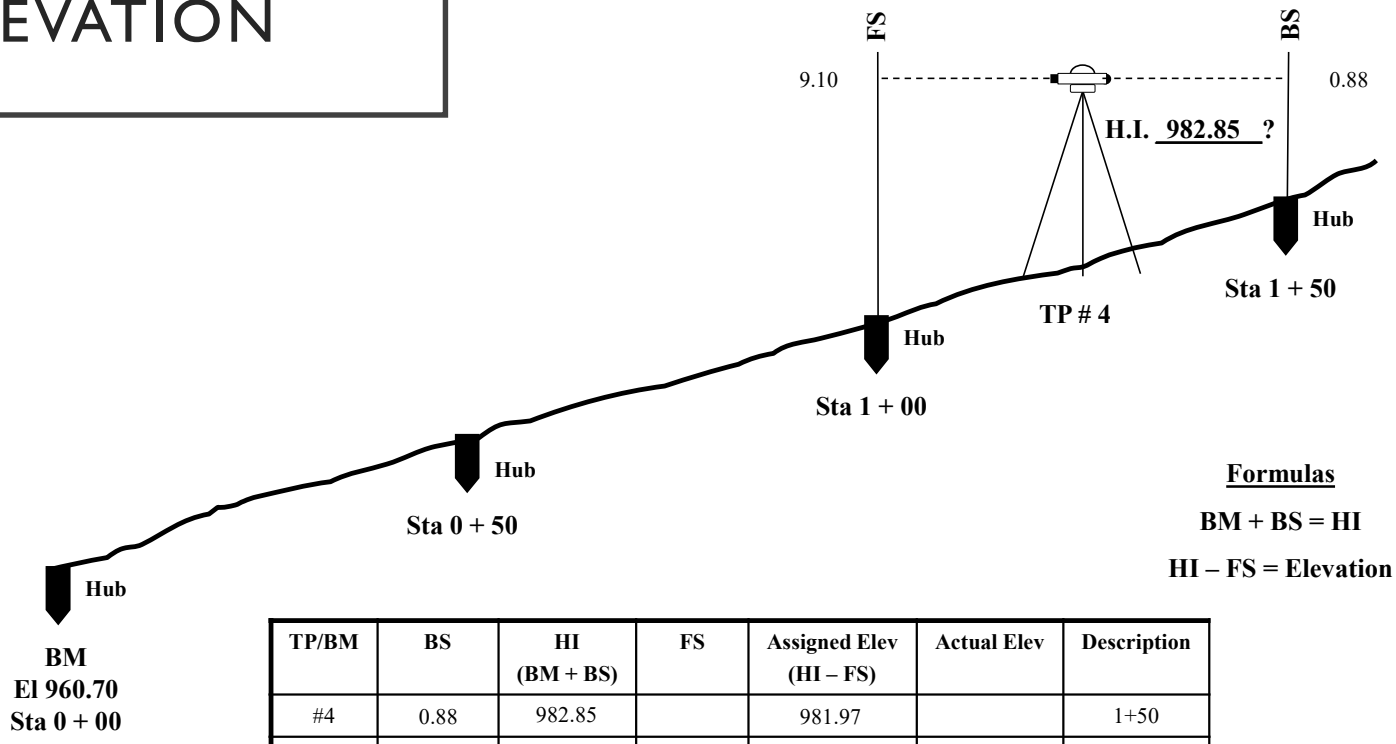
BM + BS = HI

HI – FS = Elevation

TP	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev BM	Description
#1	7.61	968.31			960.70	0+00
#2	9.10	976.25	1.16	967.15		0+50
#3	9.20	982.95	2.50	973.75		1+00
			0.98	981.97		1+50

Difference in Hub elevations between Sta 0 + 00 & Sta 1 + 50 21.27 ?

CONFIRMING THE ELEVATION



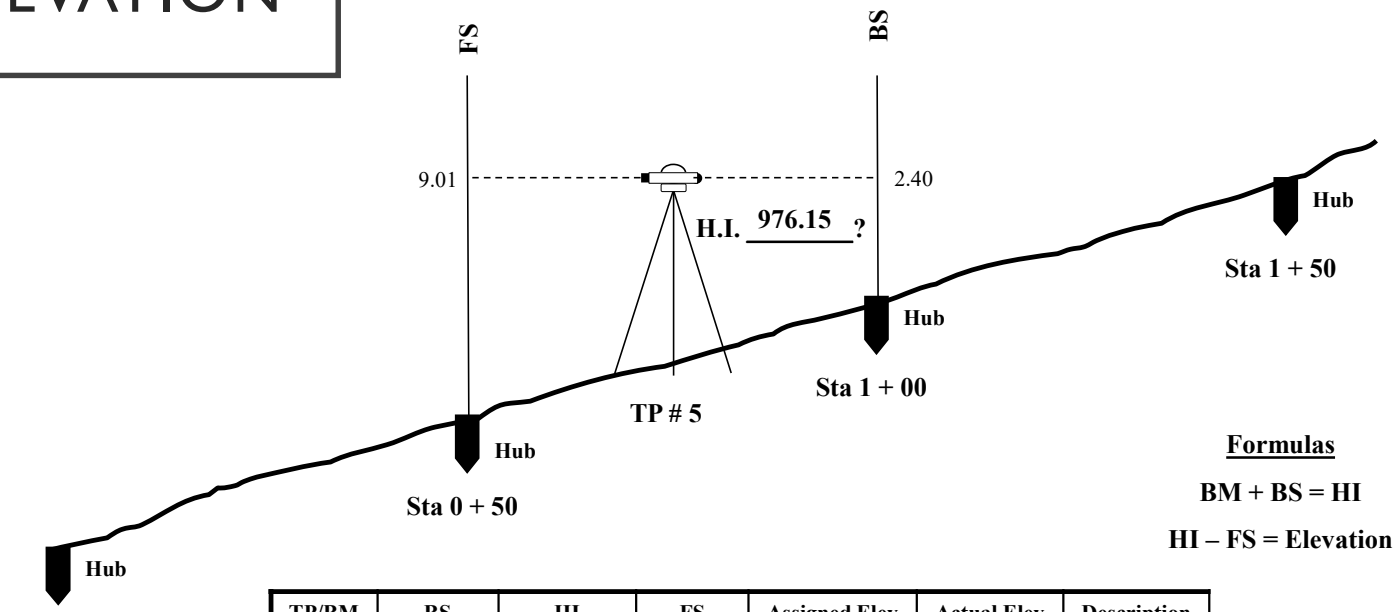
Formulas

BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	0.88	982.85		981.97		1+50
#5			9.10	973.75		1+00
#6						0+50
					960.70	0+00

CONFIRMING THE ELEVATION



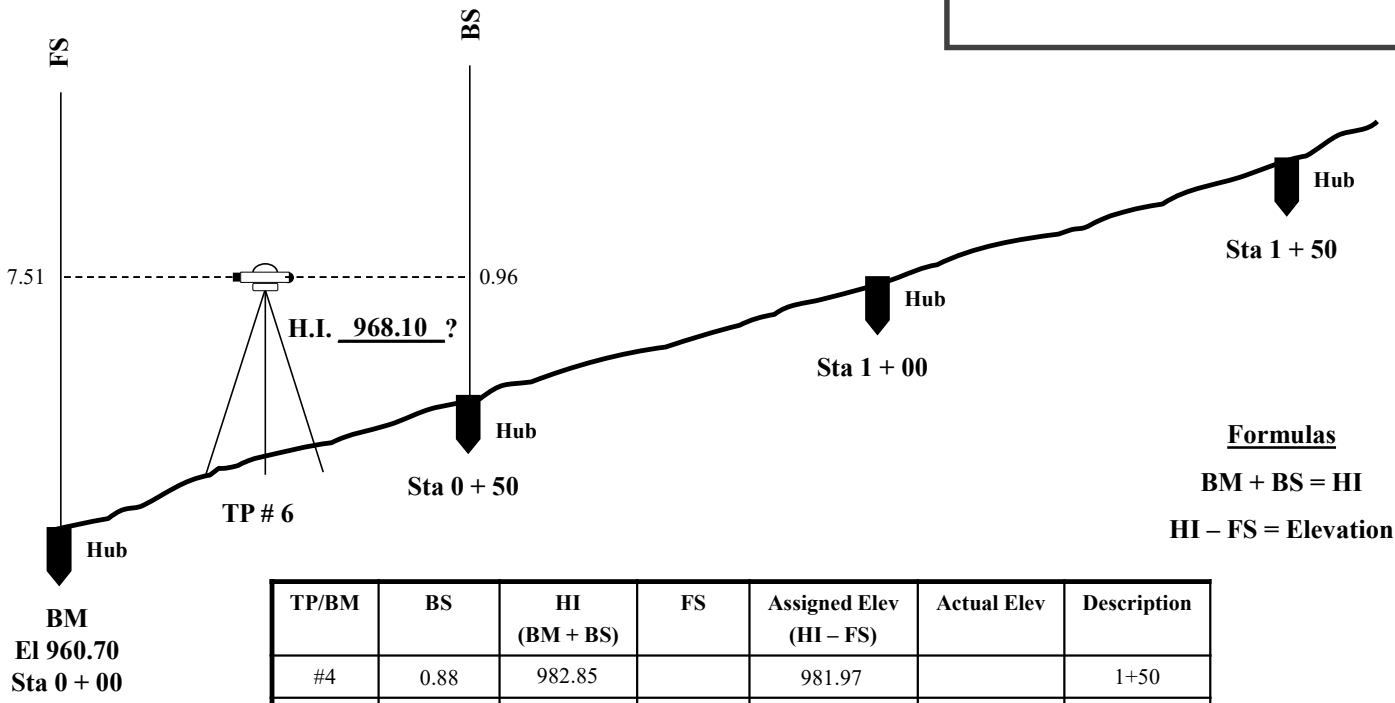
Formulas

BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	0.88	982.85		981.97		1+50
#5	2.40	976.15	9.10	973.75		1+00
#6			9.01	967.14		0+50
					960.70	0+00

CONFIRMING THE ELEVATION



Formulas

BM + BS = HI

HI – FS = Elevation

TP/BM	BS	HI (BM + BS)	FS	Assigned Elev (HI – FS)	Actual Elev	Description
#4	0.88	982.85		981.97		1+50
#5	2.40	976.15	9.10	973.75		1+00
#6	0.96	968.10	9.01	967.14		0+50
			7.51	960.59	960.70	0+00

Does this close within Tolerance? No

Straight Grade - 2 Elev/RR & Dist - Grade Rod

BM	BS RR	HI	FS RR	Elevation	Distance
980.32	3.24	983.56			
			LP RR – 9.87	973.69	132.50
			HP RR – 6.54	977.02	
	Highest RR – Lowest RR =		(9.87 – 6.54) = 3.33'	3.33 / 132.50 = FT/FT = 0.02513 FT/FT	
		Want it staked in 4 Equal Segments		132.50 / 4 = 33.125'	

DIST	X	FT/FT	=	RISE	LP RR – RISE	=	FG RR	SECTION–4"BIT+8"CL–5 FG RR+SECTION=SG RR
33.125		0.02513		0.83	9.87 – 0.83		9.04	9.04 + 1.00 = 10.04
66.25		0.02513		1.66	9.87 – 1.66		8.21	8.21 + 1.00 = 9.21
99.375		0.02513		2.50	9.87 – 2.50		7.37	7.37 + 1.00 = 8.37
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
975.72	4.06	979.78			
			LP RR – 8.75	971.03	196.44
			HP RR – 6.24	973.54	
	Highest RR – Lowest RR =		(8.75 - 6.24) = 2.51	2.51 / 196.44 = FT/FT = 0.0127774	
		Want it staked in 4 Equal Segments		196.44 / 4 = D = 49.11	

	DIST (D)	X	FT/FT	=	RISE	LP RR – RISE	=	FG RR	SECTION–4"BIT+8"CL–5 FG RR+SECTION=SG RR
(DX1)	49.11		0.0127774		0.63	8.75 – 0.63		8.12	8.12 + 1.00 = 9.12
(DX2)	98.22		0.0127774		1.25	8.75 – 1.25		7.50	7.50 + 1.00 = 8.50
(DX3)	147.33		0.0127774		1.88	8.75 – 1.88		6.87	6.87 + 1.00 = 7.87
(DX4)	196.44		0.0127774		2.51	8.75 – 2.51		6.24	6.24 + 1.00 = 7.24
	TRY SOME RANDOM DISTANCES								
	62.22		0.0127774		0.80	8.75 – 0.80		7.95	7.95 + 1.00 = 8.95
	107.10		0.0127774		1.37	8.75 – 1.37		7.38	7.38 + 1.00 = 8.38
	118.59		0.0127774		1.52	8.75 – 1.52		7.23	7.23 + 1.00 = 8.23
	132.07		0.0127774		1.69	8.75 – 1.69		7.06	7.06 + 1.00 = 8.06

Straight Grade - 2 Elev/RR & Dist - Lenker Rod

BM	BS RR	HI	FS RR	Elevation	Distance
980.32		0.32			
			LP RR – 3.69	973.69	132.50
			HP RR – 7.02	977.02	
	Highest RR – Lowest RR =		(7.02 – 3.69) = 3.33'	3.33 / 132.50 = FT/FT = 0.02513 FT/FT	
		Want it staked in 4 Equal Segments		132.50 / 4 = 33.125'	

DIST	X	FT/FT	=	RISE	LP RR + RISE	=	FG RR	SECTION–4"BIT+8"CL–5 FG RR–SECTION=SG RR
33.125		0.02513		0.83	3.69 + 0.83		4.52	4.52 – 1.00 = 3.52
66.25		0.02513		1.66	3.69 + 1.66		5.35	5.35 – 1.00 = 4.35
99.375		0.02513		2.50	3.69 + 2.50		6.19	6.19 – 1.00 = 5.19
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
952.22		2.22			
			LP RR – 4.47	954.47	176.00
			HP RR – 6.40	956.40	
	Highest RR – Lowest RR =		(6.40 – 4.47) = 1.93	1.93 / 176.00 = FT/FT = 0.0109659	
		Want it staked in 4 Equal Segments		176.00 / 4 = D = 44.00	

	DIST (D)	X	FT/FT	=	RISE	LP RR + RISE	=	FG RR	SECTION–4"BIT+8"CL–5 FG RR–SECTION=SG RR
(DX1)	44.00		0.0109659		0.48	4.47 + 0.48		4.95	4.95 - 1.00 = 3.95
(DX2)	88.00		0.0109659		0.96	4.47 + 0.96		5.43	5.43 - 1.00 = 4.43
(DX3)	132.00		0.0109659		1.45	4.47 + 1.45		5.92	5.92 - 1.00 = 4.92
(DX4)	176.00		0.0109659		1.93	4.47 + 1.93		6.40	6.40 - 1.00 = 5.40
	TRY SOME RANDOM DISTANCES								
	20.27		0.0109659		0.22	4.47 + 0.22		4.69	4.69 - 1.00 = 3.69
	57.64		0.0109659		0.63	4.47 + 0.63		5.10	5.10 - 1.00 = 4.10
	97.01		0.0109659		1.06	4.47 + 1.06		5.53	5.53 - 1.00 = 4.53
	162.72		0.0109659		1.78	4.47 + 1.78		6.25	6.25 - 1.00 = 5.25

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

BM	BS RR	HI	FS RR	Elevation	Distance	+ % = Rise − % = Fall
980.32	3.24	983.56				
			RR − 9.87	973.69	20.00	+2.00%
		Want Rise/Fall in FT/FT		+2.00% / 100 = 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)	5.00		0.02		0.10	9.87 − 0.10		9.77	9.77 + 1.00 = 10.77
(DX2)	10.00		0.02		0.20	9.87 − 0.20		9.67	9.67 + 1.00 = 10.67
(DX3)	15.00		0.02		0.30	9.87 − 0.30		9.57	9.57 + 1.00 = 10.57
(DX4)	20.00		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 (−)
980.32	4.77	985.09				
			8.72	976.37	20.00	-2.00%
		Want Rise/Fall in FT/FT		-2.00% / 100 = 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)	5.00		-0.02		-0.10	8.72 + 0.10		8.82	8.82 + 1.00 = 9.82
(DX2)	10.00		-0.02		-0.20	8.72 + 0.20		8.92	8.92 + 1.00 = 9.92
(DX3)	15.00		-0.02		-0.30	8.72 + 0.30		9.02	9.02 + 1.00 = 10.02
(DX4)	20.00		-0.02		-0.40	8.72 + 0.40		9.12	9.12 + 1.00 = 10.12
	TRY SOME RANDOM DISTANCES								
	3.33		-0.02		-0.07	8.72 + 0.07		8.79	8.79 + 1.00 = 9.79
	6.66		-0.02		-0.13	8.72 + 0.13		8.85	8.85 + 1.00 = 9.85
	12.27		-0.02		-0.25	8.72 + 0.25		8.97	8.97 + 1.00 = 9.97
	17.52		-0.02		-0.35	8.72 + 0.35		9.07	9.07 + 1.00 = 10.07

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

BM	BS RR	HI	FS RR	Elevation	Distance	+ % = Rise − % = Fall
980.32		0.32				
			RR − 3.69	973.69	20.00	+2.00%
		Want Rise/Fall in FT/FT		+2.00% / 100 = 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)	5.00		0.02		0.10	3.69 + 0.10		3.79	3.79 − 1.00 = 2.79
(DX2)	10.00		0.02		0.20	3.69 + 0.20		3.89	3.89 − 1.00 = 2.89
(DX3)	15.00		0.02		0.30	3.69 + 0.30		3.99	3.99 − 1.00 = 2.99
(DX4)	20.00		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 (−)
980.32		0.32				
			9.00	979.00	40.00	+2.00%
		Want Rise/Fall in FT/FT		+2.00% / 100 = FT/FT =		+0.02
		Want it staked in 4 Equal Segments		40.00 / 4 = D =		10.00

	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)	10.00		+0.02		+0.20	9.00 + 0.20		9.20	9.20 - 1.00 = 8.20
(DX2)	20.00		+0.02		+0.40	9.00 + 0.40		9.40	9.40 - 1.00 = 8.40
(DX3)	30.00		+0.02		+0.60	9.00 + 0.60		9.60	9.60 - 1.00 = 8.60
(DX4)	40.00		+0.02		+0.80	9.00 + 0.80		9.80	9.80 - 1.00 = 8.80
					TRY SOME RANDOM DISTANCES				
	12.50		+0.02		+0.25	9.00 + 0.25		9.25	9.25 - 1.00 = 8.25
	26.62		+0.02		+0.53	9.00 + 0.53		9.53	9.53 - 1.00 = 8.53
	30.77		+0.02		+0.62	9.00 + 0.62		9.62	9.62 - 1.00 = 8.62
	38.21		+0.02		+0.76	9.00 + 0.76		9.76	9.76 - 1.00 = 8.76