

Mastering Cut-Sheets, Part II

When working out cut-sheet problems, the primary equation used is-

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

In order to find a missing slope, invert or station on a cut-sheet problem, it helps to know how to convert the slope equation. We will begin with how to find a missing invert by converting the “slope” equation to a “rise” equation.

Example 1-

When looking for a missing invert you must isolate the “rise” aspect of the equation.

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

$$\frac{\text{Run}}{1} \times \frac{\text{Slope}}{1} = \frac{\text{Rise}}{\text{Run}} \times \frac{\text{Run}}{1}$$

$$\frac{\text{Run}}{1} \times \frac{\text{Slope}}{\cancel{1}} = \frac{\cancel{\text{Rise}}}{\text{Run}} \times \frac{\text{Run}}{1}$$

$$\frac{\text{Run}}{1} \times \frac{\text{Slope}}{1} = \frac{\text{Rise}}{1}$$

$$\text{Run} \times \text{Slope} = \text{Rise}$$

If you have two stations and the slope, you can now find the missing invert associated with one of the used stations.

Example 1A- Given

$$\text{Slope} = 0.020$$

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | |
| 1 + 25 | 94.50 | | 7.00 |

A missing invert is a “rise” issue, given the slope (0.020) and the “run” $(0 + 00) + (1 + 25) = 125$, use the equation:

$$\text{Run} \times \text{Slope} = \text{Rise} \quad \text{or} \quad 125 \times 0.020 = 2.5$$

This means over 125’ the invert elevation has a “rise” of 2.5, therefore you must add 2.5 to the previous invert elevation, so:

$$85.00 + 2.5 = 87.50$$

Answer to example 1A-

Slope = 0.020

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | 90.00 | 85.00 | |
| 1 + 25 | 94.50 | 87.50 | 7.00 |

Note-

Had the invert elevation for station (0 + 00) been missing rather than that for station (1 + 25), you would subtract 2.5 (the answer) from 87.50 to get 85.00.

Example 2-

When looking for a missing station you must isolate the “run” aspect of the equation.

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

$$\frac{1}{\text{Rise}} \times \frac{\text{Slope}}{1} = \frac{\text{Rise}}{\text{Run}} \times \frac{1}{\text{Rise}}$$

$$\cancel{\frac{1}{\text{Rise}}} \times \cancel{\frac{\text{Slope}}{1}} = \frac{\text{Rise}}{\cancel{\text{Run}}} \times \frac{1}{\text{Rise}}$$

$$\frac{\text{Slope}}{\text{Rise}} = \frac{1}{\text{Run}}$$

invert the equation to:

$$\frac{\text{Rise}}{\text{Slope}} = \frac{\text{Run}}{1}$$

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

If you have two inverts and the slope, you can now find the missing station associated with one of the used inverts.

Example 2A- Given

Slope = 0.020

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | |
| | 94.50 | 87.50 | 7.00 |

A missing station is a “run” issue, given the slope (0.020) and the “rise” $(87.50) - (85.00) = 2.5$, use the equation:

$$\mathbf{Run} = \frac{\mathit{Rise}}{\mathit{Slope}} \quad \text{or} \quad \mathbf{Run} = \frac{2.5}{0.020} = 125$$

This means it takes a “run” of 125’, or 1+25 to achieve a 2.5 difference in invert elevations with a slope of 0.020, therefore you must add 1+25 to the previous station, so once again:

Answer to example 2A-

Slope = 0.020

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | |
| 1 + 25 | 94.50 | 87.50 | 7.00 |

Note-

As before, had the station for invert elevation (85.00) been missing rather than that for invert elevation (87.50), you would subtract 125 (the answer) from 1 + 25 to get 0 + 00.

Example 3-

When looking for a missing slope you must use the primary equation:

$$\mathbf{Slope} = \frac{\mathit{Rise}}{\mathit{Run}}$$

If you have two stations and two inverts, you can find the missing slope.

Example 3A- Given

Slope = _____

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | |
| 1 + 25 | 94.50 | 87.50 | 7.00 |

To find the missing slope you need two stations to represent “run” and two inverts to represent “rise”. In this case the “run” is $(1 + 25) - (0 + 00)$, or 125 and the “rise” is $(87.50) - (85.00)$, or 2.5. Use the equation:

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} \quad \text{or} \quad \text{Slope} = \frac{2.5}{125} = 0.020$$

Answer to example 3A-

$$\text{Slope} = 0.020$$

Note-

Any two sets of stations and invert elevations can be used to find a missing slope.

Example 4-

When looking for a missing “cut”, you simply subtract the invert elevation from the stake elevation.

Example 4A- Given

$$\text{Slope} = 0.020$$

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 +00 | 90.00 | 85.00 | |
| 1 + 25 | 94.50 | 87.50 | 7.00 |

To find the missing “cut”, subtract the invert elevation from the stake elevation.

$$\text{Stake elevation (90.00)} - \text{Invert elevation (85.00)} = 5.00$$

Answer to example 4A-

$$\text{Slope} = 0.020$$

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | 5.00 |
| 1 + 25 | 94.50 | 87.50 | 7.00 |

Note-

The addition of a known “cut” to an invert elevation will give you a missing stake elevation. The subtraction of a known “cut” from a stake elevation will give you a missing invert elevation.

Finish Cut- Sheet A

Slope = 0.020

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | 90.00 | 85.00 | 5.00 |
| 1 + 25 | 94.50 | 87.50 | 7.00 |
| 3 + 00 | | 91.00 | 6.25 |
| 5 + 00 | 101.20 | 95.00 | |
| 6 + 00 | 103.15 | | 6.15 |

Finish Cut- Sheet B

Slope = 0.050

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | | | 7.66 |
| 1 + 21 | 98.20 | | |
| 2 + 80 | 105.67 | | 8.97 |
| 4 + 86 | 115.22 | 107.00 | |
| 6 + 19 | | 113.65 | 6.71 |

Finish Cut-Sheet C

Slope = 0.030

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | | 55.90 | 9.10 |
| 3 + 60 | 72.50 | | 5.80 |
| 6 + 80 | 85.80 | 76.30 | |
| 9 + 10 | | | 3.60 |
| 12 + 10 | 104.00 | | |

Finish Cut-Sheet D

Slope = 0.010

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | 20.00 | | |
| 2 + 80 | | | 7.50 |
| 3 + 40 | 22.10 | | 8.50 |
| 5 + 10 | | | 8.55 |
| 6 + 90 | 25.65 | | |

Finish Cut-Sheet E

Slope = _____

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 18.65 | | 8.15 |
| 2 + 50 | | | 6.75 |
| 4 + 50 | 30.20 | 21.75 | |
| 6 + 00 | 33.60 | | |
| 7 + 30 | 35.15 | | 6.40 |

Answers

Cut- Sheet A

Slope = 0.020

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.00 | 85.00 | 5.00 |
| 1 + 25 | 94.50 | 87.50 | 7.00 |
| 3 + 00 | 97.25 | 91.00 | 6.25 |
| 5 + 00 | 101.20 | 95.00 | 6.20 |
| 6 + 00 | 103.15 | 97.00 | 6.15 |

Cut-Sheet B

Slope = 0.050

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|-----------------|------------------|------|
| 0 + 00 | 90.36 | 82.70 | 7.66 |
| 1 + 21 | 98.20 | 88.75 | 9.45 |
| 2 + 80 | 105.67 | 96.70 | 8.97 |
| 4 + 86 | 115.22 | 107.00 | 8.22 |
| 6 + 19 | 120.36 | 113.65 | 6.71 |

Cut-Sheet C

Slope = 0.030

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|-------|
| 0 + 00 | 65.00 | 55.90 | 9.10 |
| 3 + 60 | 72.50 | 66.70 | 5.80 |
| 6 + 80 | 85.80 | 76.30 | 9.50 |
| 9 + 10 | 86.80 | 83.20 | 3.60 |
| 12 + 10 | 104.00 | 92.20 | 11.80 |

Cut-Sheet D

Slope = 0.010

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | 20.00 | 10.20 | 9.80 |
| 2 + 80 | 20.50 | 13.00 | 7.50 |
| 3 + 40 | 22.10 | 13.60 | 8.50 |
| 5 + 10 | 23.85 | 15.30 | 8.55 |
| 6 + 90 | 25.65 | 17.10 | 8.55 |

Cut-Sheet E

Slope = 0.025

| STATION | STAKE ELEVATION | INVERT ELEVATION | CUT |
|---------|--------------------|---------------------|------|
| 0 + 00 | 18.65 | 10.50 | 8.15 |
| 2 + 50 | 23.50 | 16.75 | 6.75 |
| 4 + 50 | 30.20 | 21.75 | 8.45 |
| 6 + 00 | 33.60 | 25.50 | 8.10 |
| 7 + 30 | 35.15 | 28.75 | 6.40 |

Remember

$$\text{Slope} = \frac{\text{Rise}}{\text{Run}} \quad \text{Run} = \frac{\text{Rise}}{\text{Slope}} \quad \text{Rise} = \text{Run} \times \text{Slope}$$

If you insert the number (4) where you see “slope”, the number (8) where you see “rise” and the number (2) where you see “run”, you get:

$$4 = \frac{8}{2} \quad 2 = \frac{8}{4} \quad 8 = 2 \times 4$$

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