


Cut and Fill Calculations

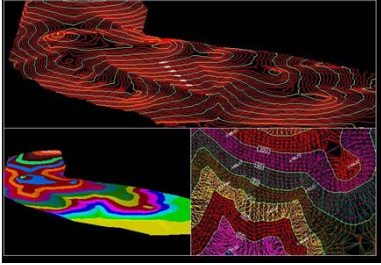
- Calculation of the cut-and-fill volumes is an essential component to any site development project



A topographic map showing a site layout with project boundaries in yellow and green. Elevation contours are shown in purple and blue. The map includes various annotations such as 'Cut Area - 2000', 'Fill Area - 2000', and 'Project Limits'.

Cut and Fill Calculations

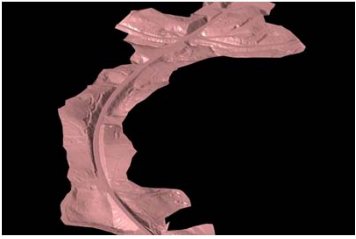
- Topographic data is required to estimate cut-and-fill volumes



A 3D topographic surface model showing a terrain with a color gradient from blue (low elevation) to red (high elevation). The model is shown from a perspective view, highlighting the terrain's contours and elevation changes.

Cut and Fill Calculations

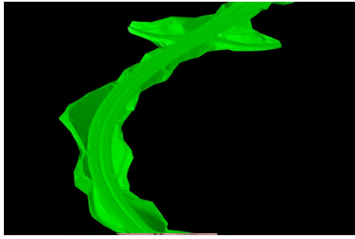
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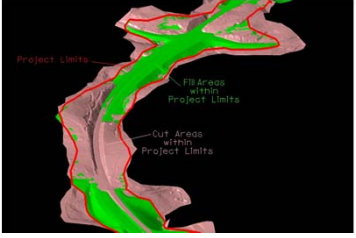
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Cut and Fill Calculations

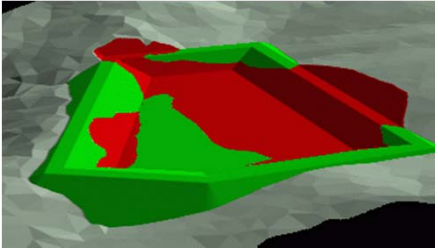
- Topographic data is required to estimate cut-and-fill volumes



A 3D topographic surface model showing a terrain with a color gradient from blue (low elevation) to red (high elevation). The model is shown from a perspective view, highlighting the terrain's contours and elevation changes. The image includes labels: 'Project Limits', 'Fill Area within Project Limits', and 'Cut Area within Project Limits'.


Cut and Fill Calculations

- Topographic data is required to estimate cut-and-fill volumes

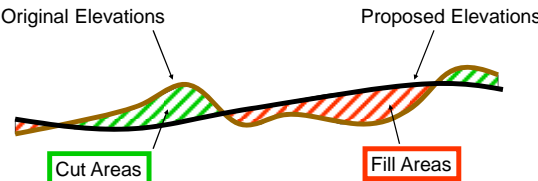


A 3D topographic surface model showing a terrain with a color gradient from blue (low elevation) to red (high elevation). The model is shown from a perspective view, highlighting the terrain's contours and elevation changes. The image includes labels: 'Project Limits', 'Fill Area within Project Limits', and 'Cut Area within Project Limits'.

Cut and Fill Calculations



- From the topographic data of the site, different alternative site plans can be evaluated
- The basic calculation is the difference between the desired elevation and the original elevations




Original Elevations

Proposed Elevations

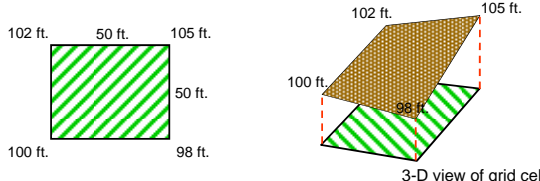
Cut Areas

Fill Areas

Cut and Fill Calculations



- Traditionally, elevations for a topographic survey are collected using some type of regular grid system
- Using the elevation data and the grid system, a three-dimensional model of the cut-and-fill volumes can be constructed




102 ft. 50 ft. 105 ft.

100 ft. 50 ft. 98 ft.

3-D view of grid cell

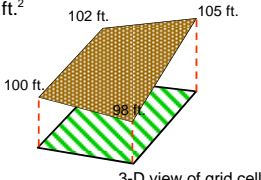
Cut and Fill Calculations



- The volume of material in this grid cell may be estimated as the volume of the quadrilateral cell
- Volume equals the average of the cell height times the area of the cell


Cell Area = (50 ft.)(50 ft.) = 2,500 ft.²

$$\text{Volume} = \left(\frac{98 + 100 + 102 + 105}{4} \right) \text{ft.} (2,500 \text{ft.}^2)$$

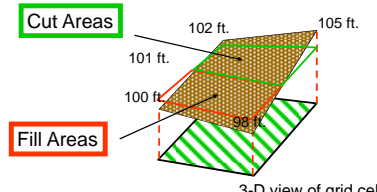
$$\text{Volume} = 253,125 \text{ft.}^3 = 9,375 \text{yd.}^3$$


3-D view of grid cell

Cut and Fill Calculations



- Consider a cell in the grid system with the following elevations
- Development at this site requires that this area be at an elevation of 101 feet




Cut Areas

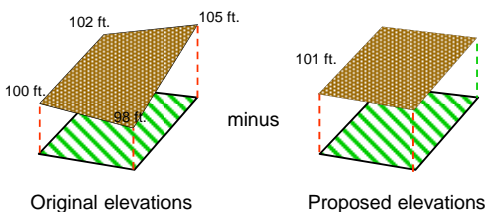
Fill Areas

3-D view of grid cell

Cut and Fill Calculations




- To estimate the cut-and-fill required in this cell, first compute the change in volume
- $\Delta V = \text{original elevations} - \text{proposed elevations}$



Original elevations

Proposed elevations

Cut and Fill Calculations



- The volume of cut-and-fill in this grid cell may be estimated as the volume of the quadrilateral cell
- Volume equals the average of the cell height times the area of the cell


$$\text{Cell Area} = (50 \text{ft.})(50 \text{ft.}) = 2,500 \text{ft.}^2$$

$$\text{Volume} = \left(\frac{-3 - 1 + 1 + 4}{4} \right) \text{ft.} (2,500 \text{ft.}^2)$$

$$\text{Volume} = 625 \text{ft.}^3 = 23.15 \text{yd.}^3$$

- The total cut-and-fill can be estimated by summing the cut-and-fill from each cell for the entire grid system

Cut and Fill Calculations




- Compute the total cut-and-fill for the following site
- The original elevations are:

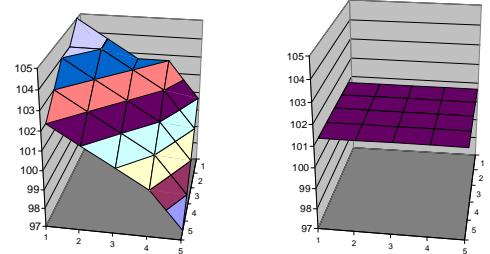
	1	2	3	4	5
1	105	104	104	103	102
2	104	104	103	102	101
3	103	103	102	101	100
4	103	102	101	100	99
5	101	100	99	98	97

- The size of each cell is 25 ft. by 25 ft.
- The proposed site is at an elevation of 101 ft.


Cut and Fill Calculations



- Below is an Excel plot of the original elevations and the proposed elevations



Cut and Fill Calculations




- To compute the cut-and-fill compute the change in elevations (original elevations minus proposed elevations gives).

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- Positive values indicate cut and negative values indicate fill.

Cut and Fill Calculations




- Compute the volume of cut-and-fill for each grid cell
- Average the elevations for each grid cell times the cell area

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(4+3+3+3)\text{ft.}}{4} (625\text{ft.}^2) = 2,031.3\text{ft.}^3 = 75.23\text{yd.}^3$$

Cut and Fill Calculations




- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(3+3+3+2)\text{ft.}}{4} (625\text{ft.}^2) = 1,718.8\text{ft.}^3 = 63.66\text{yd.}^3$$

Cut and Fill Calculations



- For the cell to the right, compute the volume of cut-and-fill

	1	2	3	4	5
1	4.00	3.00	3.00	2.00	1.00
2	3.00	3.00	2.00	1.00	0.00
3	2.00	2.00	1.00	0.00	-1.00
4	2.00	1.00	0.00	-1.00	-2.00
5	0.00	-1.00	-2.00	-3.00	-4.00

- For the cell above, the volume of cut-and-fill is:

$$\text{Volume} = \frac{(3+2+2+1)\text{ft.}}{4} (625\text{ft.}^2) = 1,250\text{ft.}^3 = 46.30\text{yd.}^3$$

Cut and Fill Calculations

- The resulting cut-and-fill volumes (yd.³) for each cell in the entire grid system is:

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- A sited model with a 5 x 5 grid system contains 4 x 4 cells

Cut and Fill Calculations

- The total cut-and-fill for this site may be estimated by summing the cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example the total is: 284 yd.³

Cut and Fill Calculations

- The total cut this site may be estimated by summing the positive (+) cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example the total is: 411 yd.³
- Use Excel function: =sumif(A1:D4,">0")

Cut and Fill Calculations

- The total fill this site may be estimated by summing the negative (-) cut-and-fill volumes for each cell

	1	2	3	4
1	75.23	63.66	46.30	23.15
2	57.87	46.30	23.15	0.00
3	40.51	23.15	0.00	-23.15
4	11.57	-11.57	-34.72	-57.87

- For this example the total is: -127 yd.³
- Use Excel function: =sumif(A1:D4,"<0")

Cut and Fill Calculations

- An estimate of the cost of cut-and-fill for the entire site can be made by considering:
- On-site cost (\$2.50/yd.³) for total cut-and-fill volume:

$$\text{Onsite} = \left(\frac{\$2.50}{\text{yd.}^3}\right)(\text{cut} - \text{fill}) = \left(\frac{\$2.50}{\text{yd.}^3}\right)(411 - (-127))\text{yd.}^3$$

Onsite = \$1,345

- Note: since fill volume is always (-) negative, therefore to compute the total earthwork volume use (cut - fill)

Cut and Fill Calculations

- An estimate of the cost of cut-and-fill for the entire site can be made by considering:
- Off-site cost: \$5/yd.³ for fill and \$3/yd.³ for cut)

$$\text{Off site} = \left(\frac{\text{cost}}{\text{yd.}^3}\right)|\text{cut} + \text{fill}| = \left(\frac{\text{cost}}{\text{yd.}^3}\right)|411 - 127|\text{yd.}^3$$

$$\text{Off site} = \left(\frac{\$3}{\text{yd.}^3}\right)|284\text{yd.}^3| = \$852$$

Total Cost = \$1,345 + \$852 = **\$2,197**

End of Cut-and-Fill 1



Any Questions?