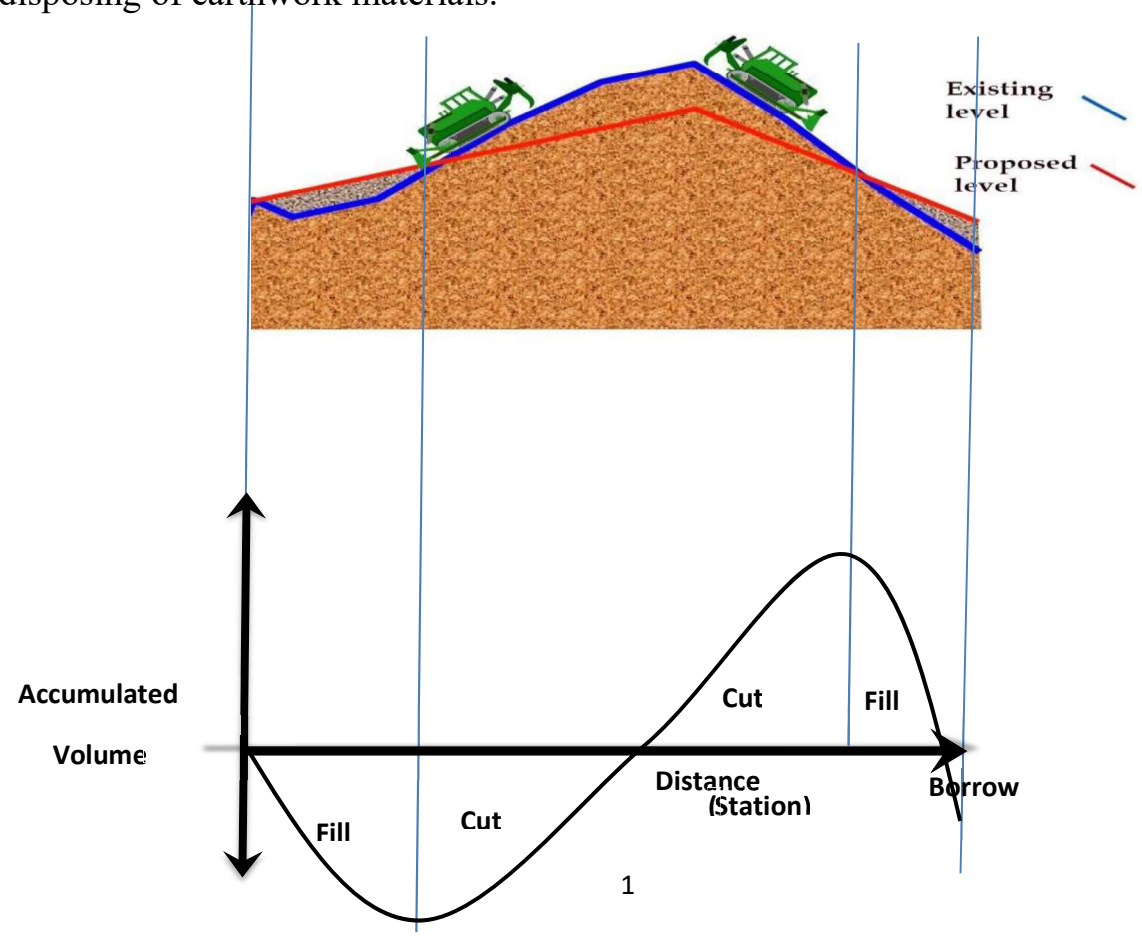
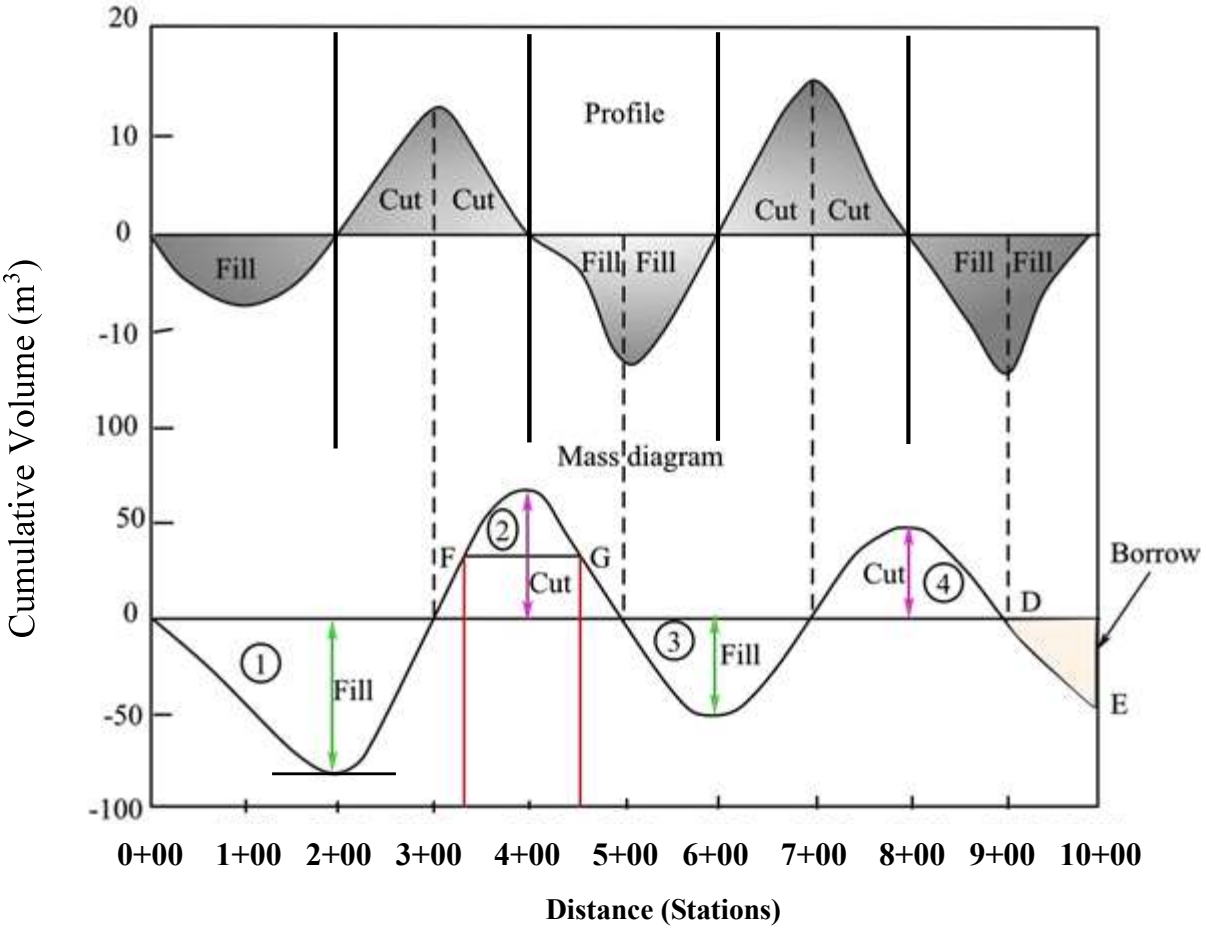
MASS HAUL DIAGRAM

The main aim of developing the mass haul diagram is to study the quantities of embankment and excavation in order to make grading cost = minimum through minimizing material waste or borrow.

Mass haul diagram: continuous curve showing the relationship between accumulated algebraic sums of corrected earthwork volume of soil and stations within the road, which represents distance along the road. It presents a picture of the earthwork requirements, accumulated volume of earthwork at the horizontal axis (Y = 0) is 0.

- Cut volumes are taken to be positive and fill volumes to be negative.
- Mass haul diagram is used to minimize the cost of excavating, hauling, and disposing of earthwork materials.





Cut ⟶ Rising

Fill ⟶ Falling

Steep Slope ⟶ High cut or Fill

Zero Slope ⟶ Change from cut to fill or vice versa

Zero value ⟶ balance between cut and fill

- An Earthwork Profile is a plot of the net earthwork along a roadway or airstrip, horizontal stationing is plotted along the X-axis;
- Net earthwork values are plotted along the Y-axis;

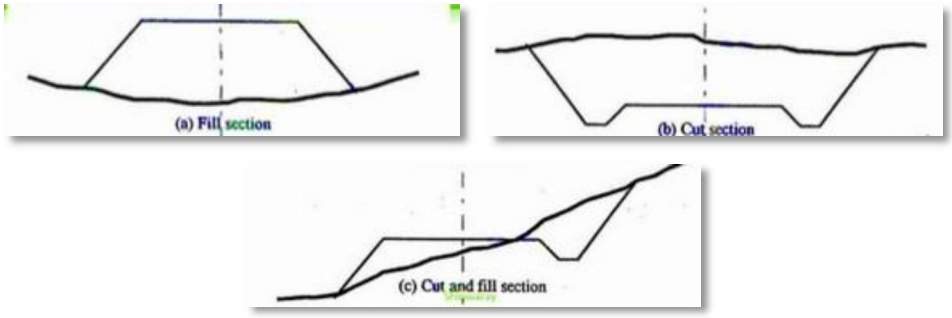
- The vertical coordinate is a plot of the cumulative earthwork from the origin to that point;
- Net cut values are plotted above the X-axis (positive Y value);
- Net fill values are plotted below the X-axis (negative Y value);
- Upward sloping curves indicate (rising left to right) indicate a cut section;
- Downward sloping (falling left to right) curves occur in a fill section;
- The peaks indicate a change from cut to fill and valleys occur when the earthwork changes from fill to cut;
- When a horizontal line intersects two or more points along the curve, the accumulated volumes at those points are equal.(The accumulated volume of earthwork at the horizontal axis (Y = 0) is 0);
- A negative value at the end of the curve indicates that borrow is required to complete the fill;
- A positive value at the end of the curve indicates that a waste operation will be the net result.

To construct the Mass Haul Diagram manually:

- Compute the net earthwork values for each station, applying the appropriate shrink factor;
- Net cuts have a positive value, net fills have a negative value;
- The value at the first station (origin) = 0;
- Plot the value of each succeeding, which equals the cumulative value to that point.

Calculation of accumulated volume

1. Find the cross section area of cut and fill work



2. Find the net cut volume by multiply the average cut area of two successive stations by the distance between the two stations.
3. Find the net fill volume by multiply the average fill area of two successive stations by the distance between the two stations.
4. Find the corrected cut volume by multiply the cut volume found in step 2 by the shrinkage or swelling value based on the soil type factor

Shrinkage or swell factor – it is well known that one cubic meter of material excavated from the ground will not necessarily occupy exactly 1 m^3 of space when placed in the fill. Therefore, an adjustment must be made to account for the change in volume between the cut and fill conditions.

Shrinkage and swell are often expressed as "percent shrinkage" or "percent swell"; which represent the percentage change in volume between cut and fill conditions.

- Normal soil (silt, clay, sand) (sandy, silty clay) shrinkage factor = 0.05 - 0.15

↓

0.1

Corrected cut = cut volume * (1-shrinkage factor)

- Stone (limestone, sand stone) or rock, bulk factor = 0.1- 0.3
  ↓
  0.2

Corrected cut = cut volume * (1+bulk factor)

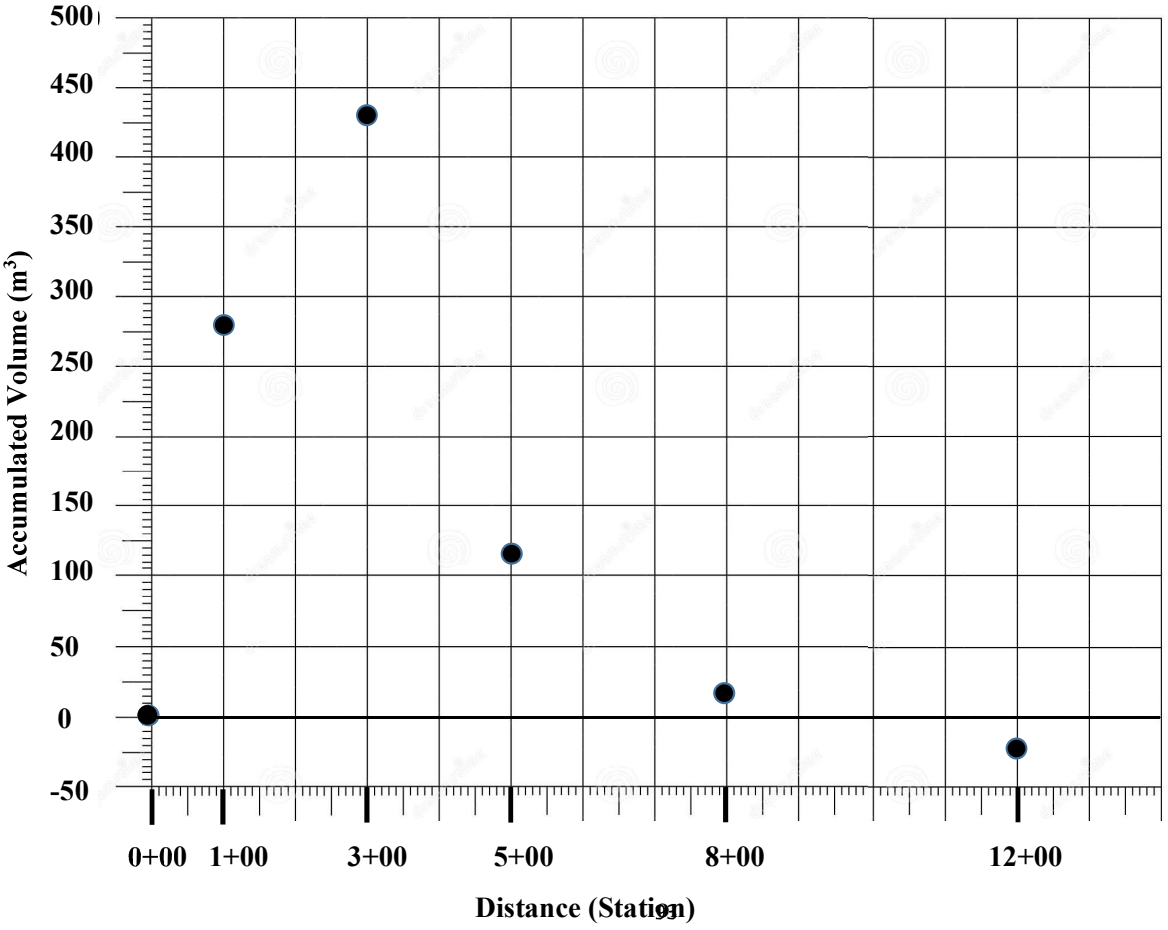
Bulk factor is the ratio or percentage of the volume change of excavated material to the volume of the original in situ volume before excavation.

Example 1: calculate the Accumulated volume of earth work for the data shown in the table below: (Assume shrinkage factor = 0.1)

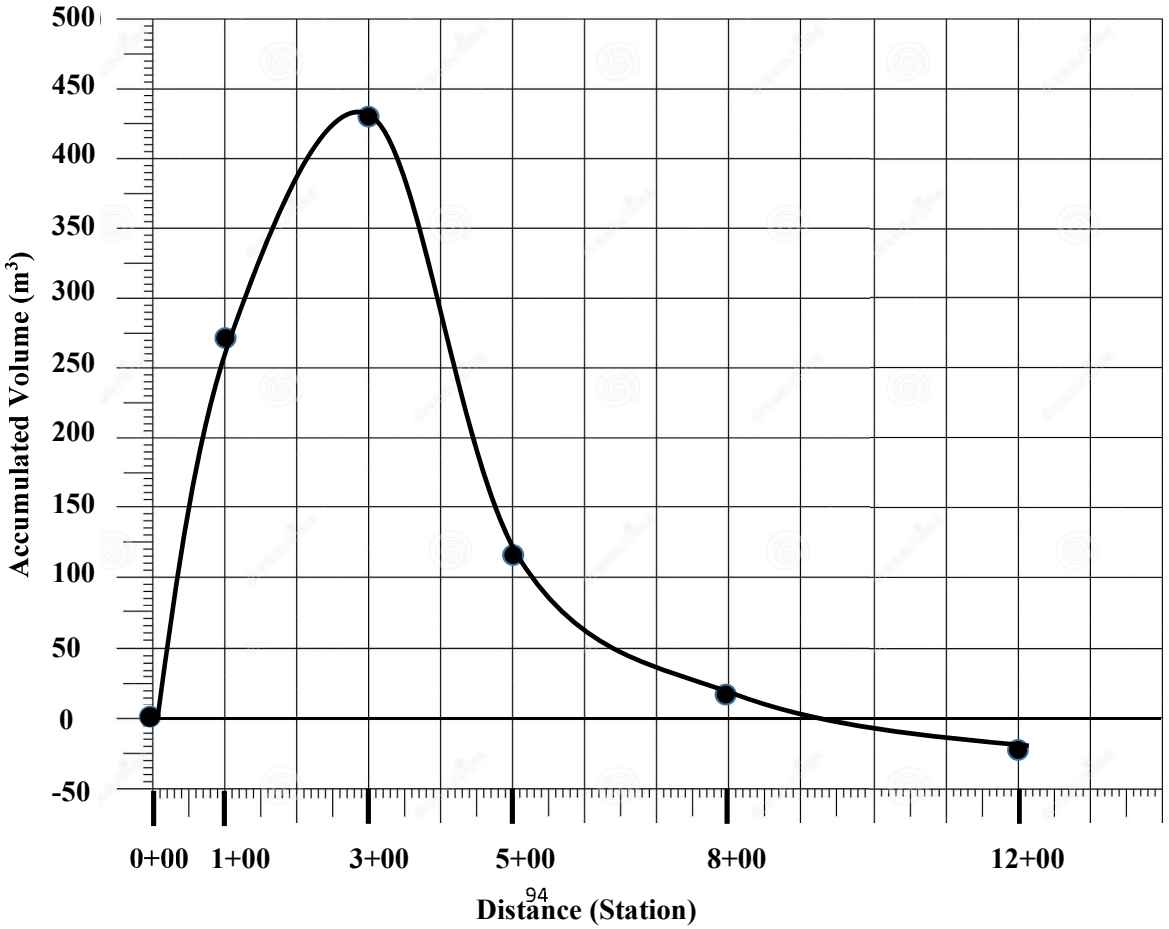
Station	End Area (m^2)	
	Fill	Cut
0+00	0	2
1+00	0	4
3+00	2	0
5+00	3	2
8+00	3	4
12+00	1.7	1

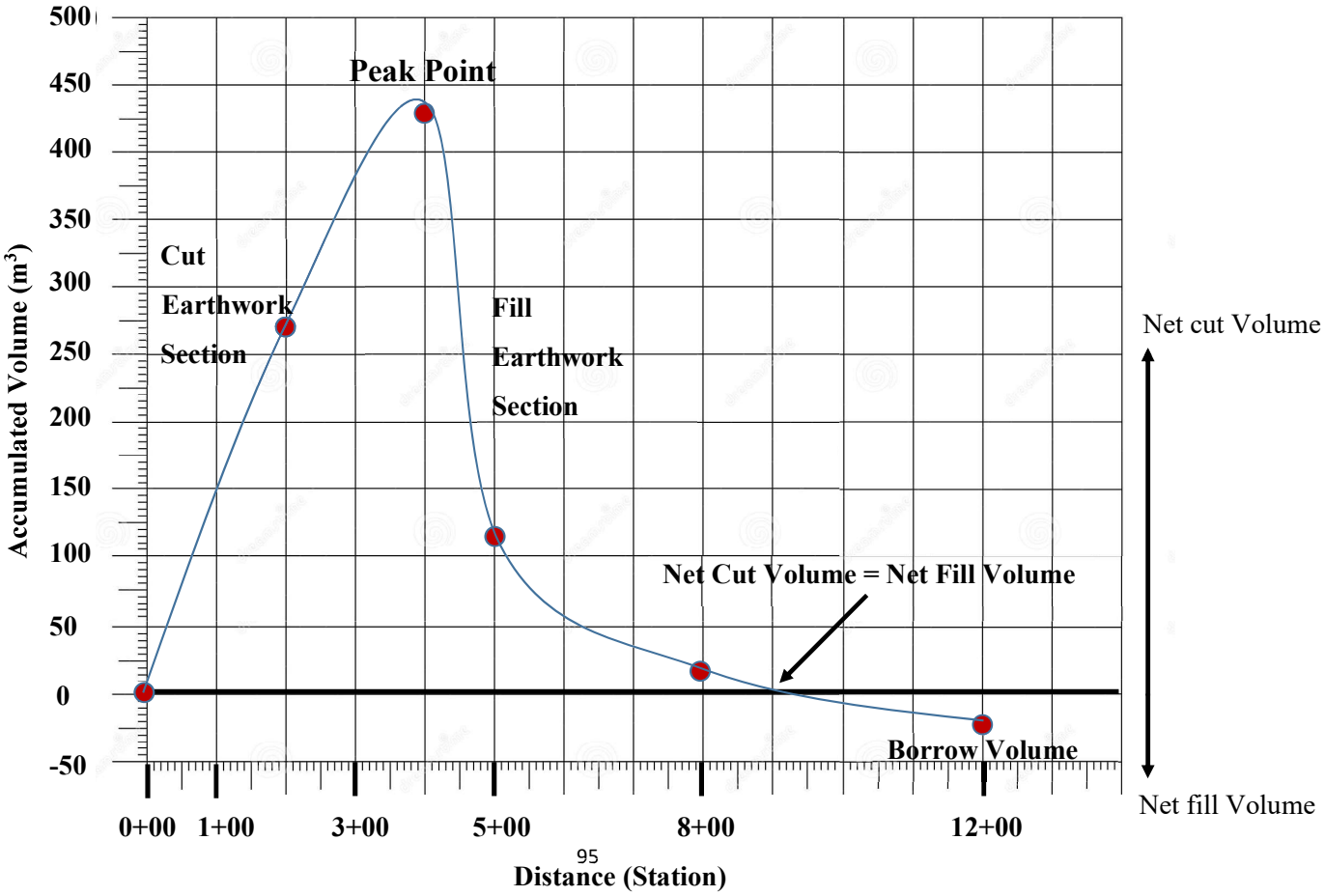
Solution:

Station	Area (m^2)		Volume (m^3)		Corrected Cut multiplied by (1- shrinkage factor)	Balance	Acc. vol. (m^3)
	Fill (-)	Cut (+)	Fill (-)	Cut (+)			
0+00	0	2					0
			0	300	+270	+270	
1+00	0	4					+270
			200	400	360	+160	
3+00	2	0					+430
			500	200	180	-320	
5+00	3	2					+110
			900	900	810	-90	
8+00	3	4					+20
			940	1000	900	-40	
12+00	1.7	1					-20



Station	Acc. vol. (m^3)
0+00	0
1+00	+270
3+00	+430
5+00	+110
8+00	+20
12+00	-20


500
450
400
350
300
250
200
150
100
50
0
-50
Accumulated Volume (m3)
0+00
1+00
3+00
5+00
8+00
12+00
Distance (Station)


500
450
400
350
300
250
200
150
100
50
0
-50
Accumulated Volume (m3)
Peak Point
Cut
Earthwork
Section
Fill
Earthwork
Section
Net Cut Volume = Net Fill Volume
Borrow Volume
Net cut Volume
Net fill Volume
0+00
1+00
3+00
5+00
8+00
12+00
Distance (Station)