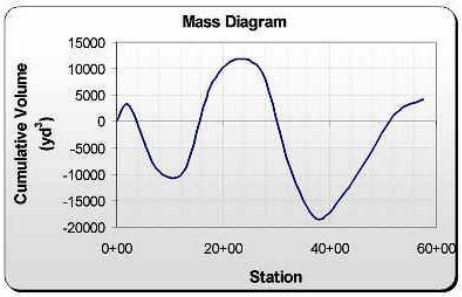
Earthwork Mass Diagrams

Basic Definitions

Mass Diagram- A graphical representation of the cumulative amount of earthwork moved along the centerline and distances over which the earth and materials are to be transported.



Characteristics of Mass Curve:

1- Rising sections of the mass curve indicates areas where excavating exceeds fill, whereas falling sections indicate where fill exceeds excavation.
2- Steep slopes reflect heavy cuts & Fills, while flat slopes indicate areas fro small amount of earthwork.
3- The difference in ordinates between any two points indicate net excess of excavation over embankment or vise versa.
4- Any horizontal line dawn to intersect two points within the same curve indicates a balance of excavation (cut) and embankment (fill) quantities between the two points.
5- Points of zero slope represent points where roadway goes from cut to fill or from fill to cut.
6- The highest or the lowest points of the mass haul diagram represents the crossing points between the grade line (roadway level) and natural ground level.

What does a Mass Diagram tell us?

1. Mass diagrams determine the average haul, free haul, and overhaul on a given segment of roadway.
2. Mass diagrams tell the contractors and inspectors the quantity of material moved and how far it can be economically moved.

Definitions

Haul →the transportation of excavated material from its original position to is final location in the work or other disposal area. This is also know as authorized haul.
Average haul → determined from mass diagram. Average haul is the area of the mass diagram representing the number of cubic yard stations of haul between balance points divided by the ordinate of the mass which the yardage is hauled.
Overhaul → the authorized hauling of excavation beyond the specified free-haul distance.
Free haul →Average haul for project that is free

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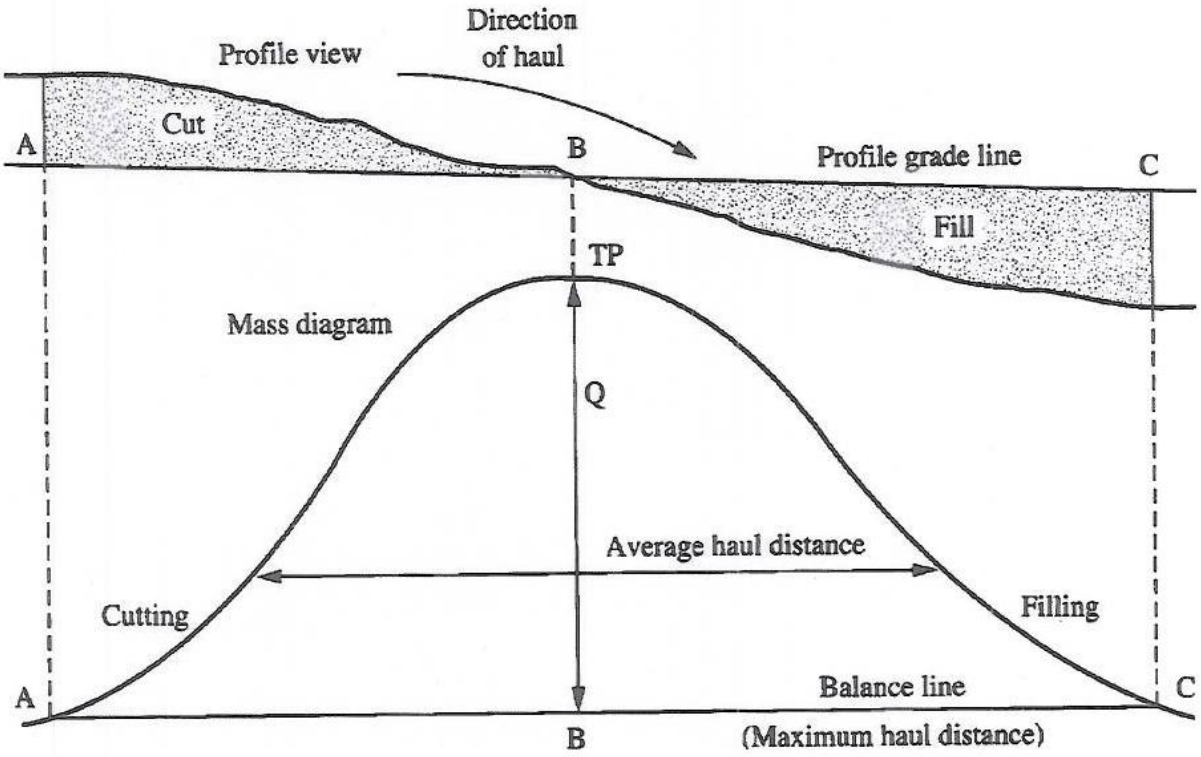
Economic Haul Distances:

Machine Type	Economical Haul Distance
Large Dozers (pushing material)	Up to 300 feet
Push-loaded Scrapers	300 – 500 feet
Trucks	> 500 feet



For the mass diagram shown above, assuming A (expressed as CY-STA or CY-ft) is the area bounded by the balance line and the curve, the average haul distance is A/Q (expressed as STA or ft).

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Sample Mass Diagrams

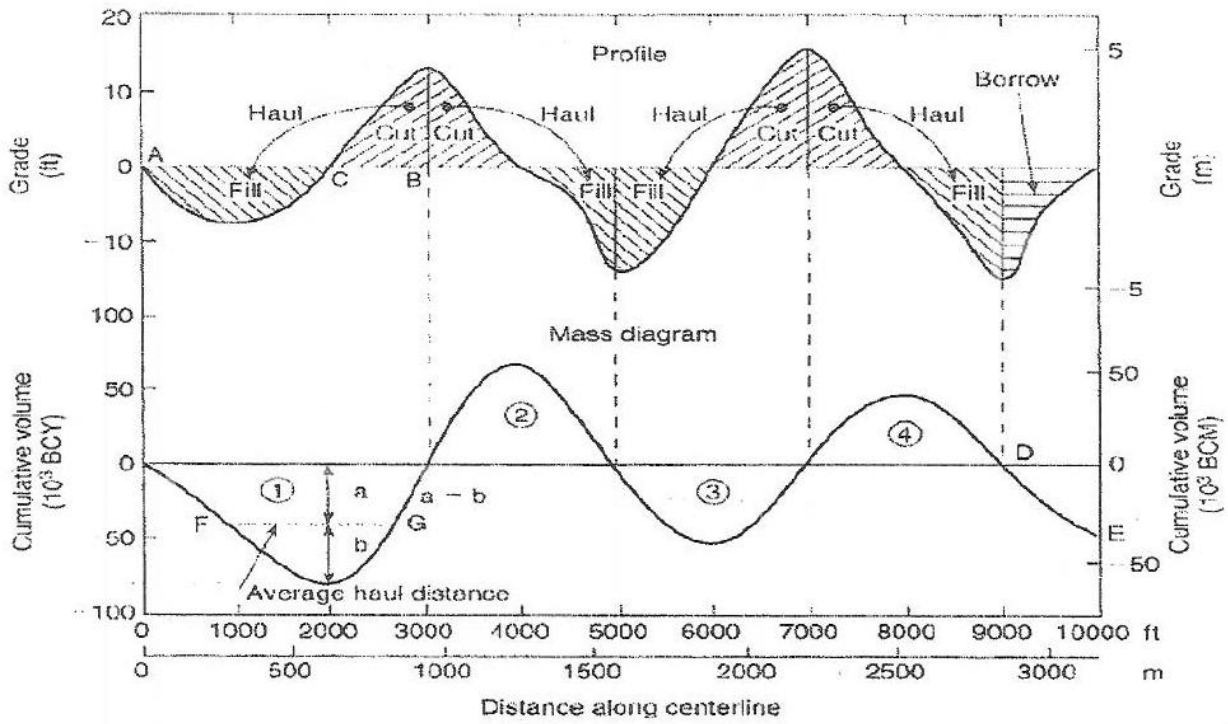

Figure 8 A Sample Mass Diagram

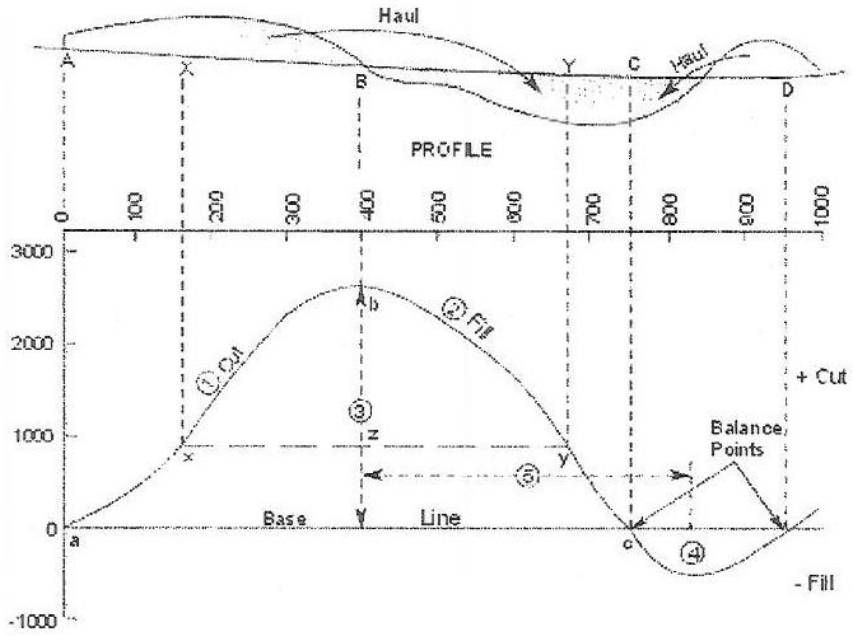

Figure 9 A Sample Mass Diagram

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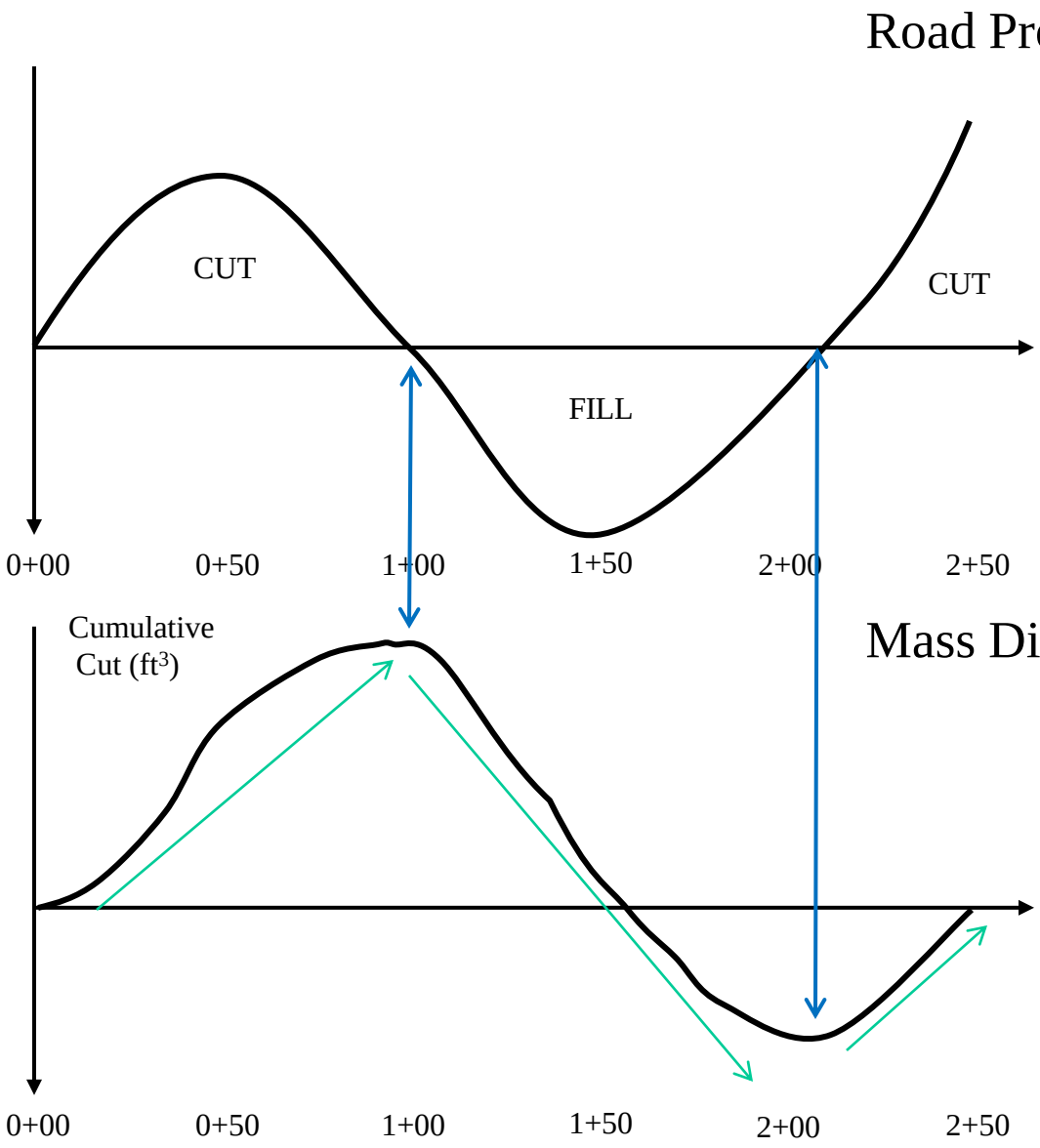


From STA 0+00 to STA 1+00 : This is all cut which is why the Mass diagram continues to increase.

From STA 1+00 to STA 2+10: This is all fill, so this is why the mass diagram begins decreasing in value.

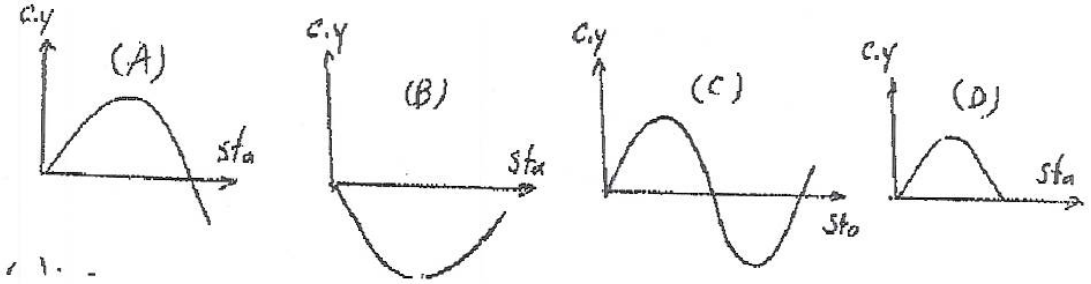
From STA 2+10 to STA 2+50: This is cut again until the end of the project. It just so happens that the cut and fill are exactly the same in this example.

Earthwork Mass Diagrams

Mass Diagram Problem 1:

For the given mass diagrams which statement(s) are correct?

A) A & B are deficit earthwork operations
B) C is an excess earthwork operation
C) D is a balanced earthwork operation
D) All above statements (A, B, C) are correct



Mass Diagram Solution 1:

D) All above statements (A, B, C) are correct

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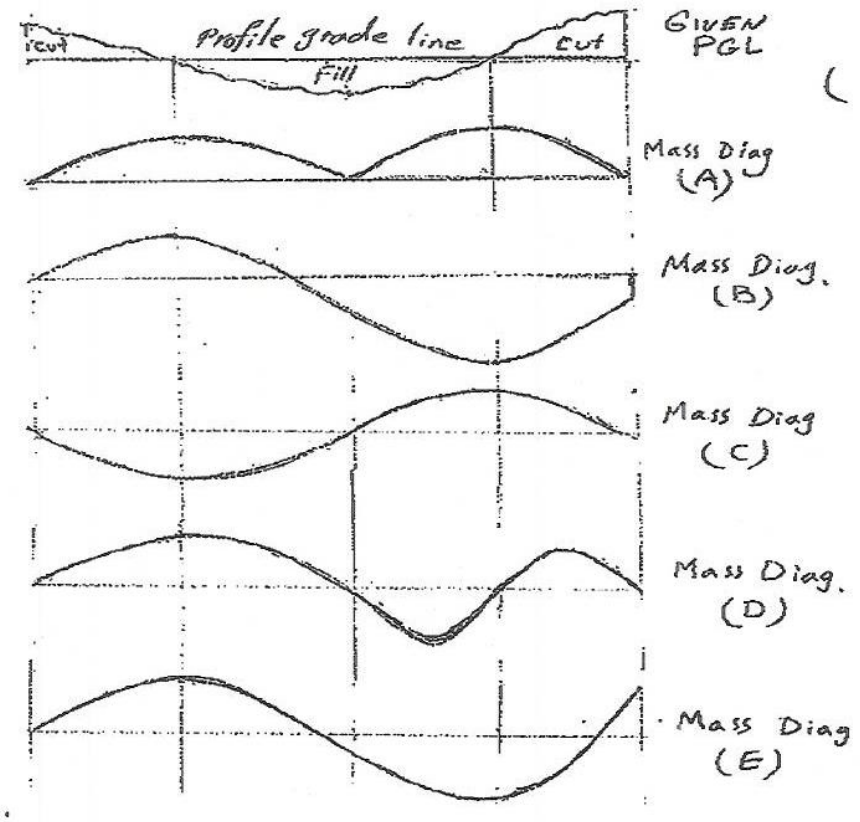
Mass Diagram Problem 2:

For the given PGL (Profile Grade Line), the correct mass diagram is most nearly:



A) A
B) C
C) B or D
D) B or E

Mass Diagram Solution 2:

D) B or E

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Mass Diagram Problem 3:

A mass haul diagram shows a freehaul distance of 3,300 feet, cost of excavation of $1.91 per cubic yard and a price of overhaul of $0.01/cy-foot. The limit of economical haul is most nearly:

E) 3,000 feet
F) 3,109 feet
G) 3,491 feet
H) 3,500 feet

Mass Diagram Solution 3:

C) 3,491 feet

Length of economic haul = h + free haul distance
h = e / o
h = ($1.91/CY) / ($0.01/CY-foot) = 191 feet
Length of economic haul = 191 + 3,300 = **3,491 feet**

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Mass Diagram Problem 4:

Given the following requirements for a site balancing project:

- The total haul distance is between Station 9+63 and 15+21
- Freehaul distance is between Station 10+39 and 14+56
- Overhaul is approximately 642,186 CY-ft

The freehaul volume is most nearly:

A) 658 CY
B) 1150 CY
C) 1540 CY
D) 4555 CY

Mass Diagram Solution 4:

D) 4555 CY

Total Haul distance = 15+21 – 9+63 = 15.21 – 9.63 = 5.58 stations = 558 feet
Freehaul distance = 14+56 – 10+39 = 14.56 – 10.39 = 4.17 stations = 417 feet
Overhaul distance = Total Haul distance – Freehaul distance
= 558 feet – 417 feet = 141 feet (or 1.41 stations)
Freehaul Volume = Overhaul Volume = Overhaul / Overhaul distance
= 642,186 CY-ft / 141 feet
= **4554.5 CY**

Earth Mass Diagram Problem 5

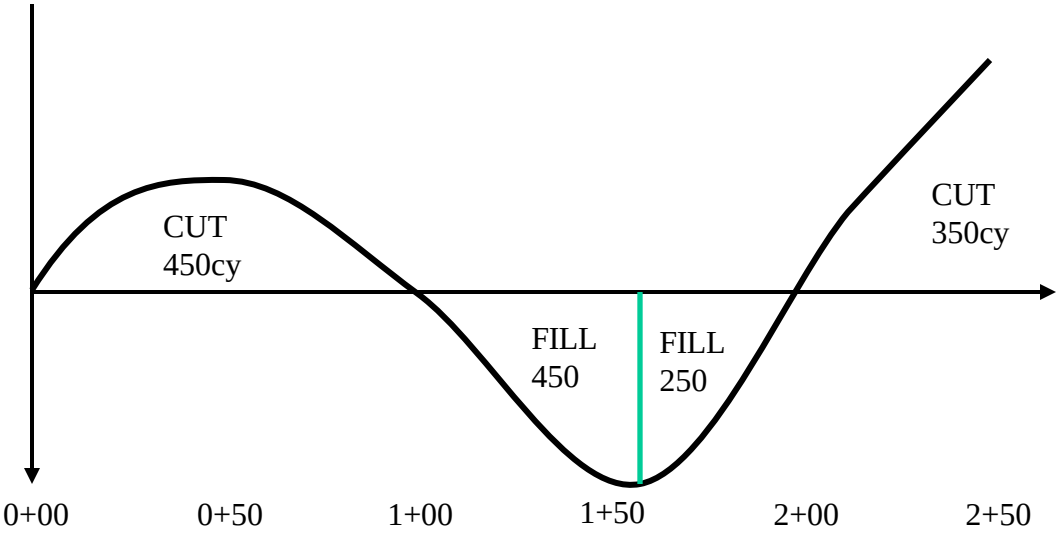
Problem 5. The free haul distance for a cut and fill project 100yds. Draw the Mass diagram and shade in the areas that will cost money to haul.

Station 0+00 to 1+00: 450cy cut
Station 1+00 to 1+60: 450cy fill
Station 1+60 to 2+00: 250cy fill
Station 2+00 to 2+50: 350cy cut

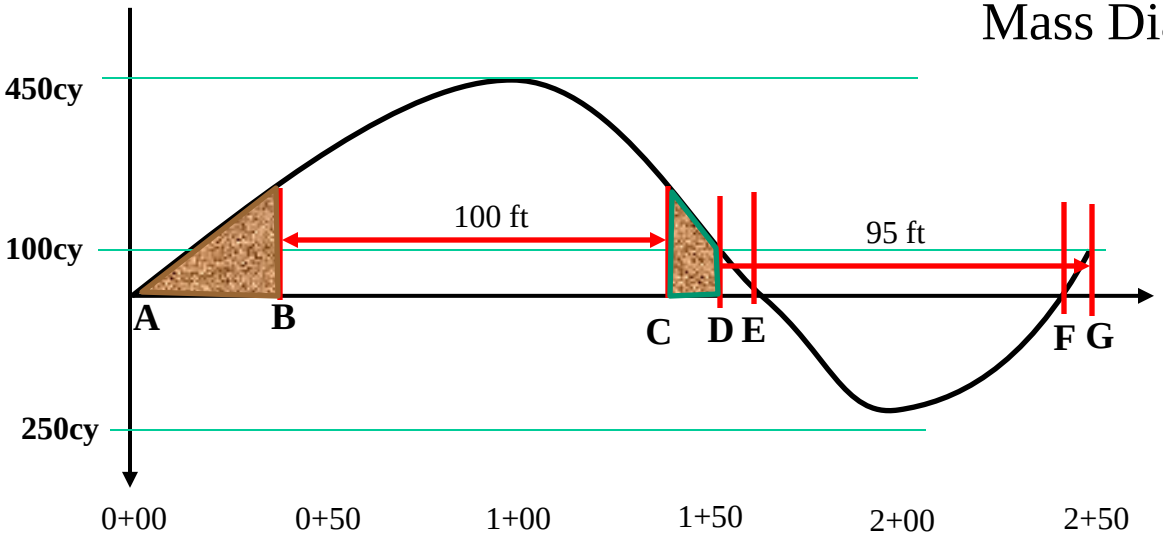
Earthwork Mass Diagram Solution #5

Step 1: Draw a road profile and mass diagram.

Road Profile



Mass Diagram



Step 2: Find the Free haul areas : Given: 100 ft is free

- From Point B to Point C since that is the 100ft haul distance: as you can see you try to find the location at the largest amount of volume.

- From Point D to Point G is free haul, as you can see the distance is a little shorter than 100 ft because the amount of cut is only 100cy so it couldn't fill the whole way(assuming swell and shrinkage factor is the same)

Step 3: So the haul areas that are going to cost money are Point A to Point B and Point C to Point D