

Chapter 12 - Volumes and Mass Haul Diagram

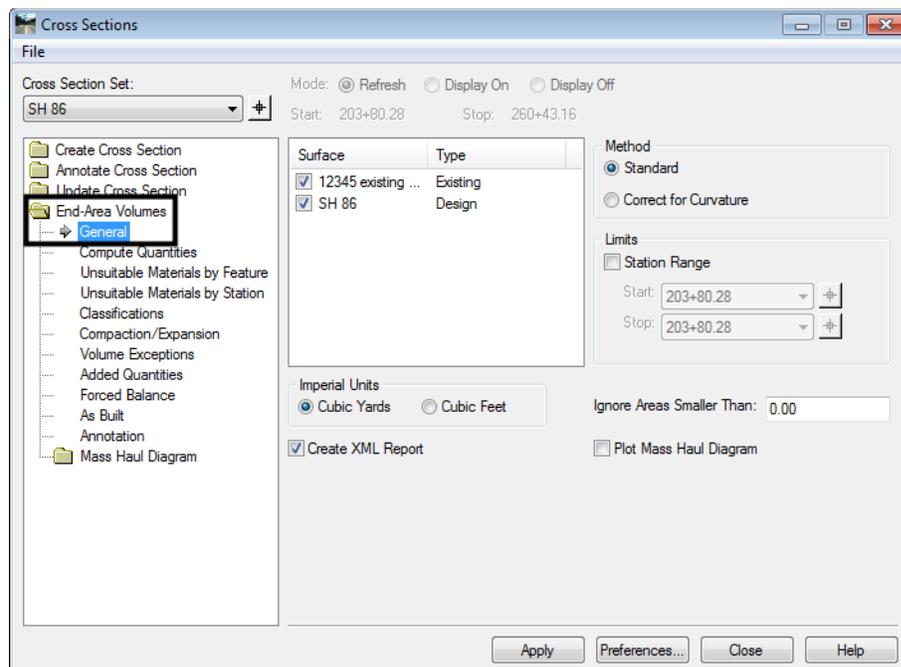
The changes in templates and surface data have made it necessary to change end area volumes as well. The use of components stored in the design surface allows the program to calculate volumes with greater accuracy than previously. To calculate End Area Volumes:

Chapter Objectives:

- Calculate basic end area volumes.
- Create an end area volume report.
- Add unsuitable material to calculations.
- Add a volume exception.
- Generate a Mass Haul diagram.

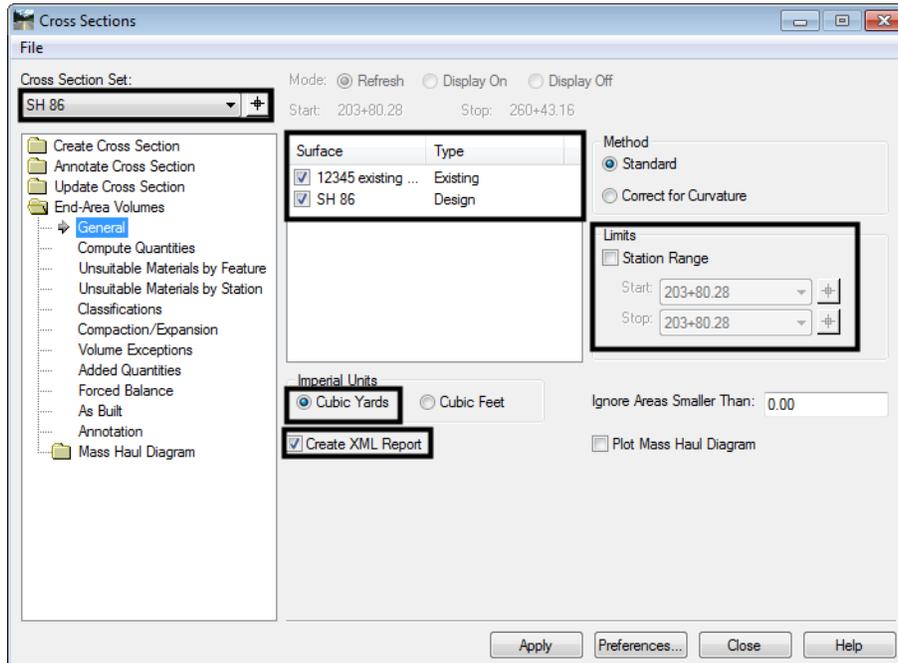
Calculating Volumes

1. Select **Evaluation > Cross Sections > Cross Sections** from the InRoads menu bar.
2. Select the **End-Area Volumes** folder from the dialog box explorer.
3. Select the **General** leaf from the dialog box explorer.

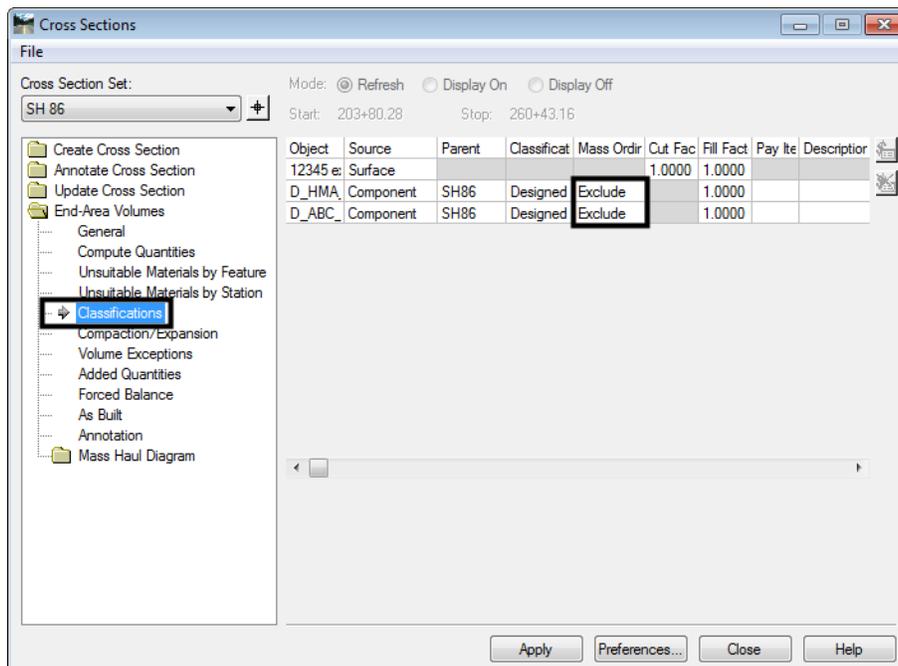


4. Select the desired **Cross Section Set** from the drop down menu.
5. Toggle on the desired surfaces.
6. Toggle on **Cubic Yards** in the **Imperial Units** area.
7. Toggle on **Create XML Report** if desired.

8. Toggle on **Station Limits** if desired. If used, key in **Start Station** and **Stop Station**.

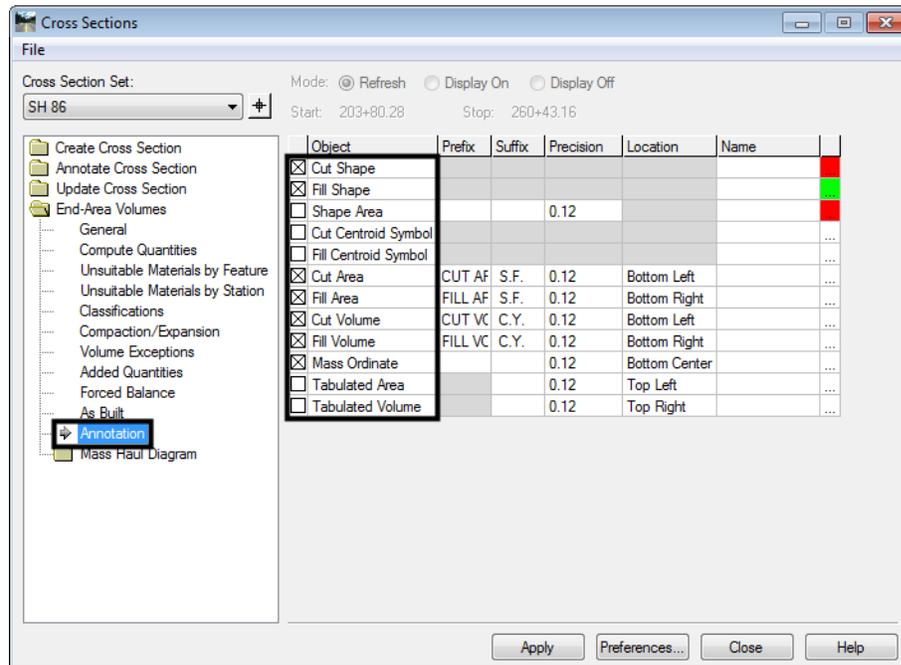


9. Select **Classification** leaf from the dialog box explorer.
10. To change the status of a material, <D> in the **Mass Ordinate** cell of the desired material. **Include** adds the material to the volume calculation, **Exclude** does not add the material to the volume calculation.



11. Select **Annotation** leaf from the dialog box explorer.

- Toggle on or off the desired objects.



- <D> **Apply** to calculate the volume. Cut and fill areas and volumes are displayed under each cross section.
- <D> **Close** to dismiss the dialog box.

Volume Reports

End Area Volume XML Report

If **Create XML Report** was toggled on in [Step 7](#) above, a Bentley InRoads Report Browser window is displayed. This window uses style sheets to determine the layout of the data. To select a style sheet:

- Select **Tools > Style Sheet Root** from the **Bentley InRoads Report Browser** menu bar. The Browse For Folder dialog box is displayed.
- Navigate to: **C:\Workspace\Workspace-CDOT\Standards-Global\InRoads\XML Style Sheets**
- <D> **OK**. The style sheet folder structure is displayed in the left pane of the **Bentley InRoads Report Browser**.
- <D> on the **Evaluation** folder to expose its style sheets.

5. <D> on the desired end-area volume style sheets to format the data in the right pane.

End Area Volume Report
Report Created: 3/4/2009
Time: 2:08pm

Cross Section Set Name: SH 86_1
Alignment Name: SH 86
Input Grid Factor: 1.000000 Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Baseline Station	Station Quantities						Added Quantities						Mass	
	Factor	Area	Volume	Adjusted Factor	Area	Volume	Adjusted Factor	Area	Volume	Adjusted Factor	Area	Volume		Adjusted Ordinate
100+00.00	1.00	54.76	0.00	0.00	1.00	16.75	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
100+50.00	1.00	58.17	104.56	1.00	24.63	38.32	38.32	1.00	0.00	0.00	0.00	0.00	0.00	43.13
101+00.00	1.00	61.69	110.98	1.00	19.41	40.78	40.78	1.00	0.00	0.00	0.00	0.00	0.00	91.71
101+50.00	1.00	65.08	117.37	1.00	7.08	24.53	24.53	1.00	0.00	0.00	0.00	0.00	0.00	167.33
102+00.00	1.00	66.88	122.18	1.00	3.92	10.19	10.19	1.00	0.00	0.00	0.00	0.00	0.00	266.34
102+50.00	1.00	63.57	120.79	1.00	2.54	5.98	5.98	1.00	0.00	0.00	0.00	0.00	0.00	370.09
103+00.00	1.00	58.22	112.77	1.00	5.15	7.12	7.12	1.00	0.00	0.00	0.00	0.00	0.00	463.48
103+50.00	1.00	59.48	108.98	1.00	0.49	5.23	5.23	1.00	0.00	0.00	0.00	0.00	0.00	554.85
104+00.00	1.00	59.71	110.36	1.00	4.81	4.91	4.91	1.00	0.00	0.00	0.00	0.00	0.00	648.06
104+50.00	1.00	51.92	103.36	1.00	6.85	10.80	10.80	1.00	0.00	0.00	0.00	0.00	0.00	727.06
105+00.00	1.00	38.70	83.91	1.00	8.26	14.00	14.00	1.00	0.00	0.00	0.00	0.00	0.00	782.99
105+50.00	1.00	32.02	65.49	1.00	11.68	18.47	18.47	1.00	0.00	0.00	0.00	0.00	0.00	813.30
106+00.00	1.00	32.82	60.04	1.00	11.33	21.31	21.31	1.00	0.00	0.00	0.00	0.00	0.00	833.52
106+50.00	1.00	29.12	57.36	1.00	8.33	18.21	18.21	1.00	0.00	0.00	0.00	0.00	0.00	854.47
107+00.00	1.00	27.68	52.60	1.00	2.90	10.40	10.40	1.00	0.00	0.00	0.00	0.00	0.00	877.81
107+50.00	1.00	29.27	52.73	1.00	2.40	4.91	4.91	1.00	0.00	0.00	0.00	0.00	0.00	906.66
108+00.00	1.00	32.27	56.99	1.00	2.02	4.09	4.09	1.00	0.00	0.00	0.00	0.00	0.00	943.40
108+50.00	1.00	36.13	63.34	1.00	1.44	3.20	3.20	1.00	0.00	0.00	0.00	0.00	0.00	991.08

The formatted data can be copied and pasted into Excel or Word.

Unsuitable Material

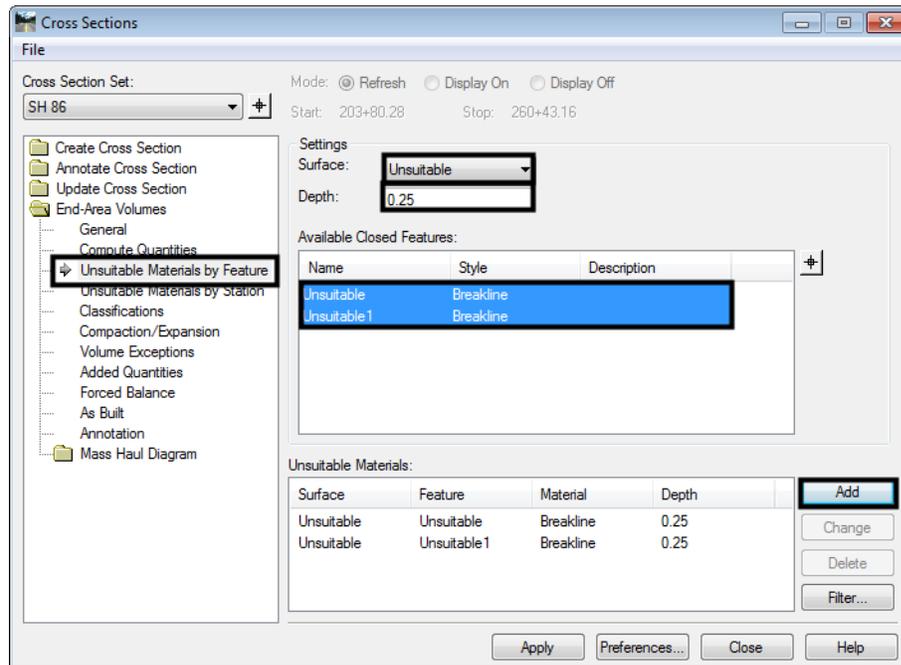
InRoads has the option to modify end area calculations for unsuitable material (like topsoil and muck). There are two options for determining the area of unsuitable material: by feature and by station extents. If both are used, the station extents override the feature method.

Unsuitable Material by Feature

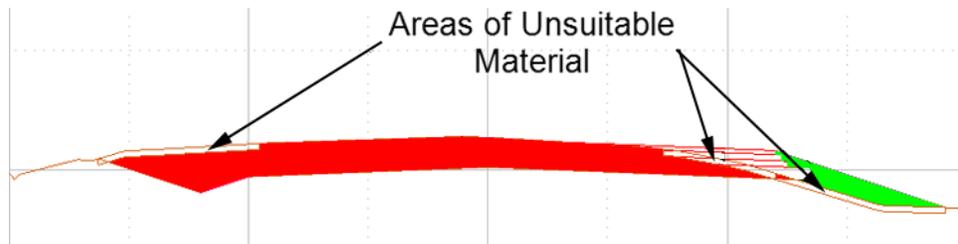
Before using this option a closed shape feature(s) must be created that defines the area of the material. The feature(s) do not have to reflect the actual elevation of the surface. It can be placed in its own surface at a zero elevation. To use the Unsuitable Material by Feature option:

1. Repeat steps 1 through 10 under Calculating Volumes.
2. Select the **Unsuitable Material by Feature** leaf from the dialog box explorer.
3. Select the desired **Surface** from the drop down menu.
4. Key in the desired **Depth**.
5. Highlight the desired features from the **Available Closed Features** area.

6. <D> **Add**. The data is added to the Unsuitable Materials list.



7. <D> **Apply** to calculate the volumes. The area of unsuitable material is shown on the cross sections.



Note: Unsuitable material located under fill is included in the Mass Ordinate calculation. This occurs because materials removed from under fills must be replaced with embankment material.

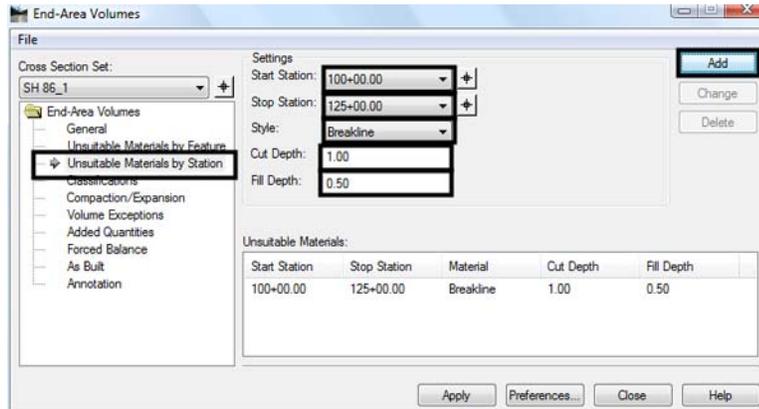
8. <D> **Close** to dismiss the *End-Area Volumes* dialog box.

Unsuitable Material by Station

There are no prerequisites for using this option. To use the Unsuitable Material by Station option:

1. Repeat steps 1 through 10 under Calculating Volumes.
2. Select the **Unsuitable Material by Station** leaf from the dialog box explorer.
3. Select the **Start Station** using the drop down menu.
4. Select the **Stop Station** using the drop down menu.

5. Select the **Style** using the drop down menu.
6. Key in the **Cut Depth**
7. Key in the **Fill Depth**.
8. <D> **Add**. The data is added to the **Unsuitable Materials** list.



9. <D> **Apply** to calculate the volumes. The area of unsuitable material is shown on the cross sections. The calculations and displays are the same as those used for the Unsuitable Material by Feature option.
10. <D> **Close** to dismiss the **End-Area Volumes** dialog box.

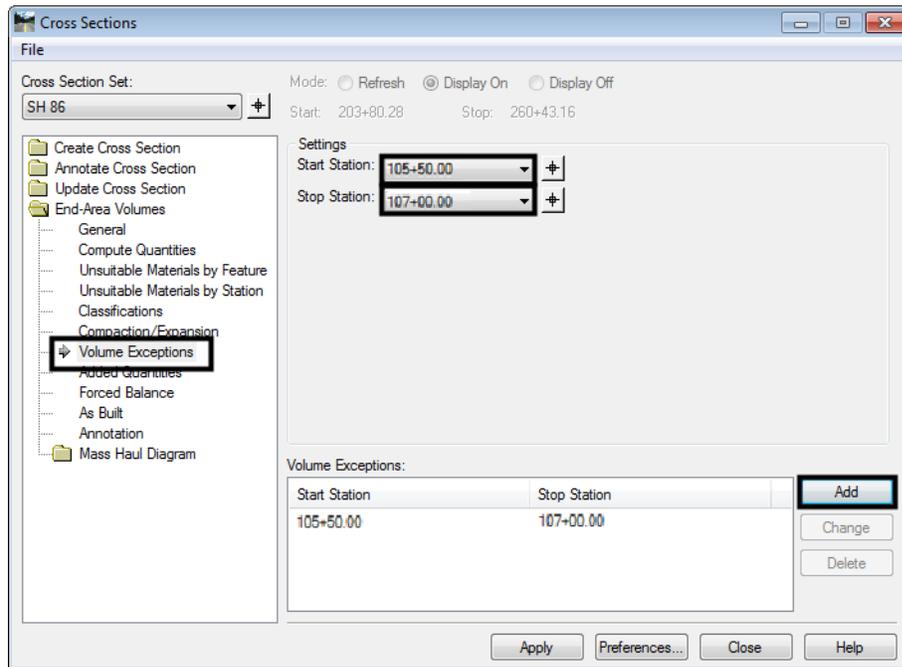
Volume Exceptions

Volume exceptions are used to remove the amount of earthwork calculated for an area where no work is done but is present in the design model (in the area of a bridge, for example). Using a volume exception allows the user to create a single design dtm for the project and still account for areas where no earthwork will take place.

The cross section set must have a cross section at the beginning station of the exception and the ending station of the exception. Horizontal Event Stations or Key Stations (from Roadway Designer) can be used to include these stations if they do not fall on normal intervals. To set up a volume exception:

1. Repeat steps 1 through 10 under Calculating Volumes.
2. Repeat the steps under *Unsuitable Material by Feature* and/or *Unsuitable Material by Station*, if needed.
3. Select the **Volume Exceptions** leaf from the dialog box explorer.
4. Select the **Start Station** from the drop down menu. This is the last station where a volume will be calculated before the exception.
5. Select the **Stop Station** from the drop down menu. This is the last station where no volume will be calculated at the end of the exception.

- <D> **Add**. This adds the data to the **Volume Exception** area.



- <D> **Apply** to calculate the volumes. Below is an example of an End-Area Volume Report with an exception.

End Area Volume Report

Report Created: 3/5/2009
Time: 10:37am

Cross Section Set Name: SH 86_1
Alignment Name: SH 86
Input Grid Factor: 1.000000 **Note:** All units in this report are in feet, square feet and cubic yards unless specified otherwise.

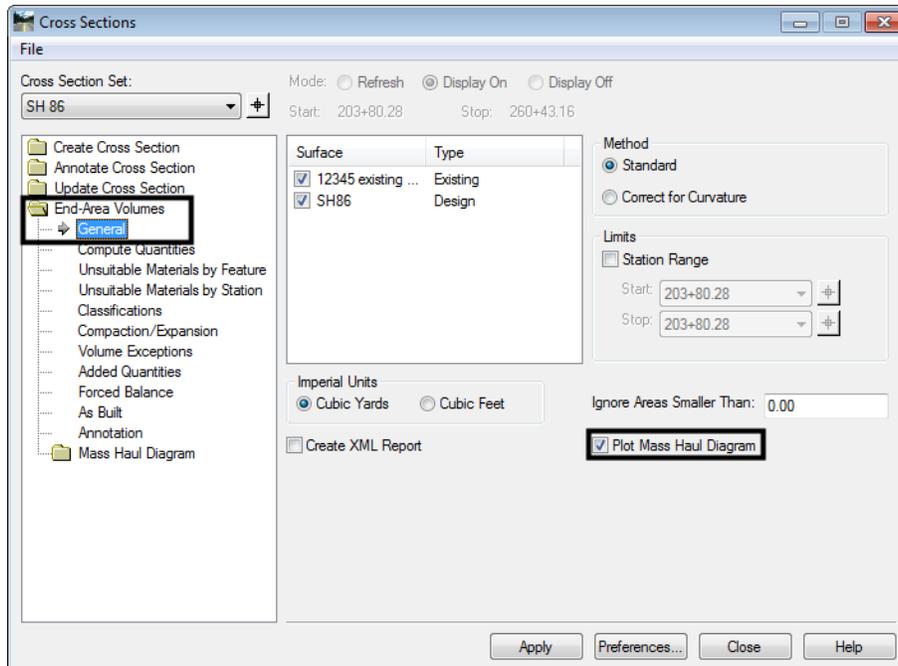
Baseline Station	Station Quantities				Added Quantities				Mass	
	Factor	Area	Volume	Adjusted	Factor	Area	Volume	Adjusted		
100+00.00	1.00	88.40	0.00	0.00	1.00	16.75	0.00	0.00	0.00	0.00
100+50.00	1.00	91.57	166.64	166.64	1.00	24.63	38.32	38.32	1.00	0.00
101+00.00	1.00	95.00	172.75	172.75	1.00	19.41	40.78	40.78	1.00	0.00
101+50.00	1.00	98.83	179.47	179.47	1.00	7.08	24.53	24.53	1.00	0.00
102+00.00	1.00	103.11	186.98	186.98	1.00	3.92	10.19	10.19	1.00	0.00
102+50.00	1.00	101.52	189.47	189.47	1.00	2.54	5.98	5.98	1.00	0.00
103+00.00	1.00	91.30	178.54	178.54	1.00	5.15	7.12	7.12	1.00	0.00
103+50.00	1.00	92.90	170.55	170.55	1.00	0.49	5.23	5.23	1.00	0.00
104+00.00	1.00	91.84	171.05	171.05	1.00	4.81	4.91	4.91	1.00	0.00
104+50.00	1.00	83.52	162.36	162.36	1.00	6.85	10.80	10.80	1.00	0.00
105+00.00	1.00	66.31	138.73	138.73	1.00	8.26	14.00	14.00	1.00	0.00
105+50.00	1.00	59.31	116.31	116.31	1.00	11.68	18.47	18.47	1.00	0.00
106+00.00	1.00	61.03	0.00	0.00	1.00	11.33	0.00	0.00	1.00	0.00
106+50.00	1.00	56.48	0.00	0.00	1.00	8.33	0.00	0.00	1.00	0.00
107+00.00	1.00	59.52	0.00	0.00	1.00	2.90	0.00	0.00	1.00	0.00
107+50.00	1.00	60.52	111.15	111.15	1.00	2.40	4.91	4.91	1.00	0.00
108+00.00	1.00	66.63	117.73	117.73	1.00	2.02	4.09	4.09	1.00	0.00
108+50.00	1.00	71.36	127.77	127.77	1.00	1.44	3.20	3.20	1.00	0.00
109+00.00	1.00	64.90	126.17	126.17	1.00	1.83	3.02	3.02	1.00	0.00
109+50.00	1.00	63.71	119.08	119.08	1.00	2.44	3.96	3.96	1.00	0.00

- <D> **Close** to dismiss the **End-Area Volumes** dialog box.

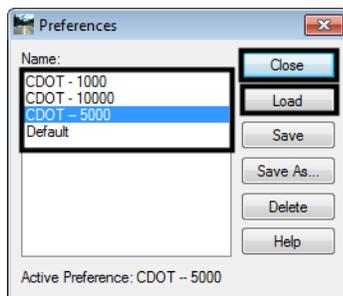
Creating a Mass-Haul Diagram

A mass-haul diagram looks like a profile but the “ground line” represents the amount of earthwork. It is, in fact, using the Mass Ordinate for the data line. Set up the **End Area Volumes** dialog box as desired. To display a Mass Haul diagram:

1. Select **End-Area Volumes** from the dialog box explorer.
2. Toggle on **Plot Mass Haul Diagram**.



3. Select **Mass Haul Diagram** from the dialog box explorer.
4. <D> the **Preferences** button.
5. Select the desired preference then <D> **Load** and **Close**.



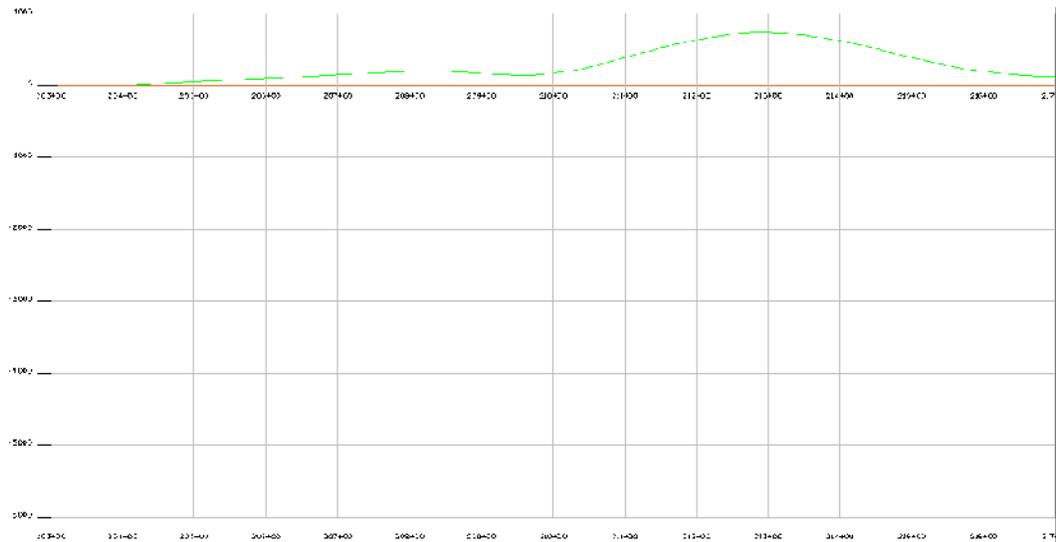
The mass-haul diagram is generated when the end-area volumes are calculated.

6. <D> the **Apply** button.

- After the end-area volumes are calculated, you are prompted to identify the location for the mass haul diagram.

> Identify point for Mass Haul Diagram/Reject

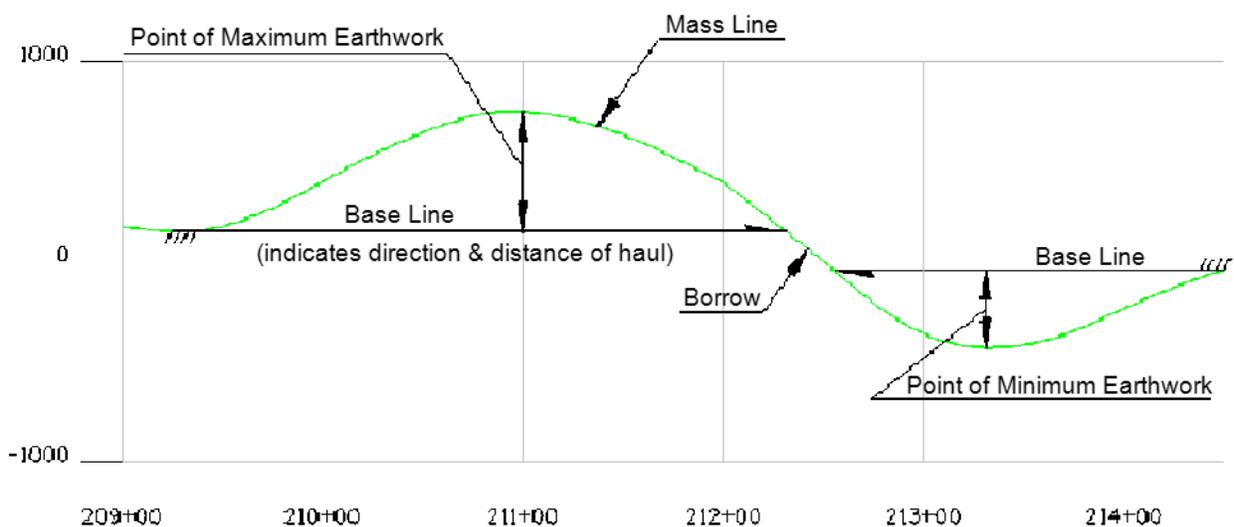
- <D> to identify the location of the lower left corner of the diagram. Below is an example of a mass haul diagram.



Reading and Using a Mass Haul Diagram

A mass haul diagram illustrates the accumulated algebraic sum of the cubic yards of earthwork on a project. These diagrams are used as an aid in balancing earthwork, computing haul distances, and calculating quantities.

The mass haul diagram is laid out with Stations running horizontally and cubic yards of earthwork running vertically. Items of interest in the diagram are:



- **Mass Line** - This is the data line of the mass haul diagram. It is a graphic representation of the Mass Ordinate that is displayed on cross sections and in the end area volume report.
 - ◆ **Excavation** - This is shown by a rise in the data line when read going up station.
 - ◆ **Embankment** - This is shown by a drop in the data line when read going up station.
- **Point of Maximum Earthwork** - This is where the volumes change from a net excavation to a net embankment.
- **Point of Minimum Earthwork** - This is where the volumes change from a net embankment to a net excavation.
- **Base Line** - This indicates the limits of an area of balanced earthwork (where excavation and embankment have equal values). The arrow indicates the direction of haul.
- **Borrow (or Waste)** - This indicates an area where additional material will have to be brought in from off-site in the case of borrow. Waste indicates an area where excess material must be disposed of.

It is up to the designer to indicate the Base Lines, Point of Maximum Earthwork, Point of Minimum Earthwork, and areas of Borrow or Waste on the mass haul diagram. Other items that can be added to the diagram are haul volumes for each base line, volumes for areas of borrow and waste, and sheet estimate volumes.

Chapter Summary:

- Surfaces are compared based on their Type property. There must be an Existing and at least one Design type surface loaded to calculate volumes.
- The end area volume report can be created when the volumes are calculated.
- Unsuitable material locations can be defined based on a station range or a closed feature. Volumes within these areas are adjusted to account for the removal of this material.
- Volume exceptions ignore earthwork quantities through a given cross section range. This allows the user to calculate a single quantity for the project instead of separate quantities between each area of no construction.
- The Mass-Haul Diagram command uses the raw data from the end area volume report to create its data line.
- Choose the Mass-Haul preference that best suits the amount of earthwork on the job. Small jobs can use the CDOT - 1000 preference (1000 Cu. Yds. per major grid) while large jobs should use the CDOT - 10000 preference (10,000 Cu. Yds. per major grid).
- When reading a mass haul diagram, if the data line rises that indicates a net excavation (cut) area. A dropping data line indicates an area of net embankment (fill).