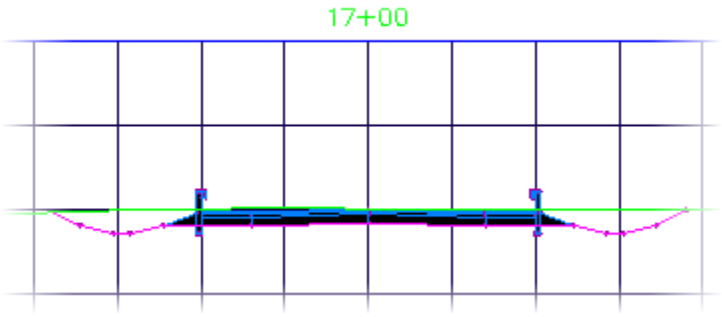
Lesson 4

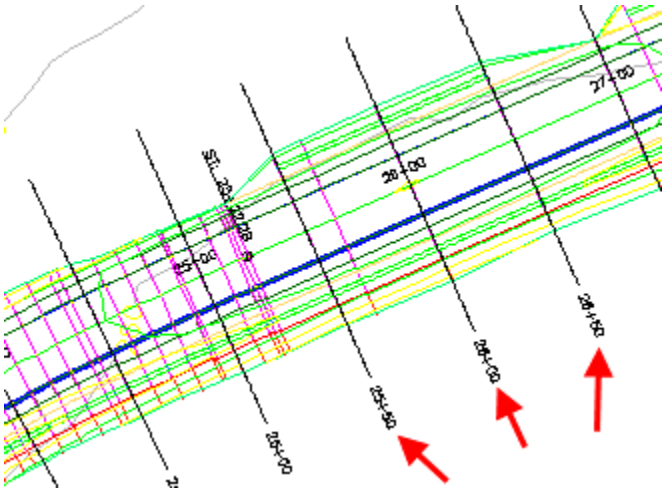
Cross Sections and Quantities

Overview

In this lesson, students work with cross sections, sample lines, corridor quantities, and quantity reports. Cross-section views are inserted at sample line locations along the alignment and illustrate the materials to be used at that particular location. Section views display surface, corridor surface, corridor, pipe network, and material section data at the sample line locations. Section data in the section views is automatically updated when the corridor recalculates or section data changes. A section view is shown in the following illustration.

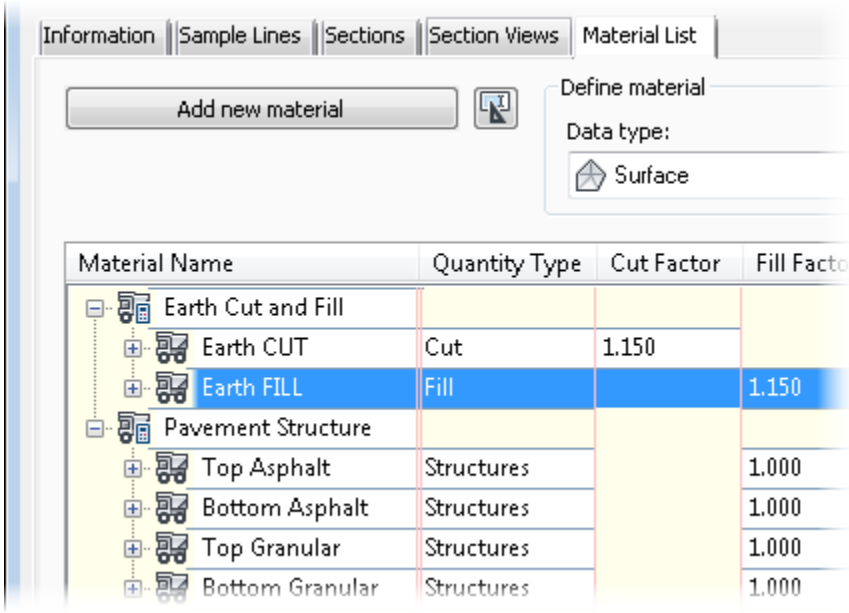


Sample lines are required to calculate quantities and to create section views that display section data. Sample lines are attached to an alignment, as shown in the following illustration.



Earth cut and fill, and pavement structure quantities, are calculated from data associated with cross sections at the sample lines in order to estimate the amount of earth to be moved and the required materials for construction. Earth cut and fill volumes are calculated by comparing the corridor datum surface section data with the existing ground surface section data. Pavement and base material volumes necessary to construct the roadway are calculated directly from the corridor section data.

The following illustration shows a material list for corridor quantities. The material list is assigned to a sample line group.



Quantity reports are created from a sample line group and can be inserted in a drawing as a table, or extracted to an external file. After a quantity report is created, if the corridor model changes, the section data attached to the sample lines also updates. When the section data attached to the sample lines updates, the quantity table in the drawing also updates. This

makes it very easy to quickly analyze quantities and adjust corridor models to balance earth cut and fill volumes.

The following illustration shows a portion of a quantity report in a table in a drawing area.

Total Volume Table						
Station	Fill Area	Cut Area	Fill Volume	Cut Volume	Cumulative Fill Vol	Cumulative Cut Vol
22+00.00	22.49	132.73	31.34	325.98	125.78	3360.02
22+50.00	44.54	84.68	74.13	219.93	199.91	3579.96
23+00.00	89.36	54.86	147.60	140.70	347.50	3720.66
23+50.00	173.73	11.25	288.62	66.40	636.13	3787.06
24+00.00	196.97	0.00	402.83	11.36	1038.96	3798.41
24+50.00	190.12	0.00	416.84	0.00	1455.80	3798.41
25+00.00	100.86	17.09	311.71	17.90	1767.51	3816.31
25+50.00	46.68	38.46	157.09	59.15	1924.61	3875.46
26+00.00	14.99	60.49	65.66	105.36	1990.27	3980.83
26+50.00	1.18	95.42	17.22	166.02	2007.49	4146.85

Objectives

After completing this lesson, students will be able to:

- Describe sample lines and how they are used in cross sections.
- Create and edit sample lines.
- Modify the sample line group properties and add additional section data.
- Describe criteria used in quantity takeoff calculations.
- Calculate the earth cut and fill and pavement structure quantities for a corridor model.
- Create quantity reports that display quantity calculations.
- Create a quantity report in a table and a quantity report in a web browser.
- Create section views from sample lines.
- Create multiple section views.

Exercises

The following exercises are provided in a step by step format in this lesson:

1. Create and Edit Sample Lines
2. Modify Sample Line Group Properties
3. Calculate Corridor Quantities
4. Create Quantity Reports
5. Create Multiple Section Views

About Sample Lines

Sample lines are linear objects with a specific width that are used to cut sections at a specified interval along an alignment. Sample lines are created along the corridor baseline and are used to:

- Calculate earth cut/fill and pavement structure corridor quantities.
- Create section views.

Sample lines are created for an alignment and extract section data for surfaces, corridors, and pipe networks. They represent the locations where section data is generated.

Sample Line Groups

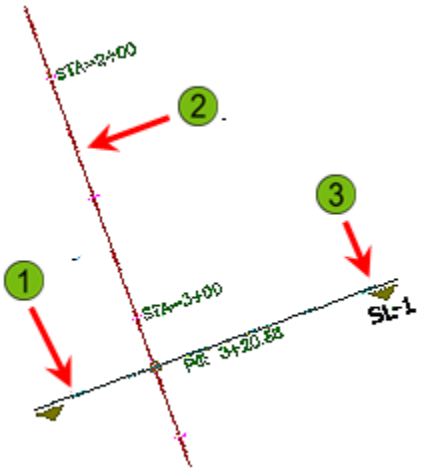
Sample lines are organized in sample line groups. Sample line groups contain the following elements:

- Sample line data.
- Section data.
- Section view groups.
- Mass haul lines and views.

You can perform the following tasks when you modify the properties of a sample line group:

- Edit the swath width and change the labels assigned to the sample lines.
- Add or remove section data from the sample lines.
- Modify properties of the section views.
- Modify the material list.

The last two functions are applicable only after you create section views and calculate the quantities for the corridor. The following illustration shows a single sample line placed on an alignment. The name SL-1 was generated automatically.



1. Sample line
2. Alignment
3. Sample line label

Sample Line Parameters

To create sample lines, you specify the data source and location parameters. The section data you attach to the sample lines is used to calculate quantities and can be displayed on section views. You can attach the following types of section data to sample lines:

Data source	Description
Surface Section Data	Existing ground or other surface data used for calculating earthworks volumes and displaying in section views.
Corridor Surface Section Data	A corridor datum surface that can be used for volume calculations and optionally displayed in section views.
Corridor Section Data	Use for calculating pavement structure quantities and for displaying in section views.
Pipe Network Section Data	Use for displaying pipe networks in section views.
Material Section Data	Created after volumes have been calculated and used to show material areas in section views.

Location

You create sample lines by specifying a range of stations and the width of the swath to the left and the right of the alignment. When you create sample lines, you can specify their location using the following methods.

Location	Description
From corridor stations	Sample lines created at the locations where the assembly was inserted to create the corridor.
By range of stations	User-specified sample line increment, independent of the corridor assembly insertion frequency.
At a station	User-specified individual stations, such as driveways, entrances, and BC and EC of intersection curb returns.
Pick points on screen	Create skewed sample lines or multivertex sample lines.

Creating Sample Lines

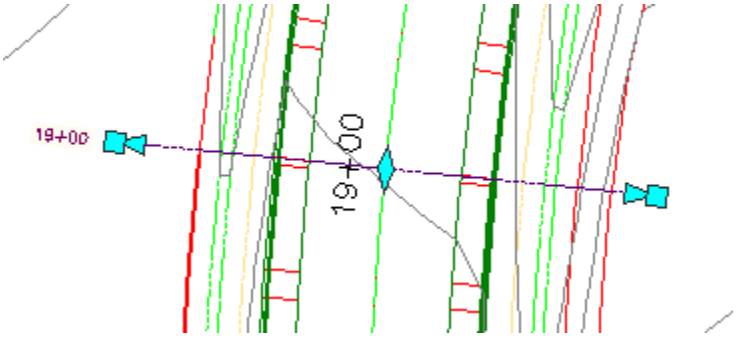
You create sample lines to:

- Create design cross sections at intervals along an alignment.
- Calculate corridor earth cut and fill and pavement structure quantities.

To create sample lines, you first select an alignment. You then specify the data that is to be attached to the sample lines. You select the section data to attach to the sample lines based on data required for quantity calculations, and data you want to view in the section view objects. The next step is to determine where the sample lines are created along the alignment. Finally, you specify the width of the sample lines. The sample line width can either be a fixed value or can be determined from another alignment.

Moving Sample Lines

You can edit the locations of sample lines in plan view by using grips. The sample line grips are shown in the following illustration.



The grips are summarized as follows:

- Diamond grip repositions the sample line along the alignment.
- Triangle grips change the length (swath width) of the sample line.
- Square grips change the length and skew angle of the sample line.

When you change the location of a sample line, the data attached to the sample line is updated based on the new location. Quantities tables in the drawing and cross-section views also automatically update.

About Quantity Takeoff Criteria

Quantity takeoff criteria indicate precisely how the quantities are to be calculated. Quantity takeoff criteria are defined in the drawing template and can be modified to suit specific project requirements. You can specify the name of the material, the data used to calculate the material quantity, the condition, and the quantity type. For earth cut and fill quantities, you can also specify cut factors, fill factors, and refill factors.

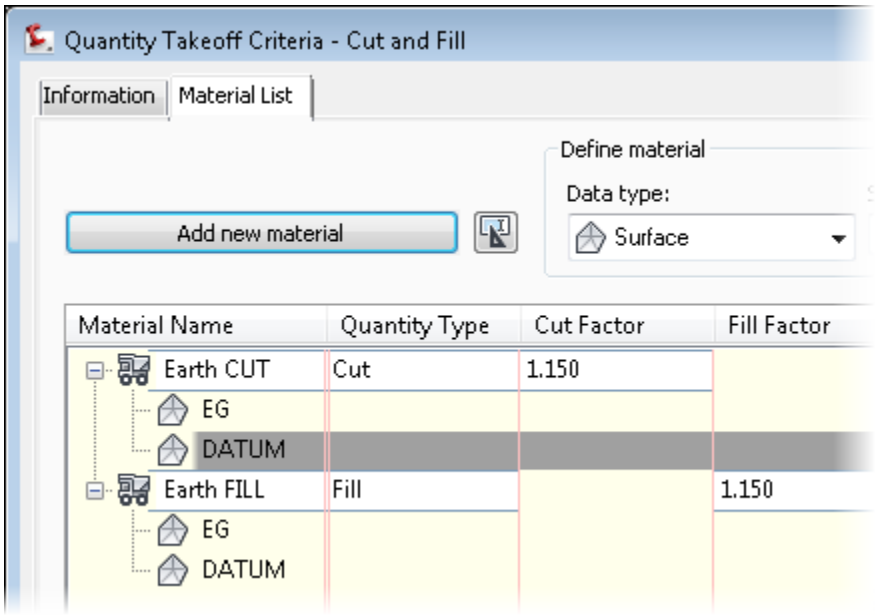
When you create quantity takeoff criteria, you specify the following information:

Item	Description
Material name	Name of the material to appear in the report.
Data type	Surface or pavement structure.
Condition	Above or below.
Quantity type	Cut, fill, cut and refill, earthworks, structures.
Cut factor	Earth cut material expansion factor.
Fill factor	Earth fill material compaction factor.
Refill factor	Percentage of earth cut material that is suitable for engineering fill material.
Shape style	Controls the display of the material in the cross section views.

Cut and Fill Factors

The cut factor is also referred to as an expansion factor. If you measure 100 cubic yards of excavation, then you actually excavate 115 (1.15 factor) cubic yards because the material expands after excavating. Conversely, a fill factor is also known as a compaction factor. If you measure 100 cubic yards of fill, you actually require 115 (1.15 factor) cubic yards of material because of compaction. The refill factor is the percentage of cut material suitable for engineering fill material.

The following illustration shows examples of quantity takeoff criteria used to calculate earth cut and fill quantities.

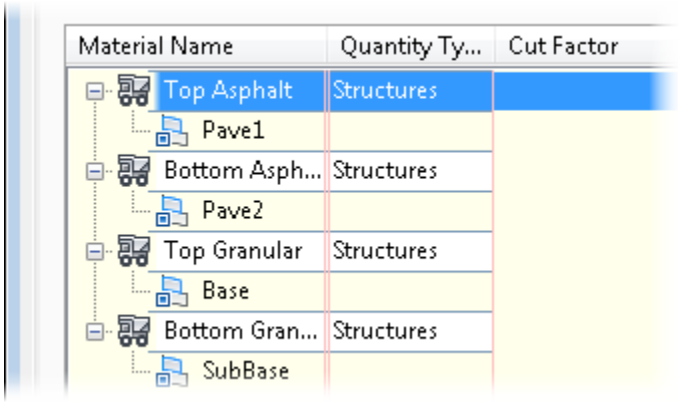


Calculating Corridor Quantities

To calculate corridor quantities, you first create quantity takeoff criteria. After you create the quantity takeoff criteria, you then compute the material volumes. Earth cut and fill volumes are calculated using the existing ground and corridor surface section data attached to sample lines. Pavement structure volumes are calculated using the corridor section data attached to sample lines.

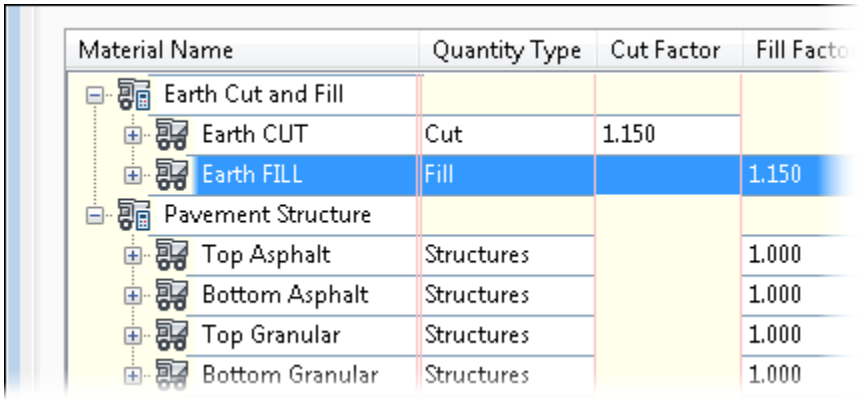
Quantity takeoff criteria is created in your company/client drawing template, and can be used to calculate the quantities for most projects. You can also create new quantity takeoff criteria in the current drawing for projects that have unique quantity calculation requirements.

Quantity takeoff criteria for pavement structure is shown in the following illustration.



After you create or review the quantity takeoff criteria, you then compute the material quantities as a single step.

When you compute the material quantities, a material list is attached to the sample line group. This is shown in the following illustration. When the corridor model changes, the material list, and hence the volumes, automatically update.



Keep the following guidelines in mind when calculating corridor quantities:

- A common practice is to create individual quantity takeoff criteria that can be used for earth cut/fill volumes and for pavement structure volumes. This simplifies and organizes the reporting process.
- When you compute materials, no quantities are displayed. To view the quantities, you must generate a report.

About Quantity Reports

Quantity reports form the basis for construction contracts. For earth cut and fill quantity reports, an existing surface is compared to a corridor datum surface (which represents the subgrade of the corridor model), and the results are broken down by station in a report. Quantity reports display the total volume of material required to create a finished grade surface. The values displayed include area and volume for both cut and fill, or other specified criteria. There are default criteria and table styles for this kind of report.

Quantity reports are either static or dynamic. Dynamic quantity reports are created in the drawing area as quantity tables. Dynamic quantity reports are useful when you need to achieve a quantity balance, or generate a material excess or deficit. Static quantity reports are generated in a web browser. The format of the quantity report is controlled with a style sheet.

A portion of a static quantity report generated in a web browser is shown in the following illustration.

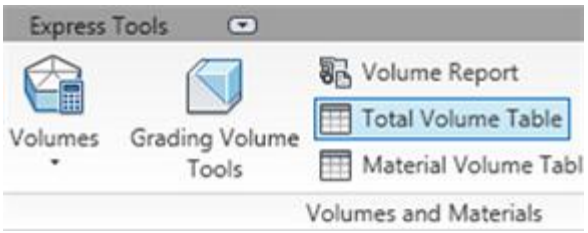
	Area Type	Area	Inc.Vol.	Cum.Vol.	MassHaul
		Sq.ft.	Cu.yd.	Cu.yd.	Cu.yd.
Station: 17+00.000					
	Adjusted Cut	141.33	227.16	303.82	
	Adjusted Usable	141.33	197.53	264.19	
	Adjusted Fill	0.00	0.00	0.00	
					303.82
Station: 17+50.000					
	Adjusted Cut	140.23	299.81	603.63	
	Adjusted Usable	140.23	260.71	524.90	
	Adjusted Fill	0.00	0.00	0.00	
					603.63

Creating Quantity Reports

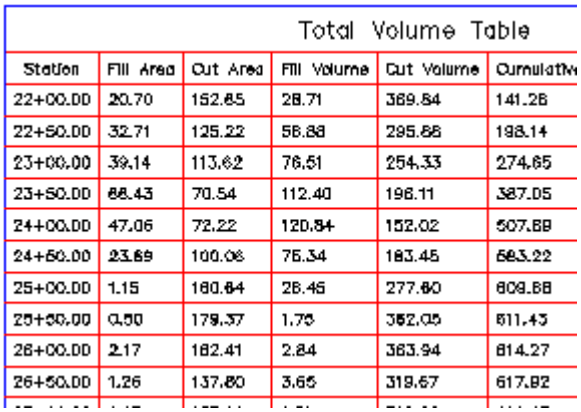
You create quantity reports after the material quantities are calculated. You can create quantity reports in a web browser or as a table in the drawing. To generate quantity takeoff, you set criteria, associate surfaces with criteria, calculate volumes, and generate reports.

The following steps outline the process for generating a volume table.

1. Execute the appropriate command from the ribbon.
   - Total Volume Table creates a table in the drawing.
   - Volume Report creates a table in a web browser.



2. Pick a location in the drawing to create the table.
   - Select the material list.
   - Create the table.

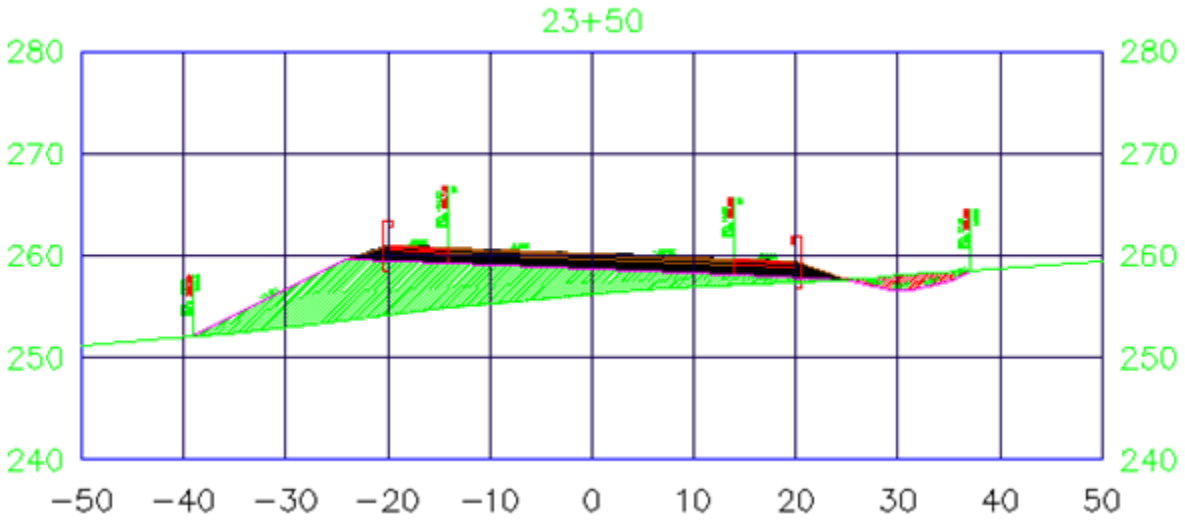


Quantity reports are created for sample lines in a sample line group. You must create multiple sample line groups when cross sections change significantly (rural to urban and vice versa, either side of bridge abutments, and so on).

About Section Views

Section views are the grid objects that display section data. Section views are dynamic, and are updated automatically if the geometry or location of the sample lines change. The section view style controls the display of the section view. After you create sample lines, you create section views to show section data at the sample line locations.

The following illustration shows a section view with corridor section data, existing ground surface section data, and material section data.

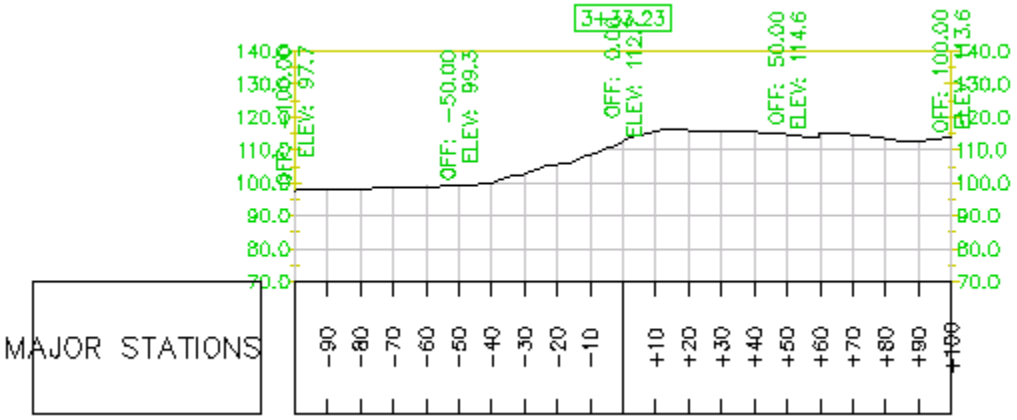


Section View Style and Groups

A section view style controls the display of section views. The section data that you display in a section view originates from the sample lines in the sample line group. Section views are organized in a section view group, which is shown as a collection under the sample line group in Prospector. You can modify the properties of a section view group to:

- Change the group plot style.
- Change the style assigned to section views.
- Change the volume tables attached to section views.
- Show profile grade lines for other alignments and profiles in section views.

The following illustration shows a section view created using a sample line extending 100 feet in each direction from the alignment centerline. The top label identifies the station where the sample line intersects the alignment. The section line has labels showing the offset and elevation values at 10 foot intervals. A data band marking the offset distance is included at the bottom of the graph.



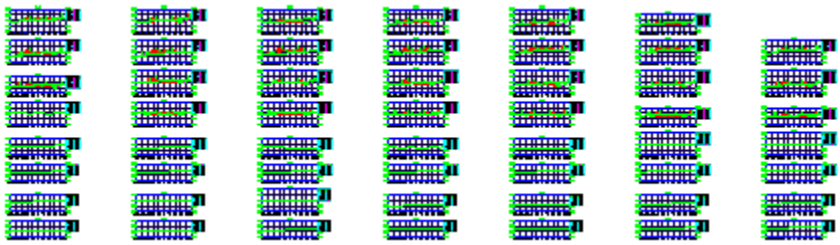
Creating Section Views

After you create sample lines, you can either create a single or multiple section views. To create multiple section views, select Sections - Create Multiple Section Views from the menu. When you create multiple section views, you specify the following in the Create Multiple Section View wizard:

- Alignment and sample line group.
- Station range for section views to create.
- Section view style.
- Group plot style.
- Offset and elevation ranges.
- The section data and associated styles to view in the section views.
- Material table details and placement relative to the section views.

The section views are then plotted in the drawing.

Section views are shown in the following illustration:



To erase section views, you delete the section view group in Prospector.

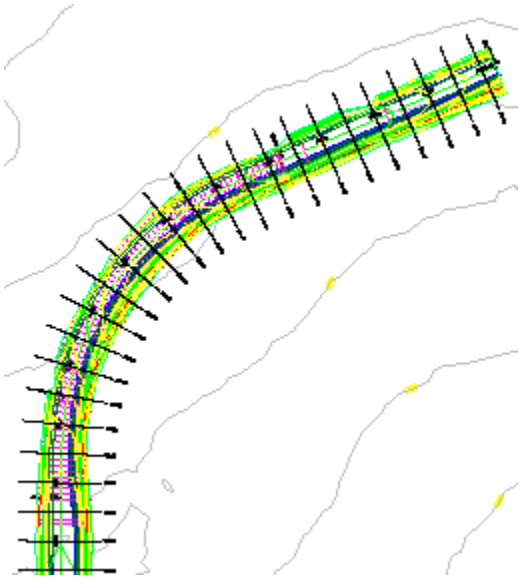
Key Terms

Code Set Style	Used to control the display of points, links, and shapes in an assembly, corridor, or corridor section data that is displayed in a section view. Can also be used to annotate corridor section data in section views and when you view/edit corridor sections.
Construction Staking Data	Data extracted from a Civil 3D design that can be used in the field for construction staking and layout.
Corridor Section Data	Corridor data attached to sample lines in a sample line group and used for viewing the corridor in the section views and calculating pavement structure volumes.
Corridor Surface Section Data	Corridor surface data attached to sample lines in a sample line group and used for viewing corridor surfaces in the section views and calculating earthwork volumes.
Group Plot Style	Controls the orientation and placement of section views in a drawing.
Material List	Attached to a sample line group after material volumes have been calculated. The material list indicates those materials that have had their volumes calculated. You can have several material lists as part of a sample line group.
Material Section Data	Material data attached to sample lines in a sample line group used for reporting volumes and displaying in section views.
Pipe Section Data	Pipe data attached to sample lines in a sample line group used for displaying pipe network data in section views.
Quantity Takeoff Criteria	Quantity takeoff criteria define the methods used to calculate cross-section quantities. For earthworks quantities, the criteria are based on a defined relationship between surfaces. Pavement structure quantities reference subassembly shapes in the criteria. Quantity takeoff criteria can be saved in a drawing template file (DWT).
Sample Line	Also known as cross-section lines. Lines created typically perpendicular to an alignment, with a specified width and at a specified interval along an alignment. Section data is attached to sample lines that can be used for viewing in section views and calculating quantities.
Sample Line Group	Sample lines are organized in a sample line group. The sample line group appears as a collection under the Alignments tree on the Prospector tab of the Toolspace window.
Section Data	Data attached to sample lines within a sample line group.
Section View	The “grid” that displays section data.

Exercise 1: Create and Edit Sample Lines

In this exercise, students create and edit sample lines.

The completed drawing is as shown.

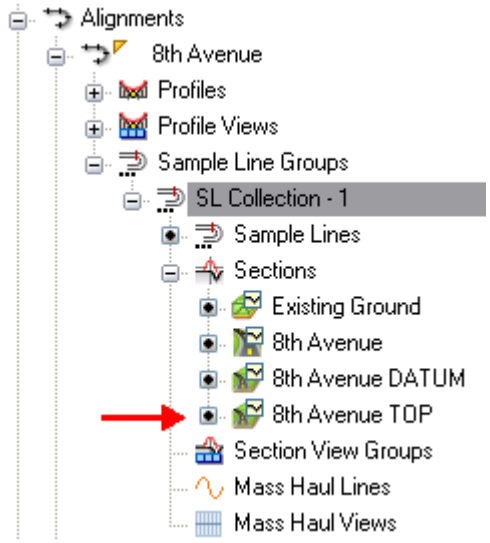


For this exercise, open *…\I_CrossSectionsandQuantities-EX1.dwg (M_CrossSectionsandQuantities-EX1.dwg).*

Exercise 2: Modify Sample Line Group Properties

In this exercise, students modify the sample line group properties and add additional section data.

The completed drawing is as shown.

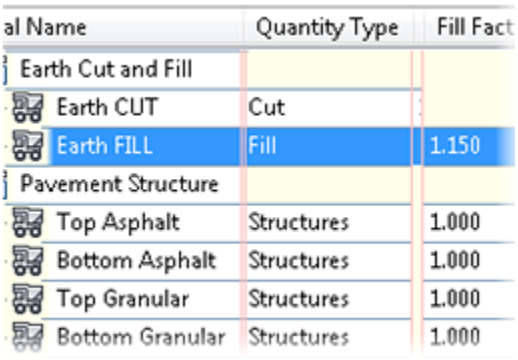


For this exercise, open *…\I_CrossSectionsandQuantities-EX2.dwg (M_CrossSectionsandQuantities-EX2.dwg).*

Exercise 3: Calculate Corridor Quantities

In this exercise, students review the quantity takeoff criteria, and calculate the earth cut and fill and pavement structure quantities for a corridor model.

The completed drawing is as shown.



al Name	Quantity Type	Fill Fact
Earth Cut and Fill		
Earth CUT	Cut	
Earth FILL	Fill	1.150
Pavement Structure		
Top Asphalt	Structures	1.000
Bottom Asphalt	Structures	1.000
Top Granular	Structures	1.000
Bottom Granular	Structures	1.000

For this exercise, open *…\I_CrossSectionsandQuantities-EX3.dwg (M_CrossSectionsandQuantities-EX3.dwg).*

Exercise 4: Create and Edit Sample Lines

In this exercise, students create a quantity report in a table and a quantity report in a web browser.

The completed drawing is as shown.

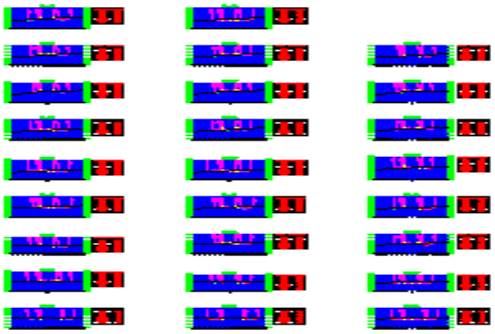
Area Type	Area	Inc.'	Cum.Vol
	Sq.ft.	Cu.yd	Cu.yd.
Top Asphalt	4.48	0.00	0.00
Bottom Asphalt	4.48	0.00	0.00
Top Granular	17.98	0.00	0.00
Bottom Granular	42.00	0.00	0.00
Top Asphalt	4.47	8.29	8.29
Bottom Asphalt	4.47	8.29	8.29
Top Granular	17.93	33.25	33.25
Bottom Granular	41.84	77.63	77.63

For this exercise, open *…\I_CrossSectionsandQuantities-EX4.dwg (M_CrossSectionsandQuantities-EX4.dwg).*

Exercise 5: Create Multiple Section Views

In this exercise, students create multiple section views.

The completed drawing is as shown.



For this exercise, open *…\I_CrossSectionsandQuantities-EX5.dwg (M_CrossSectionsandQuantities-EX5.dwg).*

Assessment

Challenge Exercise

Instructors provide a master or challenge exercise for students to do based on this lesson.

Questions

1. What is a sample line?
2. How can you set the location of the sample lines?
3. What is section data?
4. What are the types of section data that can be attached to sample lines?
5. What controls the placement and orientation of section views?
6. When is a material list generated?
7. What is quantity takeoff criteria?
8. What object is used to display section data?

Answers

1. A sample line is also known as a cross-section line and indicates the location where a cross-section view will be created. The sample line is part of the sample line group created along an alignment. Section data is attached to sample lines and the data is displayed in section views and used for quantity calculations.
2. You can specify the location of sample lines by manually selecting locations, selecting existing lines/polylines, using Corridor Assembly insertion locations, or by specifying an interval.
3. Section data is attached to sample lines in a sample line group and is displayed in section views and used for quantity calculation. You can attach surface, corridor, corridor surface, material, and pipe network section data to sample lines.
4. You can attach surface, corridor surface, corridor, material, and pipe network section data to sample lines.
5. In Prospector Settings, click Section Views to find the group plot styles that control the placement and orientation of section views.
6. The material list is generated when volumes are computed. The material list becomes part of the sample line group.
7. Quantity takeoff criteria define the method used to calculate quantities.
8. The Section View object displays the section data. The display of the section view is controlled with a Section View style.

Lesson Summary

In this lesson, students learned how to generate roadway cross sections and calculate quantities. In order to perform these tasks, the first step was to create sample lines. Data required for display in section views and for calculating quantities was attached to the sample lines as section data. Sample lines with a defined width were generated at specific intervals along a horizontal alignment and were organized in a sample line group.

The next step was to calculate the volumes. The quantity takeoff criteria were reviewed and modified. Volumes were then calculated and attached as material lists to the sample line group. Reports for the volumes were generated in Internet Explorer and in the drawing as tables.

Section views were then created to display the section data that was attached to the sample lines. Section views were oriented and placed in the drawing with a group plot style.