

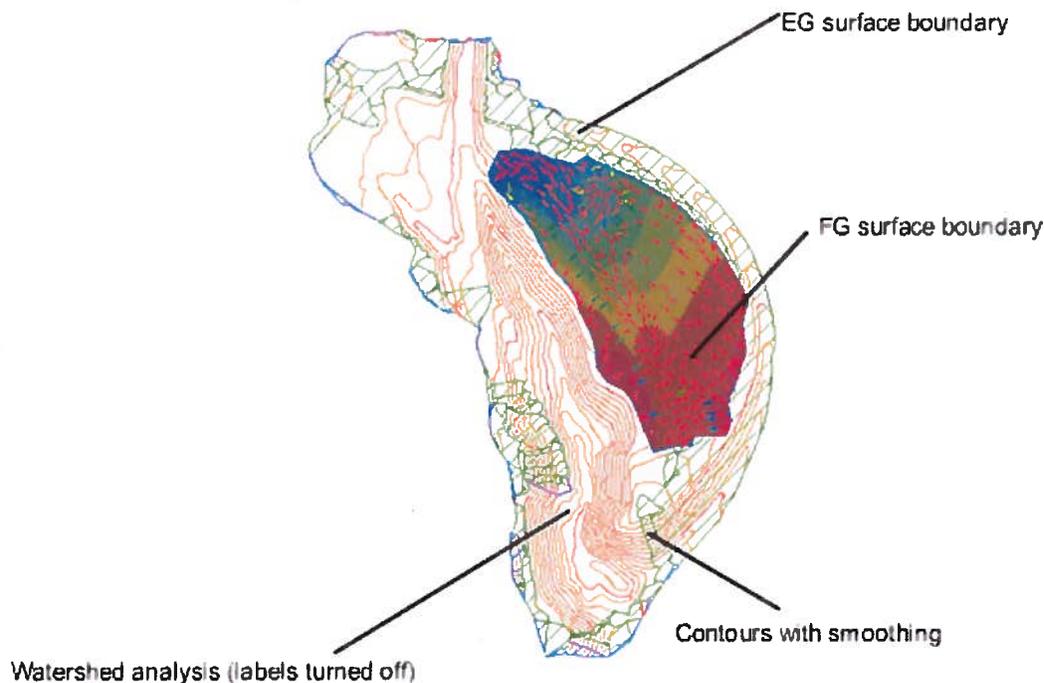
Appendix C
Volume Estimates of Potential Cover Materials

AutoCAD Civil 3D 2010 User's Guide > Getting Started > Feature Overview >

Surfaces

You can work with two types of surfaces: TIN (triangulated irregular network) and grid. For each of these types, you can create volume surfaces, which are differential surfaces created from two existing surfaces. Surface styles define the appearance of any surface. They can also be used to control the visibility of any analysis that has been performed on that surface. Watersheds can be drawn on the surface, with information about the type of drainage area and where each area drains to.

Boundaries define the visible area of a surface. Only the area within the boundary is included in calculations, such as for total area and volume. You can also define masks to hide or show parts of a surface for editing or presentation purposes, while still including that area in calculations.

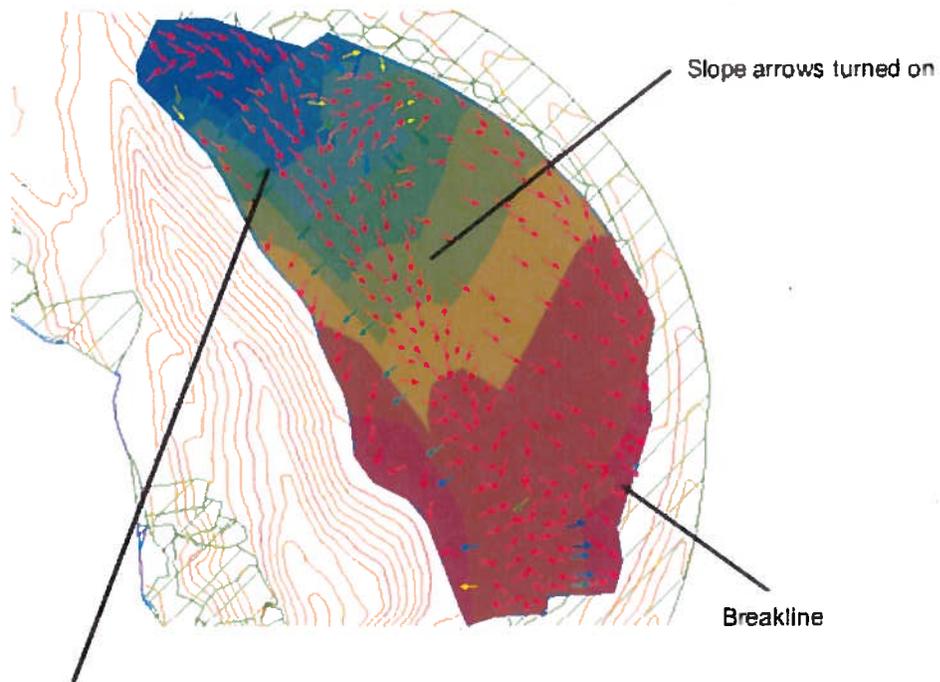


Surfaces displaying boundaries, contours, and elevation analysis

Breaklines are used on TIN surfaces to define linear features that triangles cannot cross, such as retaining walls or streams. Breaklines affect triangulation of the surface.

You can define different sets of contours, for example, for different intervals. Smoothing is provided for the surface object as a whole, which gives better results than simply smoothing the contours. In AutoCAD Civil 3D, the build process for surfaces is incremental. Whenever data is added or corrected, the surface is updated. Each surface has a definition list. This list contains all the operations performed on the surface. By turning the operations on and off,

you can return a surface to a previous state or modify it to support different types of analysis.



Surfaces displaying slope arrows elevation analysis

For information about....	See...
Working with Surfaces	Surfaces and Surfaces Dialog Boxes
Workflow	 Surfaces Workflow
Tutorials	 Surfaces Tutorials
Best Practices	 Surface Data

AutoCAD Civil 3D 2010 User's Guide > Surfaces > Calculating Surface Volumes >

Calculating Composite Volumes

Concept

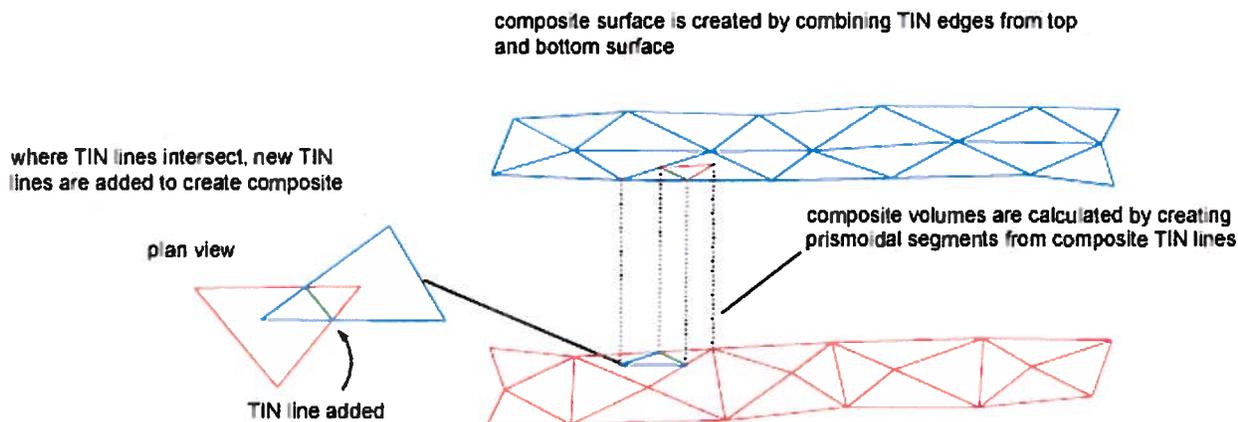
Procedure

Quick Reference

Calculate volumes using the composite method, which triangulates a new surface, based on points from both surfaces.

This method uses the points from both surfaces, as well as any location where the edges of the triangles between the two surfaces intersect to create prismatical segments from composite TIN lines.

The new composite surface elevations are calculated based on the difference between the elevations of the two surfaces, as follows:



This method gives accurate volume measurements between the two surface definitions.

See Also

- [Creating a TIN Volume Surface](#)
- [Creating a Grid Volume Surface](#)



[Tutorial Exercise: Creating a Composite Volume Calculation](#)

Calculating Composite Volumes

Concept

Procedure

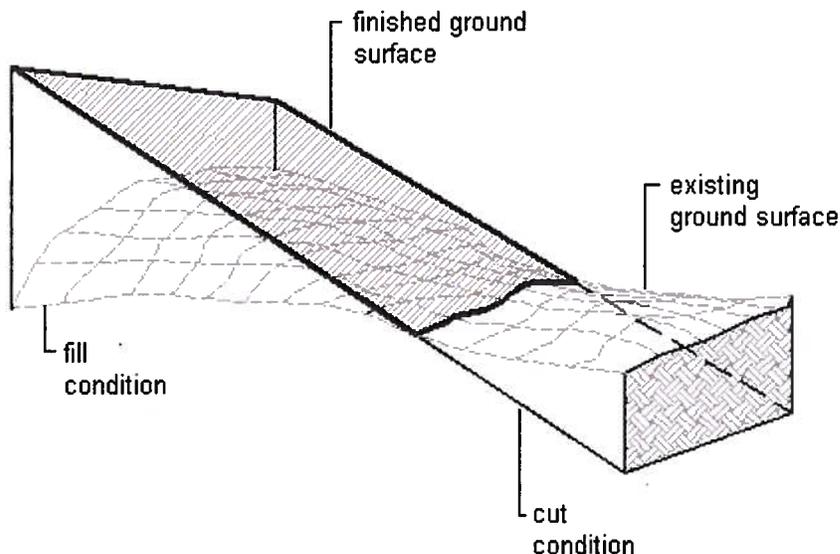
Quick Reference

To calculate composite surface volumes

1. Open, create, or import the TIN or grid surfaces for which you want to measure the composite volume. See [Creating Surfaces](#).
Note The Composite Volumes utility compares two surfaces (surface pairs), so you must have two surfaces available in your drawing.
2. Click Analyze tab > Volumes and Materials panel > Volumes drop-down > Volumes 
3. Do one of the following:
 - In the [Composite Volumes](#) vista, click  and select the surfaces to compare by clicking the <select surface> entry from the Base Surface and Comparison Surface columns (for the base and comparison surfaces respectively).
 - In the Composite Volumes vista, click  and select both the base and comparison surfaces from the drawing area.

After you select the surfaces, the volumes are calculated and the following information is displayed:

- **Cut.** The amount of material that has to be removed.
- **Fill.** The amount of material that has to be added.



- **Net.** The difference between the cut and the fill. For example, if a volume is 200 m³ of cut and 100 m³ of fill, the net is 100 m³ <cut>.

- **Net Graph.** A graphical percentage representation of the whole volume. A fill net is displayed as a green bar indicating that material needs to be added to the project site. A cut net is displayed as a red bar, indicating that material must be removed.

AutoCAD Civil 3D 2010 User's Guide > Surfaces > Creating Surfaces >

Creating a TIN Volume Surface

Concept

Procedure

Quick Reference

A TIN volume surface is a composite of points in a base surface and comparison surface.

A TIN volume surface provides an exact difference between the base and comparison surfaces. Therefore, the Z-value of any point in the volume surface is precisely the difference between the Z of the comparison surface at that point and the base surface at that point. This is true whether the comparison and base surfaces are both grid surface, both TIN surfaces, or one of each.

A volume surface is a persistent surface object. Therefore, you can display cut and fill contours, cut and fill points, and add labels to it. You can view volume properties (cut, fill, net) of a volume surface by selecting Surface Properties. For more information, see [Editing and Viewing the Surface Definition](#).

If you want only to query and obtain information about a surface volume or bounded volume, use the Volumes and Bounded Volumes utilities.

See Also

- [Calculating Surface Volumes](#)



[Tutorial Exercise: Creating a TIN Volume Surface](#)

Creating a TIN Volume Surface

Concept

Procedure

Quick Reference

To create a TIN volume surface

1. Click Home tab > Create Ground Data panel > Surfaces drop-down > Create Surface .

In the [Create Surface](#), in the Type list, select TIN Volume Surface.

2. Click  to select a layer. For more information about layers, see [Object Layer Dialog Box](#).
Note If you do not select a layer, the surface is placed on the current layer.

3. In the properties grid, click the Value column for the Name property and enter a name for the surface.

Note To name the surface, click its default name and enter a new name, or use the name template. For more information, see [Name Template Dialog Box](#).

4. To change the style for the surface, click the Style property in the properties grid and click  in the Value column.

The Select Surface Style dialog box is displayed. For more information, see [Surface Styles and Visualization](#).

5. To change the render material for the surface, click the Render Material property in the properties grid and click  in the Value column.

The Select Render Material dialog box is displayed. For more information, see [Applying Render Materials to Objects](#)

6. Click the Base Surface property to select the base (bottom) surface. Enter the surface name or click  to open the [Select Base Surface](#) dialog box where you can select the surface in the list.

Note Select a surface in the drawing by clicking  and following the instructions at the command line.

7. Click the Comparison Surface property to select the comparison (top) surface. Enter the surface name or click  to open the Select Comparison Surface dialog box where you can select the surface in the list.

Note Select a surface in the drawing by clicking  and following the instructions at the command line.

8. Click OK to create the surface.

The surface name is displayed under the Surfaces collection in the Prospector tree. For information about adding data to the surface, see [Adding and Editing Surface Data](#).

AutoCAD Civil 3D Volume Outputs

Surface Properties - PHASE 3 SOUTH HLP BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	1451
Minimum X coordinate	322781.414'
Minimum Y coordinate	1544459.943'
Maximum X coordinate	324555.948'
Maximum Y coordinate	1546944.334'
Minimum elevation	4491.155'
Maximum elevation	4556.310'
Mean elevation	4537.700'
Extended	
2D surface area	1973045.07 Sq. Ft.
3D surface area	1976876.41 Sq. Ft. = 45 AC.
Minimum grade/slope	0.31%
Maximum grade/slope	193.87%
Mean grade/slope	4.38%
TIN	
Number of triangles	1449
Maximum triangle area	311677.31 Sq. Ft.
Minimum triangle area	0.30 Sq. Ft.
Minimum triangle length	0.169'
Maximum triangle length	1080.404'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume				Cut Factor	Fill Factor	C
	Base Surface	Comparison Surface	Cut	Fill	Net				
1	PHASE 3 SOUTH HLP BOTTO... EG		12143.03 Cu. Yd.	4371890.15 Cu. Yd.	4384033.18 Cu. Yd. <FW>		1.000	1.000	117

Panorama

Surface Properties - PHASE 3 4X HLP BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	1298
Minimum X coordinate	321200.783'
Minimum Y coordinate	1545555.802'
Maximum X coordinate	322920.099'
Maximum Y coordinate	1547732.300'
Minimum elevation	4495.866'
Maximum elevation	4577.314'
Mean elevation	4528.947'
Extended	
2D surface area	2305408.88 Sq. Ft.
3D surface area	2310141.86 Sq. Ft. = 53 ac
Minimum grade/slope	0.23%
Maximum grade/slope	2658.15%
Mean grade/slope	4.47%
TIN	
Number of triangles	1296
Maximum triangle area	656639.93 Sq. Ft.
Minimum triangle area	0.22 Sq. Ft.
Minimum triangle length	0.024'
Maximum triangle length	1303.823'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume			Cut Factor	Fill Factor	C
	Base Surface	Comparison Surface	Cut	Fill	Net			
1	PHASE 3 4X HLP BOTTOM F...	EG	5102.17 Cu. Yd.	5208442.24 Cu. Yd.	5203844307 Cu. Yd. <F8>	1.000	1.000	5.11

Grading Elevation Editor

Panorama

Surface Properties - PHASE 4 SLOT HLP BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	1741
Minimum X coordinate	326931.788
Minimum Y coordinate	1542671.734'
Maximum X coordinate	329116.603
Maximum Y coordinate	1544942.019'
Minimum elevation	4402.126'
Maximum elevation	4526.415'
Mean elevation	4444.642'
Extended	
2D surface area	3256366.27 Sq. Ft.
3D surface area	3274530.65 Sq. Ft. = 75 AC
Minimum grade/slope	0.31%
Maximum grade/slope	825.16%
Mean grade/slope	7.83%
TIN	
Number of triangles	1739
Maximum triangle area	619654.68 Sq. Ft.
Minimum triangle area	0.00 Sq. Ft.
Minimum triangle length	0.012'
Maximum triangle length	1544.703'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume				
	Base Surface	Comparison Surface	Cut	Fill	Net	Cut Factor	Fill Factor
1	PHASE 4 SLOT HLP BOTTOM...	FG	254,541.16 Cu. Yd.	6,771,131.15 Cu. Yd.	6,516,589.99 Cu. Yd.	1.000	1.000

Grading Elevation Editor

Panorama

Surface Properties - PHASE 4 VLT HLP BOTTOM FOOTPRINT

Information Definition Analysis Statistics

Statistics	Value
General	
Revision number	0
Number of points	1278
Minimum X coordinate	321629.120'
Minimum Y coordinate	1551044.596'
Maximum X coordinate	323550.375'
Maximum Y coordinate	1553099.775'
Minimum elevation	4377.298'
Maximum elevation	4461.784'
Mean elevation	4405.240'
Extended	
2D surface area	2202357.19 Sq. Ft.
3D surface area	2210291.12 Sq. Ft. = 51 AC.
Minimum grade/slope	0.62%
Maximum grade/slope	3388.93%
Mean grade/slope	5.95%
TIN	
Number of triangles	1276
Maximum triangle area	593011.94 Sq. Ft.
Minimum triangle area	0.00 Sq. Ft.
Minimum triangle length	0.024'
Maximum triangle length	1427.938'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume				
	Base Surface	Comparison Surface	Cut	Fill	Net	Cut Factor	Fill Factor
1	PHASE 4 VLT HLP BOTTOM F...	F.G.	7281.99 Cu. Yd.	2169726.73 Cu. Yd.	5467446.79 Cu. Yd. (Fill)	1.000	1.000

Grading Elevation Editor

Panorama

Surface Properties - PIT SURFACE PRE-MINING

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	994
Minimum X coordinate	323237.205'
Minimum Y coordinate	1539482.219'
Maximum X coordinate	329525.775'
Maximum Y coordinate	1543982.531'
Minimum elevation	4358.000'
Maximum elevation	4630.000'
Mean elevation	4484.037'
Extended	
2D surface area	15624206.01 Sq. Ft.
3D surface area	15758360.10 Sq. Ft. = 362 AC
Minimum grade/slope	0.00%
Maximum grade/slope	9119.49%
Mean grade/slope	9.60%
TIN	
Number of triangles	1445
Maximum triangle area	1108991.80 Sq. Ft.
Minimum triangle area	0.38 Sq. Ft.
Minimum triangle length	3.324'
Maximum triangle length	2722.476'

OK Cancel Apply Help

Surface Properties - BEDROCK-ALLUVIUM CONTACT SURFACE

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	1159
Minimum X coordinate	323858.647'
Minimum Y coordinate	1539726.693'
Maximum X coordinate	329455.837'
Maximum Y coordinate	1543540.472'
Minimum elevation	4190.000'
Maximum elevation	4420.000'
Mean elevation	4359.192'
Extended	
2D surface area	11136137.24 Sq. Ft.
3D surface area	11279226.76 Sq. Ft. = 259 AC
Minimum grade/slope	0.00%
Maximum grade/slope	13114.97%
Mean grade/slope	11.99%
TIN	
Number of triangles	1453
Maximum triangle area	773875.07 Sq. Ft.
Minimum triangle area	0.14 Sq. Ft.
Minimum triangle length	2.808'
Maximum triangle length	2154.632'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume					
	Base Surface	Comparison Surface	Cut	Fill	Net	Cut Factor	Fill Factor	C
1	PIT SURFACE PRE-MINING	PIT LAKE ALLUVIUM BED...	59864057.66 Cu. Yd.	457.36 Cu. Yd.	59863600.30 Cu. Yd. <Cut>	1.000	1.000	598

Panorama

Surface Properties - **OXIDE TAILINGS BOTTOM FOOTPRINT**

Information | Definition | Analysis | **Statistics**

Statistics	Value
General	
Revision number	0
Number of points	3595
Minimum X coordinate	319959.275'
Minimum Y coordinate	1546378.812'
Maximum X coordinate	324105.057
Maximum Y coordinate	1551816.265'
Minimum elevation	4386.000'
Maximum elevation	4574.664'
Mean elevation	4466.273'
Extended	
2D surface area	14972383.63 Sq. Ft.
3D surface area	15010182.55 Sq. Ft. = 345 AC
Minimum grade/slope	0.42%
Maximum grade/slope	1614.05%
Mean grade/slope	4.80%
TIN	
Number of triangles	3593
Maximum triangle area	3142997.63 Sq. Ft.
Minimum triangle area	0.08 Sq. Ft.
Minimum triangle length	3.653'
Maximum triangle length	3244.667'

OK Cancel Apply Help

Grading Elevation Editor

Composite Volumes

Index	Surface Pair		Volume				Cut Factor	Fill Factor	C
	Base Surface	Comparison Surface	Cut	Fill	Net				
1	OXIDE TAILINGS BOTTOM F...	...	1062910.25 Cu. Yd.	31739054.93 Cu. Yd.	106677094.60 Cu. Yd.	<Fill>	1.000	1.000	100

Panorama

Surface Properties - **SULFIDE TAILINGS** BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	5077
Minimum X coordinate	324076.471
Minimum Y coordinate	1546594.988'
Maximum X coordinate	329587.114'
Maximum Y coordinate	1554652.435'
Minimum elevation	4356.842'
Maximum elevation	4458.979'
Mean elevation	4405.555'
Extended	
2D surface area	29342797.38 Sq. Ft.
3D surface area	29354073.03 Sq. Ft. = 674 AC.
Minimum grade/slope	0.02%
Maximum grade/slope	459.94%
Mean grade/slope	2.10%
TIN	
Number of triangles	5075
Maximum triangle area	4524559.38 Sq. Ft.
Minimum triangle area	0.21 Sq. Ft.
Minimum triangle length	3.822'
Maximum triangle length	4198.429'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume			Cut Factor	Fill Factor	C
	Base Surface	Comparison Surface	Cut	Fill	Net			
1	SULFIDE TAILINGS BOTTOM...	F-G	2260771.53 Cu. Yd.	18326420.15 Cu. Yd.	15965648.50 Cu. Yd. <PW>	1.000	1.000	

Panorama

Surface Properties - S-32 BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	765
Minimum X coordinate	325046.096'
Minimum Y coordinate	1543997.516'
Maximum X coordinate	326122.998'
Maximum Y coordinate	1545089.318'
Minimum elevation	4461.867'
Maximum elevation	4515.116'
Mean elevation	4492.151'
Extended	
2D surface area	818175.77 Sq. Ft.
3D surface area	819303.87 Sq. Ft. 18.81 AC
Minimum grade/slope	1.17%
Maximum grade/slope	300.52%
Mean grade/slope	4.49%
TIN	
Number of triangles	838
Maximum triangle area	195356.23 Sq. Ft.
Minimum triangle area	0.28 Sq. Ft.
Minimum triangle length	4.642'
Maximum triangle length	769.236'

MAX PILE HEIGHT
4594'

OK Cancel Apply Help

Surface Properties - NWRA - W-3 BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	1791
Minimum X coordinate	325689.360'
Minimum Y coordinate	1545068.252'
Maximum X coordinate	328752.571'
Maximum Y coordinate	1546682.742'
Minimum elevation	4414.036'
Maximum elevation	4598.394'
Mean elevation	4467.528'
Extended	
2D surface area	3664534.26 Sq. Ft.
3D surface area	3690663.12 Sq. Ft. 84.73 AC
Minimum grade/slope	0.44%
Maximum grade/slope	122.07%
Mean grade/slope	9.36%
TIN	
Number of triangles	1789
Maximum triangle area	494832.78 Sq. Ft.
Minimum triangle area	0.31 Sq. Ft.
Minimum triangle length	4.152'
Maximum triangle length	1487.850'

MAX PILE HEIGHT:
4648'

OK Cancel Apply Help

Surface Properties - SWRA BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	940
Minimum X coordinate	323539.163'
Minimum Y coordinate	1535729.318'
Maximum X coordinate	328740.854'
Maximum Y coordinate	1541377.572'
Minimum elevation	4411.889'
Maximum elevation	4613.583'
Mean elevation	4527.333'
Extended	
2D surface area	16910409.61 Sq. Ft.
3D surface area	16935923.81 Sq. Ft. 388.80 AC.
Minimum grade/slope	0.05%
Maximum grade/slope	106.75%
Mean grade/slope	4.66%
TIN	
Number of triangles	938
Maximum triangle area	2582028.20 Sq. Ft.
Minimum triangle area	8.13 Sq. Ft.
Minimum triangle length	13.763'
Maximum triangle length	3024.574'

MAX PILE HEIGHT = 4726

202' DIFF (4726 - 4412 = 314')

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume			Cut Factor	Fill Factor	Cu
	Base Surface	Comparison Surface	Cut	Fill	Net			
1	S-32 BOTTOM FOOTPRINT	EG	14255.56 Cu. Yd.	1478611.01 Cu. Yd.	1464355.46 Cu. Yd. <Fill>	1.000	1.000	142
2	NWRA - W-3 BOTTOM FOOT...	EG	40886.18 Cu. Yd.	12093224.50 Cu. Yd.	12052338.32 Cu. Yd. <Fill>	1.000	1.000	408
3	SWRA BOTTOM FOOTPRINT	EG	19824.72 Cu. Yd.	63264634.50 Cu. Yd.	63344809.78 Cu. Yd. <Fill>	1.000	1.000	198

Panorama

Surface Properties - PHASE 1 AND 2 HLP BOTTOM FOOTPRINT

Information | Definition | Analysis | Statistics

Statistics	Value
General	
Revision number	0
Number of points	683
Minimum X coordinate	325796.792'
Minimum Y coordinate	1544023.756'
Maximum X coordinate	326608.869'
Maximum Y coordinate	1545161.236'
Minimum elevation	4462.063'
Maximum elevation	4517.789'
Mean elevation	4488.958'
Extended	
2D surface area	509495.98 Sq. Ft.
3D surface area	511734.67 Sq. Ft. = 11.7 Ac
Minimum grade/slope	0.27%
Maximum grade/slope	230.05%
Mean grade/slope	7.67%
TIN	
Number of triangles	681
Maximum triangle area	63044.63 Sq. Ft.
Minimum triangle area	0.71 Sq. Ft.
Minimum triangle length	0.580'
Maximum triangle length	489.707'

OK Cancel Apply Help

Composite Volumes

Index	Surface Pair		Volume				Cut Factor	Fill Factor	C
	Base Surface	Comparison Surface	Cut	Fill	Net				
1	PHASE 1 AND 2 HLP BOTTO...	EG	999.06 Cu. Yd.	487618.93 Cu. Yd.	981718.87 Cu. Yd.	<F>	1.050	1.000	50

Panorama

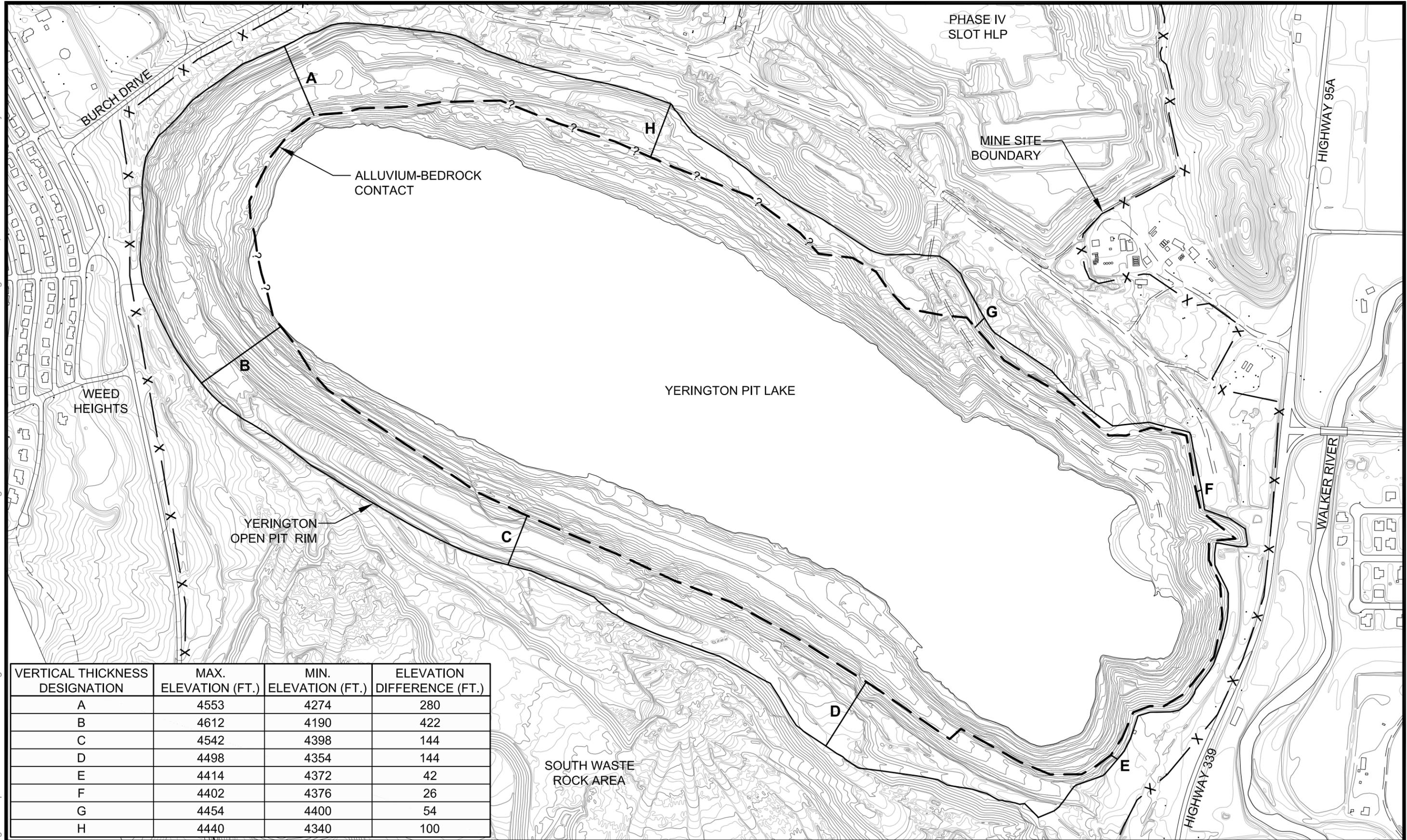
South Waste Rock Area Alluvial Material Volume Calculation

South Waste Rock Area Alluvial Material Volume Calculation

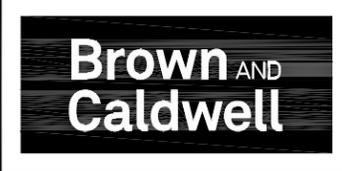
The volume of alluvial materials within the South Waste Rock Area was calculated using AutoCAD Civil 3D 2010 software and the following steps:

1. Alluvium-bedrock contact (see attached figure) was converted to a 3D feature line, and projected to the existing 2001 topography.
2. A 3D surface was created from the alluvium-bedrock contact feature line, assuming no irregularities.
3. The limits of disturbance around the pit (i.e., the perimeter of the excavated pit) were used to delineate the pre-mining ground surface and used to create a 3D surface of the pre-mining topography.
4. A new surface was created by pasting the alluvium-bedrock contact surface into the pre-mining topographic surface to create a volume of excavated alluvium, which could be compared to the volume of the South Waste Rock Area.
5. The vertical thickness designations (see line segments A-H on the attached figure) were developed to represent vertical height differences between the contact and the top of the pit rim (assumed to represent pre-mining topography), and interpolated to represent a smoothed bedrock-alluvium contact between segments.

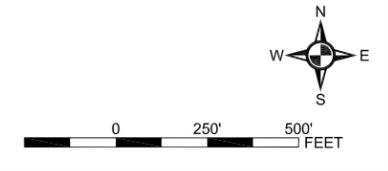
P:\Arco-Yerington\Evaporation Pond-Sulfide Tailings\138555 - Year 2010 Files\CAD\Drawings\June 2010\Alluvium Thickness in Pit-C3D.dwg Jun 25, 2010 - 9:24am johnson



VERTICAL THICKNESS DESIGNATION	MAX. ELEVATION (FT.)	MIN. ELEVATION (FT.)	ELEVATION DIFFERENCE (FT.)
A	4553	4274	280
B	4612	4190	422
C	4542	4398	144
D	4498	4354	144
E	4414	4372	42
F	4402	4376	26
G	4454	4400	54
H	4440	4340	100



Date: June 2010
 Atlantic Richfield Company
 Project: 138555



NOTE: ALLUVIUM-BEDROCK CONTACT PROVIDED BY GOLDER ASSOCIATES INC., JULY 18, 2008.

Alluvium Thickness in Yerington Open Pit