



Pit Design Tutorial

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Product

Surpac™ 6.6.1

Last modified: Tuesday, 1 April 2014

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Introduction

This tutorial demonstrates how to create pit and dump designs using Surpac.

Requirements

Before you begin this tutorial, you must have:

- basic knowledge of Surpac
It is recommended that you understand the procedures and concepts from the Introduction tutorial.
- Surpac installed on your computer
- the data set accompanying this tutorial


Objectives

The objective of this tutorial is to allow you to create a pit design.

Workflow

The process described in this tutorial is outlined below:

- using string tools to create a simple pit design
- preparing data for use in basic pit design
- using pit design tools to create ramps, crests, toes, and berms
- creating switchbacks
- extending a pit design to a DTM surface
- calculating grade and tonnage of block model blocks within a pit design
- designing a waste dump

 **Note:** This workflow demonstrates the steps in this tutorial. There are other ways to achieve a result.

Setting up for this tutorial

Setting the work directory

A work directory is the default directory for saving Surpac files. Files used in this tutorial are stored in the folder **<shared_files>\demo_data\tutorials\pit_design**.

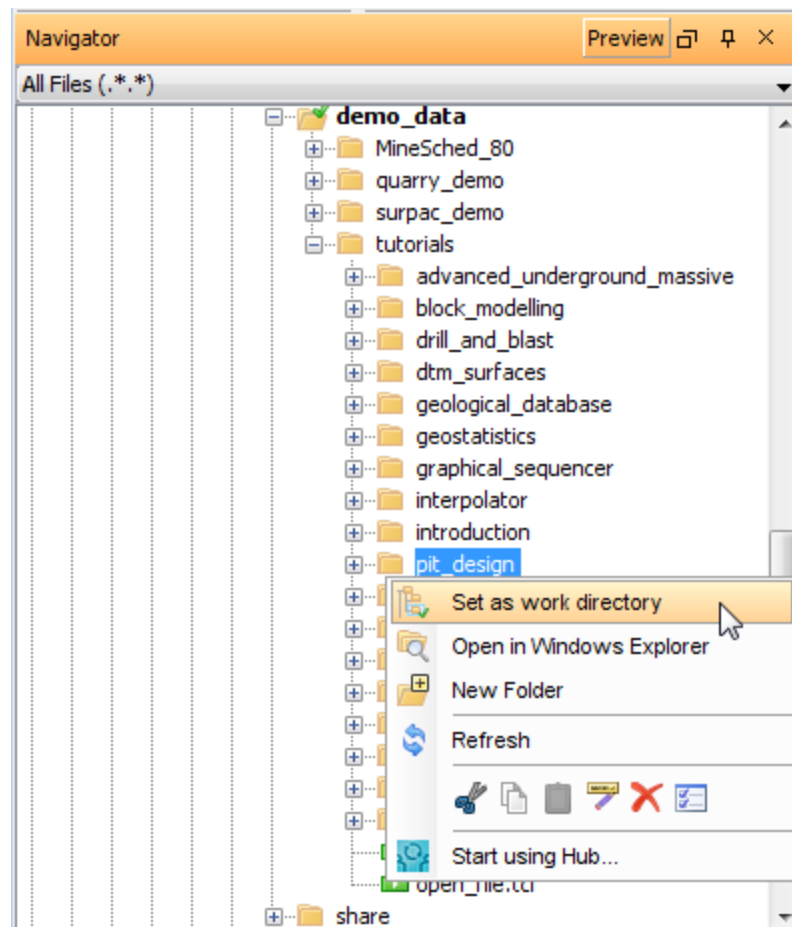
Where **<shared_files>** is the directory in which the Surpac shared files were installed.

In Windows 7, and Windows 8, the default path is

C: \Users\Public\GEOVIA\Surpac\66\demo_data\tutorials\pit_design.

Task: Set the work directory

1. In the **Navigator**, right-click the **pit_design** folder.
2. From the shortcut menu, select **Set as work directory**.

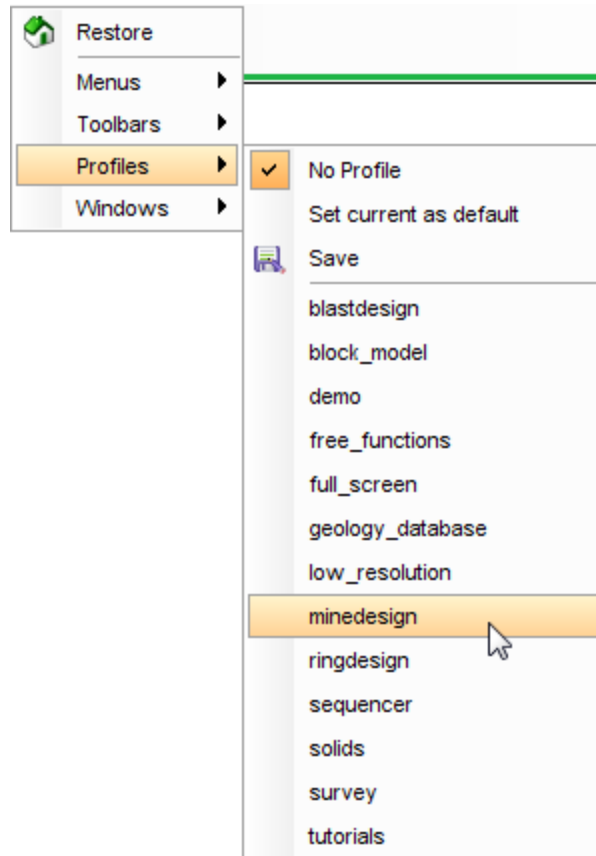



The name of the work directory is displayed in the title bar of the Surpac window.

Displaying the toolbar and menubar

Task: Display the minedesign toolbar and menubar

1. Right-click in the blank area next to the menus at the top of the Surpac main window.
2. From the shortcut menu choose **Profiles > minedesign**.




 **Tip:** For more information on setting up profiles and customising menus and toolbars, see the Introduction to Surpac tutorial.

A Simple Example

Creating a simple pit

You will design a pit base around an ore zone at an elevation of 150, and then extend it up to an elevation of 250 with a pit wall angle of 45 degrees.

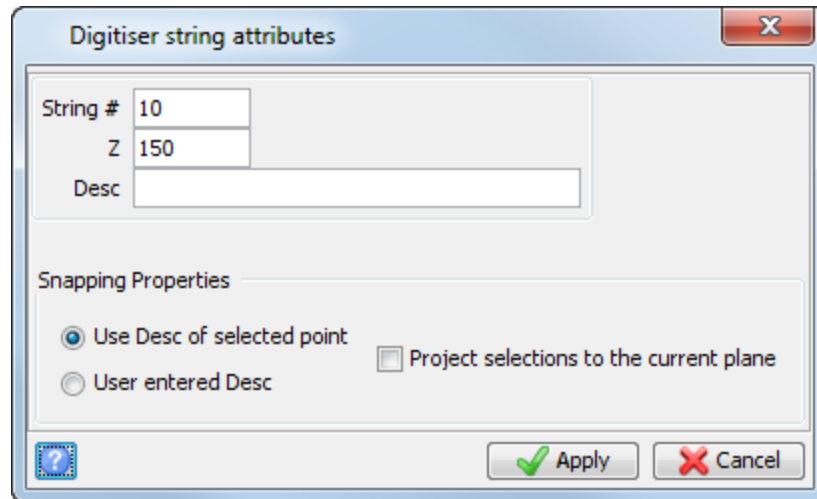
Task: Create a simple pit design

1. Click **Reset graphics** .
2. Open **ore150.str** in **Graphics**.
You can see a horizontal slice of ore zones at an elevation of 150.



3. Choose **Create > Digitise > Properties**.

4. Enter the information as shown, and click **Apply**.



Digitiser string attributes

String # 10
Z 150
Desc

Snapping Properties

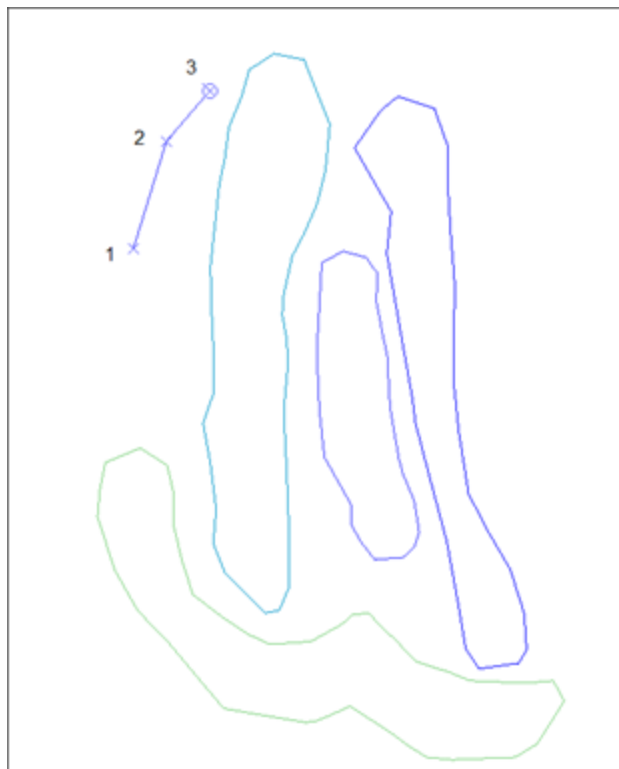
Use Desc of selected point Project selections to the current plane
 User entered Desc

Apply Cancel

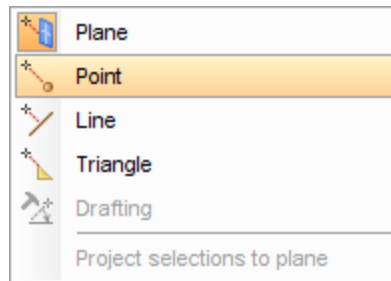
5. Choose **Create > Digitise > New point**.
6. Click in **Graphics** to create points 1, 2, and 3 as shown.

 **Notes:**

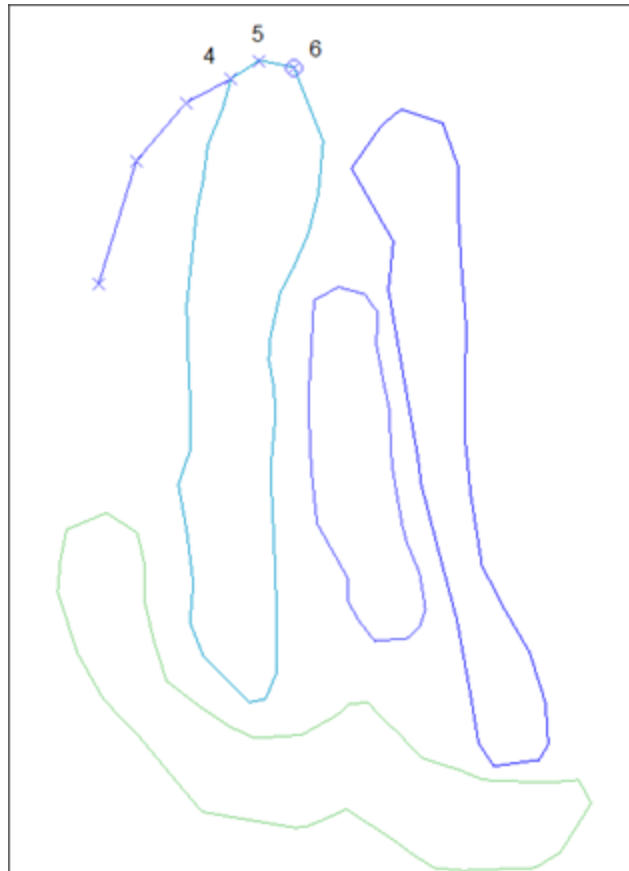
- Do **not** press ESC. You have not finished creating the string.
- Numbers 1, 2, and 3 are not displayed in **Graphics**. They are shown on the images so you know the order in which to create the points.



7. Right-click in **Graphics** and select **Point**.

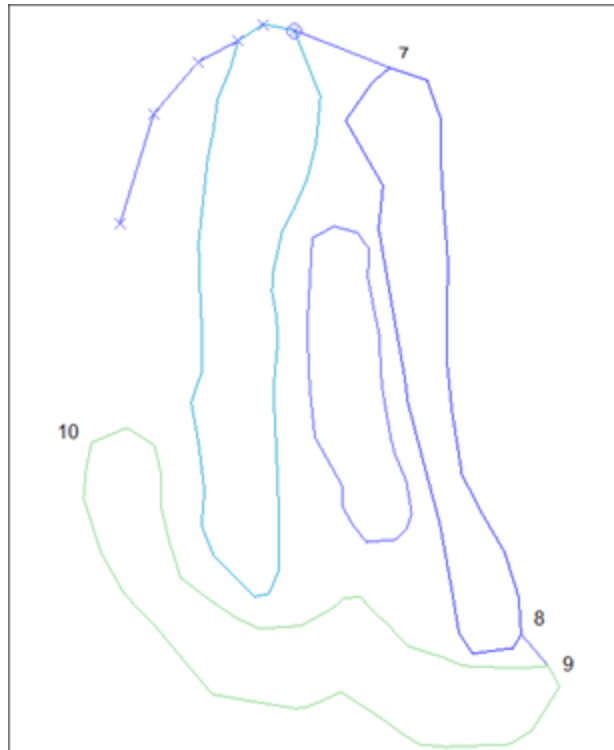


8. Click three points at the northern end of the segment as shown, to create points 4, 5, and 6.




9. Choose **Create > Digitise > By following a segment**.
10. Click and hold down the left mouse button at point 7, then drag to point 8 and release.

11. Click and hold down the left mouse button at point 9, then drag to point 10 and release.

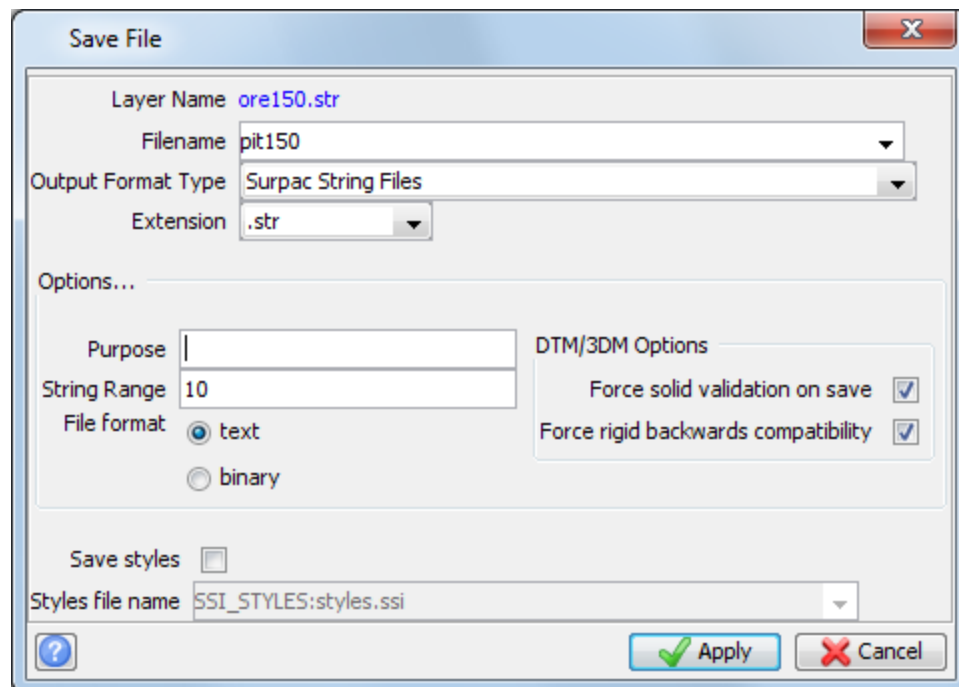


12. Choose **Create > Digitise > Close current segment**.
The closed segment is displayed.



 **Note:** When you create closed segments in the XY plane (plan view), you will usually create them in a clockwise direction. Clockwise segments are regarded as an area of inclusion, and give expected results when you intersect them with other clockwise segments.


13. Choose **File > Save > string/DTM**.
14. Enter the information as shown, and then click **Apply**.

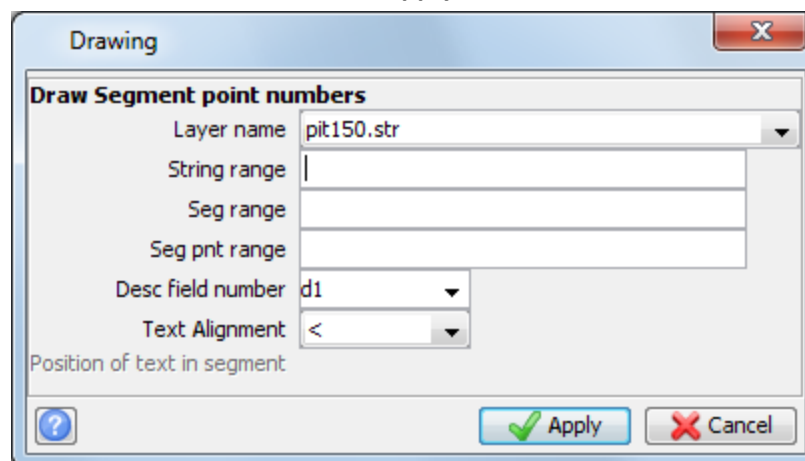


The 'Save File' dialog box is shown with the following settings:

- Layer Name: ore150.str
- Filename: pit150
- Output Format Type: Surpac String Files
- Extension: .str
- Options...:
 - Purpose: (empty text box)
 - String Range: 10
 - File format: text, binary
 - DTM/3DM Options:
 - Force solid validation on save:
 - Force rigid backwards compatibility:
- Save styles:
- Styles file name: SSI_STYLES:styles.ssi

Buttons: ? (help), Apply (green checkmark), Cancel (red X).

15. Click **Reset graphics** .
16. Open **pit150.str** in **Graphics**.
17. Choose **Display > Point > Numbers**.
18. Enter the information as shown, and click **Apply**.

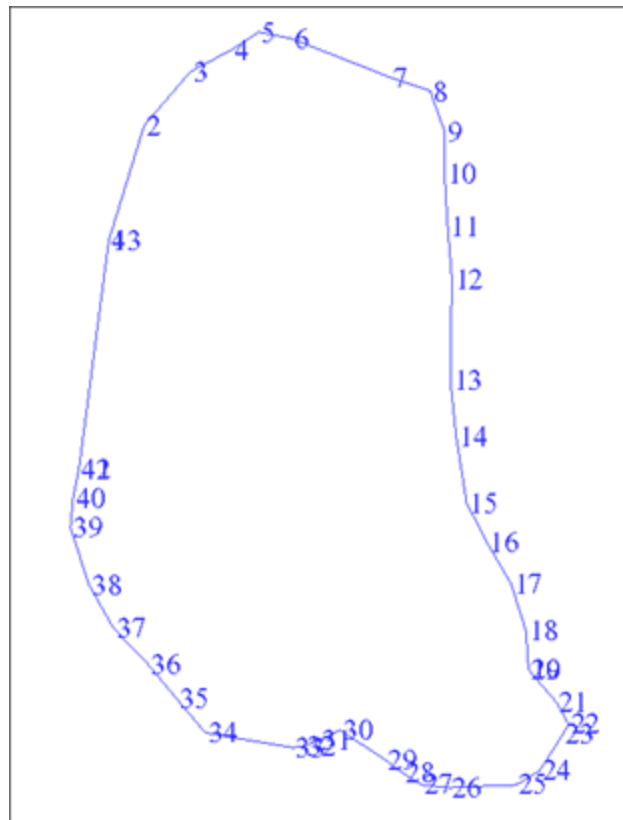


The 'Drawing' dialog box is shown with the following settings:

- Layer name: pit150.str
- String range: (empty text box)
- Seg range: (empty text box)
- Seg pnt range: (empty text box)
- Desc field number: d1
- Text Alignment: <
- Position of text in segment: (empty text box)

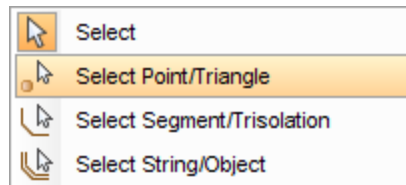
Buttons: ? (help), Apply (green checkmark), Cancel (red X).

The numbered points on the segment are displayed.

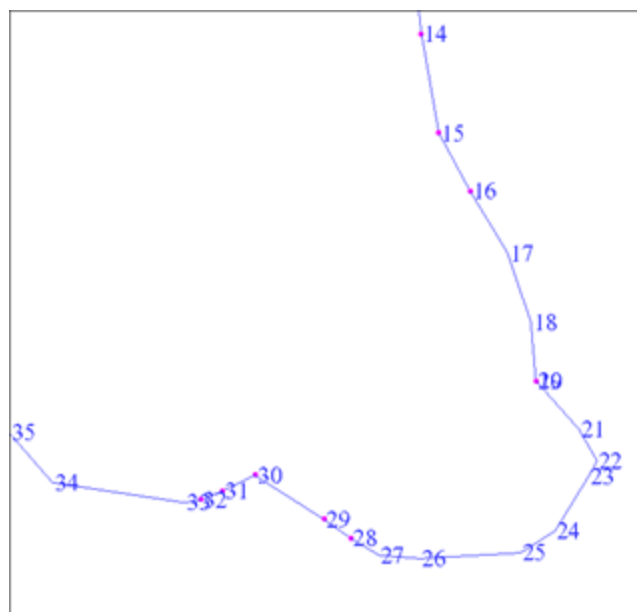


Next, you will delete some points to make the outline more convex.

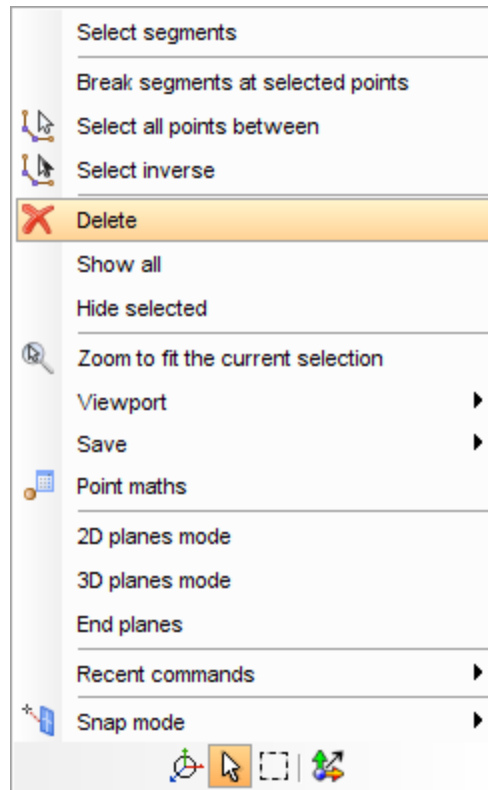
19. Set the selection mode to **Select Point/Triangle**.



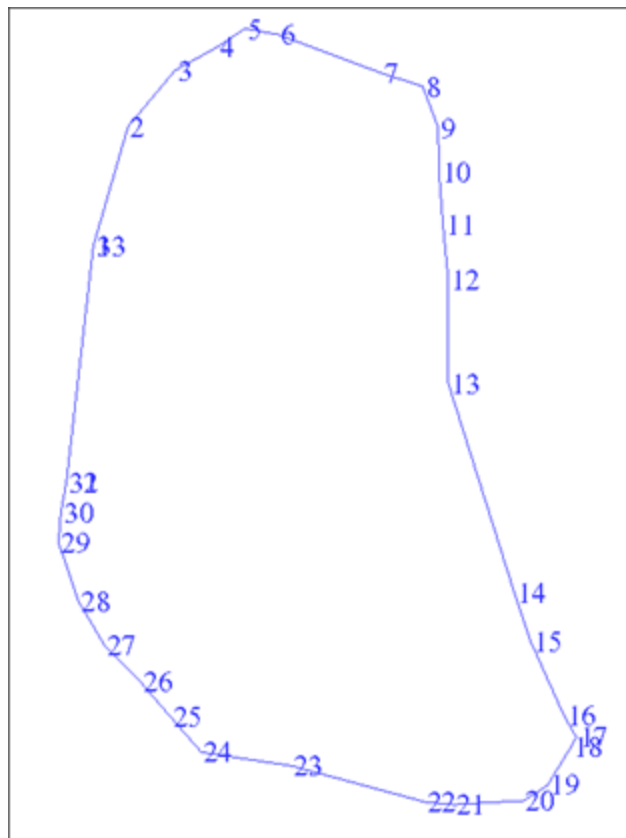
20. Hold the **CTRL** key and click several points as shown.



21. Right-click in **Graphics** to display a shortcut menu, and select **Delete**.



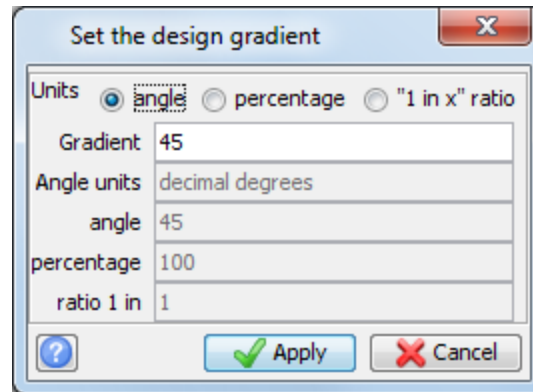
The renumbered segment is displayed.



Next, you will set the slope wall angle to 45 degrees.

22. Choose **Pit design > Set slope gradient**.

23. Enter the information as shown, and click **Apply**.



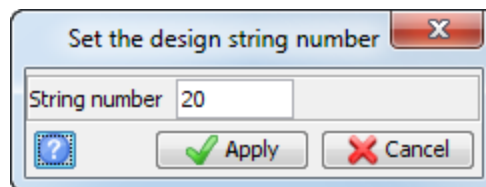
The **Design grade** button `45.000 angle` displays the current design gradient.

Next, you will set the string number for the top of the pit.

Note: This step is optional.

24. From the Status bar at the bottom of the Surpac window, click the **Design string** button `Str = 1`.

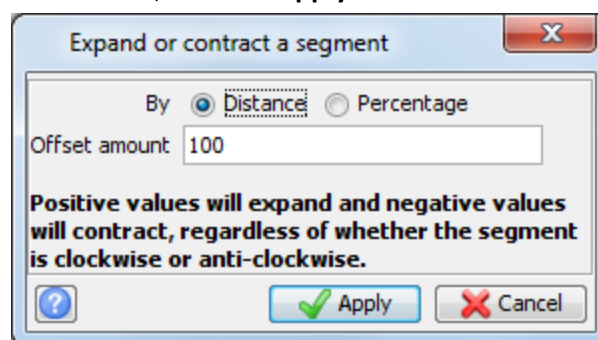
25. Enter the information as shown, and click **Apply**.



The **Design string** button displays the current design string number `Str = 20`.

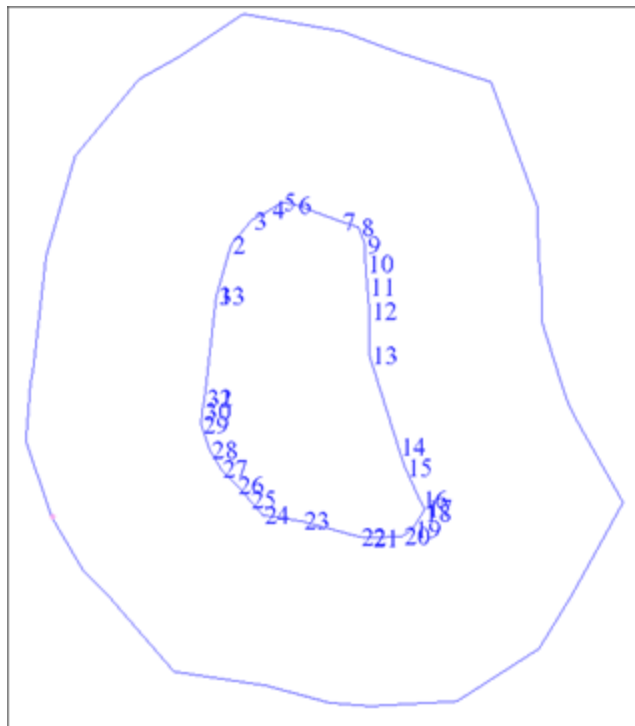
Next, you will expand the segment horizontally by a distance of 100. At an angle of 45 degrees, this will create a pit crest 100 meters above the base, at an elevation of 250.

26. Choose **Edit > Segment > Expand/Contract**.
 27. Click anywhere in **Graphics** to select the segment for expanding.
 28. Enter the information as shown, and click **Apply**.



29. Press ESC to finish expanding.

The segments representing the top and bottom of the pit are displayed.

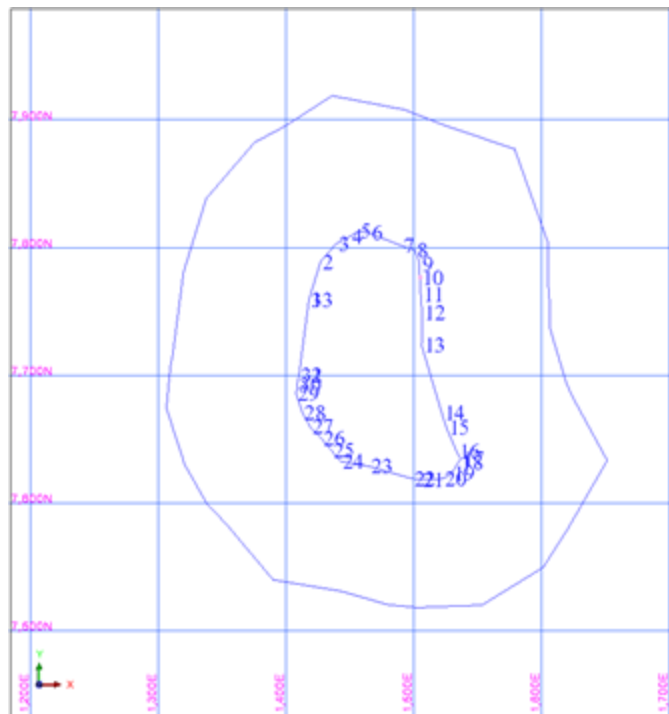


30. Hold down the right mouse button and drag down or to the left to zoom out.

31. Click the **Plan View** button .

32. Choose **Display > Dynamic 2D Grid**.

The pit strings and the Dynamic 2D grid are displayed.



This procedure can be useful for determining the limits of a block model.

Next, you will create a DTM from this data.

33. Choose **Surfaces > Create DTM from Layer**.
34. Enter the information as shown, and click **Apply**.

Create a DTM From a Layer

Object ID: 1

Object name:

Projection plane

The triangles will initially be created on a temporary 2D plane.

Create on: The XY plane

After creating the surface, change the current plane to the best-fit plane.

Creating a DTM using breakline test

Perform break line test

Interpolate additional points

Point interpolation distance: 50

Apply Cancel

35. Choose **Display > Hide grid**.
36. Choose **Display > 3D Grid**.
37. Enter the information as shown, and click **Apply**.

Draw a Grid

Grid Parameters

	Grid Line Interval	Label Frequency
Y Direction:	50	1
X Direction:	50	1
Z Direction:	50	1

Grid Planes

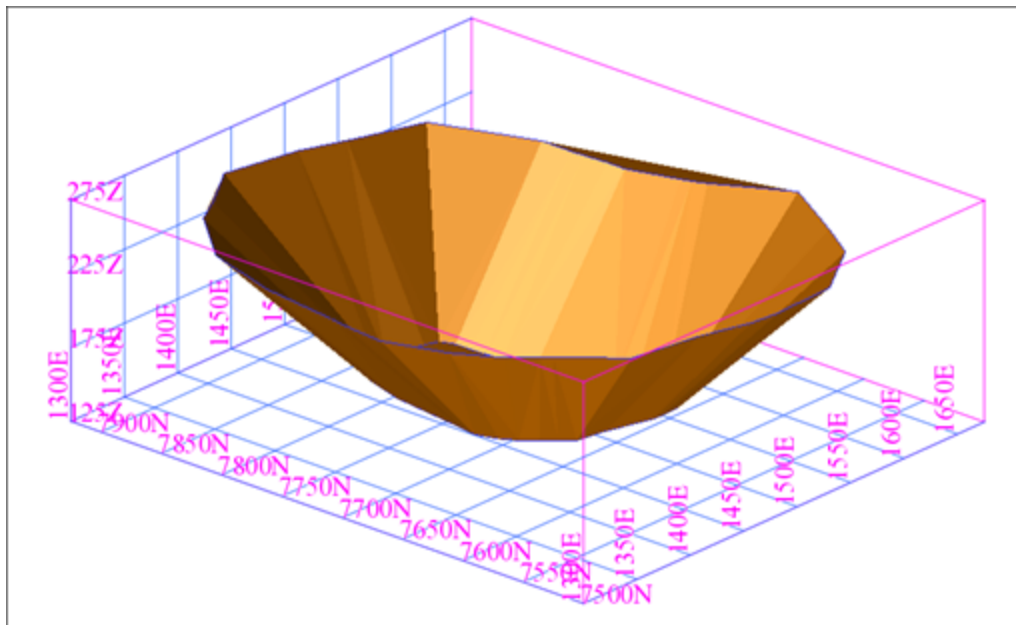
XY Plan: Below

XZ Section: Behind

YZ Long Section: None

Apply Cancel

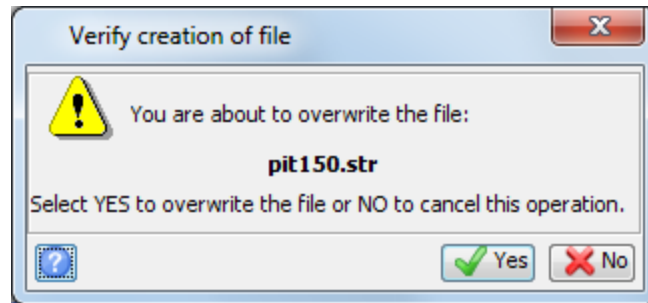
38. To rotate the data, click and drag in **Graphics**.
The pit and 3D grid are displayed.




Next, you will save the DTM file.

39. Choose **File > Save > string/DTM**.
40. Enter the information as shown, and click **Apply**.

41. In the verification form, click **Yes**.



 **Note:** To see all of the steps performed in this task run `_01_simple_pit.tcl`. You need to click **Apply** on any forms presented.

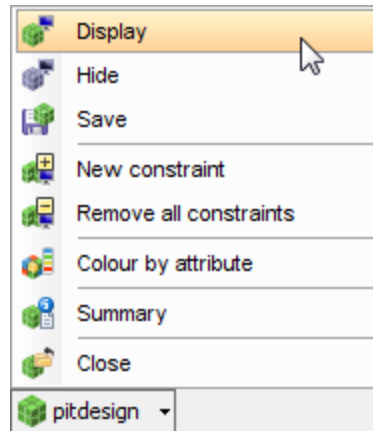
Data preparation

Create ore outlines

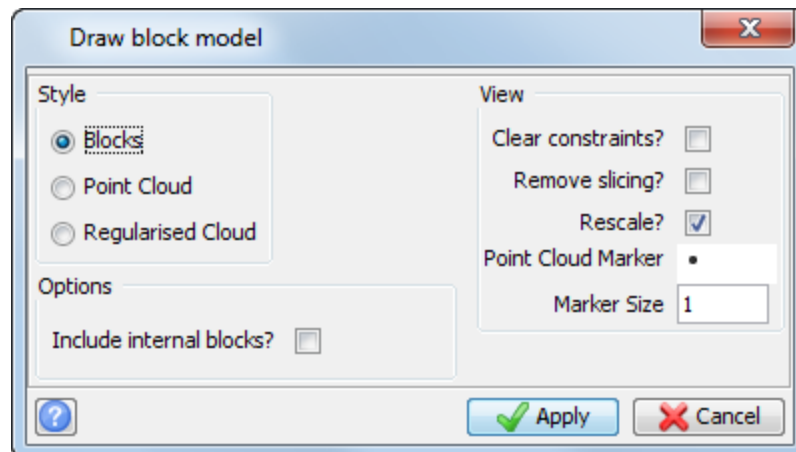
Geological outlines are a good source of information when performing pit design. They can be obtained from slicing a geological model (solid or wireframe) or taken from bench by bench interpretations.

Task: Create the ore outlines

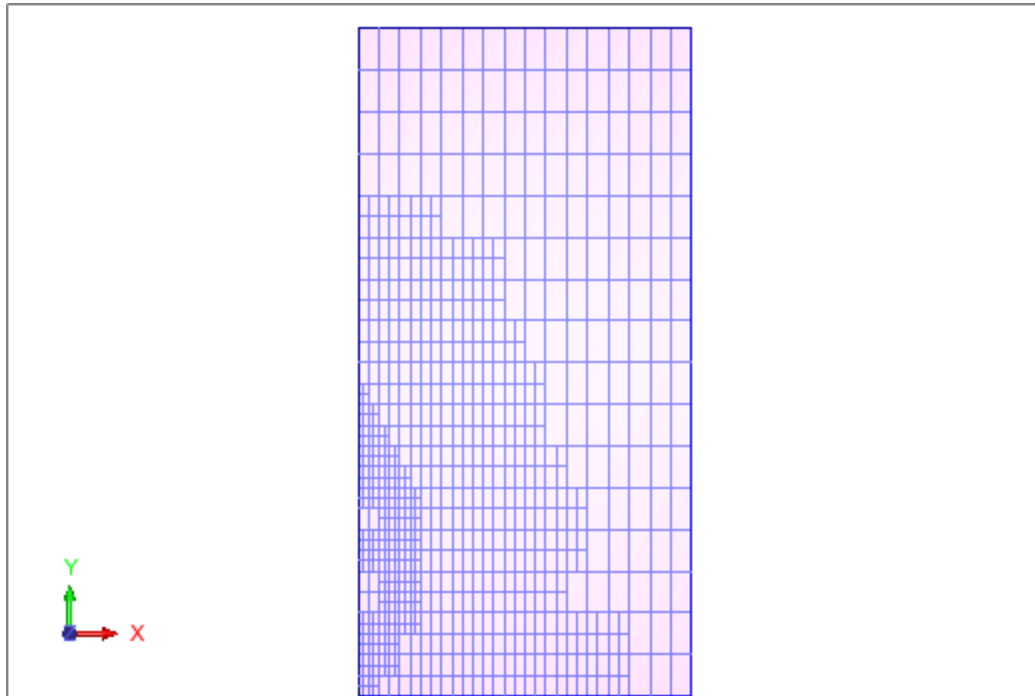
1. Connect to **pitdesign.mdl**.
2. Click the **pitdesign** icon on the Status bar, and choose **Display**.



3. Enter the information as shown, and click **Apply**.



The block model is displayed.



4. Choose **Block model > Constraints > New graphical constraint.**
5. Enter the information as shown, click **Add**, and click **Apply**.

Enter constraints

Constraint name: a
Constraint type: BLOCK

gold > 0

Add
Clear
Start Again

Constraint values

a	Block Constraint: gold > 0
b	
c	
d	
e	
f	
g	
h	
i	
j	
k	
l	

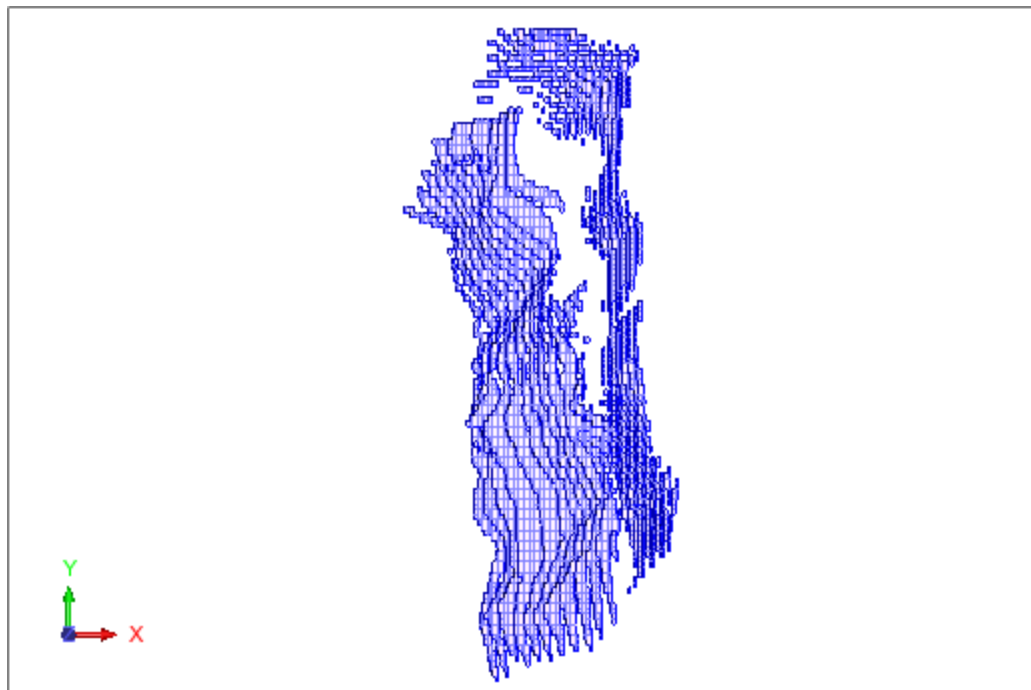
Keep blocks partially in the constraint:

Constraint combination:

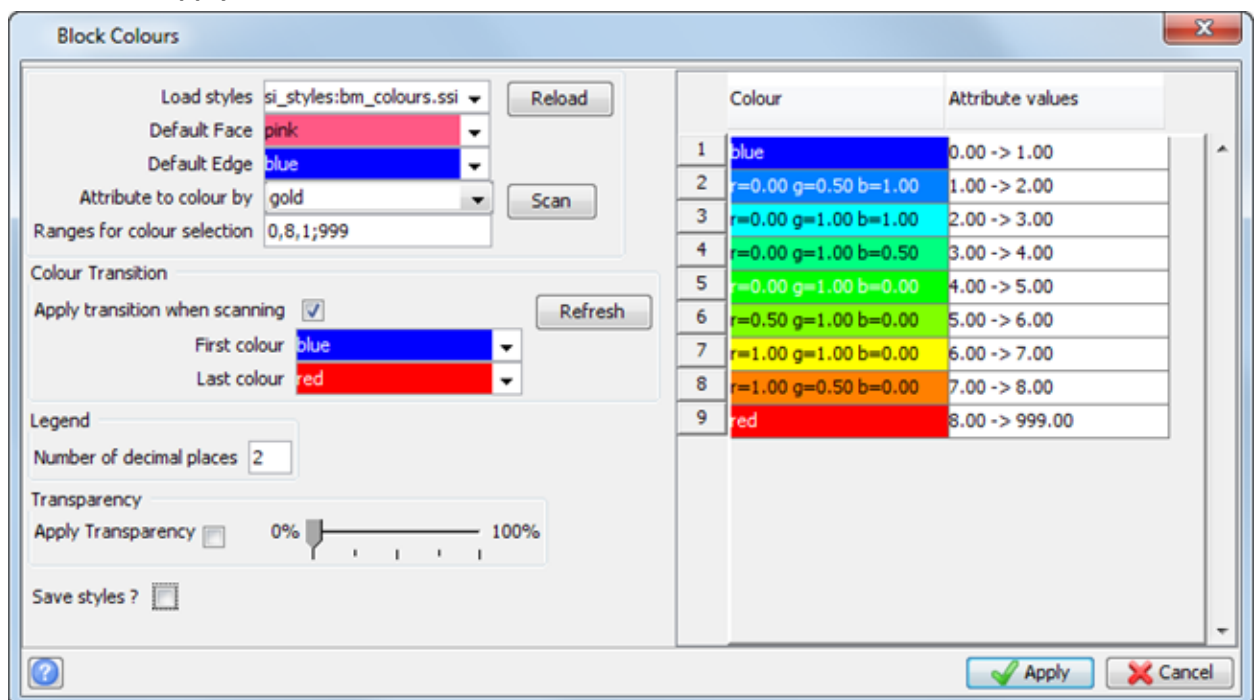
Save constraint to: ore

Apply Cancel

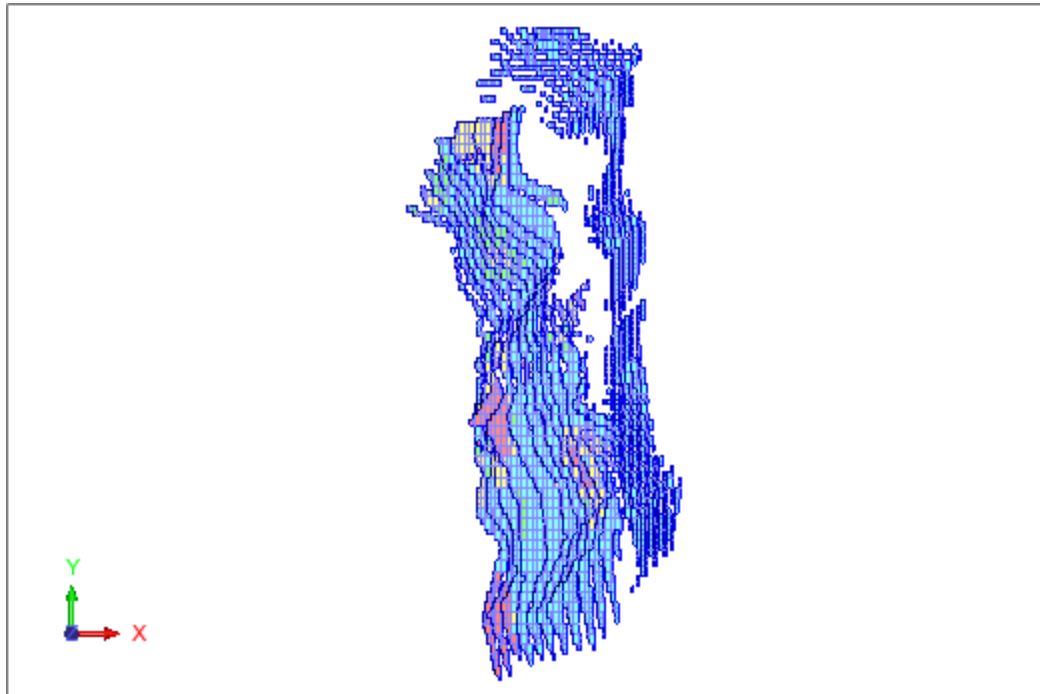
The constrained block model is displayed.



6. Choose **Block model > Display > Colour model by attribute.**
7. In the **Attribute to colour by**, select gold and click **Scan**.
8. In the **Ranges for colour selection**, type "0,8,1;999" and click **Refresh**.
9. Click **Apply**.



The block model is coloured by gold grade.



10. Choose **Planes > Quick planes**.
11. Enter the information as shown, and click **Apply**.

Quick Planes [X]

Orientation

Orientation: Elevation [v]

View direction: Looking down [v]

Plane positions

Select the plane definition method: Specific values [v]

Elevation range: 885,995,10

Plane corridor

Away: 6.000

Towards: 6.000

2D

Snap to 2D plane view

Output

Plane name suffix: El

Save

Group name: BM_sections

[?] [Apply] [Cancel]

12. Press F12 to move to the next plane.
13. Continue press F12 until you have viewed each plane.
 - 📌 **Note:** The planes you have created are temporary, and the data in each of the sections you have viewed in **Graphics** is not saved in individual files. To save the data in the active plane to a string file, you can choose **Planes > Save section to string files**. To save all planes in a group, you would need to perform this function for each plane created. The following steps use the section function in the block model module to create and save the sections in a single function.
14. Choose **Block model > Sections > Create**.
15. Enter the information as shown, and click **Apply**.

Section group definition

Section Type: NORMAL to Z Axis

Section: Define

Section Range: 885,995,10 ELEVATION 12 sections

Preview File: defgrp
Contains Section boundaries
file ID will be 0

Apply Cancel

16. Enter the information as shown, and click **Apply**.

Sections from block model

Define the section files to create :

Location: ore

Extract: Block Outlines Centroids

Shrinkage: 0.1

Coordinates: Section View Real World

Constrain model?

Output all attributes?

Output Attributes	
	Attribute name
1	gold

Define the String Classification Attribute :

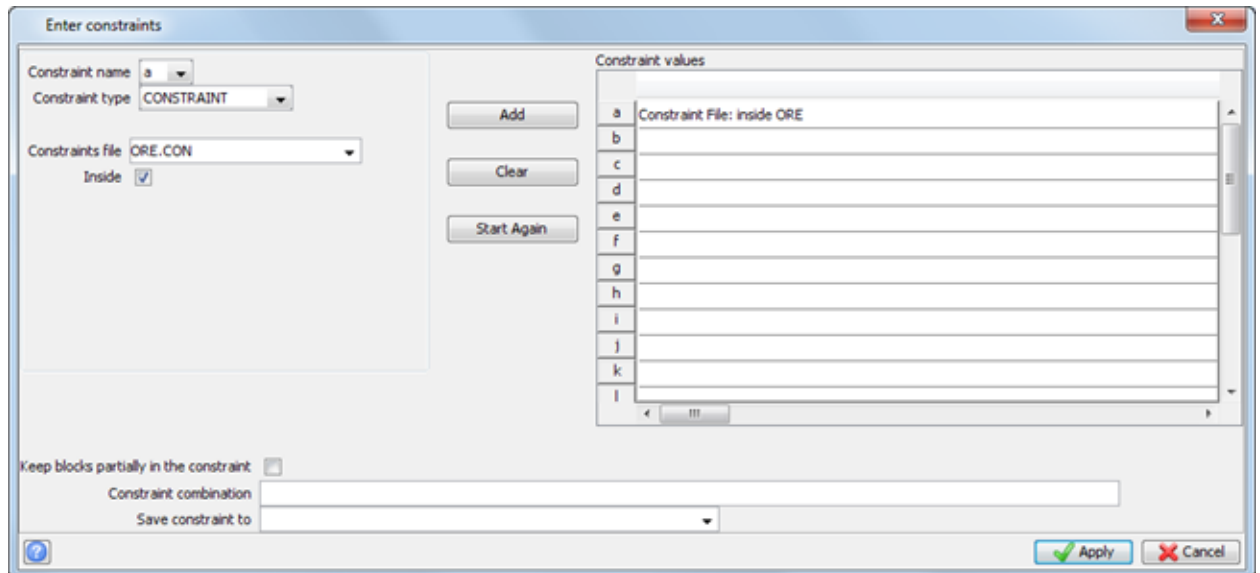
Model Attribute: gold (Numeric)

Numeric Range: 0,8;999

Choose block face to section: Previous

Apply Cancel

17. Enter the information as shown, click **Add**, and click **Apply**.

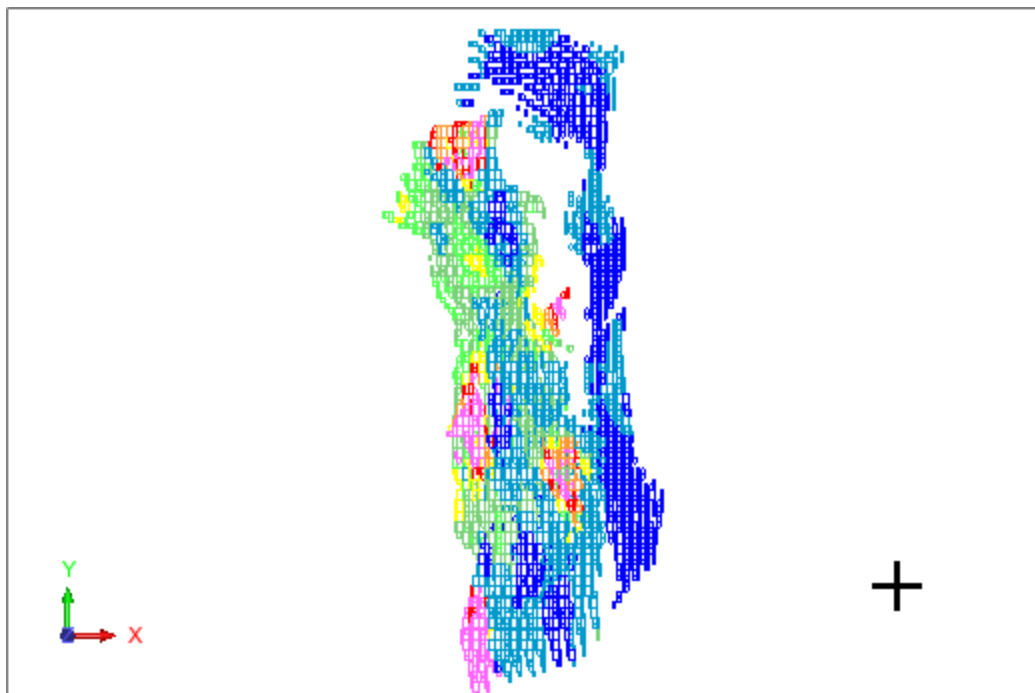


18. The sections are written to new string files.

19. Click **Reset graphics** .

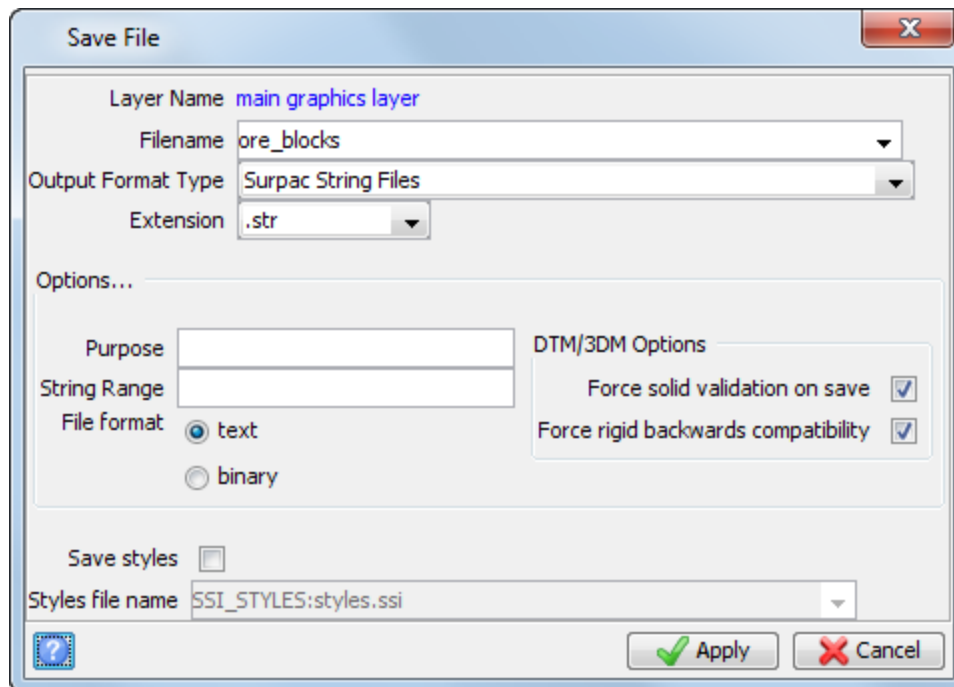
20. Hold CTRL and select all of the new section string files in the **Navigator**. That is, select **ore885.str**, **ore895.str**, **ore905.str**, **ore915.str**, **ore925.str**, **ore935.str**, **ore945.str**, **ore955.str**, **ore965.str**, **ore975.str**, **ore985.str**, and **ore995.str**.

21. Continue to hold CTRL and drag the files into **Graphics**. The sections open in the same layer.



22. Choose **File > Save > string/DTM**.


23. Enter the information as shown, and click **Apply**.

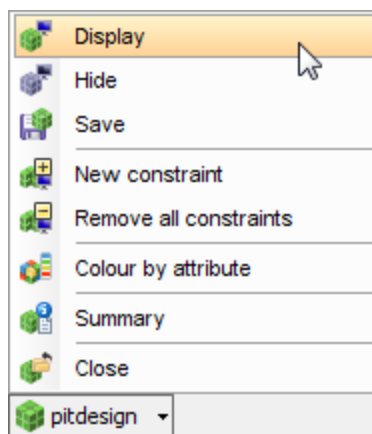


Note: To see all of the steps performed in this task, run `_02_create_ore_outlines.tcl`. You need to click **Apply** on any forms presented.

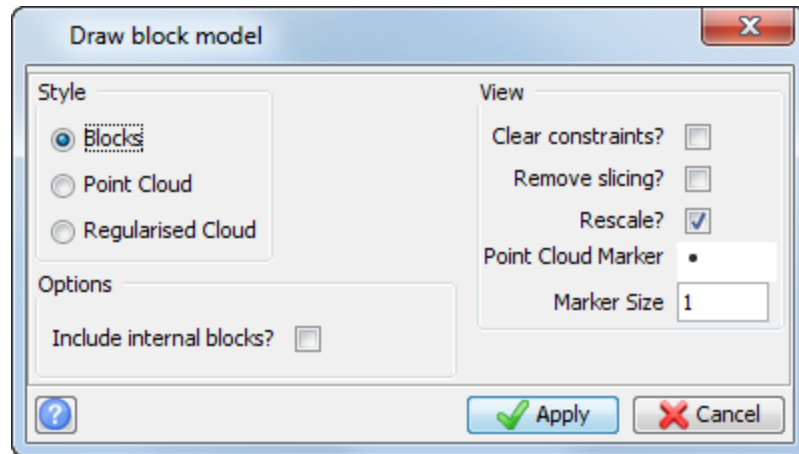
Viewing Whittle outlines

Task: View Whittle outlines from the Surpac block model

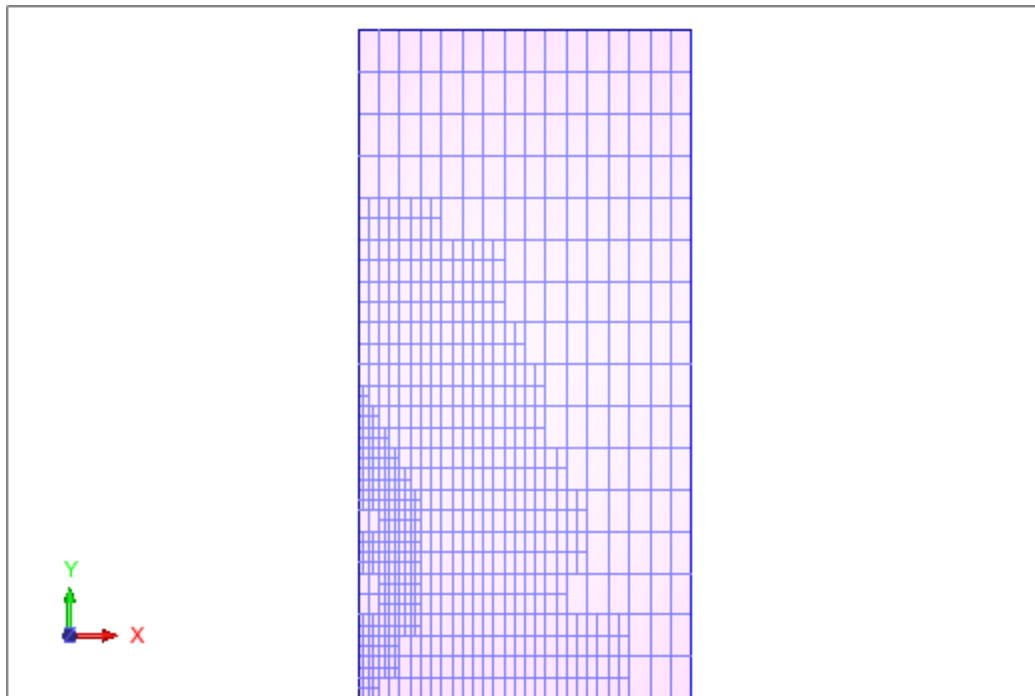
1. Click **Reset graphics** .
2. Connect to **pitdesign.mdl**.
3. Click the **pitdesign** icon on the Status bar, and choose **Display**.



4. Enter the information as shown, and click **Apply**.

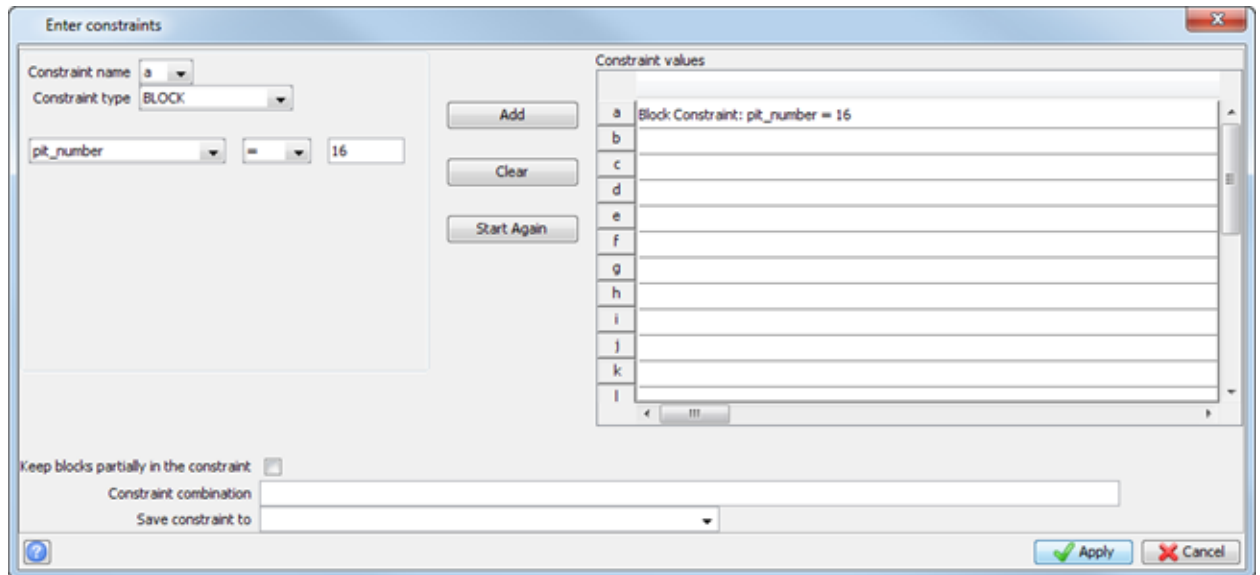


The block model is displayed.

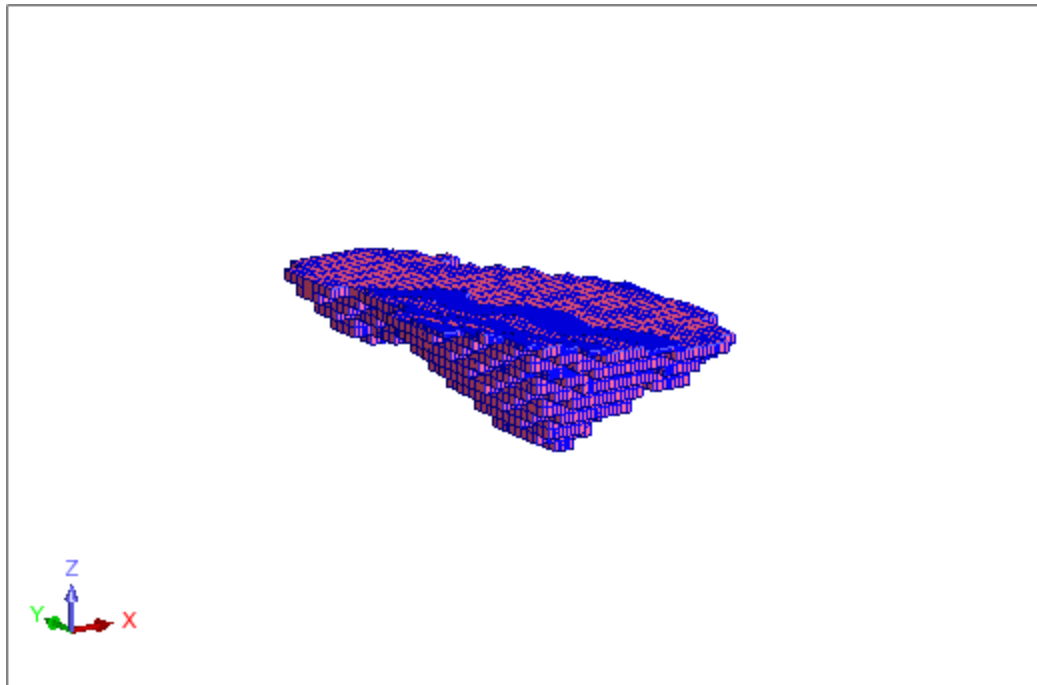


5. Choose **Block model > Constraints > New graphical constraint**.

6. Enter the information as shown, and click **Apply**.



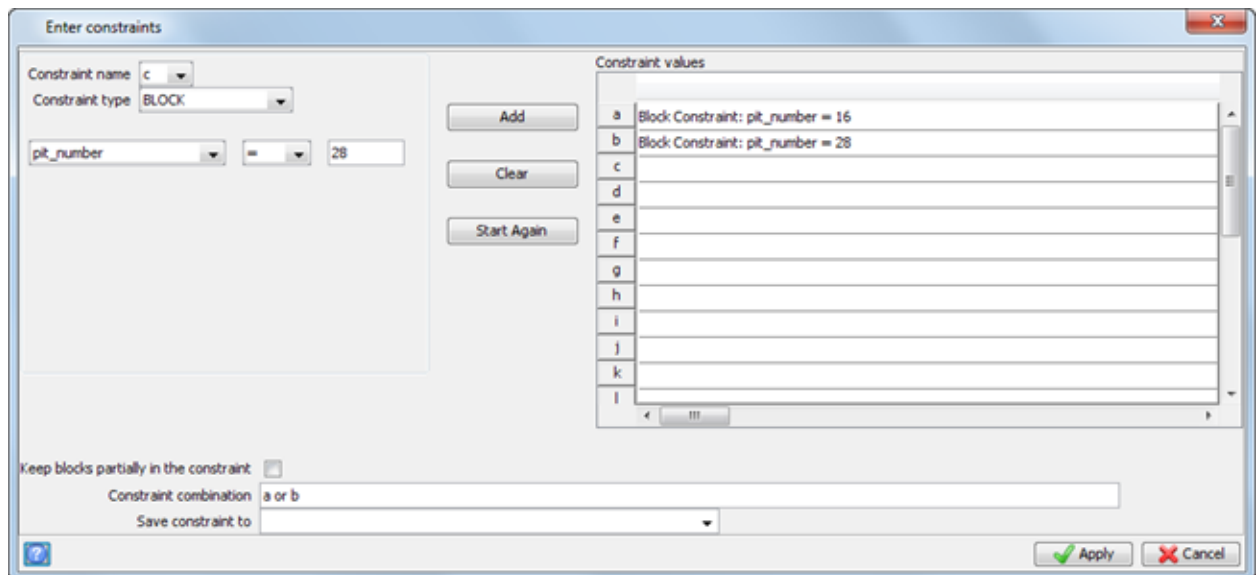
7. Rotate the model in **Graphics** to view the data.



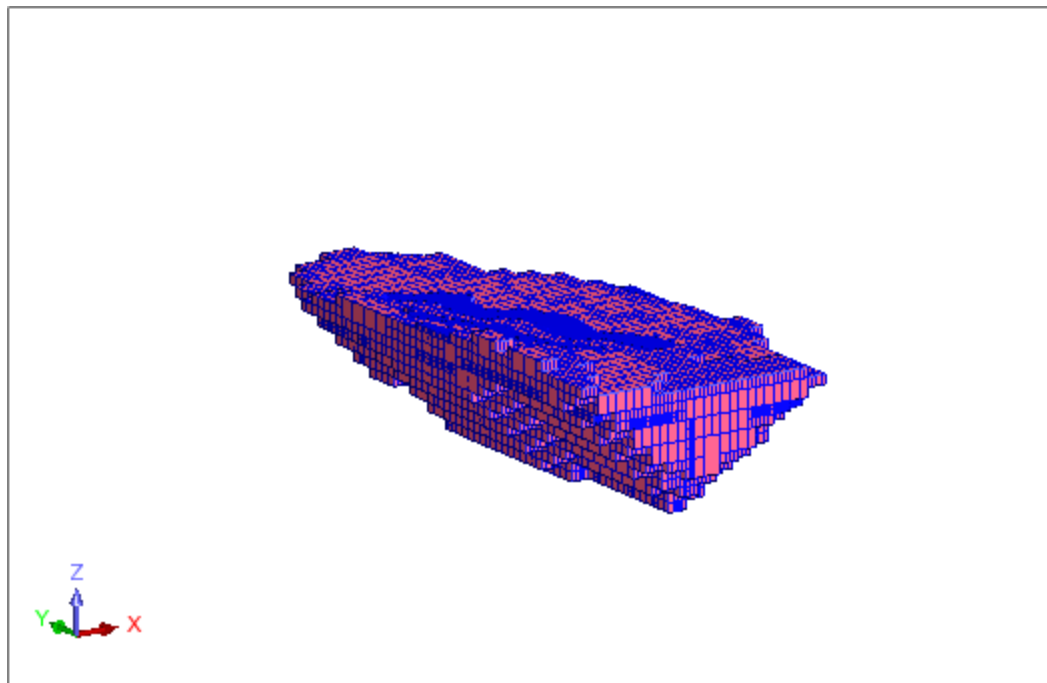
8. Choose **Block model > Constraints > Remove all graphical constraints**.

9. Choose **Block model > Constraints > New graphical constraint**.

10. Enter the information as shown, and click **Apply**.

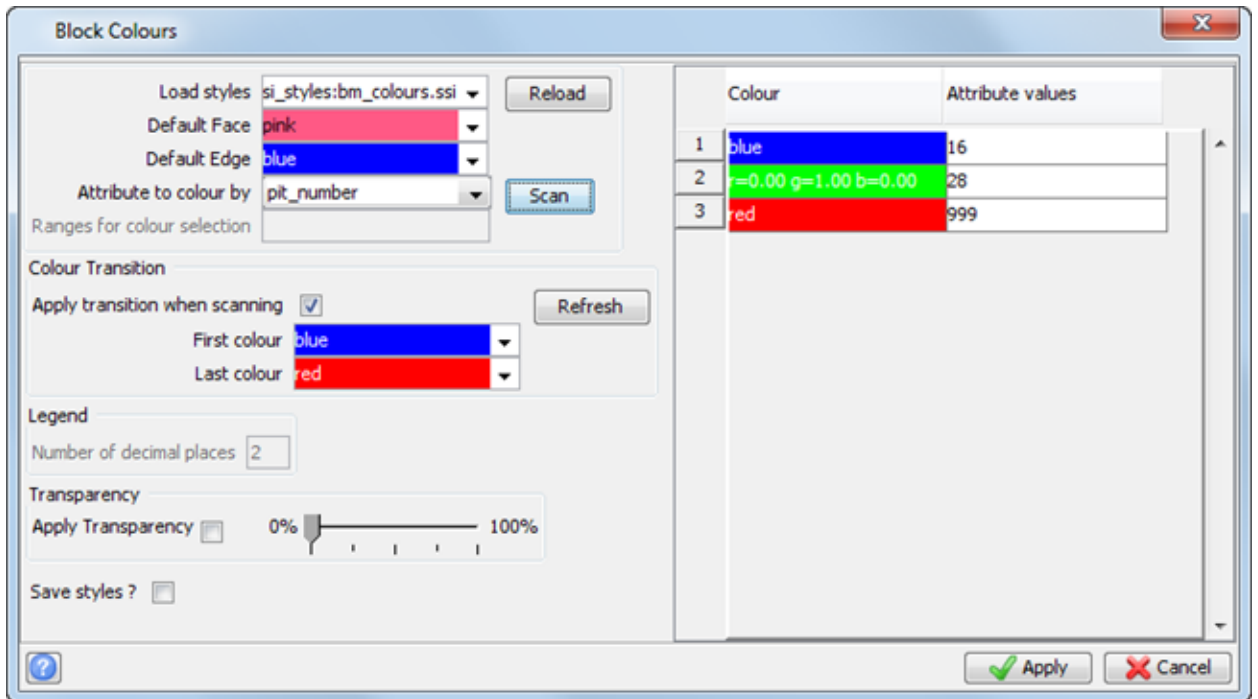


The Whittle pit shells 16 and 28 are displayed.

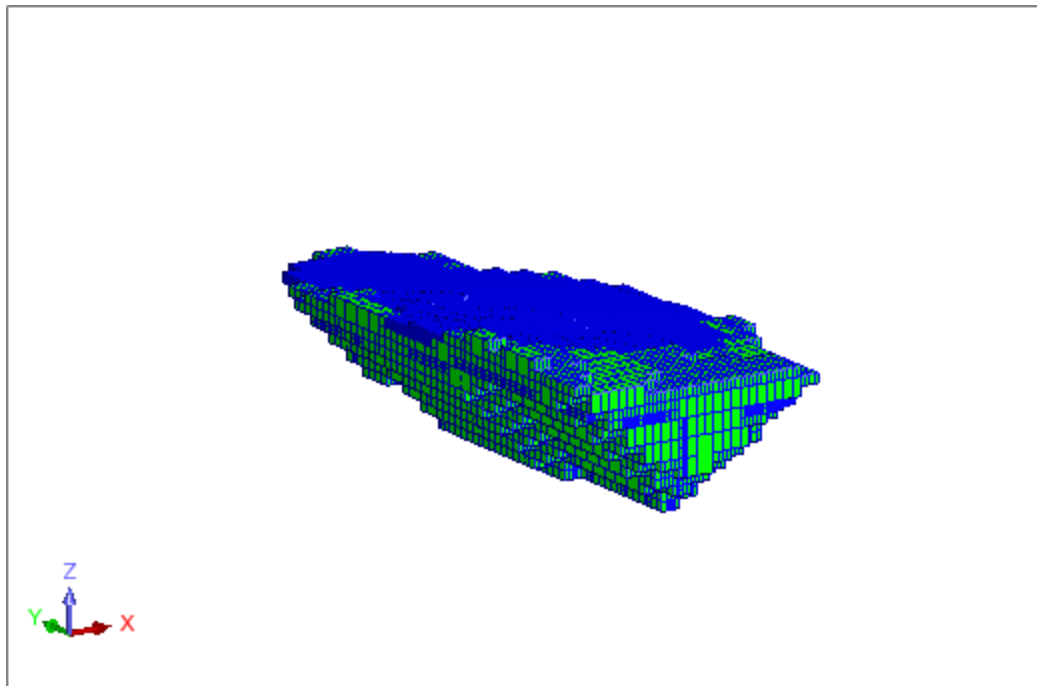


11. Choose **Block model > Display > Colour model by attribute**.

12. Enter the information as shown, click **Scan**, and click **Apply**.

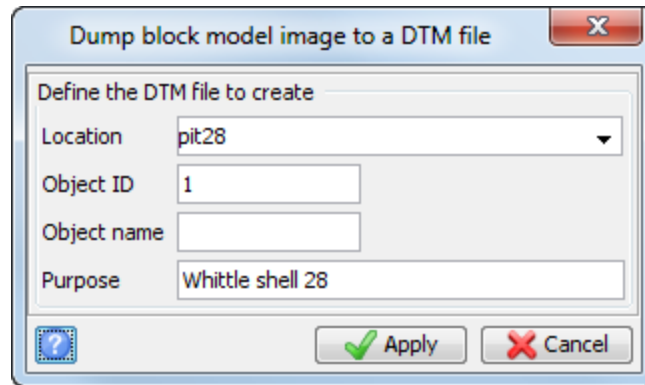


The two Whittle pit shells, 16 and 28, are displayed in different colours.

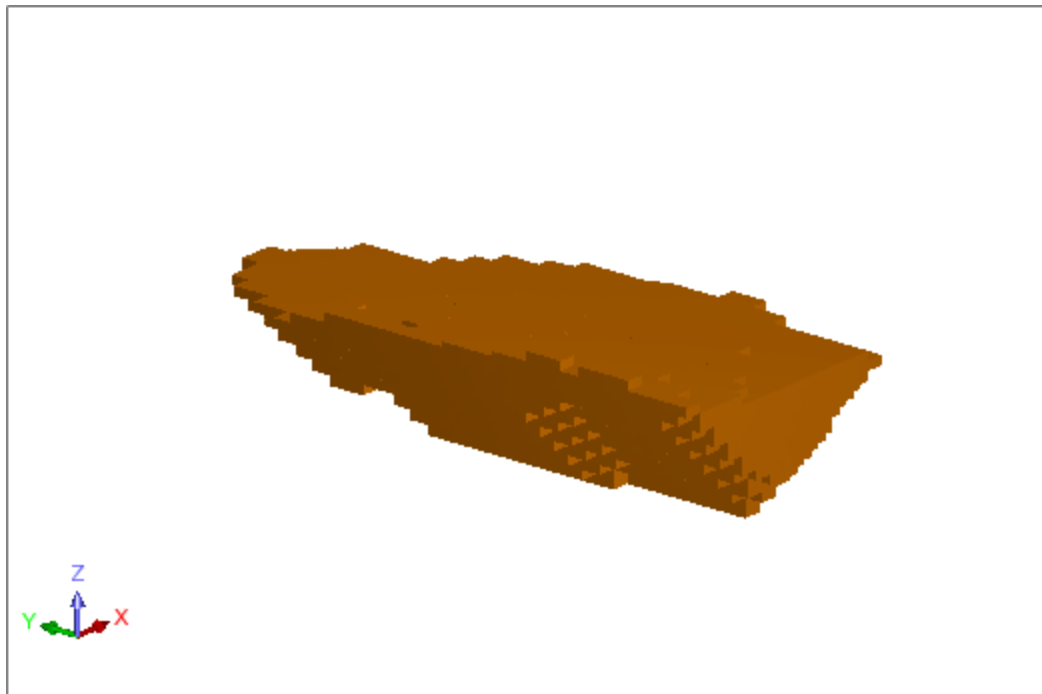


13. Choose **Block Model > Block model > Export > Block faces to DTM**.

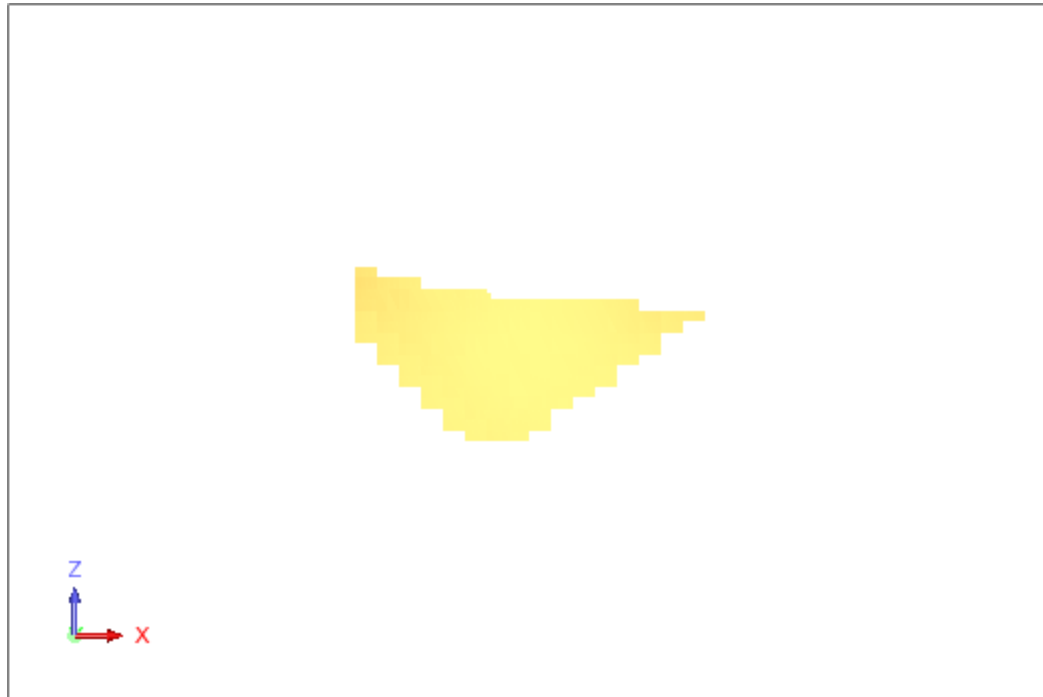
14. Enter the information as shown, and click **Apply**.



15. Click the **pitdesign** icon on the Status bar, and choose **Close**.
16. Open **pit28.dtm** in **Graphics**, and rotate to view the pit.



17. Click **Section view**  .
The data is displayed in section view.



18. Choose **Display > 2D grid**.
19. Enter the information as shown, and click **Apply**.

Draw a Grid X

Grid Parameters

	Grid Line Interval	Label Frequency
Y Direction:	50.000	1
X Direction:	50.000	1
Z Direction:		1

Grid Extents

Y Direction:	Minimum: 650	Maximum: 1250	View
X Direction:	Minimum: -300	Maximum: 800	View

Grid Position

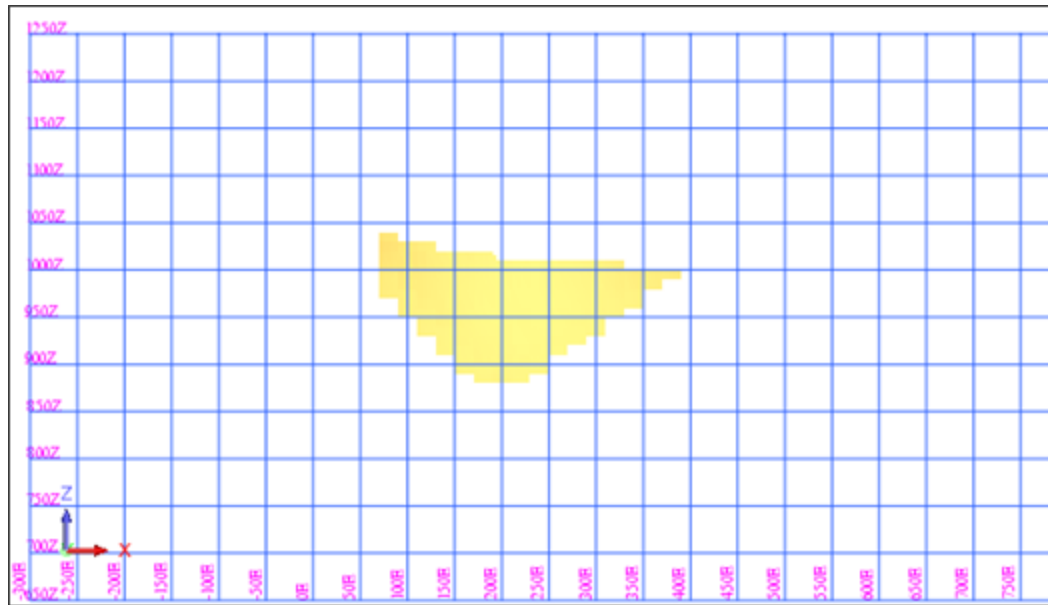
In Front
 Midpoint
 Behind
 Position

Enter the value:

Appearance

Replace current grid:
 Line colour:

Append to file:
 Text colour:



20. Choose **Solids > Solids tools > Create sections**.
21. Enter the information as shown, and click **Apply**.

Define an axis line ✕

Section orientation

Perpendicular to axis

Parallel to axis

Dip

Press this button to digitise the axis

Axis start

Y

X

Z

Axis end

Y

X

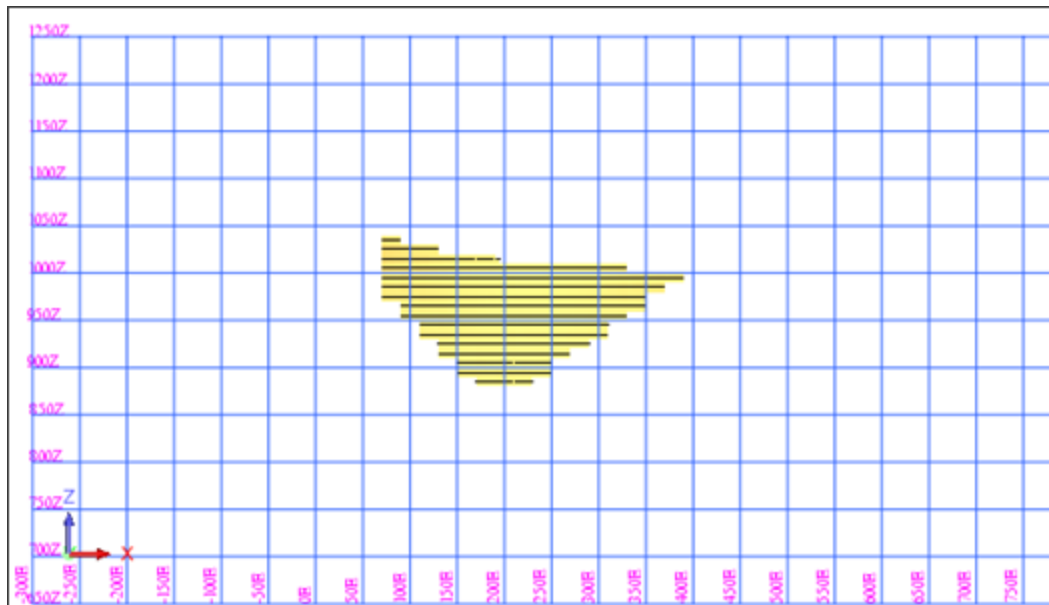
Z


?

This will give a vertical axis for slicing the DTM.

22. Enter the parameters as shown, and click **Apply**.

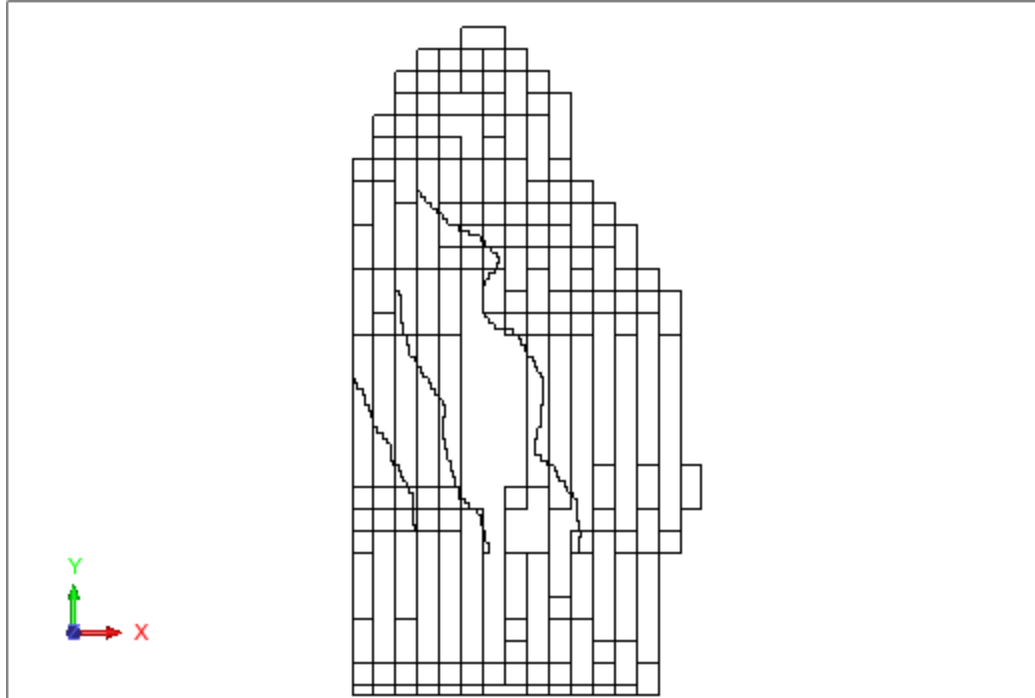
There are two results produced by the **Slice Object** function. The first result is a range of string files called **wmb805** to **wmb1085** in increments of 10, which contain the extracted horizontal sections. These files are saved to disk. The second result is a layer called **slice** which contains the extracted sections. If required, you can activate this layer and save all the sections to a single file.



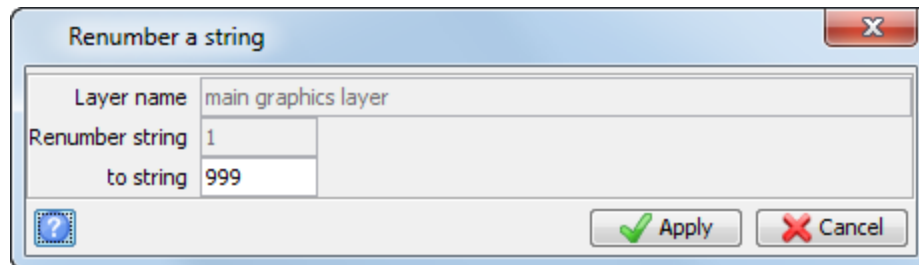
23. Click **Reset graphics** .
24. Hold CTRL and select all of the section files you have just created in the **Navigator**.

That is, select **wmb885.str**, **wmb895.str**, **wmb905.str**, **wmb915.str**, **wmb925.str**, **wmb935.str**, **wmb945.str**, **wmb955.str**, **wmb965.str**, **wmb975.str**, **wmb985.str**, **wmb995.str**, **wmb1005.str**, **wmb1015.str**, **wmb1025.str**, and **wmb1035.str**.

25. Continue to hold CTRL drag the files into **Graphics**.
26. The sections strings open in one layer.

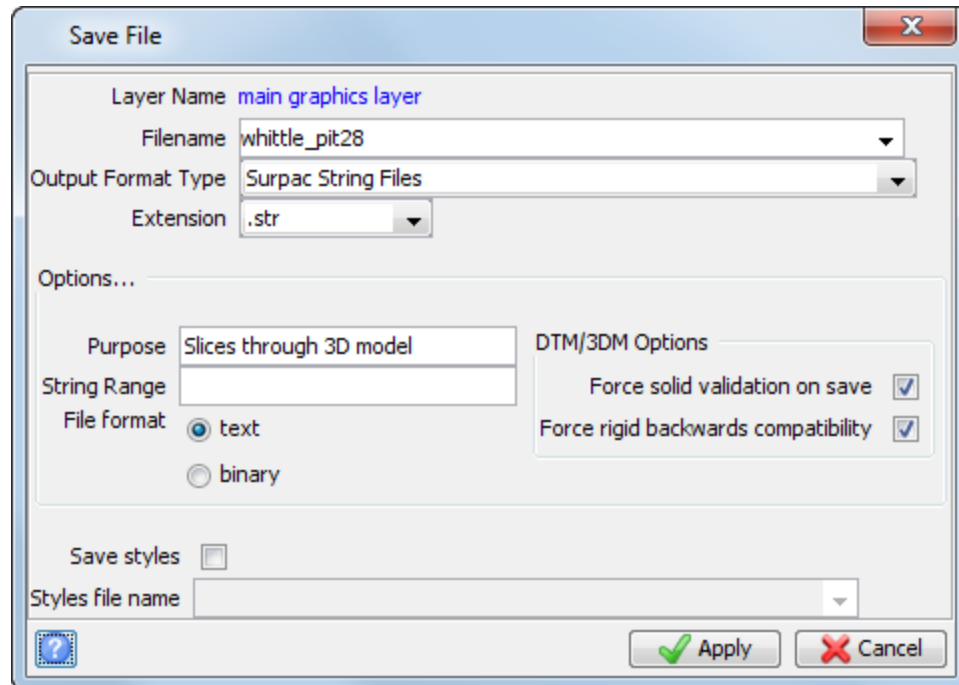


27. Choose **Edit > String > Renumber**, and click a string in **Graphics**.
28. Enter the information as shown, and click **Apply**.



29. Choose **File > Save > string/DTM**.


30. Enter the information as shown, and click **Apply**.

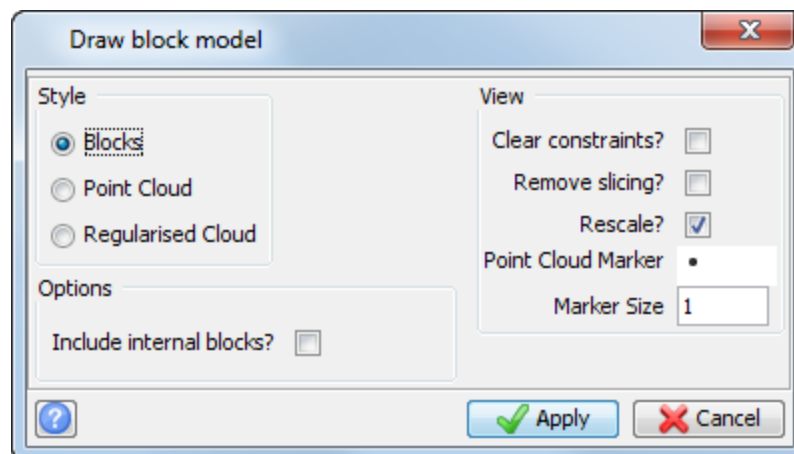


Note: To see all of the steps performed in this task, run `_03_create_whittle_outlines.tcl`. You need to click **Apply** on any forms presented.

Add slope values

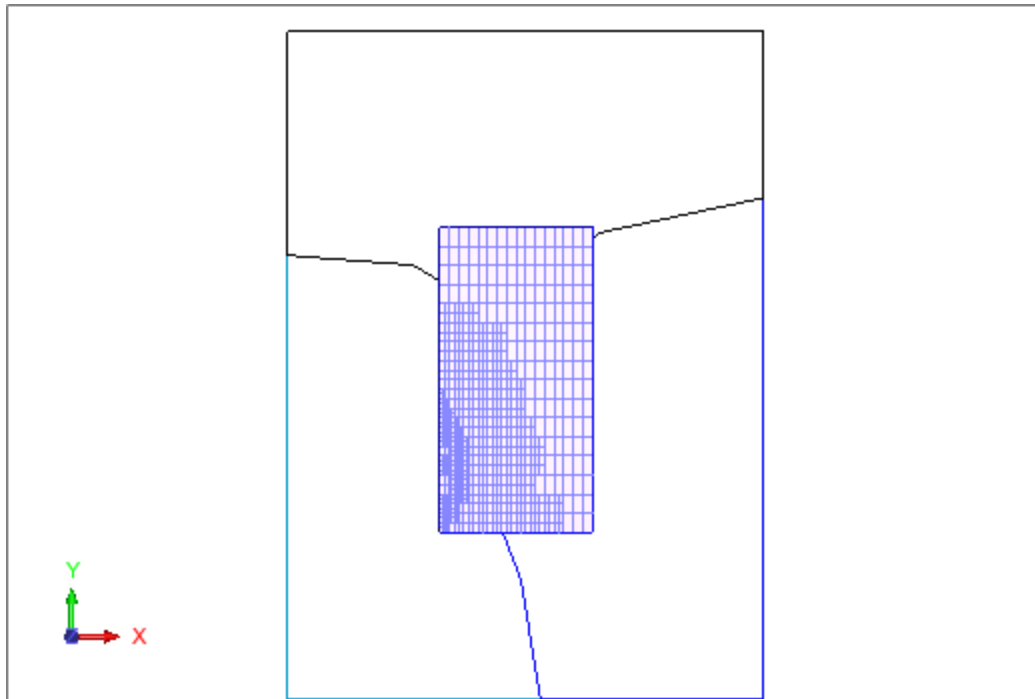
Task: Add slope values to the block model

1. Click **Reset graphics** .
2. Connect to **pitdesign.mdl**.
3. Click the **pitdesign** icon on the Status bar, and choose **Display**.
4. Enter the information as shown, and click **Apply**.

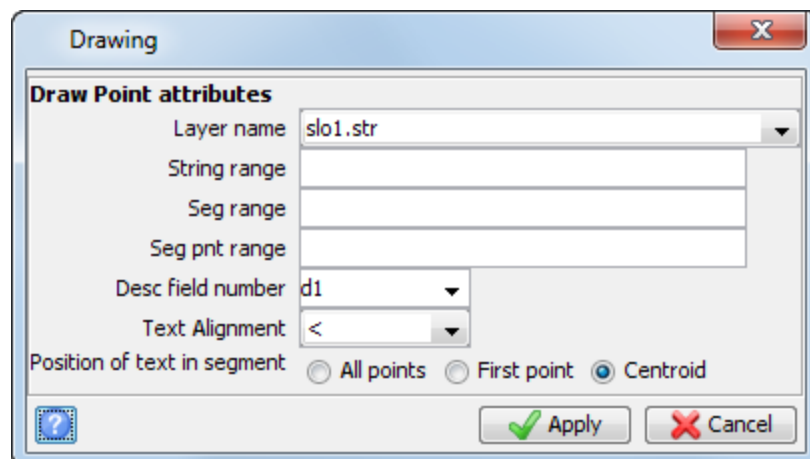


5. Open **slo1.str** in **Graphics**.

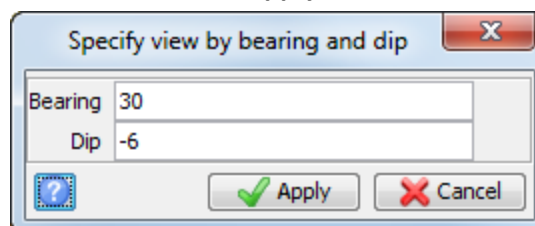
6. The block model and slope string file are displayed.



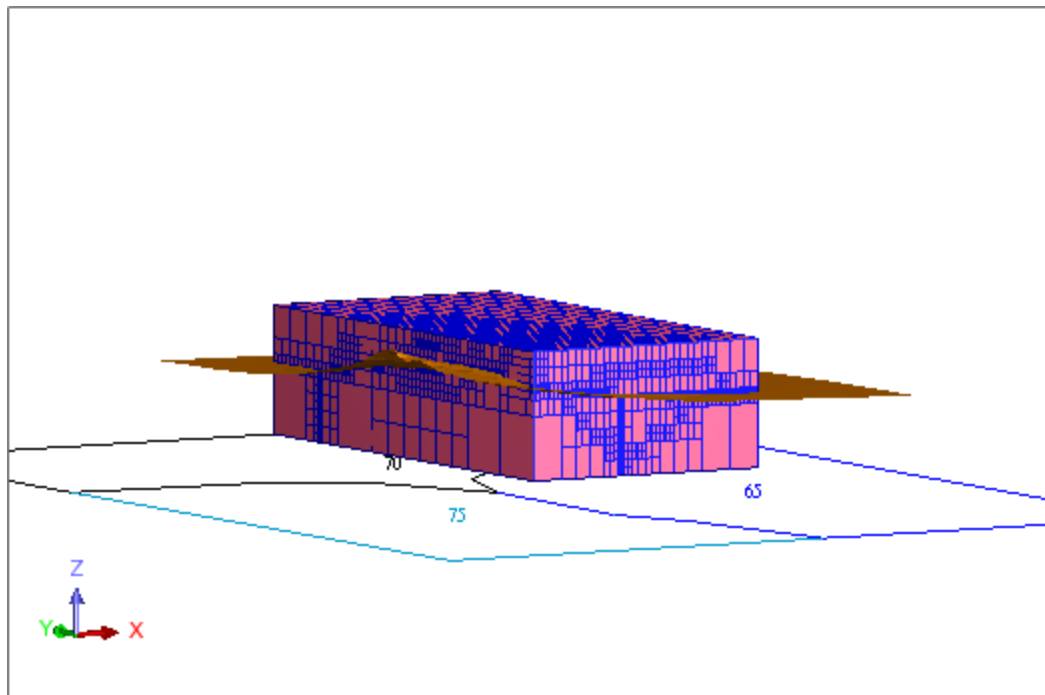
7. Choose **Display > Point > Attributes**.
 8. Enter the information as shown, and click **Apply**.



9. Open **weathering contact.dtm** in **Graphics**.
 10. Choose **View > Data view options > View by bearing & dip**.
 11. Enter the information as shown, and click **Apply**.



The block model, slope string, and DTM surface are displayed.



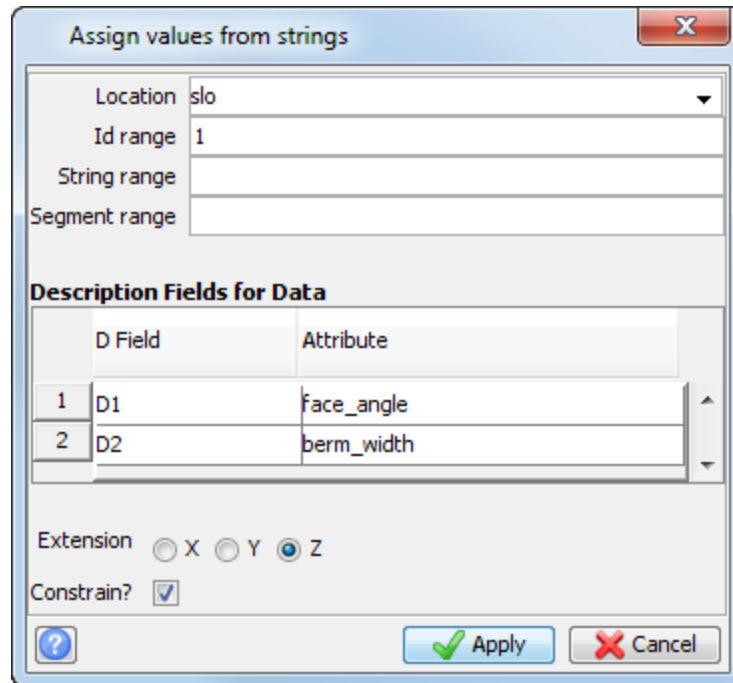
12. Choose **Block model > Attributes > New**.
13. Enter the information as shown, and click **Apply**.

Add attributes

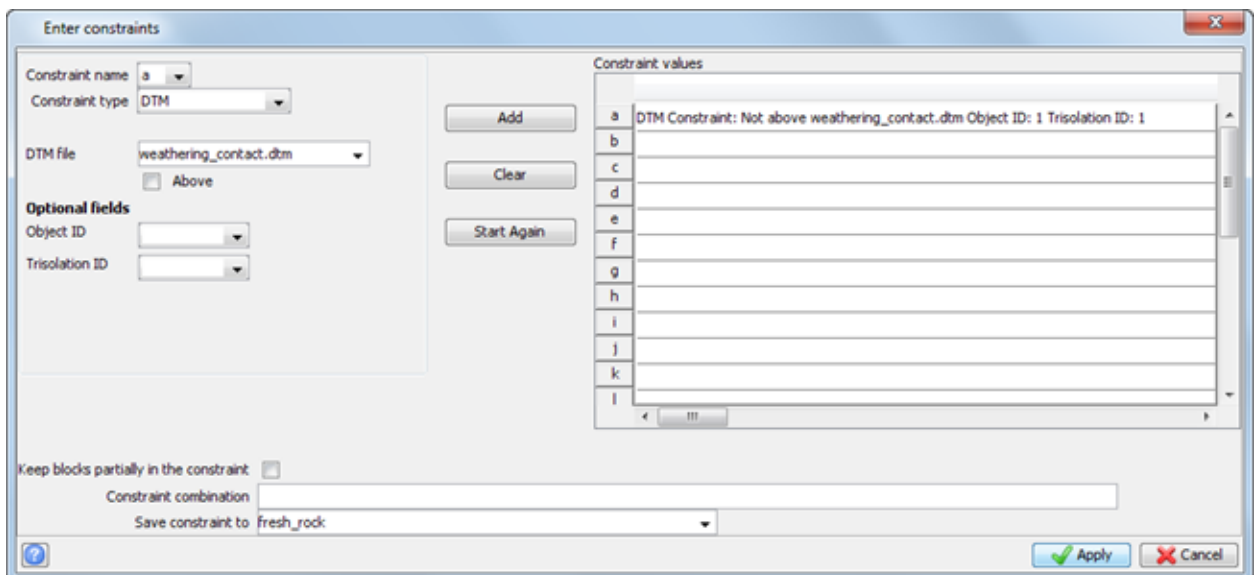
	Attribute Name	Type	Decimals	Background Value	Description / Expression
1	face_angle	integer		40	batter angle (from toe to crest)
2	berm_width	float	1	10	berm width

Apply Cancel

14. Choose **Block model > Estimation > Assign value from polygon.**
15. Enter the information as shown, and click **Apply.**

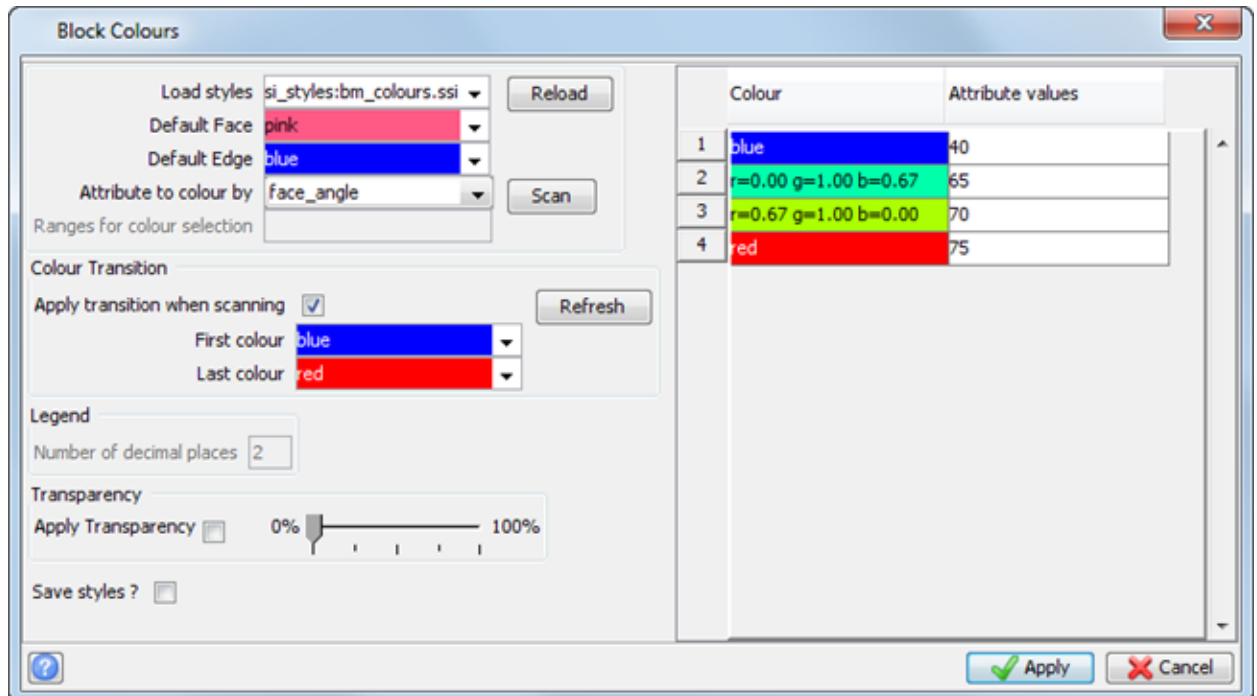


16. Enter the information as shown, and click **Apply.**

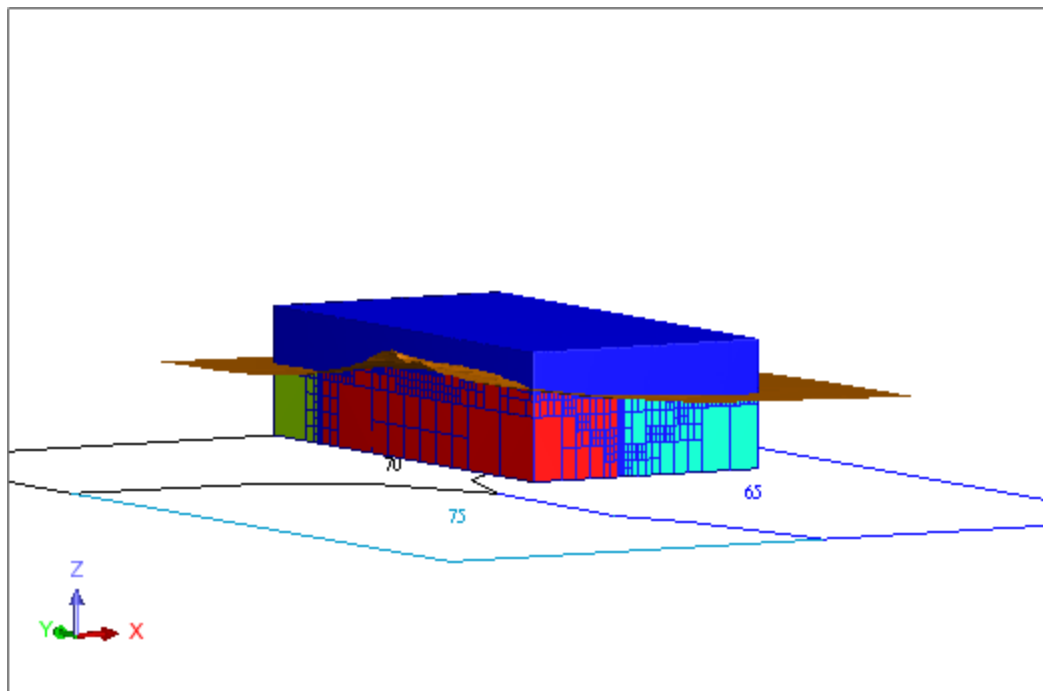


17. Choose **Block model > Display > Colour model by attribute.**

18. Enter the information as shown, click **Scan**, and click **Apply**.



The block model is coloured by face angle.



19. Choose **File > Save > Block model**.
20. Choose **Block model > Display > View attributes for one block**.
21. Click a block in **Graphics**.

The *Block attributes* form displays information similar to the following.

Block centroid		
Y	X	Z
660	80	940



Block size		
Y	X	Z
40	20	40

	Attribute	Value
1	berm_width	5.0
2	face_angle	75
3	geology	unassigned
4	gold	0
5	pit_number	999
6	silver	0

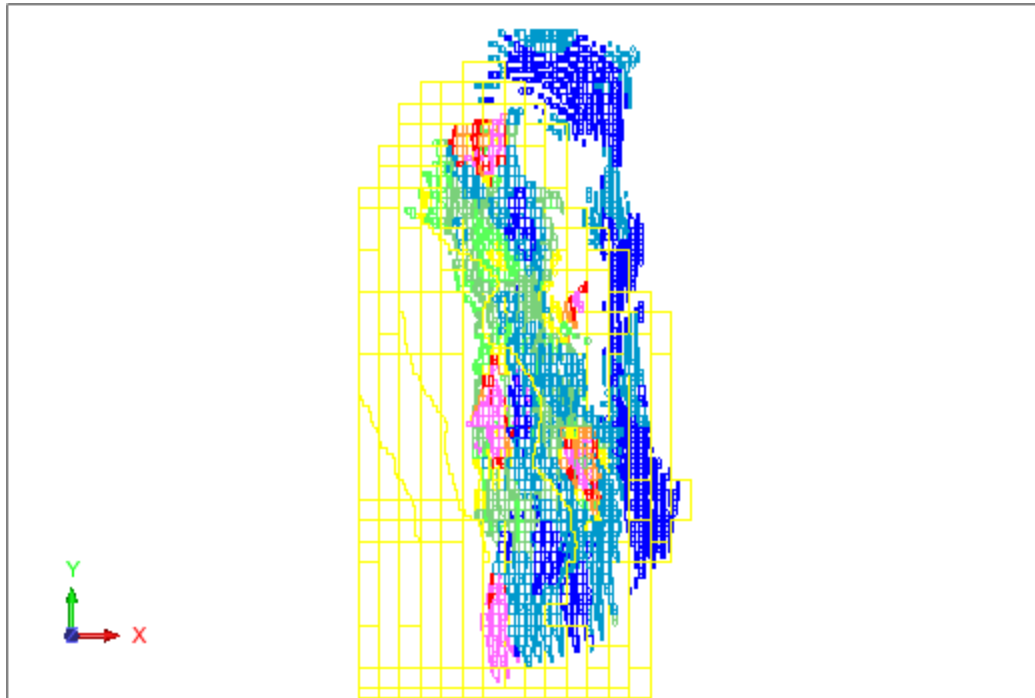
Note: To see all of the steps performed in this task, run `_04_add_slope_values_to_blockmodel.tcl`. You need to click **Apply** on any forms presented.


Load the outline and Whittle model

Task: Load the outline and Whittle model

1. Click **Reset graphics** .
2. Open `ore_blocks.str` in **Graphics**.
3. Open `whittle_pit28.str` in **Graphics**.
4. Connect to `pitdesign.mdl`.
5. Click **Zoom all** .

The ore outlines, pit, and model are displayed.



 **Note:** To see all of the steps performed in this task, run `_05_load_outline_and_whittle_model.tcl`. You need to click **Apply** on any forms presented.

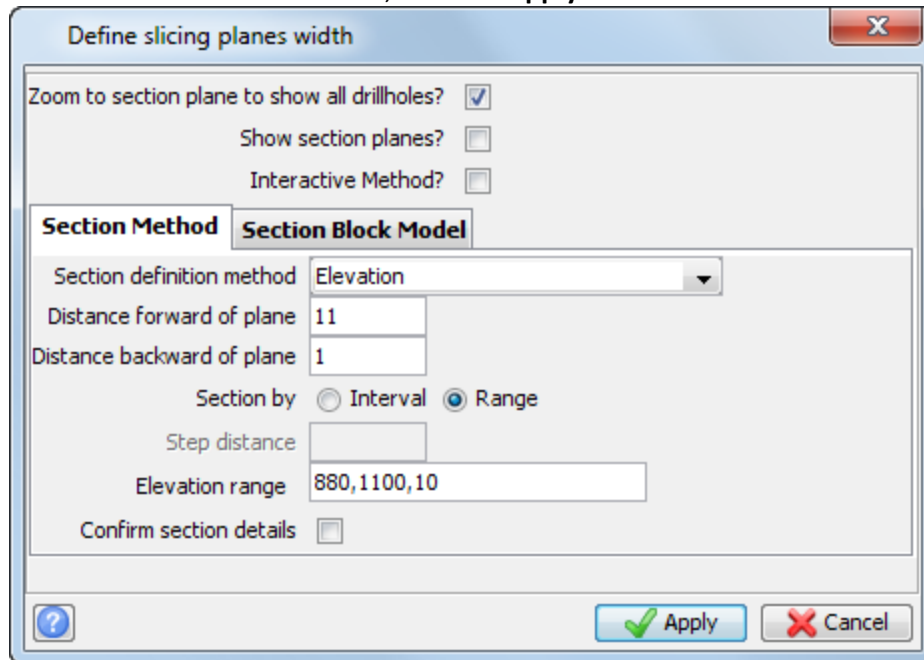
Basic pit design tools

Task: Define the starting string

In this task you will be designing from the bottom of the pit up so you will use a digitised string based on information from the Whittle model. Remember, when designing the base of the pit, you must take into account the minimum pit width.

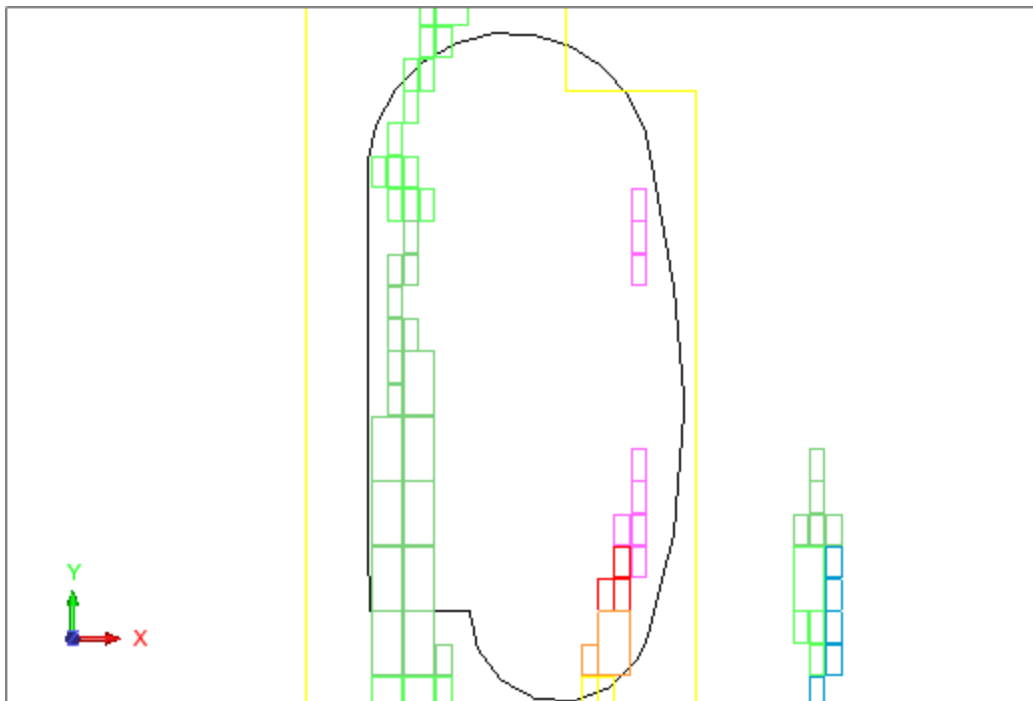
Note: Before you attempt the steps in this procedure you must complete the previous task, *Load the outline and Whittle model*, or run macro `_05_load_outlines_and_model.tcl`.


1. Choose **View > Viewing planes > Create graphical sections**.
2. Enter the information as shown, and click **Apply**.




3. Open **bas880.str** in **Graphics**.
4. Choose **View > Zoom > Out**.
5. In the Function Chooser, type **HOF**, and press ENTER.
The base is at an elevation of 880 and the blocks are between 880 and 890. For this reason, if you leave **Hide On** you would not be able to see the base where it passes below

the blocks. With **Hide Off**, you should be able to see the whole outline, as shown.

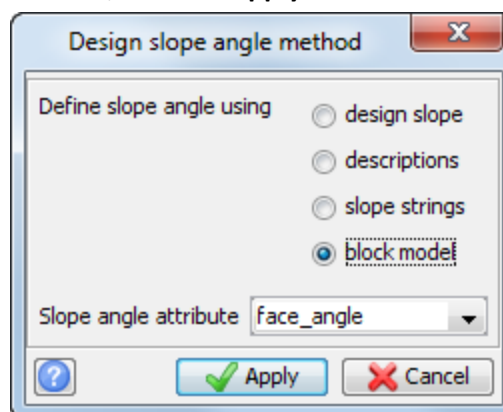



 **Note:** To see all of the steps performed in this section, run `_06_load_base_string.tcl`. You need to click **Apply** on any forms presented.

Task: Define the slope method


 **Note:** Before you attempt the steps in this procedure you must have completed the previous tasks, *Load the outline and Whittle model* and *Define the start string*, or run macro `_06_load_base_string.tcl`.

1. Choose **Pit design > Select slope method**.
2. Enter the information as shown, and click **Apply**.

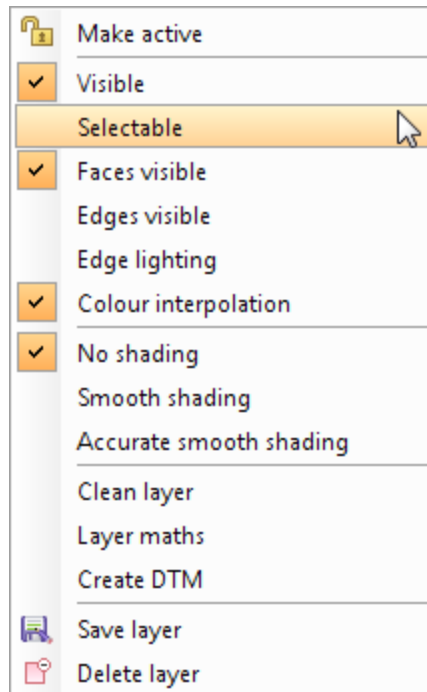


 **Note:** To see all of the steps performed in this task, run `_07_define_slope_berm_width.tcl`. You need to click **Apply** on any forms presented.

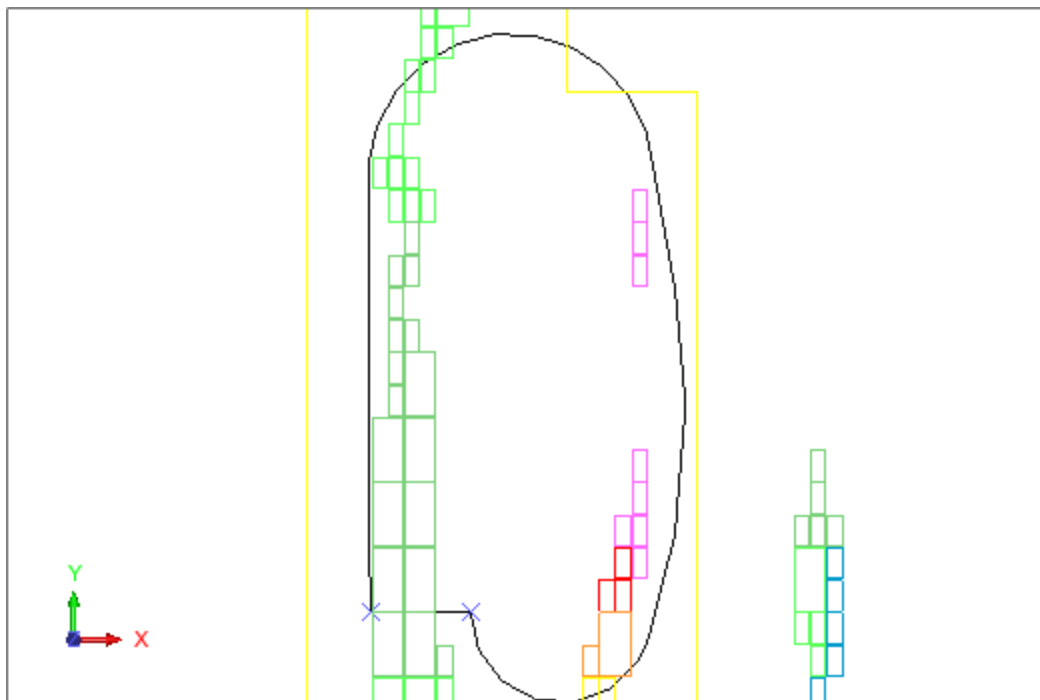
Task: Define a new ramp

 **Note:** Before you attempt the steps in this procedure you must have completed the previous tasks, *Load the outline and Whittle model*, *Define the start string*, and *Define the slope method*. Alternatively, you can run macro `_07_define_slope_berm_width.tcl`.

1. If **bas880.str** is not the active layer, right-click it in the **Layers** pane, and choose **Make active**.
2. In the **Layers** pane, right-click on **ore_blocks.str** and **whitle_pit28.str**, and clear **Selectable**, to stop these layers being selected in **Graphics**.



3. In the **Planes** panel, double-click plane **885EI** in the **BM_sections** group.
4. Choose **Pit design > New ramp**.
5. Select the ramp points as shown.



6. Enter the information as shown, and click **Apply**.

Define a new ramp

Define the ramp characteristics

Ramp name Ramp#1

Ramp String 100

Ramp type anti-clockwise

Ramp width 15

Ramp gradient 1: 6.667

Gradient method inside edge
 outside edge
 centre of ramp

Define the berm crossing characteristics

exit at: crest
 toe
 crest and toe
 neither

Berm taper distance 30

Define the switchback characteristics

Switchback angle 180

Switchback inner radius 2.5

Apply Cancel

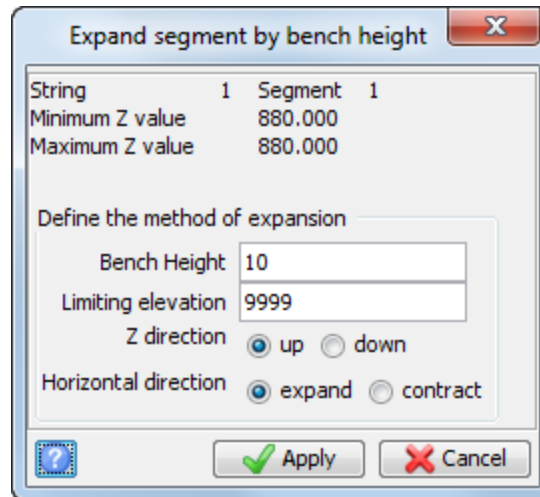
Note: To see all of the steps performed in this task, run `_08_define_new_ramp.tcl`. You need to click **Apply** on any forms presented.

Task: Expand by bench height and berm width

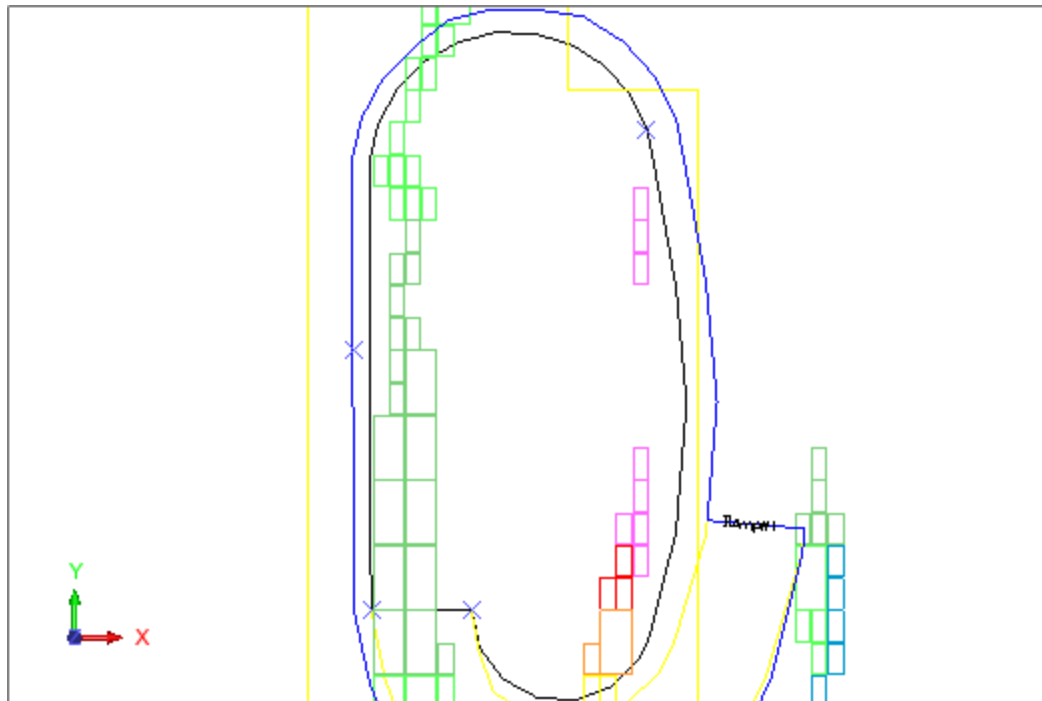
Note: Before you attempt the steps in this procedure you must have completed the previous tasks, *Load the outline and Whittle model*, *Define the start string*, *Define the slope method*, and *Define a new ramp*. Alternatively, you can run macro `_08_define_new_ramp.tcl`.

1. Choose **Expand segment > By bench height**.
2. Click on the string in **Graphics**.

3. Enter the information as shown, and click **Apply**.



4. The segment is expanded.



5. Choose **Expand segment > By berm width**, and click on the ramp.

6. Enter the information as shown, and click **Apply**.

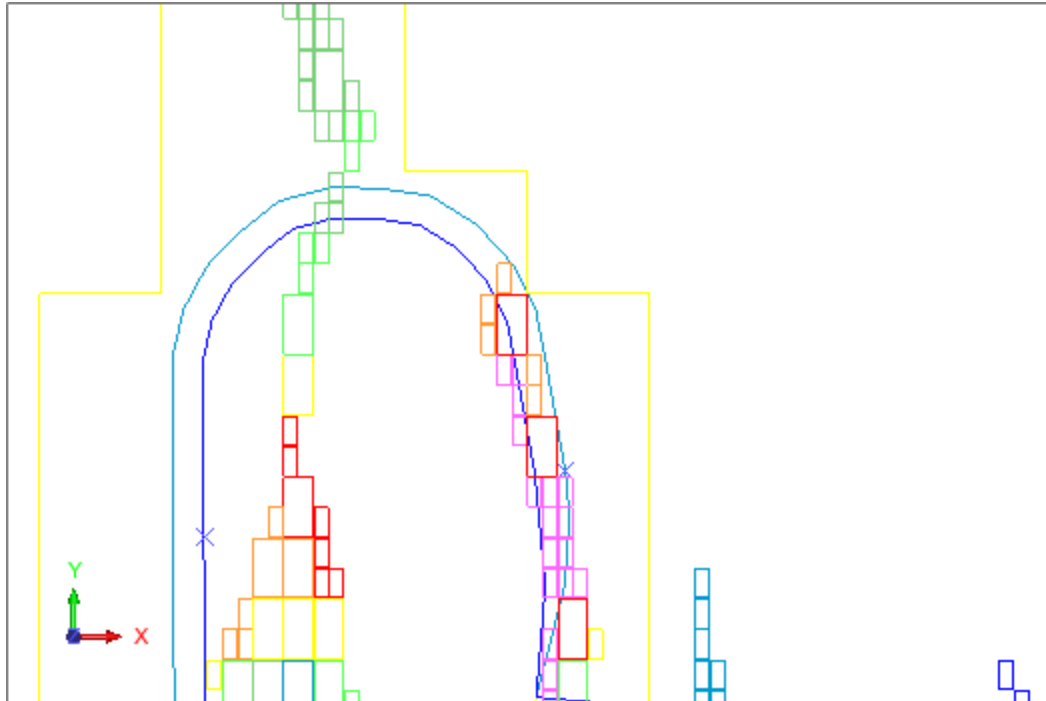
The dialog box is titled "Expand Segment by Berm Width" and contains the following fields and options:


- String: 2
- Segment: 1
- Minimum Z value: 890
- Maximum Z value: 890
- Define the method of expansion: Delta Z limit: 0
- Berm creation method: always
- Limiting elevation: 0
- Berm width method: fixed width, descriptions, slope strings, block model
- Berm width attribute: berm_width
- Default berm width: 5
- Berm gradient (%): 0
- Horizontal direction: expand, contract
- Switchback characteristics table:

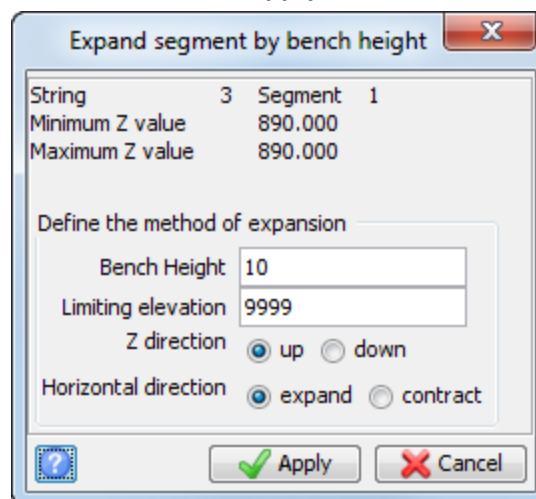
	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input type="checkbox"/>	Ramp#1	180	2.5

Buttons: ? (Help), Apply (with green checkmark), Cancel (with red X).

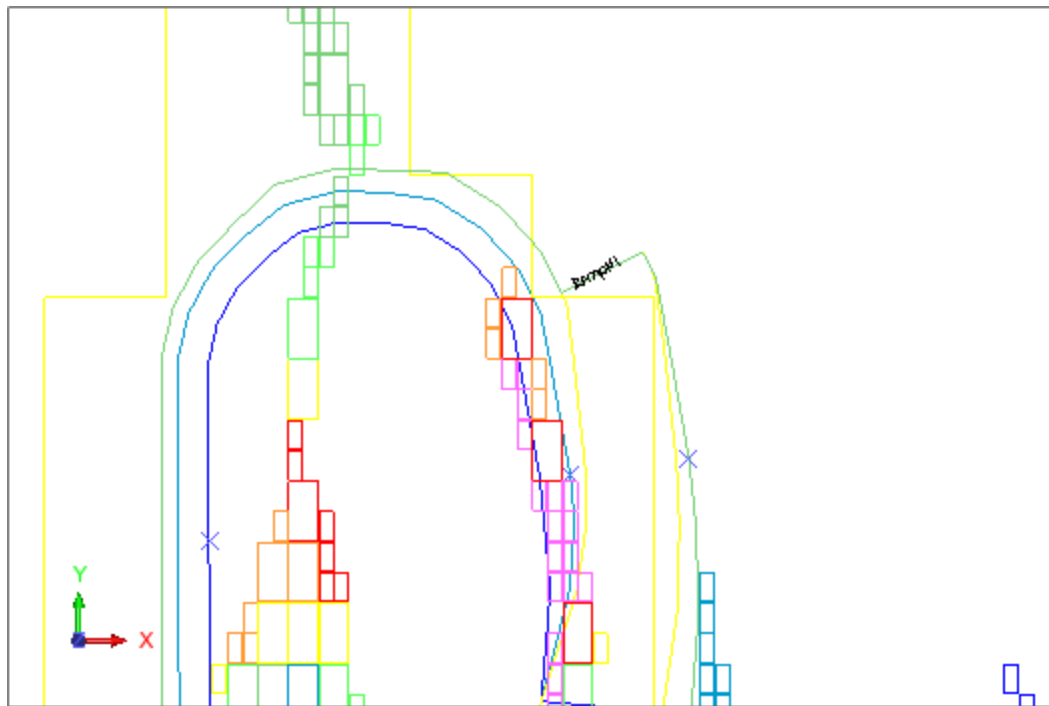
7. The segment is expanded.



8. In the **Planes** panel, click **Next plane** .
9. Choose **Expand segment > By bench height**.
10. Click on the last part of the pit that was created.
11. Enter the information as shown, and click **Apply**.



The segment is expanded.



12. Choose **Expand segment > By berm width**.
13. Click on the last part of the pit that was created.

14. Enter the information as shown, and click **Apply**.

Expand Segment by Berm Width ✖

String	4	Segment	1	
Minimum Z value		900		
Maximum Z value		900		

Define the method of expansion Delta Z limit

Berm creation method Limiting elevation

Berm width method

- fixed width
- descriptions
- slope strings
- block model

Berm width attribute

Default berm width

Berm gradient (%)

Horizontal direction

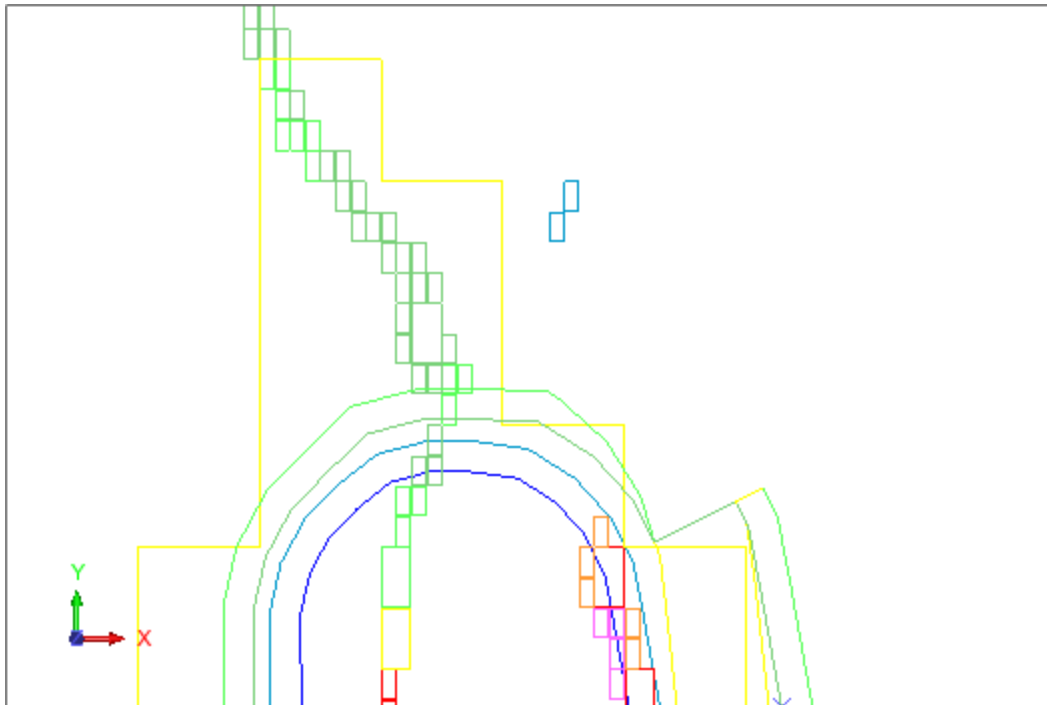
- expand
- contract


Switchback characteristics

	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input type="checkbox"/>	Ramp#1	180	2.5


The segment is expanded.

15. Press ESC.
16. Zoom in on the top of the design as shown.



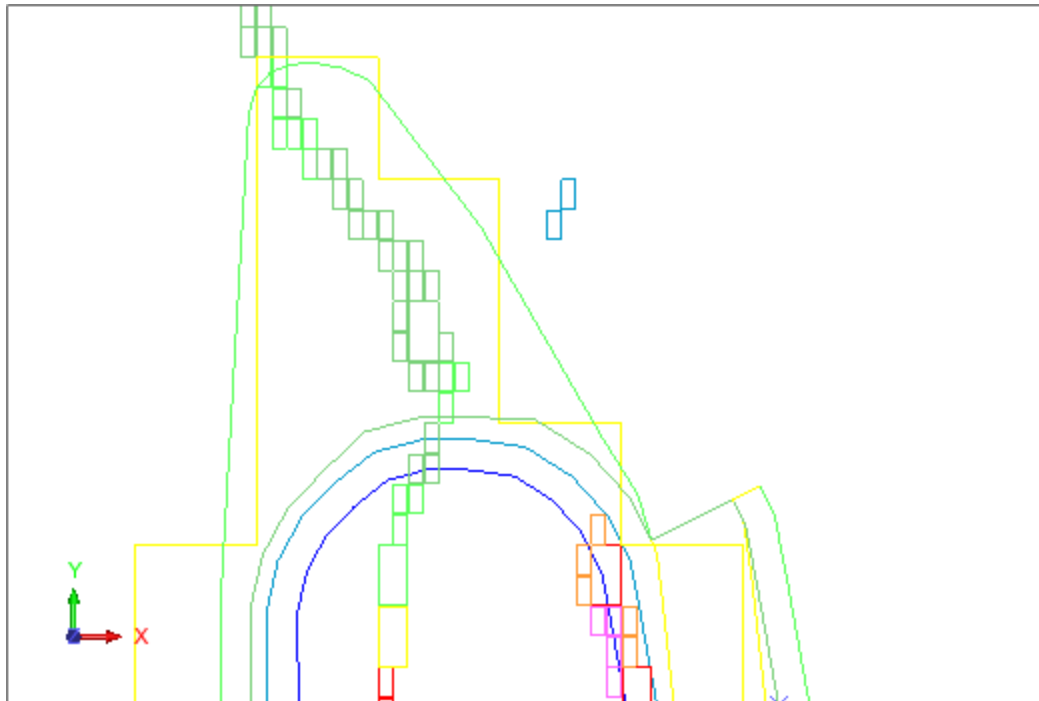
 **Note:** To see all of the steps performed in this task, run `_09_expand_bench_height_berm_width.tcl`. You need to click **Apply** on any forms presented.


Task: Edit a pit design

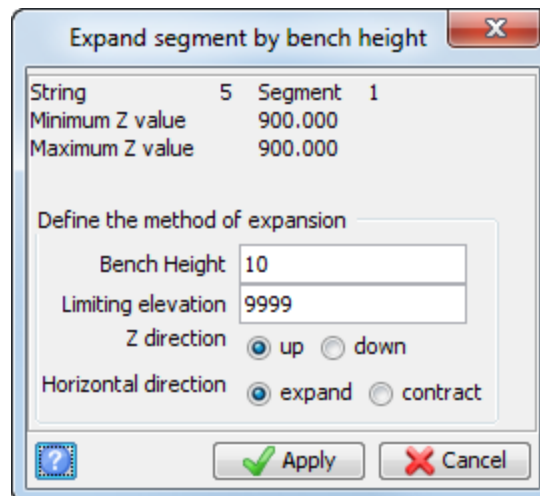
 **Note:** Before you attempt the steps in this procedure you must have completed the previous tasks, *Load the outline and Whittle model*, *Define the start string*, *Define the slope method*, *Define a new ramp*, and *Expand by bench height and berm width*. Alternatively, you can run macro `_09_expand_bench_height_berm_width.tcl`.

1. Choose **Display > Point > Markers**.
2. Enter the information as shown, and click **Apply**.

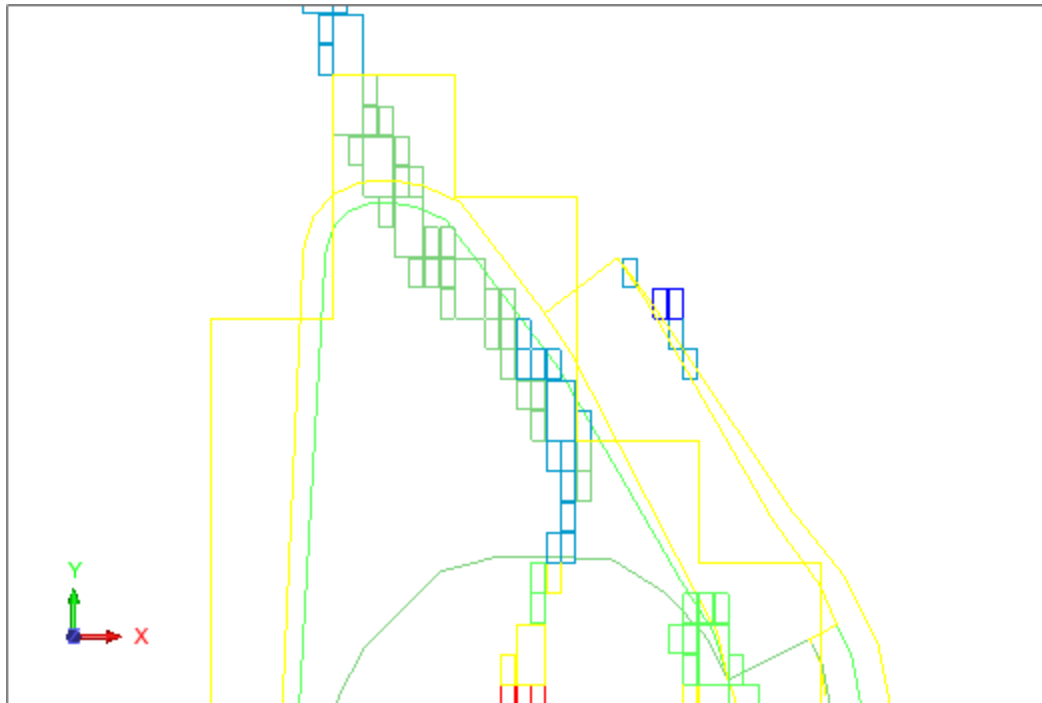
3. Choose **Edit > Point > Move**.
4. Move the points to encompass the ore as shown.



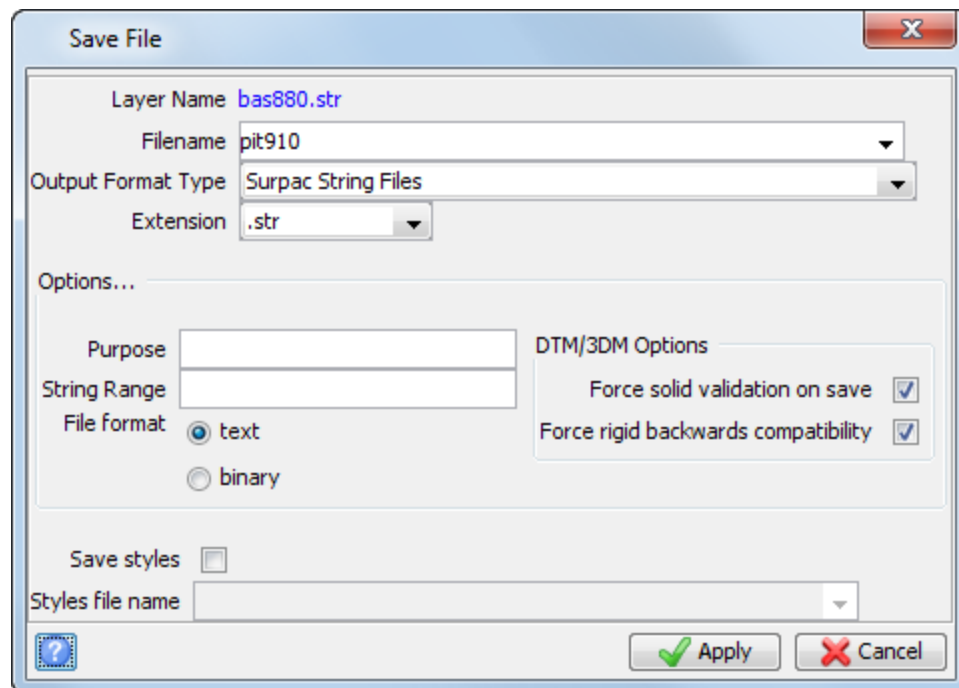
5. In the Planes panel, click **Next plane** .
6. Choose **Expand segment > By bench height**.
7. Click the line for which you moved the points.
8. Enter the information as shown, and click **Apply**.



9. The section is expanded.

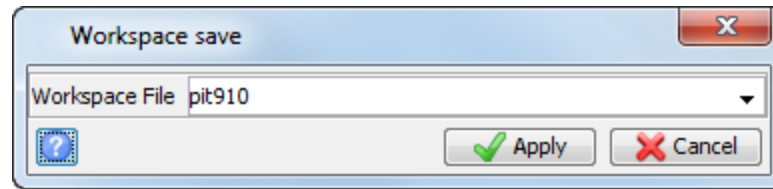



10. Choose **File > Save > string/DTM**.
 11. Enter the information as shown, and click **Apply**.




12. Open **pit910.str** in **Graphics**.
 13. In the **Layers** panel, right-click on **bas880.str** and choose **Delete layer**.
 14. Choose **File > Save > Graphics workspace**.

15. Enter the information as shown, and click **Apply**.




16. Click **Reset graphics** .
17. Click the **pitdesign** icon on the Status bar, and choose **Close**.

 **Note:** To see all of the steps performed in this task, run `_10_edit_design.tcl`. You need to click **Apply** on any forms presented.

Additional Pit Design Tools

Task: Restart a Pit Design

 **Note:** Before you attempt the steps in this procedure you must have completed the previous task, *Define the slope method*, or have run macro **_07_define_slope_berm_width.tcl**.

1. Open **pit910.swa** in **Graphics**.
2. Use the **Planes** panel to make **905E1** the active plane.
3. Choose **Pit design > New ramp**.
4. Choose the ramp points in **Graphics**.



5. Enter the information as shown, and click **Apply**.

Define a new ramp

Define the ramp characteristics

Ramp name Ramp#1

Ramp String 101

Ramp type anti-clockwise

Ramp width 15

Ramp gradient 1: 10

Gradient method inside edge
 outside edge
 centre of ramp

Define the berm crossing characteristics

exit at: crest
 toe
 crest and toe
 neither

Berm taper distance 30

Define the switchback characteristics

Switchback angle 180

Switchback inner radius 2.5

Apply Cancel

Note: To see all of the steps performed in this task, run `_11_restart_pit_design.tcl`. You need to click **Apply** on any forms presented.

Task: Design a Switchback

Instead of continuing the ramp around to the west side of the pit, you will keep the ramp on the east wall. In order to do this you will need to insert a switchback.

Note: Before you attempt the steps in this procedure you must have completed the previous tasks, *Define the slope method* and *Restart a pit design*, or have run macros `_07_define_slope_berm_width.tcl` and `_11_restart_pit_design.tcl`.

1. Choose **Expand segment > By berm width**.
2. Click the segment in **Graphics**.

3. Enter the information as shown, and click **Apply**.

Expand Segment by Berm Width

String 6 Segment 1
 Minimum Z value 910
 Maximum Z value 910

Define the method of expansion
 Berm creation method: always
 Limiting elevation: 0
 Delta Z limit: 0

Berm width method:
 fixed width
 descriptions
 slope strings
 block model

Berm width attribute: berm_width
 Default berm width: 5
 Berm gradient (%): 0

Horizontal direction:
 expand
 contract

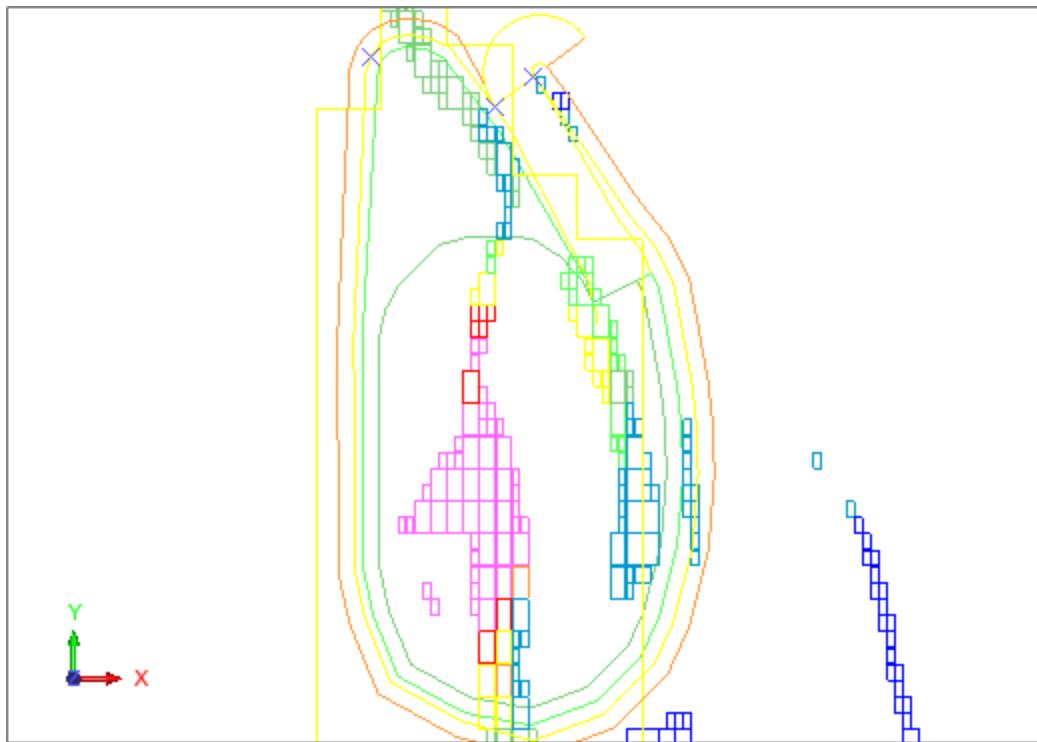
Switchback characteristics

	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input checked="" type="checkbox"/>	Ramp#1	180	2.5

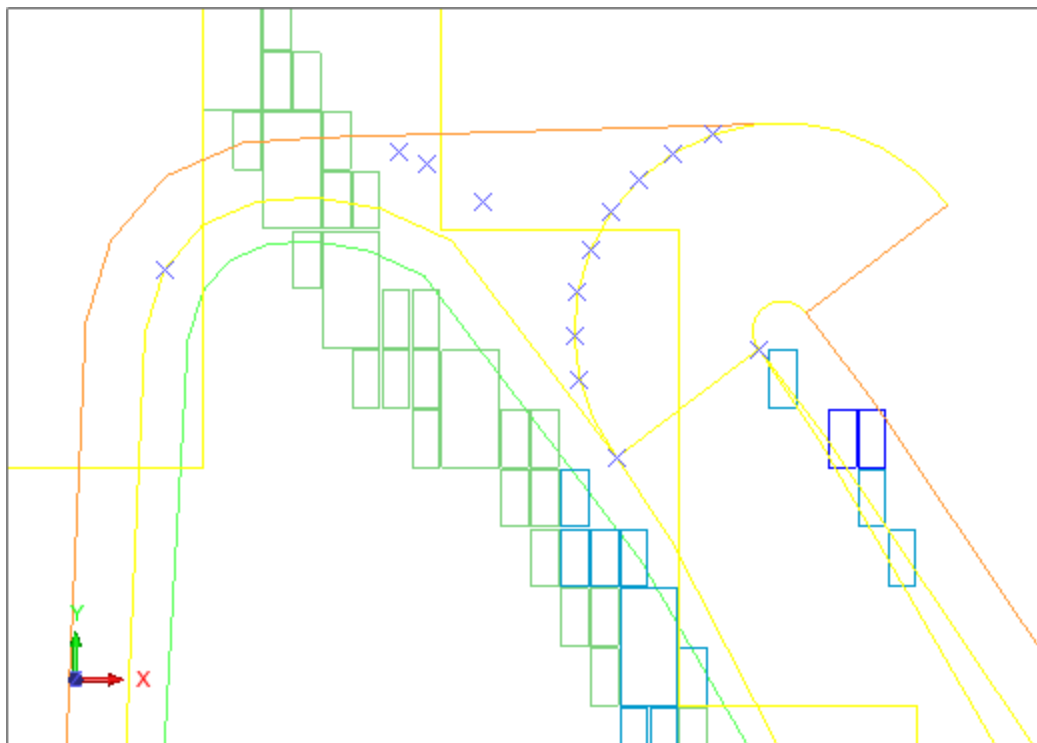
Buttons: ? Apply Cancel

Note: You are adding a switchback to this ramp, with an angle of 180 degrees and an inner radius of 2.5 meters.

The segment is expanded, and the switchback is added to the ramp.

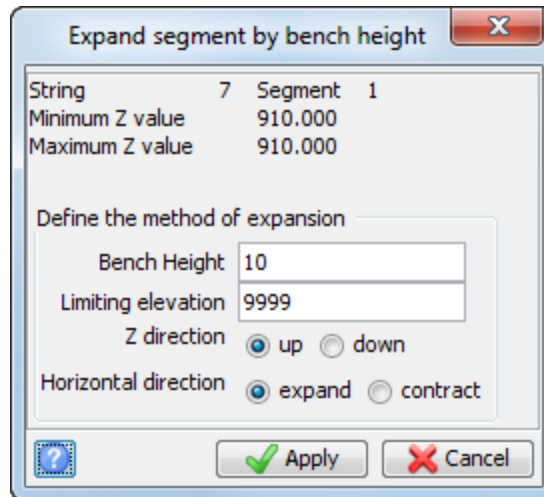


4. Choose **Edit > Point > Delete**, and delete the points as shown.



5. Choose **Expand segment > By bench height**.
6. Click the segment in **Graphics**.

7. Enter the information as shown, and click **Apply**.



The segment is expanded.

8. In the **Planes** panel, double-click **915E1** in the **BM_sections** group.



9. Choose **Expand segment > By berm width**.
10. Click the segment in **Graphics**.

11. Enter the information as shown, and click **Apply**.

Expand Segment by Berm Width X

String	8	Segment	1		
Minimum Z value		920			
Maximum Z value		920			

Define the method of expansion

Berm creation method	always	Delta Z limit	0
Limiting elevation	0		

Berm width method

- fixed width
- descriptions
- slope strings
- block model

Berm width attribute

berm_width

Default berm width

5

Berm gradient (%)

0

Horizontal direction

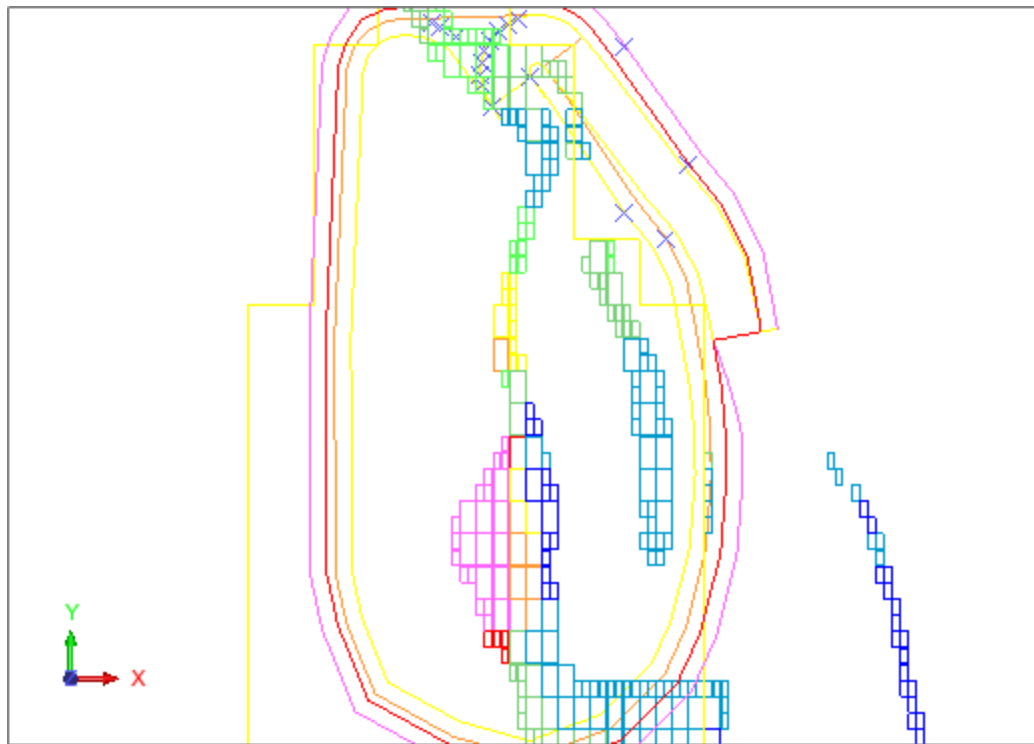
- expand
- contract

Switchback characteristics

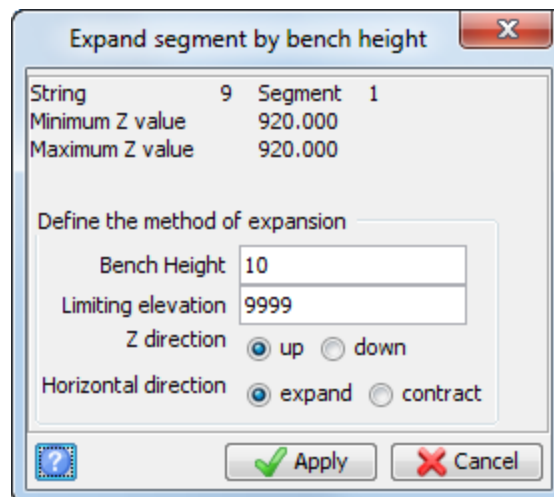
	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input type="checkbox"/>	Ramp#1	180	2.5

?
✔ Apply
✘ Cancel

The segment is expanded, and the switchback is added to the ramp.



12. Choose **Expand segment > By bench height**.
13. Click the segment in **Graphics**.
14. Enter the information as shown, and click **Apply**.



The segment is expanded.

15. In the **Planes** panel, click **Next plane** .

18. Enter the information as shown, and click **Apply**.

✖
Expand Segment by Berm Width

String	10	Segment	1
Minimum Z value	930		
Maximum Z value	930		

Define the method of expansion

Berm creation method always ▼

Limiting elevation 0

Berm width method

fixed width

descriptions

slope strings

block model

Berm width attribute berm_width ▼

Default berm width 5

Berm gradient (%) 0

Horizontal direction

expand

contract

Delta Z limit 0

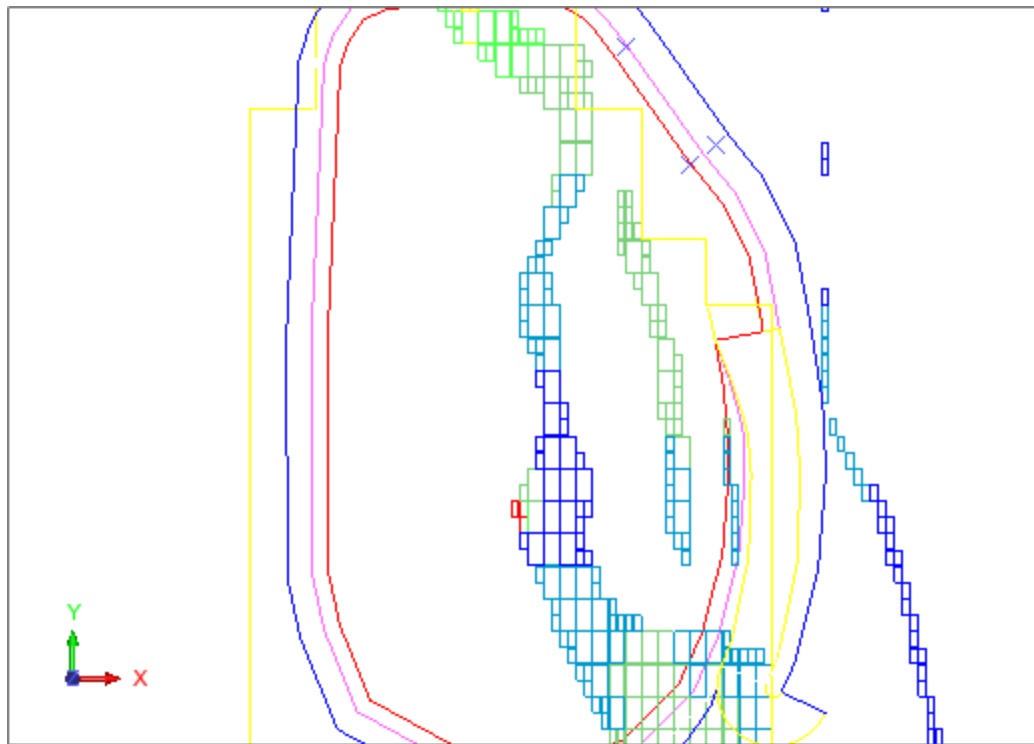
Switchback characteristics

	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input checked="" type="checkbox"/>	Ramp#1	180	2.5

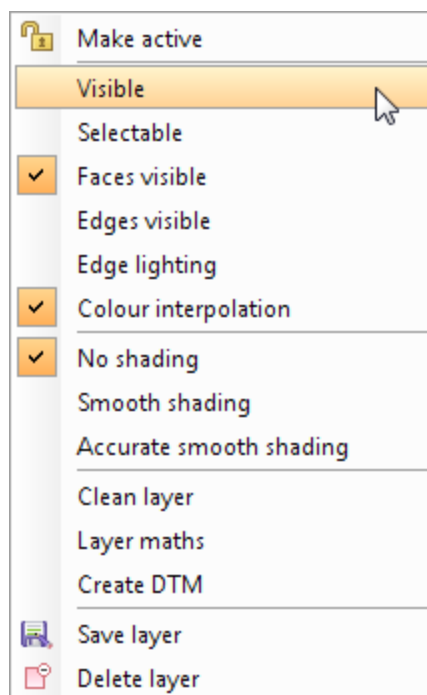
?


✔ Apply
✖ Cancel

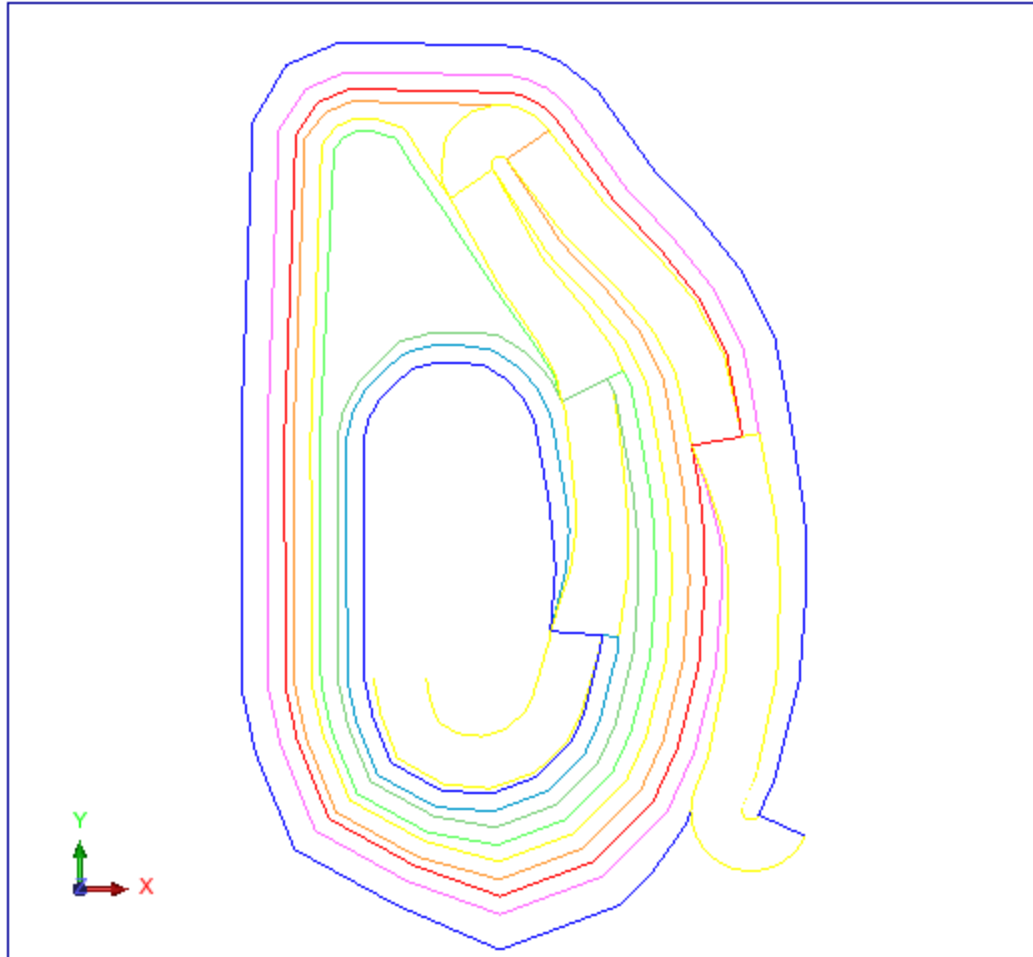
The segment is expanded, and the switchback is added to the ramp.



19. In the **Layers** pane, right-click **ore_blocks.str** and **whittle_pit28.str** and clear **Visible**, to hide these layers in **Graphics**.



20. Click **Zoom all** .
21. Choose **View > Viewing planes > Remove viewing / cutting planes**.
22. Choose **Display > Hide temporary markers**.
pit910.str is the only data visible in **Graphics**.



☑ **Note:** To see all of the steps performed in this task, run `_12_design_switchback.tcl`. You need to click **Apply** on any forms presented.

Task: Create multiple benches

☑ **Note:** Before you attempt the steps in this procedure you must have completed the previous tasks, *Define the slope method*, *Restart a pit design*, and *Design a switchback*. Alternatively, you can run macro `_12_design_switchback.tcl`.

1. Choose **Expand segment > Multi bench design**.
2. Click the segment in **Graphics**.

3. Enter the information as shown, and click **Apply**.

The 'Multi bench design' dialog box is shown with the following settings:



- String: 11
- Segment: 1
- Minimum Z value: 930.000
- Maximum Z value: 930.000
- Design method: Auto expand to elevation
- Horizontal direction: Expand (selected)
- Contract: (unselected)
- Define slope & berm method: Block model (selected)
- Fixed values: (unselected)
- Berm gradient (%): 0
- Define attributes for slope angle & berm width:
 - Slope angle attribute: face_angle
 - Berm width attribute: berm_width
- Auto expand parameters:
 - Number of benches: 1
 - Target Z: 1000
 - Slope angle: 0
 - Bench height: 10
 - Berm frequency: 1
 - Berm width: 5
 - DTM filename: (empty)
 - Object: 1
 - Trisolation: 1

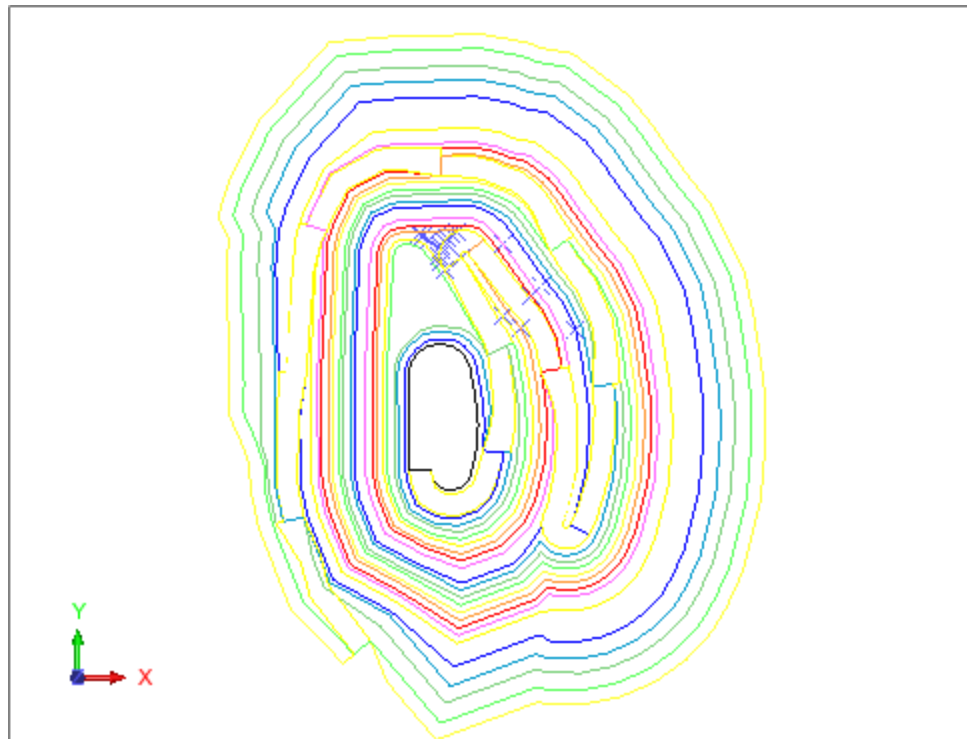
Buttons for 'Apply' and 'Cancel' are visible at the bottom right.

Benches from the current segment through to an elevation of 1000 are created.

4. In the **Layers** pane, right-click **whittle_pit28.str**, and select **Visible**.



- In the **Planes** panel, double-click **885E1** in the **BM_sections** group.
- Click **Next plane** , and move through all of the planes to view the design.
- In the **Layers** pane, right-click **whittle_pit28.str**, and clear **Visible**.
- Choose **View > Viewing planes > Remove viewing / cutting planes**.
- Click **Zoom all** .




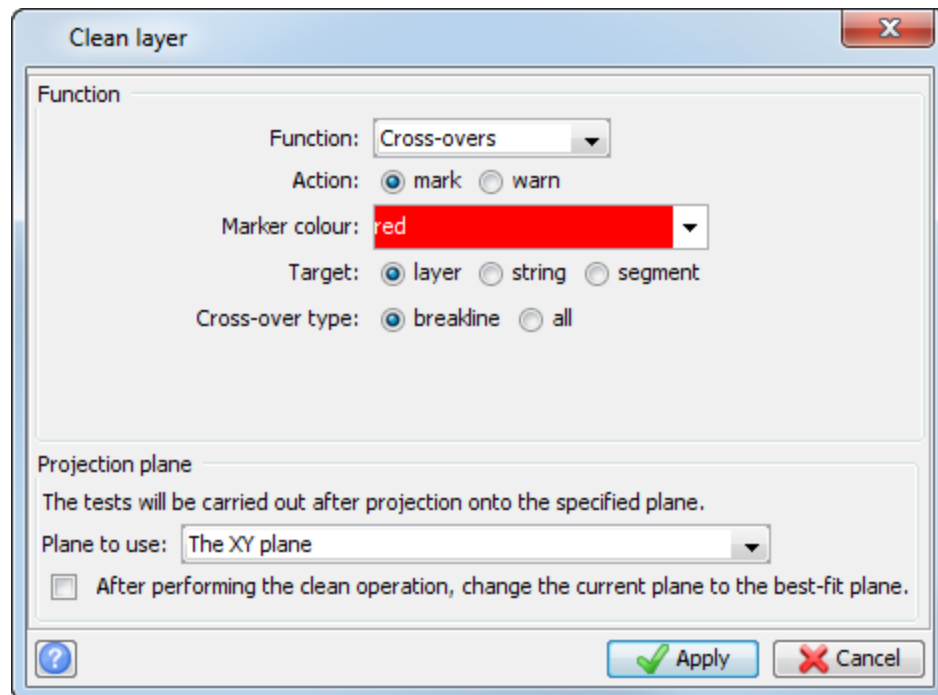
Note: To see all of the steps performed in this task, run `_13_multibench_design.tcl`. You need to click **Apply** on any forms presented.

Creating a DTM of a pit design

This section describes how to clean your pit design strings before creating a DTM, and how to create a DTM surface from the design.

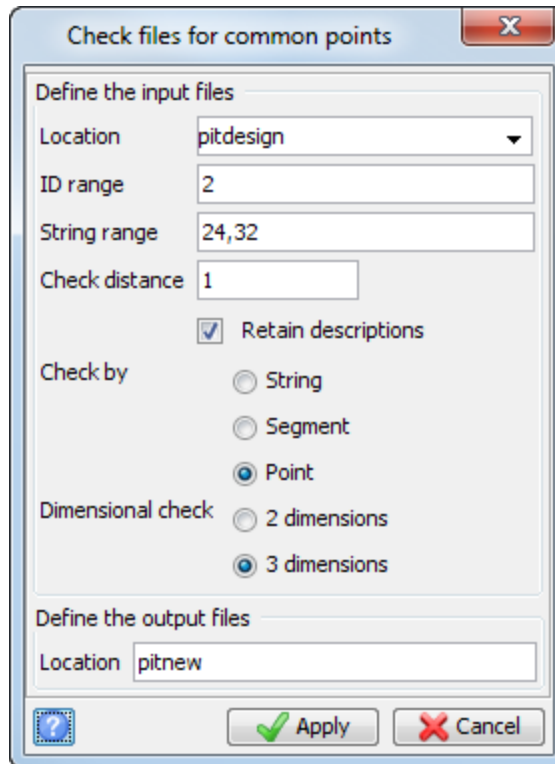
Task: Clean pit design strings


1. Click **Reset graphics** .
2. Open **pitdesign2.str**.
3. Choose **Edit > Layer > Clean**.
4. Enter the information as shown, and click **Apply**.

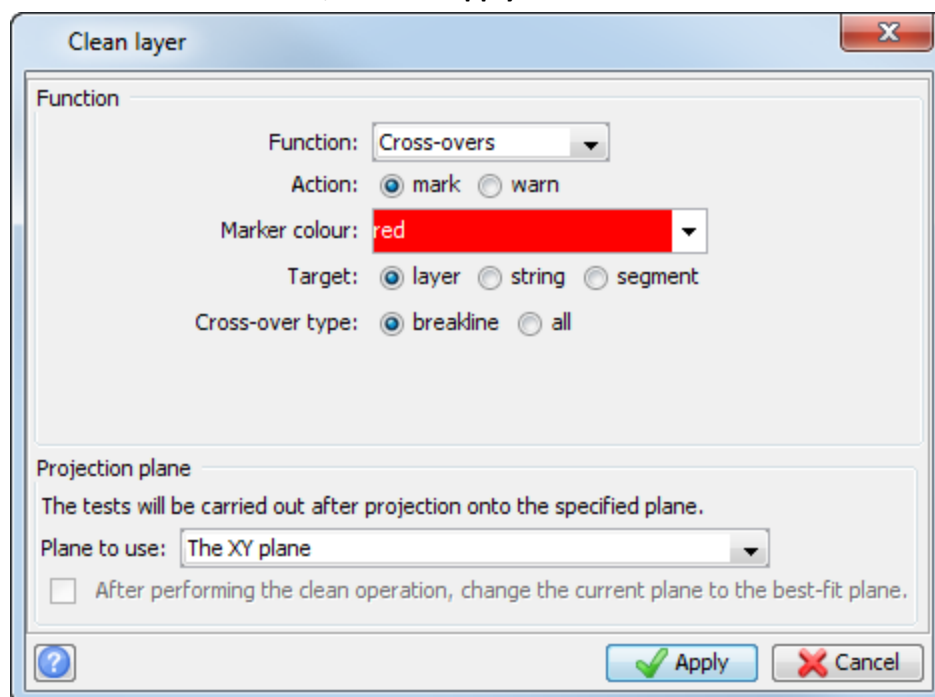



5. Choose **File tools > Check for common points**.
This function adjusts any points which are close (based on user inputs) to any other points so that they have exactly the same coordinates.

6. Enter the information as shown, and click **Apply**.



7. Click **Reset Graphics** .
8. Open **pitnew2.str**.
9. Choose **Edit > Layer > Clean**.
10. Enter the information as shown, and click **Apply**.



 **Note:** If you continue to have intersections, you may wish to clean them manually using the string edit tools in **Graphics**.

11. When you are sure you have no intersections, save your file as **pitdesign2.str**

Task: Create a DTM of a pit design

1. Choose **Surfaces > DTM File functions > Create DTM from string file**.
2. Enter the information as shown, and click **Apply**.

Create a DTM from a string file

Define the string file

Location: pitdesign2

Object ID: 1

Object name:

Projection plane

The triangles will initially be created on a temporary 2D plane.

Create on: The XY plane

After creating the surface, change the current plane to the best-fit plane.

Define other parameters

Common point check distance: 0.0050

Strings to act as break lines

Any spot height strings

Spot height string range:

Perform break line test

Interpolate additional points

Point interpolation distance: 50

Define the boundary string to clip the DTM

Would you like to clip the DTM to a boundary after creation?

Location:

String: 1

Retain triangles inside boundary

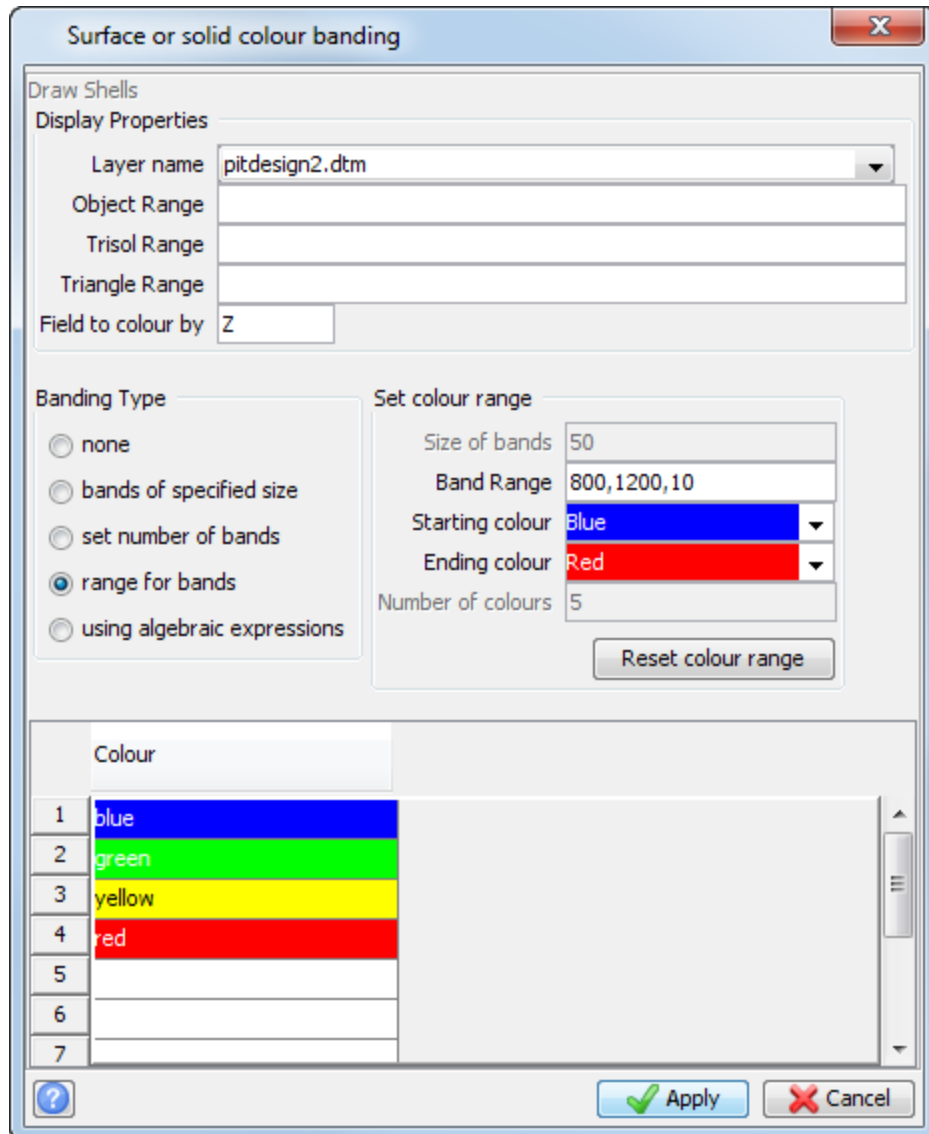
Retain triangles outside boundary

Reset graphics

Apply Cancel

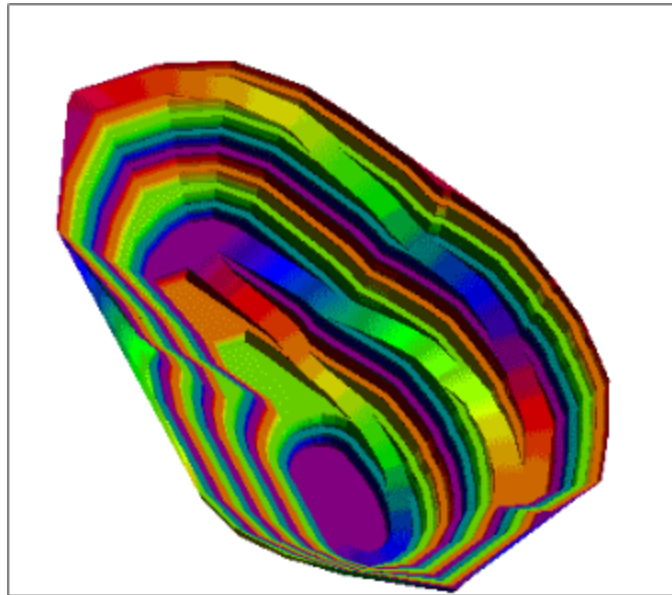
3. Click **Reset graphics** .
4. Open **pitdesign2.dtm**.
5. Choose **Display > Surface or solid with colour banding**.

- Enter the information as shown, and click **Apply**.



- Choose **Solids > Display > Condense colouring** to give sharp boundaries to the colour bands.


The pit with colour banding is displayed.

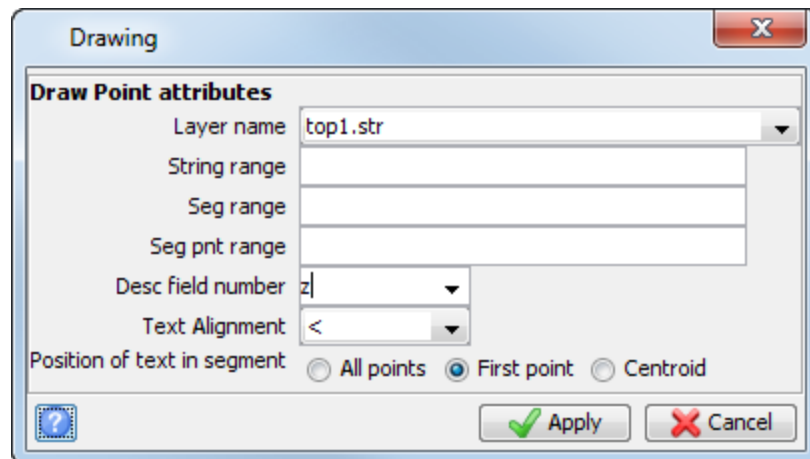


Intersect pit design with surface topography

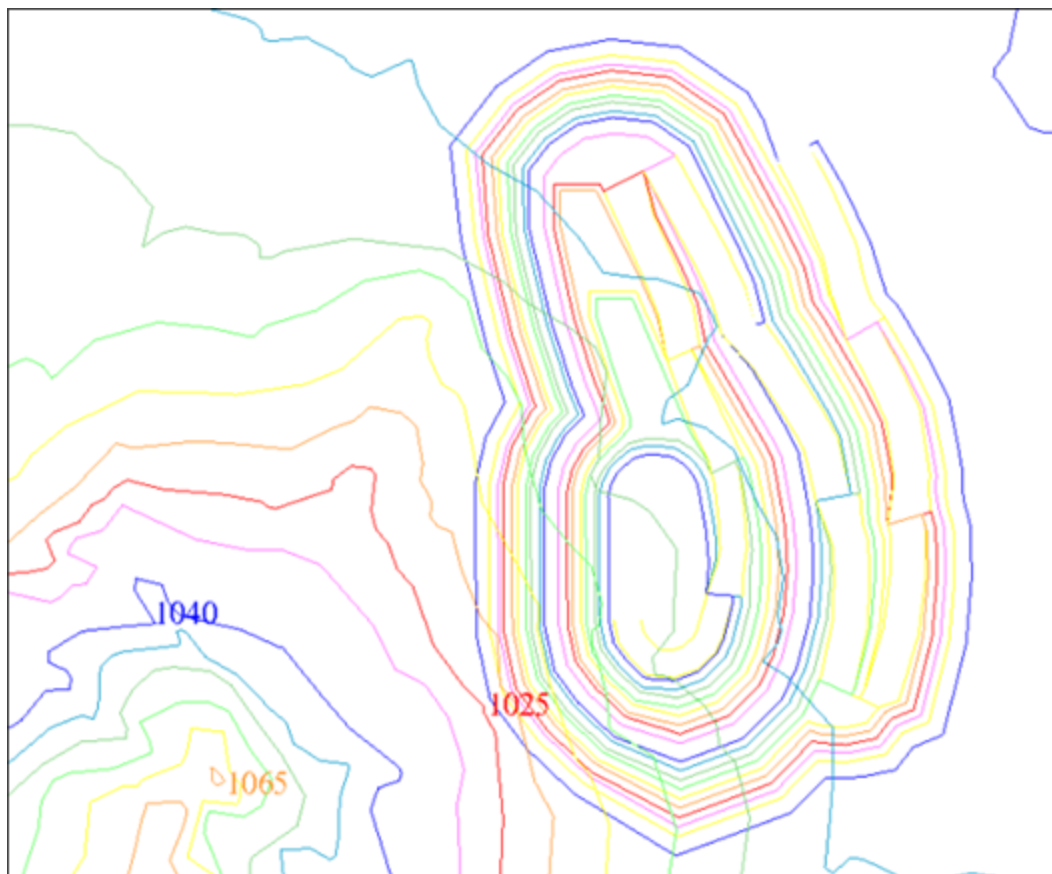
Task: Intersect pit design and topography

You will now expand the pit design past the surface topography.

1. Click **Reset graphics** .
2. If a block model is open, close it using **Block model > Close**.
3. Open **top1.str** in **Graphics**.
4. Select **Display > Point > Attributes**.
5. Enter the information as shown, and click **Apply**.

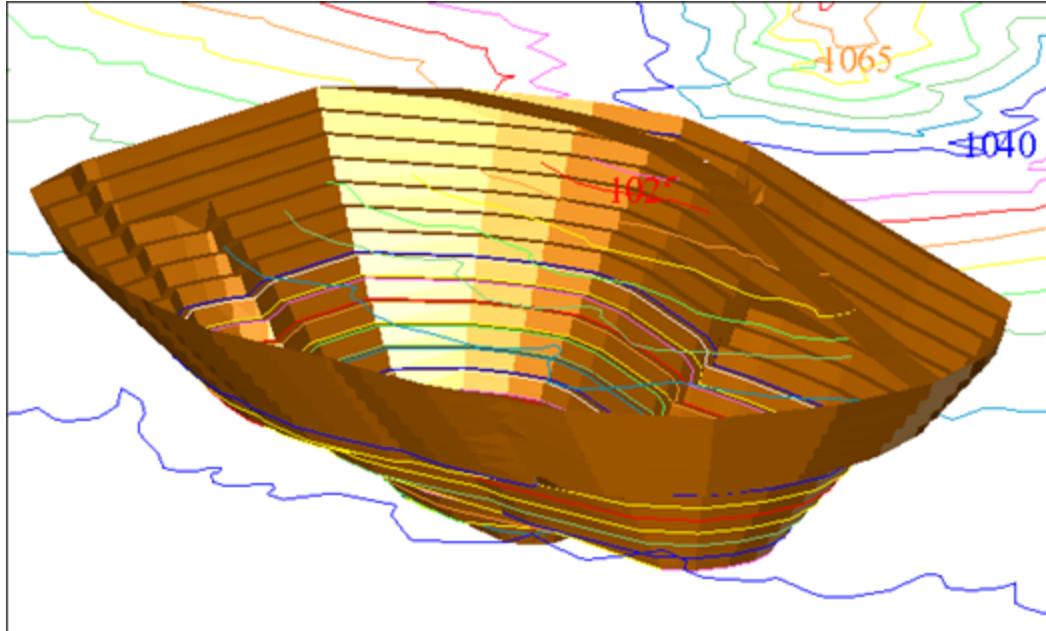


6. Open **pit980.str** in **Graphics**.
To intersect the design with the surface, you can extend the design above topography.



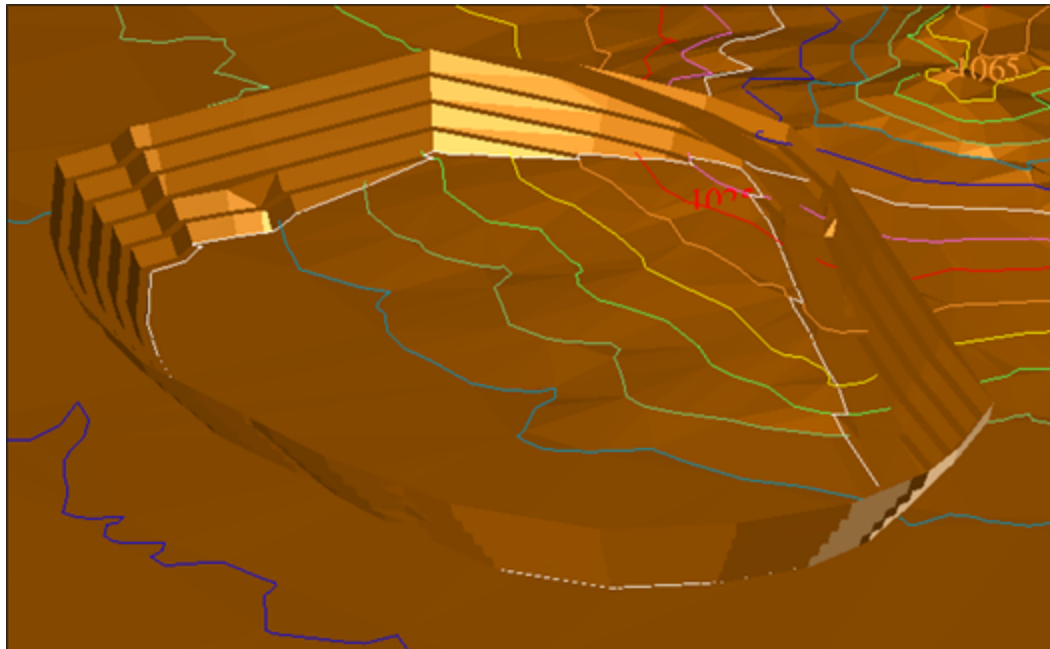
7. Open **pit1050.dtm** in **Graphics**.

This has been created by using the pit design tools previously described to extend the design from the 980 elevation so that it is above the topography.



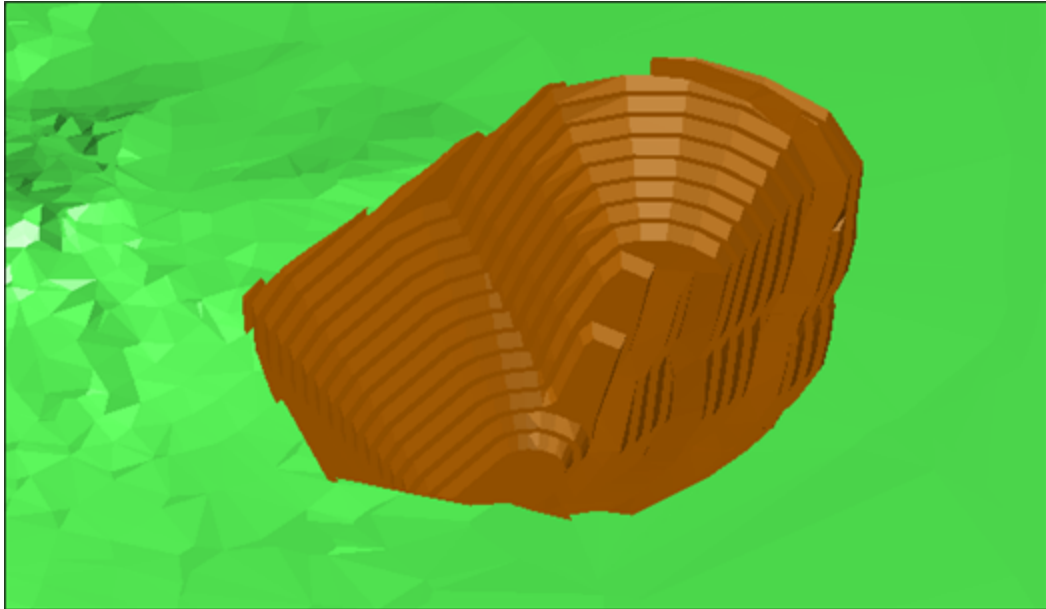
8. Open **top1.dtm** in **Graphics**.
9. Open **pit_topo_intersection.str** in **Graphics**.


The line of intersection between the pit design and the topography was created using **Surfaces > Clip or Intersect DTMs > Line of intersection between DTMs**.



10. Click **Reset graphics** .

11. Open **pit_design2.dtm** and **topo_outside_pit1.dtm** in **Graphics**. These DTM surfaces were created using **Surfaces > DTM file functions > Clip DTM by boundary string**.



 **Note:** To see all of the steps described in this task, run **_14_intersect_design_and_topo.tcl**. You need to click **Apply** on any forms presented.

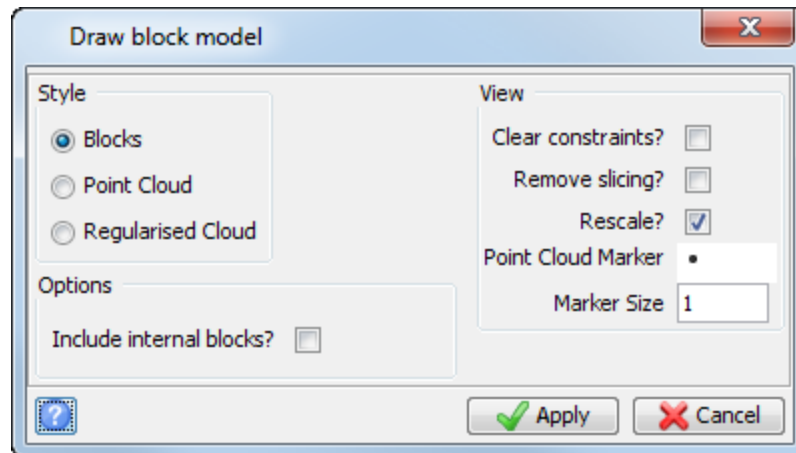
Grade and tonnage calculations

This section describes how to create a block model constraint of blocks within a pit design, and how to generate a report of the tonnes and grade of material within the constraint.

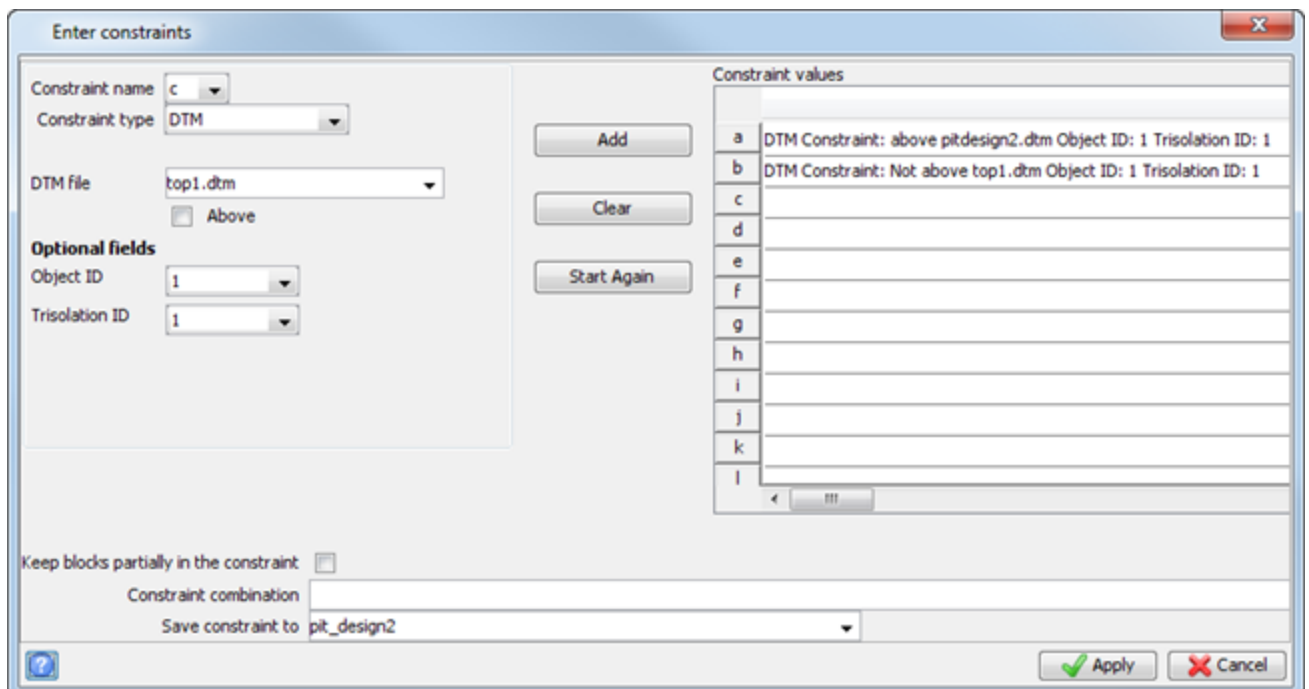
Task: Create a block model constraint of material in a pit

In order to calculate grade and tonnage from a block model, you can create the constraint that represents the material in the pit beforehand.

1. Open **pitdesign.mdl**.
2. Choose **Block model > Block model > Display**.
3. Enter the information as shown, and click **Apply**.



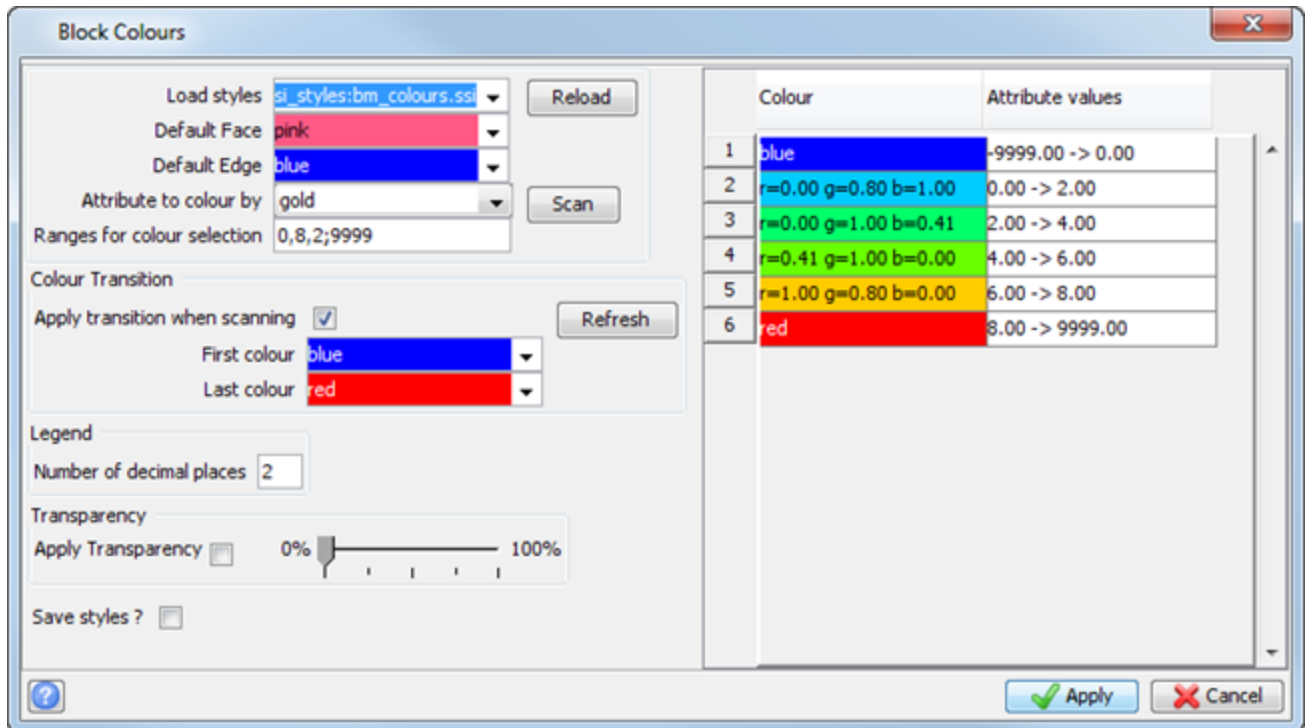
4. Choose **Block model > Constraints > New graphical constraint**.
5. Enter the information as shown, and click **Apply**.



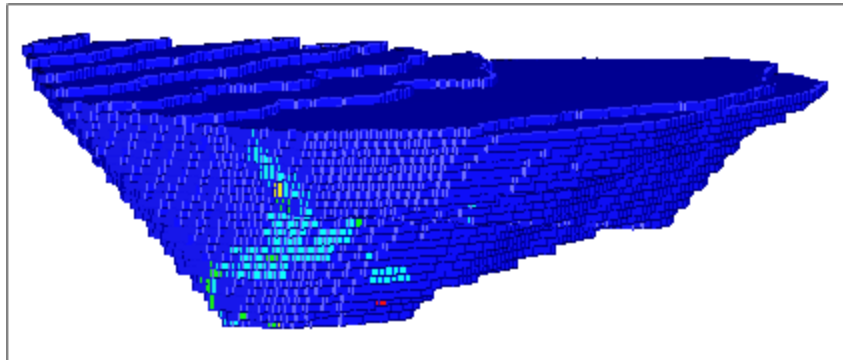
Note: The constraint file **pit_design2.con** is created, which is a list of all blocks within this constraint.

6. Choose **Block model > Display > Colour model by attribute**.

7. Enter the information as shown, and click **Apply**.



8. Spin the model around to see the blocks coloured by gold grade.
Most of the blocks are waste (gold=0), and are coloured dark blue.



Note: To see all of the steps performed in this task, run `_15_create_pit_constraint.tcl`.
You need to click **Apply** on any forms presented.

Task: Calculate Grade and Tonnage of Material in Pit

1. Open `pitdesign.mdl`.
2. Choose **Block model** > **Block model** > **Report**.

3. Enter the information as shown, and click **Apply**.

Block model report format file

Format File Name

Output Report File Name pit_design2

Output Report File Format .not - Surpac Note File

Report Type

Standard Report

Multiple Percent Report

Indicator Kriged Model

Modify Format

Constrain?

Apply Cancel

4. Enter the information as shown, and click **Apply**.

Block model report

Report description

Format headers?
 Remove lines with zero volume?
 Report volume and tonnes to 0 decimal places

Report attributes	Display?	Low cut	Upper cut	Weight by	Report	Expression
a gold	<input checked="" type="checkbox"/>			Mass	Average	
b silver	<input checked="" type="checkbox"/>			Mass	Average	

Volume adjustment
 Use volume adjustment?
 Attribute berm_width

Geometric grouping
 Group geometrically None

Density adjustment
 None
 Attribute
 Value 2.7

Grouping attributes	Numeric range
1 z	880,1200,10
2 gold	0;2;5;8;999

Fill all cells for the group attribute?
 Pivot compatible?

Use partial percentages?
 Precision 3
 Attribute to store partial percentage values

Apply Cancel

5. Enter the information as shown, and click **Apply**.

Enter constraints

Constraint name a
 Constraint type CONSTRAINT
 Constraints file PIT_DESIGN2.CON
 Inside

Add
 Clear
 Start Again

Constraint values

a	Constraint File: inside PIT_DESIGN2
b	
c	
d	
e	
f	
g	
h	
i	
j	
k	

Keep blocks partially in the constraint
 Constraint combination
 Save constraint to

Apply Cancel

6. The file **pit_design2.not** is displayed.

Block model report						
Constraints used						
a. INSIDE CONSTRAINT PIT_DESIGN2						
Keep blocks partially in the constraint : False						
Z	Gold	volume	Tonnes	Gold	silver	
880.0 -> 890.0	0.0 -> 2.0	42563	114919	0.000	0.000	
	2.0 -> 5.0	8563	23119	3.646	27.284	
	5.0 -> 8.0	1750	4725	6.140	32.473	
	8.0 -> 999.0	1000	2700	11.689	25.333	
Sub Total		53875	145463	0.996	5.861	
890.0 -> 900.0	0.0 -> 2.0	73188	197606	0.013	0.038	
	2.0 -> 5.0	8000	21600	3.973	20.229	
	5.0 -> 8.0	10750	29025	6.305	27.429	
	8.0 -> 999.0	2063	5569	10.823	24.079	
Sub Total		94000	253800	1.307	5.416	
...						
...						
...						
1010.0 -> 1020.0	0.0 -> 2.0	117313	316744	0.000	0.000	
	2.0 -> 5.0	0	0	0.000	0.000	
	5.0 -> 8.0	0	0	0.000	0.000	
	8.0 -> 999.0	0	0	0.000	0.000	
Sub Total		117313	316744	0.000	0.000	
1020.0 -> 1030.0	0.0 -> 2.0	19188	51806	0.000	0.000	
	2.0 -> 5.0	0	0	0.000	0.000	
	5.0 -> 8.0	0	0	0.000	0.000	
	8.0 -> 999.0	0	0	0.000	0.000	
Sub Total		19188	51806	0.000	0.000	
Grand Total		6992625	18880088	0.328	2.234	

Note: Your report should be similar in format, but the numbers may not be exactly the same.

Note: To see all of the steps performed in this task, run **_16_grade_and_tonnage.tcl**. You need to click **Apply** on any forms presented.

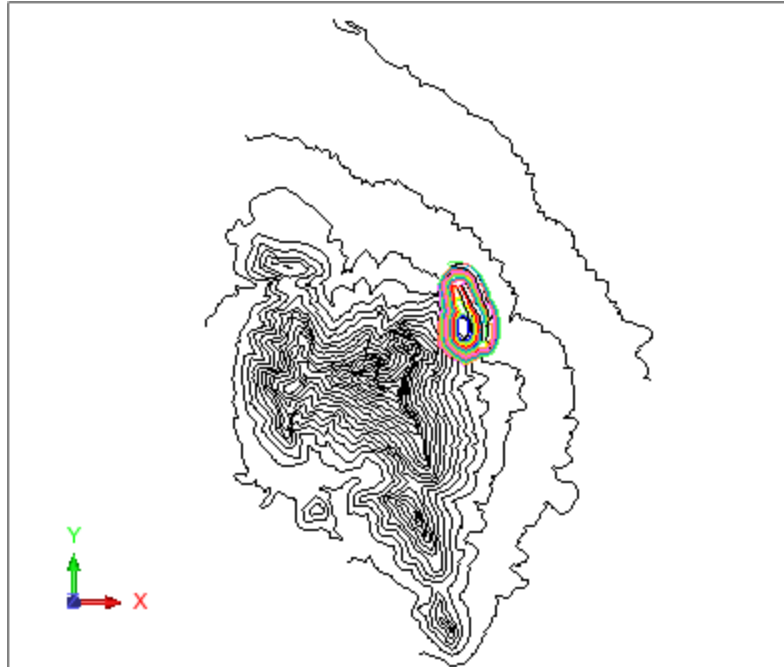
Waste dump design

This section will show you how to use Surpac to create a dump design and a digital terrain model (DTM) of that design. You will then generate a volume report, and a bench volume report of material that can be stored on each bench.

You will perform the dump design on the combined surface of the topography and the pit design. A key objective of this exercise is to show you how to set up an all-cut ramp.

Task: Design a waste dump

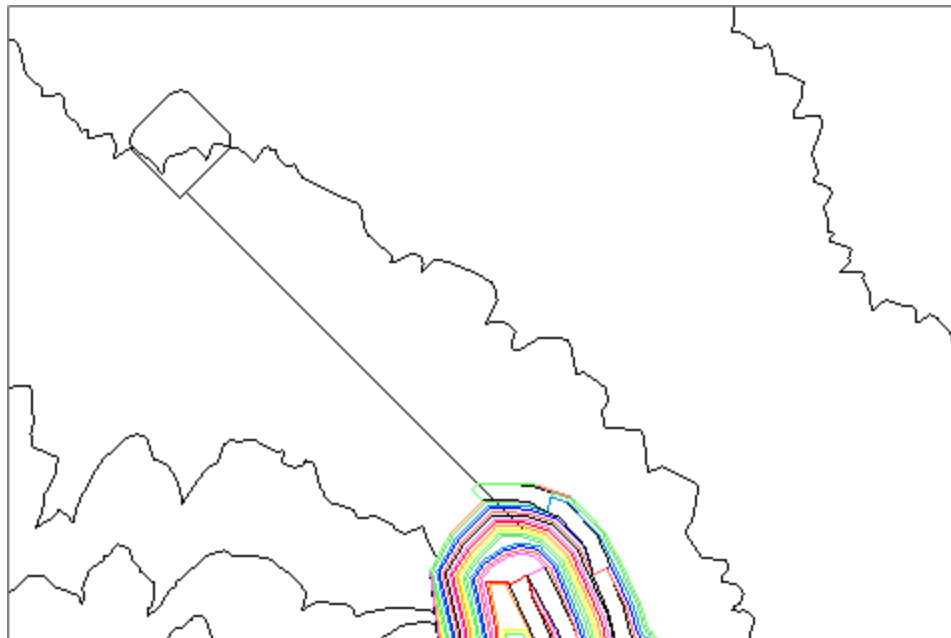
1. Open **pit_and_topo2.str** in **Graphics**.
The pit and topography is displayed.



2. Open **dcl1.str** in **Graphics**.
The decline is displayed.

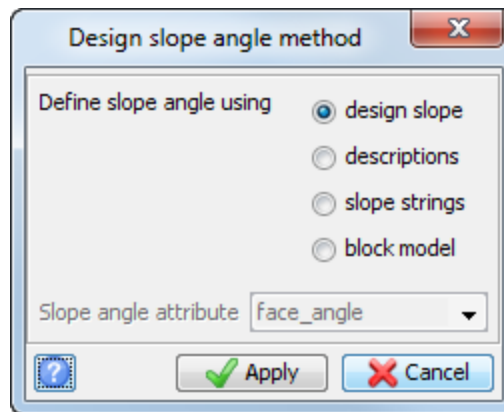


3. Open **dtop1045.str** in **Graphics**.
4. Rescale **Graphics** using a combination of window, zoom, and pan tools until the data looks approximately like the following image:

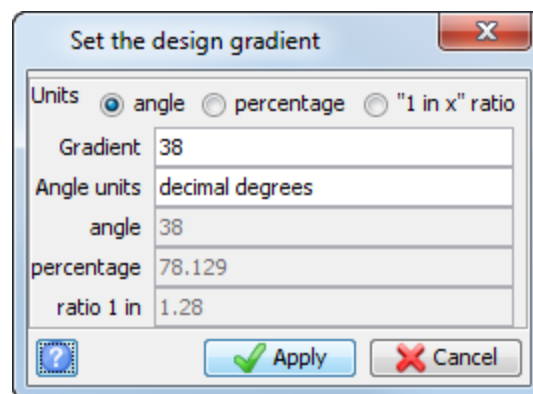


The top of the dump is approximately 50 metres above the topography, at an elevation of 1045 metres. The gradient of the centre line will be set during the dump design process.

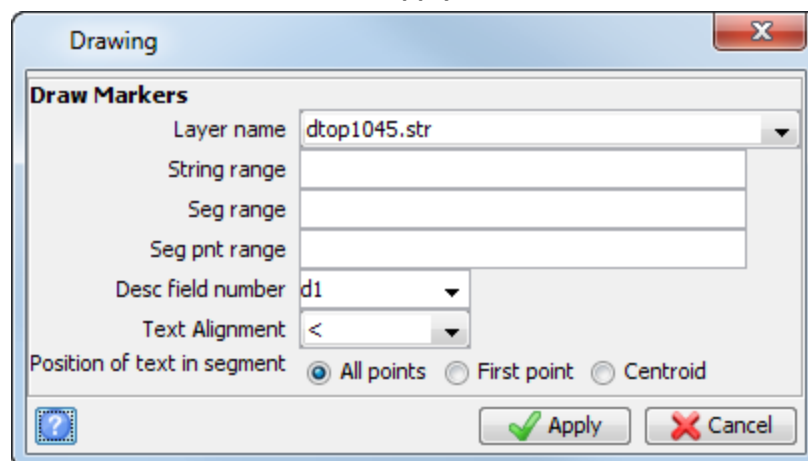
5. Choose **Pit design > Select slope method**.
6. Enter the information as shown, and click **Apply**.



7. Choose **Pit design > Set slope gradient**.
8. Enter the information as shown, and click **Apply**.
The new design gradient is shown in the status bar at the bottom of the screen.

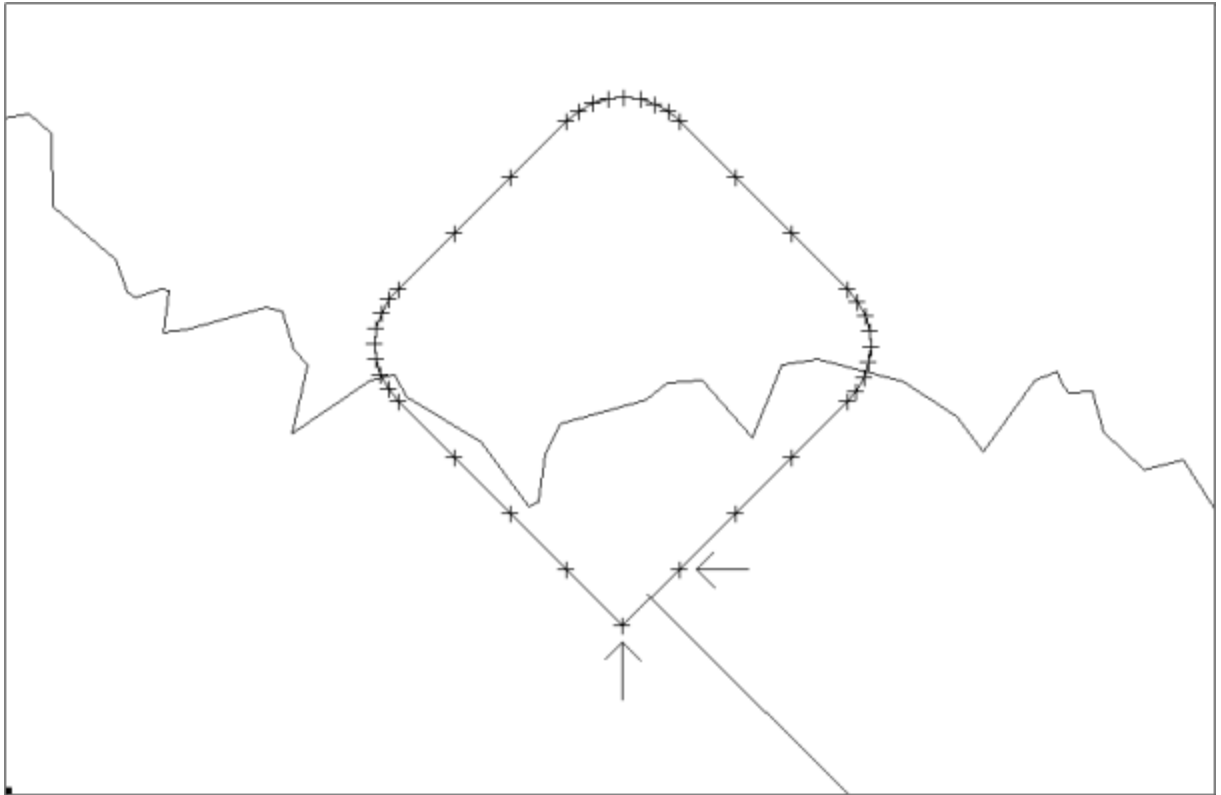


9. Choose **Display > Point > Markers**.
10. Enter the information as shown, and click **Apply**.



11. Choose **Pit design > New ramp**.

12. Select two points on the dump top, one on either side of the ramp centre line as shown.



13. Enter the information as shown, and click **Apply**.

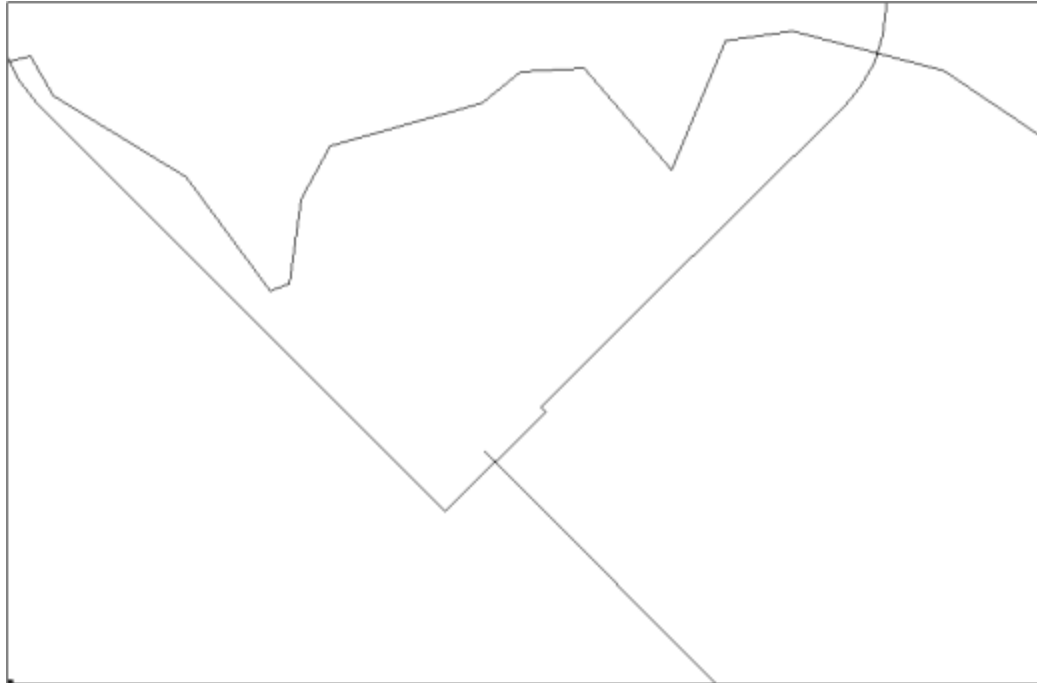
Define a new ramp


Define the ramp characteristics

Ramp name	Ramp#1
Ramp String	100
Ramp type	all cut
Ramp width	20
Ramp gradient 1:	6.667

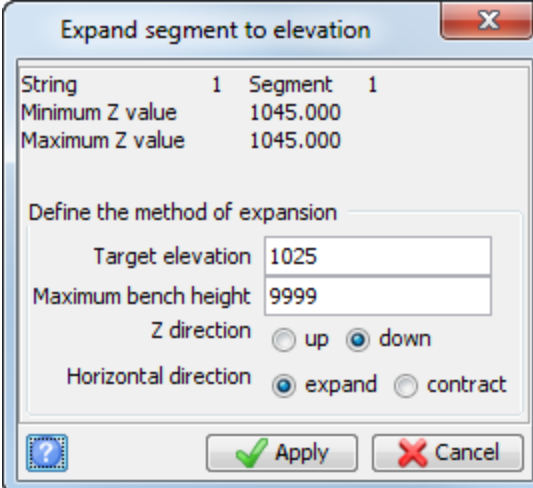
Apply Cancel

14. Following the prompt, select the ramp centre line anywhere where there are no other strings which you may accidentally snap to. After selecting the ramp centre line, the dump top outline is modified slightly as shown in the following image. This change is made to resolve geometry problems at the start of the ramp.



 **Note:** In this design you will only have one safety berm at 1025 metres in this dump.

15. Choose **Expand string > To elevation**, and click on the dump outline.
16. Enter the information as shown, and click **Apply**.



String	1	Segment	1
Minimum Z value		1045.000	
Maximum Z value		1045.000	

Define the method of expansion

Target elevation: 1025

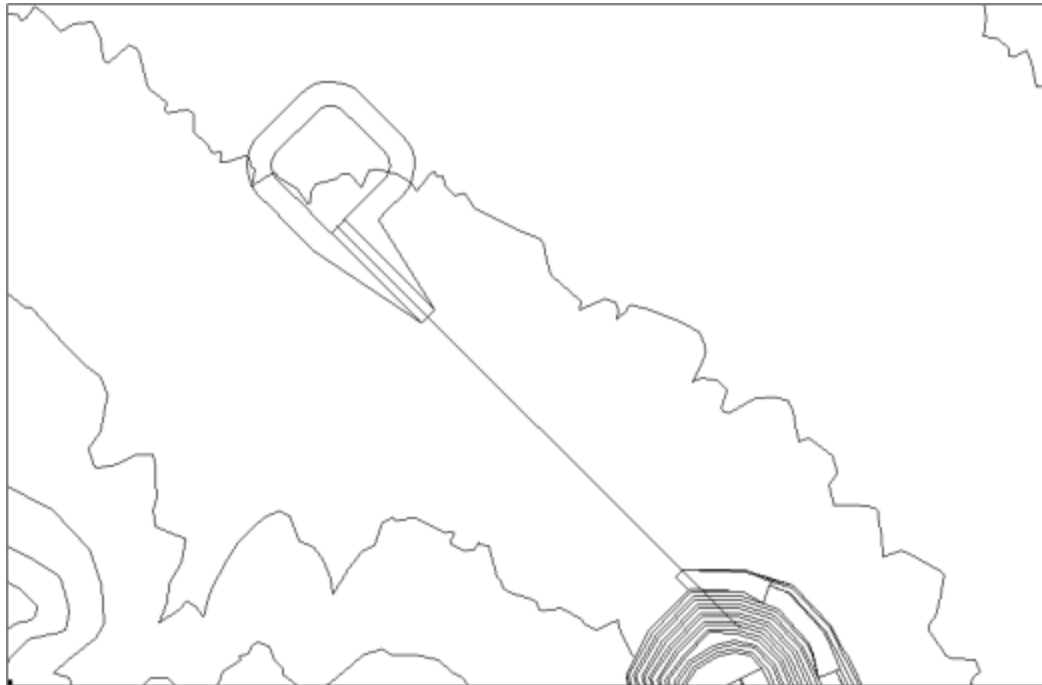
Maximum bench height: 9999

Z direction: up down

Horizontal direction: expand contract

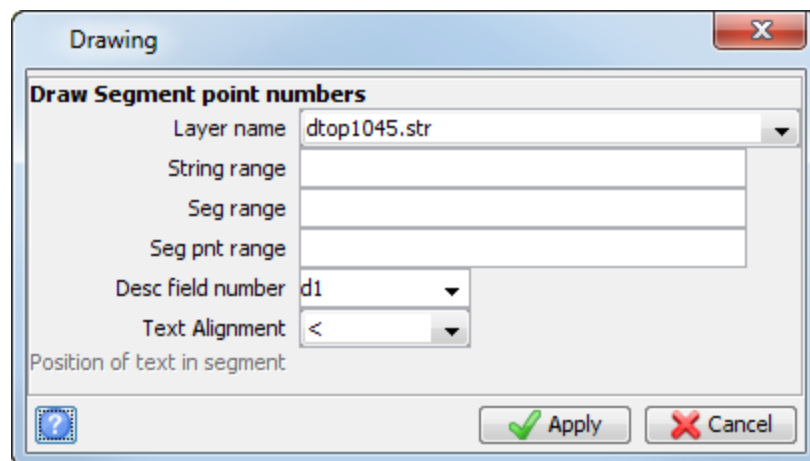
Apply Cancel

The display is updated, as shown.



You will now create a 10 metre berm at this elevation.

17. Choose **Display > Point > Numbers**.
18. Enter the information as shown, and click **Apply**.



19. Check the point numbers to identify overlapping and close points.
20. Choose **Expand segment > By berm width**.
21. Select string 2.

22. Enter the information as shown, and click **Apply**.

Expand Segment by Berm Width

String 2 Segment 1
 Minimum Z value 1025
 Maximum Z value 1025

Define the method of expansion
 Berm creation method **always** Delta Z limit 0
 Limiting elevation 0

Berm width method fixed width
 descriptions
 slope strings
 block model

Berm width attribute **berm_width**
 Default berm width 10
 Berm gradient (%) 0

Horizontal direction expand
 contract

Switchback characteristics

	Add switchback	Ramp name	Switchback angle	Switchback inner radius
1	<input type="checkbox"/>	Ramp#1	180	2.5

Apply Cancel

Now project the dump outline to the DTM of the topographic surface.

23. Choose **Pit design > Load a DTM surface** and load **top1**, leaving the display DTM at N.

Load DTM surface

Layer dtm surface layer
 Location top1
 Object ID 1
 Trisolation ID 1
 Display DTM

Apply Cancel

24. Choose **Expand segment > To DTM surface**, and click the outline of the dump.

25. Enter the information as shown, and click **Apply**.

Expand segment to DTM

Selected segment properties

String number **3**

Segment number **1**

Minimum Z value **1025.000**

Maximum Z value **1025.000**

Define the method of expansion

% of height to DTM

Maximum bench height

Z direction

up

down

to dtm

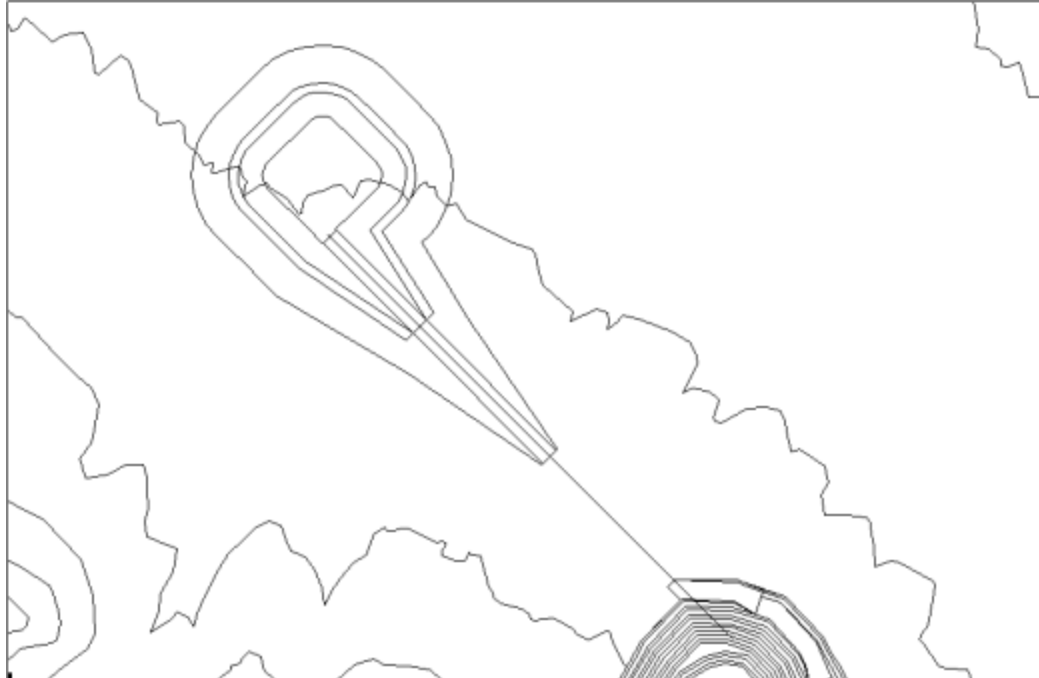
Limiting elevation

Horizontal direction

expand

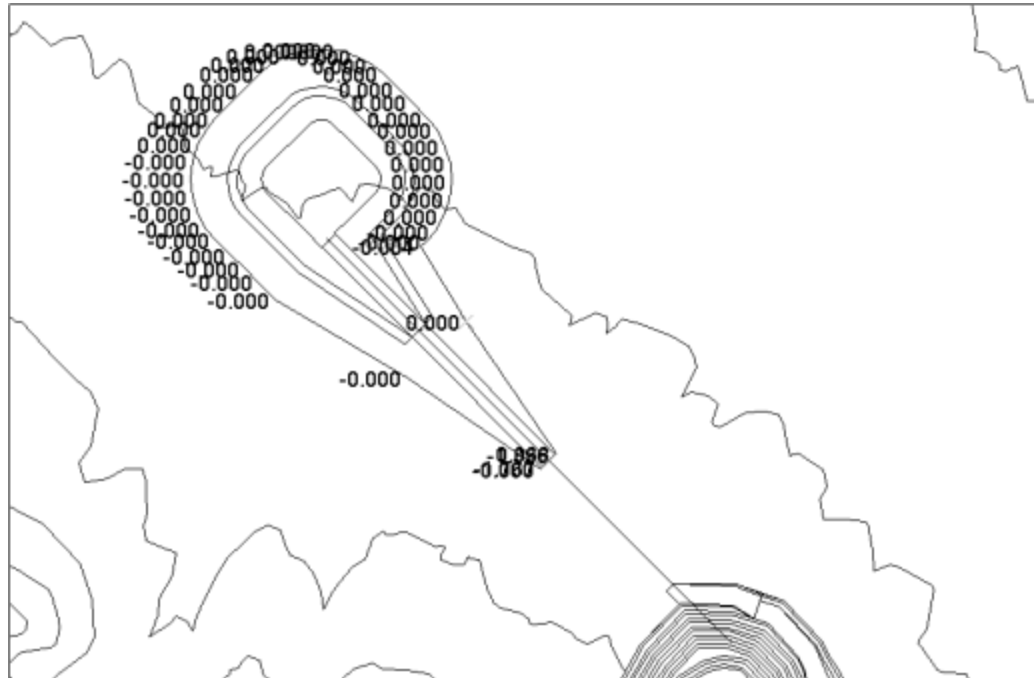
contract

26. Choose **Edit > Point > Delete**.
27. Delete any points that are close to each other, overlapping, or unwanted.
The image below is displayed.



28. Choose **Pit design > Display DTM surface offsets.**

This will show the DTM offsets to check that the base of the Dump has been extended to match the DTM surface.



29. Choose **File > Save > string/DTM.**

30. Enter the information as shown, and click **Apply**.

Save File

Layer Name **dtop1045.str**

Filename **dumpdesign1**

Output Format Type **Surpac String Files**

Extension **.str**

Options...

Purpose

String Range

File format text binary

DTM/3DM Options

Force solid validation on save

Force rigid backwards compatibility

Save styles

Styles file name

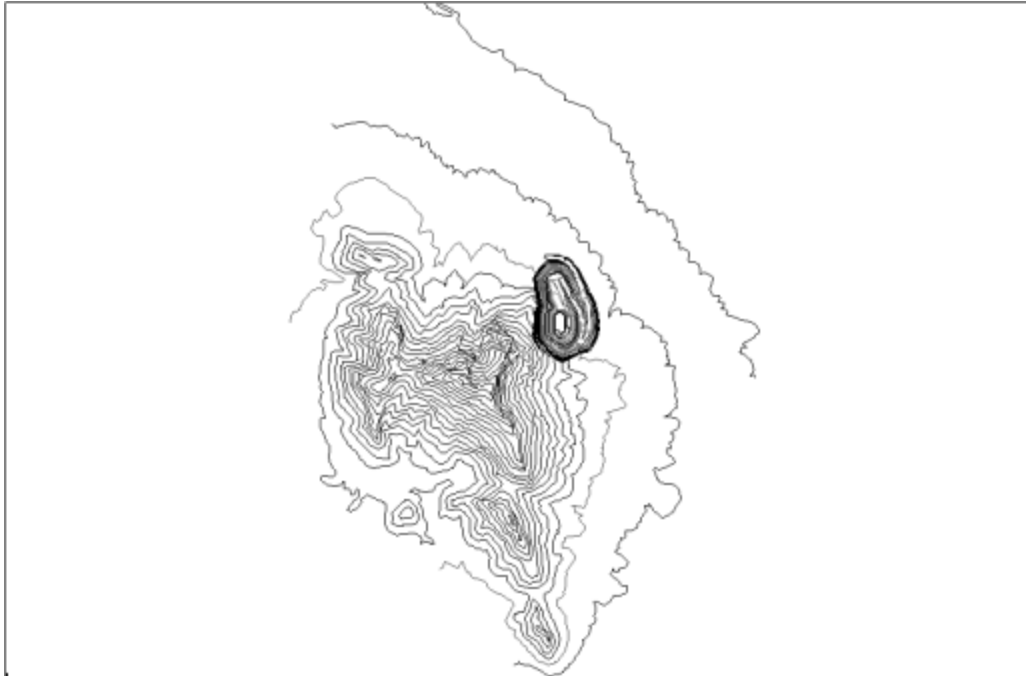
31. Choose **Surfaces > DTM File functions > Create DTM from string file.**

32. Enter the information as shown, and click **Apply**.

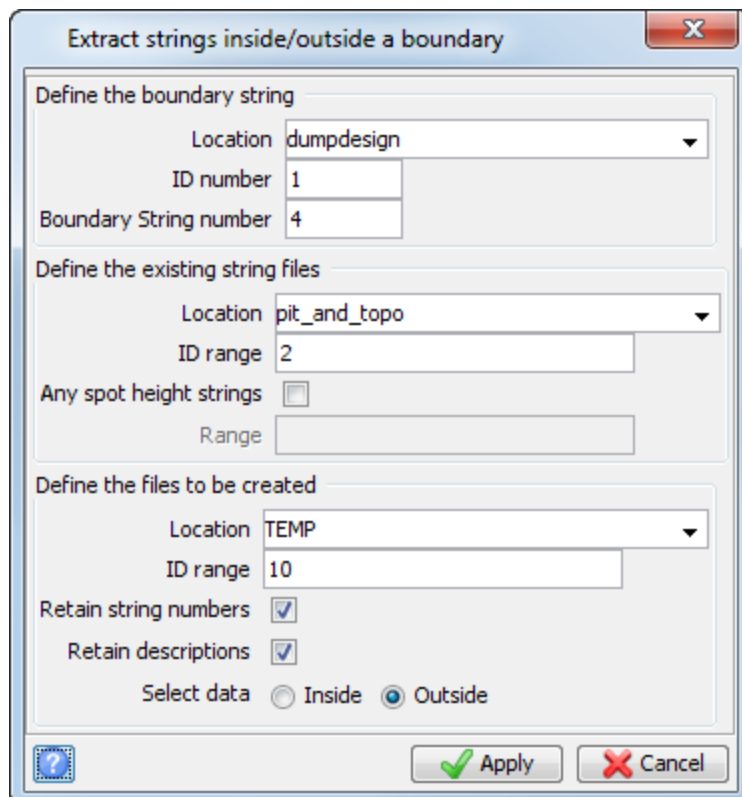
Next you will clip a hole in the topographic surface around the dump design. For a boundary string, you will use the dump design string that lies on the topographic surface (string #4). Then you will append the clipped topographic string file and dump design strings, and create a DTM of the surface. To achieve this you will use the previously created topographic surface which has already been combined with the pit design strings. The two files to combine are **pit_and_topo2.str** and **dumpdesign1.str** .

33. Click **Reset graphics** .

34. Open **pit_and_topo2.str**.
The pit and topography are displayed.

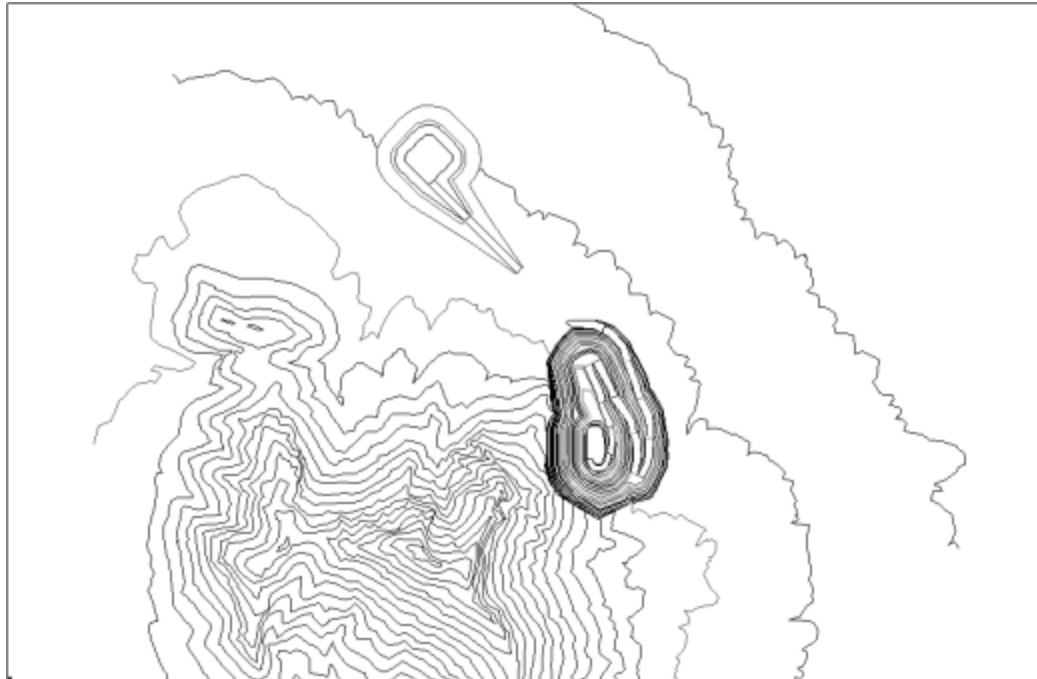


35. Select **File tools > Apply boundary string**, and enter the parameters as shown below.

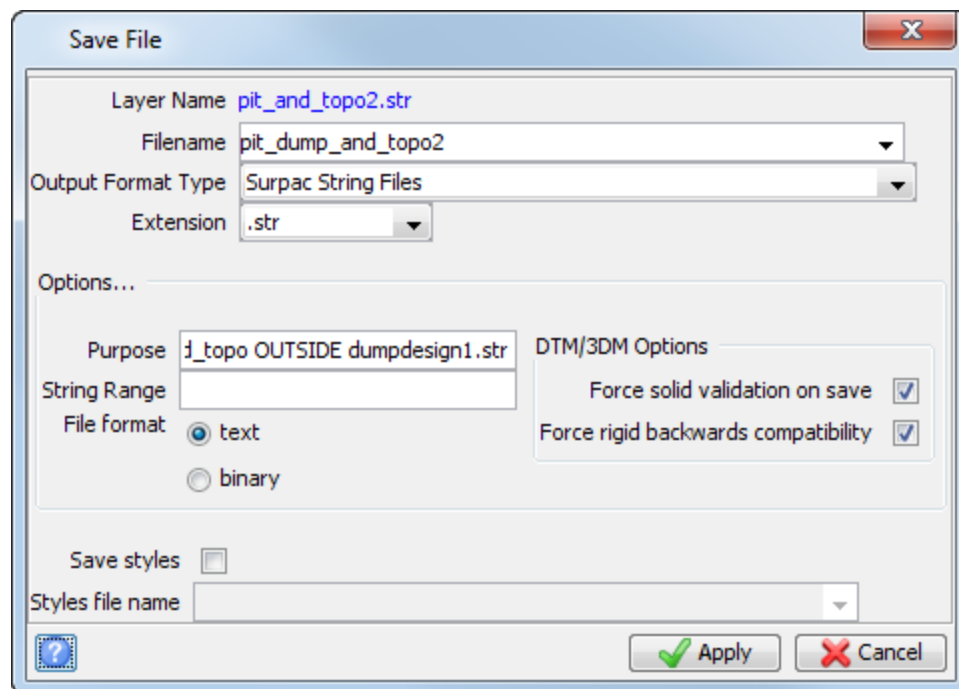
A screenshot of the 'Extract strings inside/outside a boundary' dialog box. The dialog is titled 'Extract strings inside/outside a boundary' and has a red 'X' button in the top right corner. It is divided into three sections: 'Define the boundary string', 'Define the existing string files', and 'Define the files to be created'.
- 'Define the boundary string': Location is 'dumpdesign', ID number is '1', and Boundary String number is '4'.
- 'Define the existing string files': Location is 'pit_and_topo', ID range is '2', 'Any spot height strings' is unchecked, and 'Range' is empty.
- 'Define the files to be created': Location is 'TEMP', ID range is '10', 'Retain string numbers' and 'Retain descriptions' are checked, and 'Select data' has 'Outside' selected.
At the bottom, there is a help icon (question mark in a blue square) and two buttons: 'Apply' (with a green checkmark) and 'Cancel' (with a red X).

36. Open **dumpdesign1.str** to the current layer using the replace option.

37. Open **temp10.str**, appending it to the current layer.



38. Choose **File > Save > string/DTM**.
 39. Enter the information as shown, and click **Apply**.



40. Create a DTM of **pit_dump_and_topo2.str**.
 41. Open **pit_dump_and_topo2.dtm** into the same layer as the string file, replacing the string file.

Note: To see all of the steps performed in this task, run **_17_waste_dump_design.tcl**. You need to click **Apply** on any forms presented.

Task: Calculate dump volume

Now you will calculate the total volume of the dump.

1. Choose **Surfaces > Volumes > Net volume between DTMs**.
2. Enter the information as shown, and click **Apply**.

3. Enter the information as shown, and click **Apply**.

The form below gives you the option of saving the DTM clipped within the boundary string. This is done for visualization purposes as this allows you to colour the dump differently to the surrounding topography.

✍ **Note:** As a general rule of thumb you should only use clipped DTMs for visualization, and not for other DTM functions.

After you apply the second *Save A Modified Dtm* form, the volume is calculated and written to a note file called **top1.not**.

4. View **top1.not** in a text editor.
The report is displayed.

```
VOLUME BETWEEN DTM SURFACES

Upper surface: dumpdesign1.dtm
Upper surface object ID: 1
Upper surface trisolation ID: 1
Lower surface: top1.dtm
Lower surface object ID: 1
Lower surface trisolation ID: 1

Boundary file: dumpdesign1.str
Boundary string: 4
Number of segments: 1
Density: 1

Volumes
Segment 1:
  (Volume) 1929861
  (Tonnage) 1929861
Total: 1929861
```