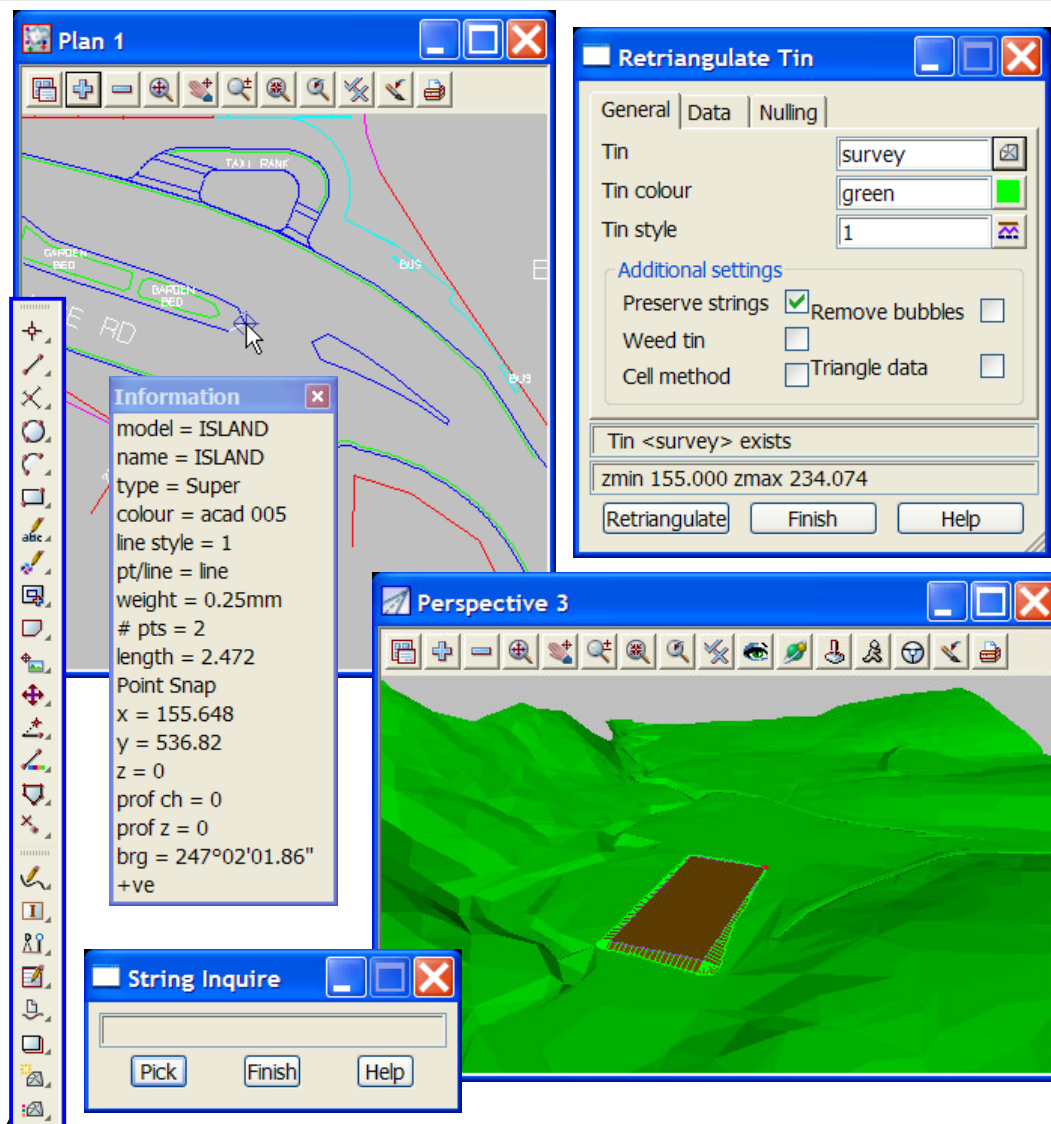




12d Model Course Notes



INTRODUCTION TO 12d MODEL Course Notes



12d Model Course Notes

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Sonia Robinson – April 2013

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Description:	Introduction to 12d Model Data Setup
Level:	Fundamental
Outcomes:	After completing this module you should understand how to setup and Install the Training Data for the Introduction to 12d Model Course.

INSTALL TRAINING DATA

To install the Training Data, please download the data from the EXDS website via the following link:

<http://www.exds.com.au/Trainingyou/CourseNotes.aspx>

The data set used in this training session is to be saved on the c:\ drive.

Once you have downloaded the zip file, open it and extract the files to the c:\drive, the training data will then be placed into the correct folders:

C:\12d\10.00\EXDS_Training\12d-1A_Introduction_to_12d\12d-1A_Introduction_to_12d_Part_1

C:\12d\10.00\EXDS_Training\12d-1A_Introduction_to_12d\12d-1A_Introduction_to_12d_Part_2

These folders above are referred to as the '**Working Folders**' and will contain the 12d Model '**Projects**'.

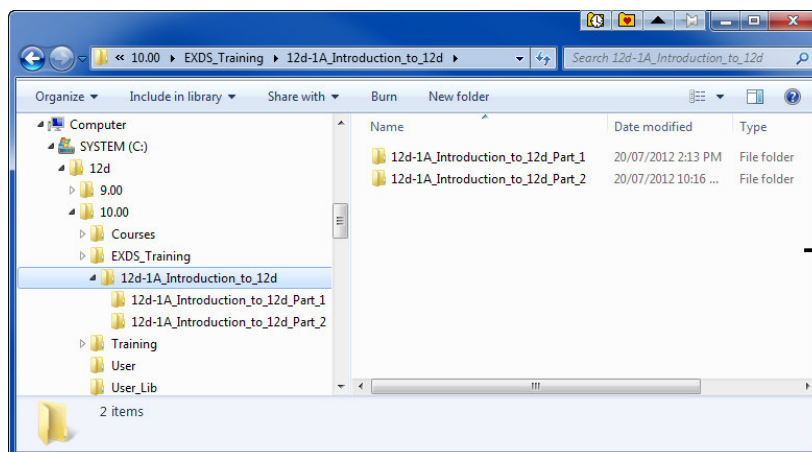
The 12d Model data used in this training session is also located in the project folders:

- 12d Model - .12da file (12d ascii file)
- AutoCAD - .dwg file (drawing format)
- AutoCAD - .dxf file (data exchange format)
- CivilCAD - .as5 file (ascii 5 format)

All the files for this course are in 2 folders, as we will create 2 Projects in this training course.

These folders will be the 'Working Folder', for the new projects.

(NOTE: NOT all these files will be used in every course.)



Working Folders created after extracting the Training Data from the Zip File.

Your folder may look slightly different, but the 'Working Folders' will be the

"12d-1A_Introduction_to_12d_Part_1" and

"12d-1A_Introduction_to_12d_Part_2" Folders.

They contains the data set for this course, as well as where the 12d Model projects will be placed.

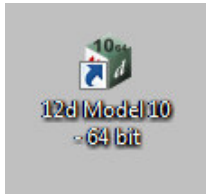


Description: Project Creation and Management

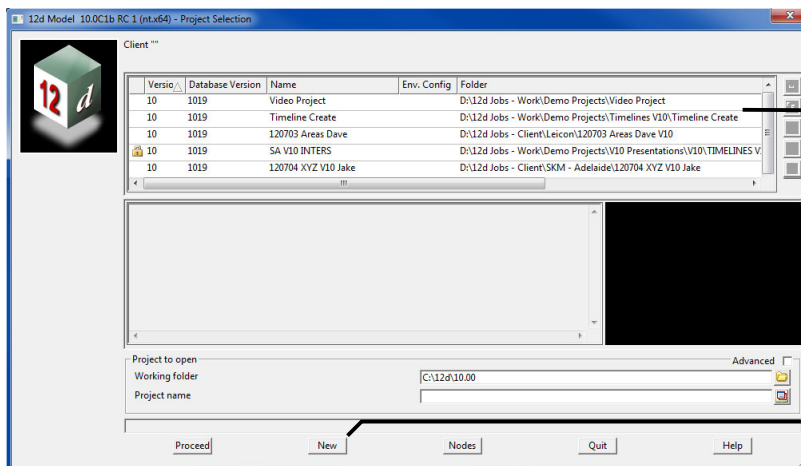
Level: Fundamental

Outcomes: After completing this module you should understand how to create a new Project how 12d Model stores Projects, and how to include Meta Data with your Project.

CREATE A NEW PROJECT

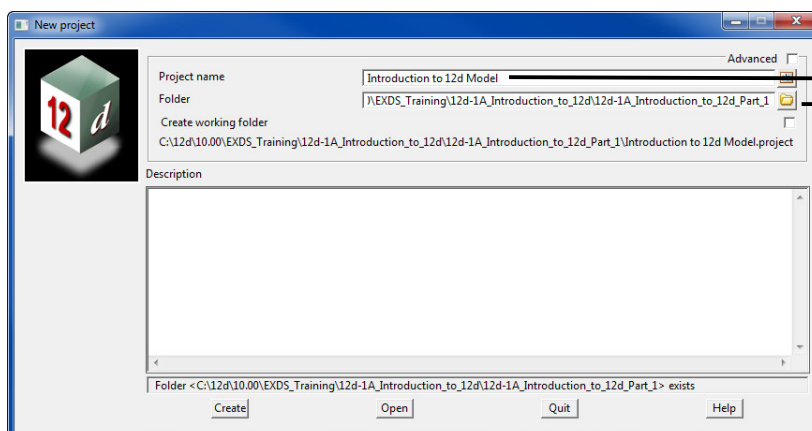


Double click on the desktop icon to start 12d Model.



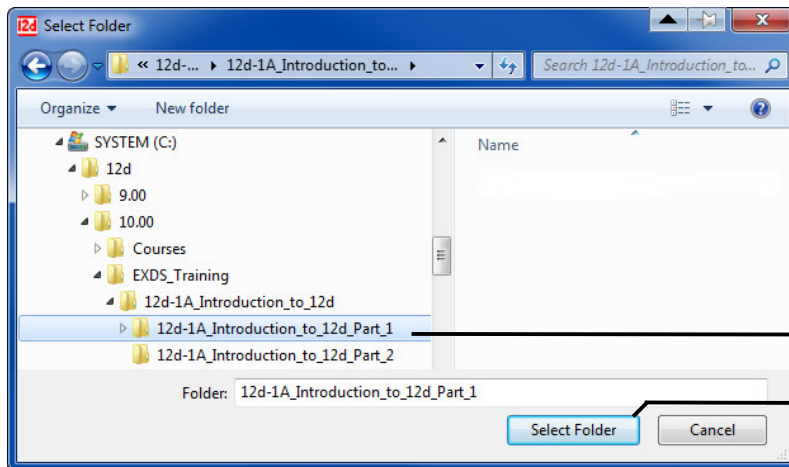
12d Model will start, and show a list of the most recently used projects. We will not use any of the existing projects; instead we will create a new project.

To start a New project click on **New**



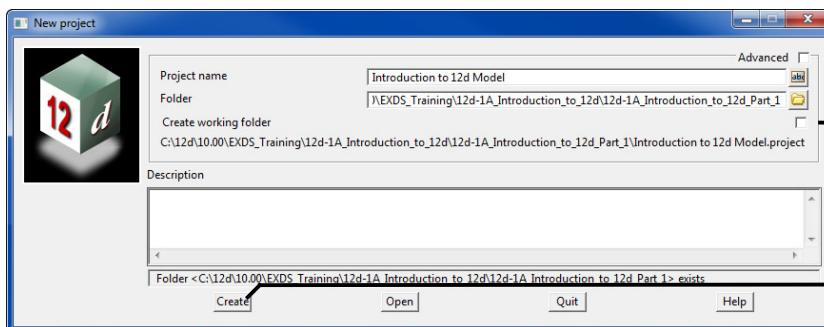
Type in a new project name. You should name your project **Introduction to 12d Model**

Click the yellow folder button to open a browser.



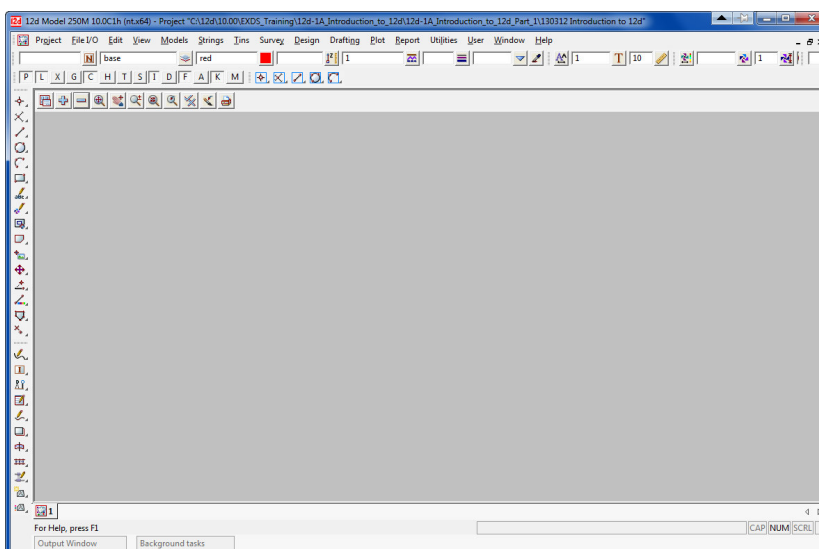
Browse to
12d-1A Introduction to 12d Part 1

Folder and press **Select Folder**



Ensure that **Create working folder**
is **not** ticked.

Press **Create**.



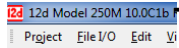
12d Model opens a new project
with a new plan view.





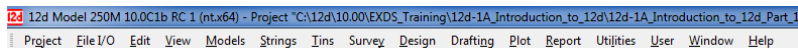
12D MODEL VERSION AND MENU LOCATION

This is the main menu structure of 12d Model that will be described throughout these course notes:



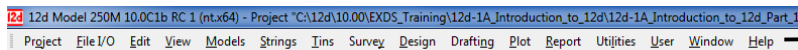
12d Model Version

The version we are using is 10.0C1b



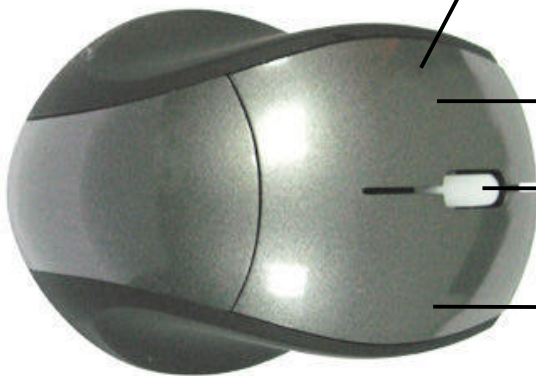
12d Model Project Location

For the current project



12d Model Main Menu Location

USING THE MOUSE IN 12D MODEL AND THIS MANUAL



Left Click

Press the left mouse button - Pick

Double Click

Press the left mouse button twice quickly

Accept

Press the middle mouse button (or wheel) quickly

Right Click

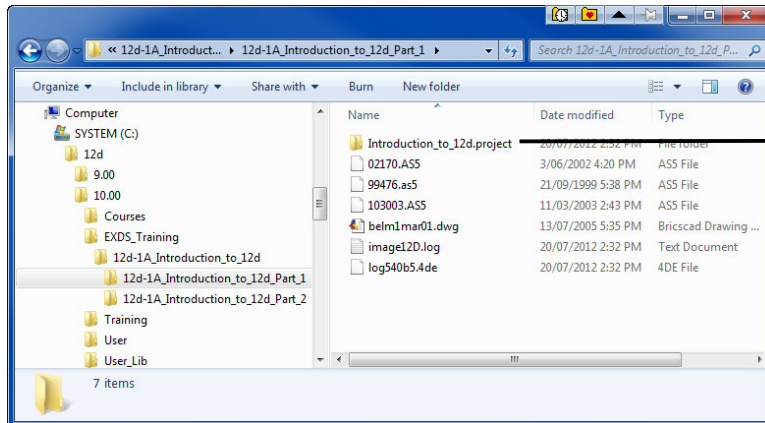
Press the right mouse button for menu options



PROJECT STORAGE ON YOUR HARD DISK DRIVE

The data used for this training session is stored in the folders shown below:

The 12d Model project is stored in the **Working Folder**



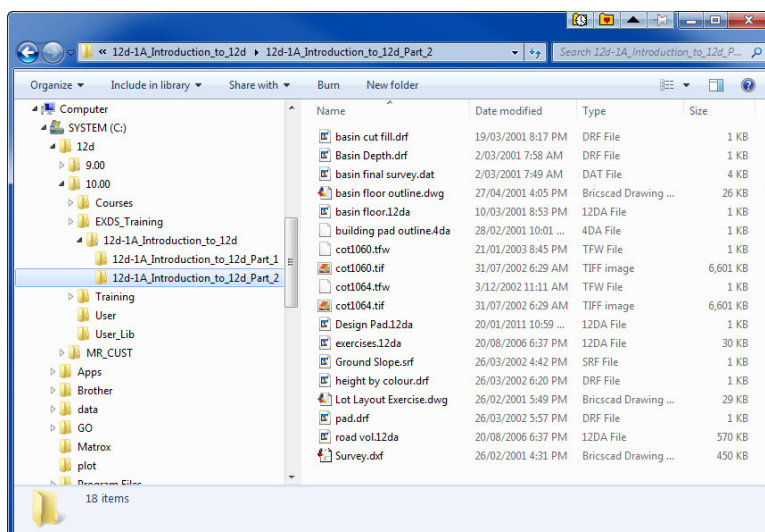
In this case, the

12d Model Project is called
Introduction to 12d.project

12d Model projects always have the
word **.project** as a suffix

The files inside 'Introduction_to_12d.project' folder belong to 12d Model

DO NOT mess with the files inside the 12d project !!



Introduction to 12d Model Part 2
Data Set



PROJECT DETAILS

The Project Details panel is displayed when a project is first created. It is used to enter metadata relevant to the project.

Project Number	
Drawing Number	
Site Address	
Job Title 1	
Job Title 2	
Job Title 3	
Job Title 4	
Client Name	
Customer Name	
Manager Name	
Surveyor Name	
Designer Name	
Checker Name	
Computer Operator Name	
Note 1	
Note 2	
Note 3	
Note 4	
RMA reference	
Start Date	
Datum	

Set Load Finish

The **Project Details** panel opens automatically on a new project, and can be accessed at anytime using:

Project => Details => Details

Metadata entered here can be linked to the 12d Title block file and will appear on every title sheet, when you plot from 12d Model.

(Additional information specific to a particular drawing can be entered separately before plotting).

PROJECT DESCRIPTION

The Project Description is a place to keep notes about the project. This allows users to track changes over the history of the project for future reference.

INTRODUCTION TO 12d PROJECT
Created By:
Date: xx/xx/xxxx
xx/xx/xxxx - This project was created for Training Purposes

Set Finish Help

The Project Description panel is opened using:

Project => Details => Description

Type a description into the white area, then press **Set**

Finish to close the panel

Version	Database Version	Name
10	1019	Video Project
10	1019	120720 Introduction to 12d V10
10	1019	Timeline Create
0	701	Standard

INTRODUCTION TO 12d PROJECT
Created By:
Date: xx/xx/xxxx
xx/xx/xxxx - This project was created for Training Purposes

The information that you type into the Project description panel is shown when you need to select an exiting project.

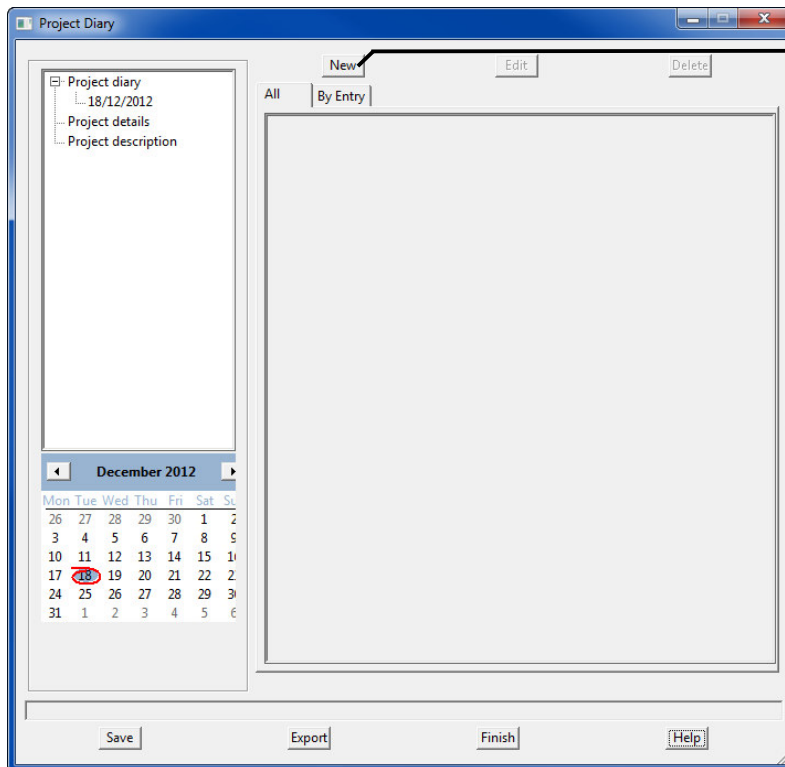
The Project Description will appear in the Project Selection panel when the project is highlighted.





PROJECT DIARY

The Project Diary is where you can document changes for projects.

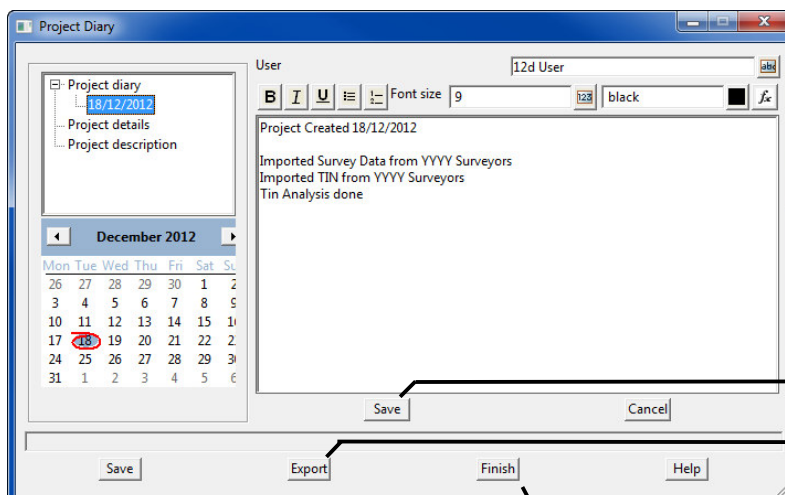


When **New** is selected, a Diary Entry is opened and the information can be typed in.

The Diary allows entries to be added for each day.

The Entries can be added to the current day, and also any previous days.

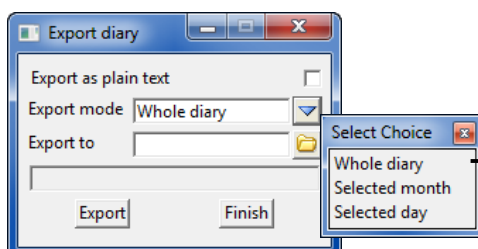
Entries **can NOT** be added to future days in the calendar.



Press **Save**, so the Entry is saved in the Diary.

Press **Save**, so the Entry is saved in the Diary.

Press **Export** to export the Diary entries to a document (.rtf)

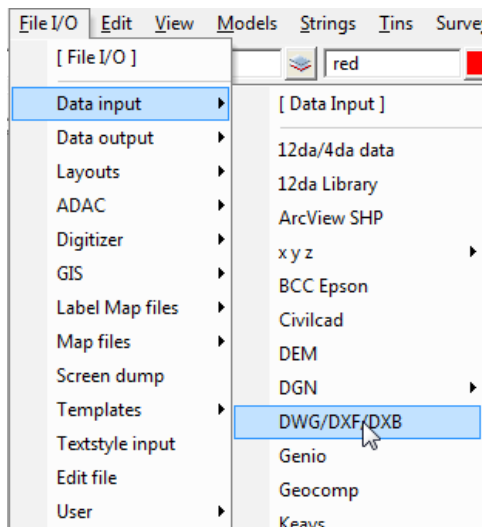


The Whole Diary, a selected Month or selected Day can be exported



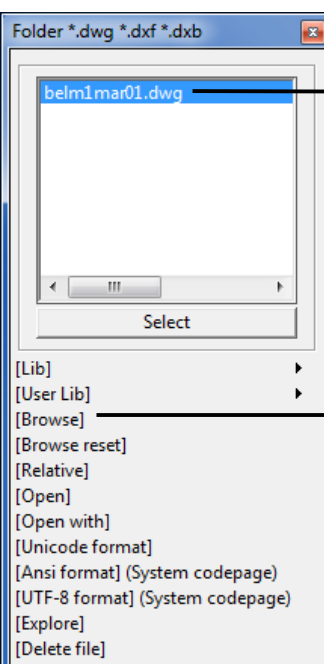
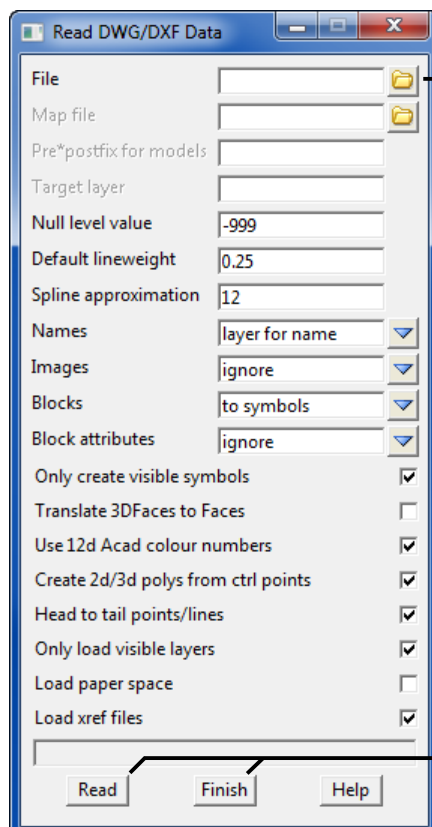
Description:	Importing CAD Data, Inquiring, Measuring, Navigating and Saving
Level:	Fundamental
Outcomes:	After completing this module you should be able to import data into 12d Model, control what is displayed on the screen, and do simple inquire and measure operations.

IMPORTING CAD DATA



From the Main Menu select:

File I/O => Data Input => DWG/DXF/DXB.



Click the folder icon to bring up a list of dwg files in the **Working Folder**

Choose the file to import into 12d Model.


You can double click, or you can pick it and press **Select**

If the dwg file is not in the **Working Folder**, you can pick **Browse** to find the file on your system.

When you have chosen the file, Press **Read** to import the file into 12d Model, then **Finish** to close the panel

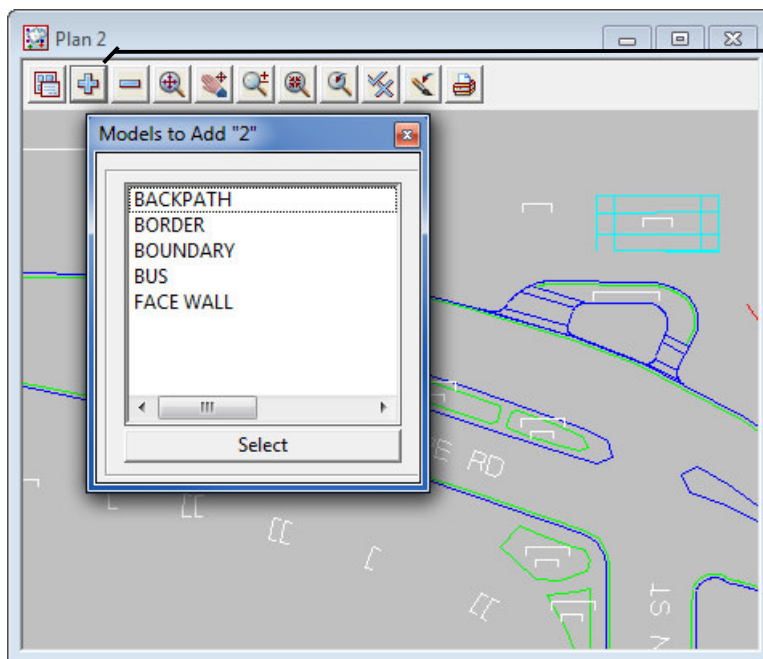



VIEWING DATA

In 12d Model **Layer = Model**. To display models on the view, click the  button, and choose the model you wish to see. You can double click on a single model to display it, or you can select multiple models by selecting them from the list.

The <shift> and <ctrl> keys work in the standard windows way, to select multiple models.


ADDING MODELS TO A VIEW



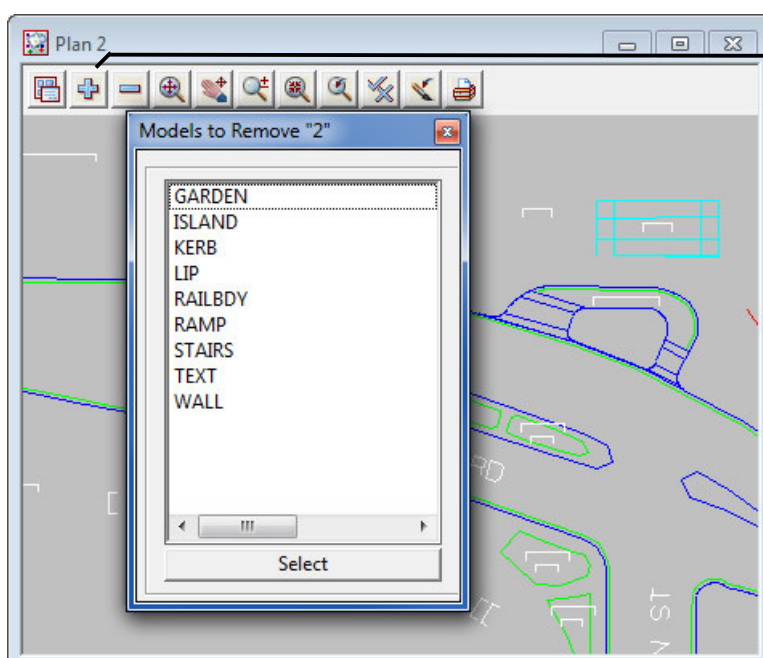
Click  to display the 'Models to Add' list.


Select the models you wish to display and click **Select**

In 12d Model a layer is called a Model.


The  button is used to add models to the view so that you can see them.


REMOVING MODELS FROM A VIEW



Click  to display the 'Models to Remove' list.


Select the models you wish to remove and click **Select**

The  button is used to remove models from the view so that they are not displayed.

Clicking the  button is a useful way of seeing which Models are on the view.

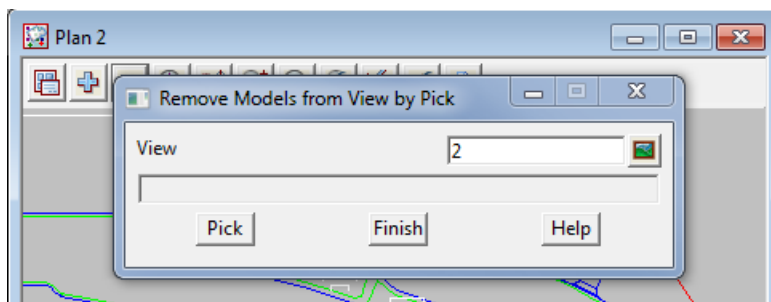


REMOVING MODELS FROM A VIEW BY PICKING

Another method for removing Models from a view is to click the  with your middle mouse button.

This will open the **Remove Models from View by Pick** panel. You can then pick lines from the screen to remove a model. Each time you pick an information panel will appear to give you information about the line you have picked. To remove the model, you must click the middle button to 'accept' the line.

This is a convenient way to remove models from the view if you don't know the model they are in.



THE 'VIEW TOOLBAR'

Each View in 12d has its own toolbar which control what is displayed on the view, and how it is displayed:

Plan View



Menu "Master Menu" for this view settings.



Add Models to View where different models are selected to be displayed on that view.



Remove Models from View where different models are selected to be removed from that view.



Zoom Extents will zoom to show the extents of all the data on the view.



Pan will allow you to move the data around the view.



View Zoom allows you to draw a box to zoom into.



View Shrink allows you to draw a box to zoom out to.



Zoom Previous will go to the previous zoom area.



Toggle will allow more information to be displayed (see next page).




Redraw will refresh the screen after a command.



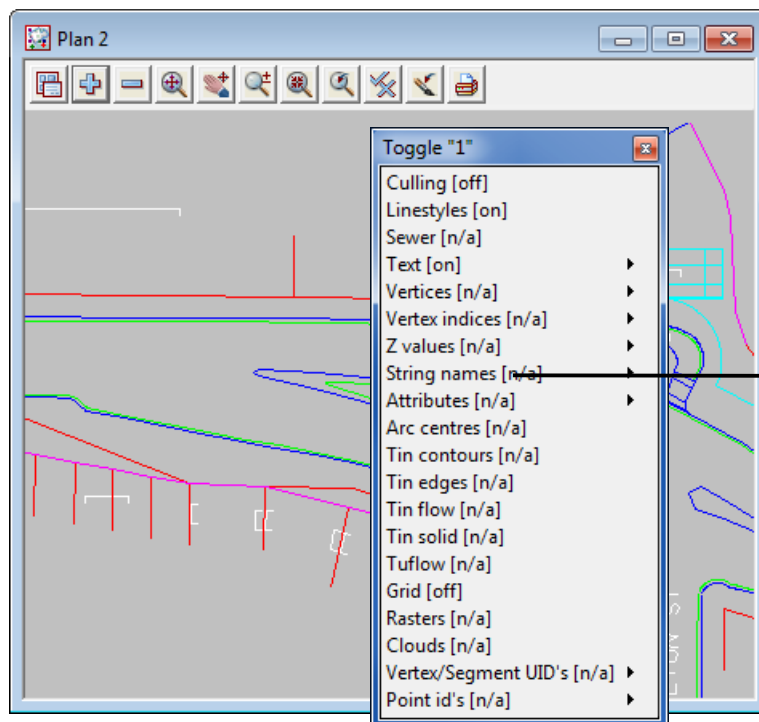
Plot allows you to plot a relevant view.



THE TOGGLE BUTTON

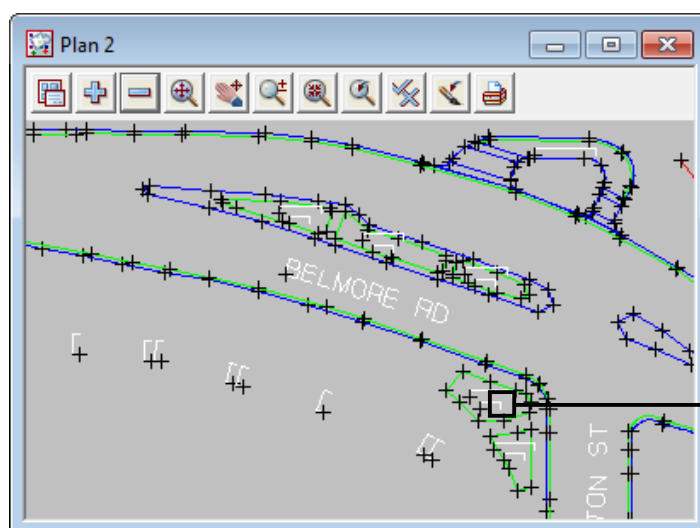
The **Toggle Button**  changes the information that is displayed in the view.

- Vertices (Points) can be turned on & off
- Z Values can be turned on & off
- Grid can be turned on



Select the **Toggle Button**
Then select the **Vertices** option

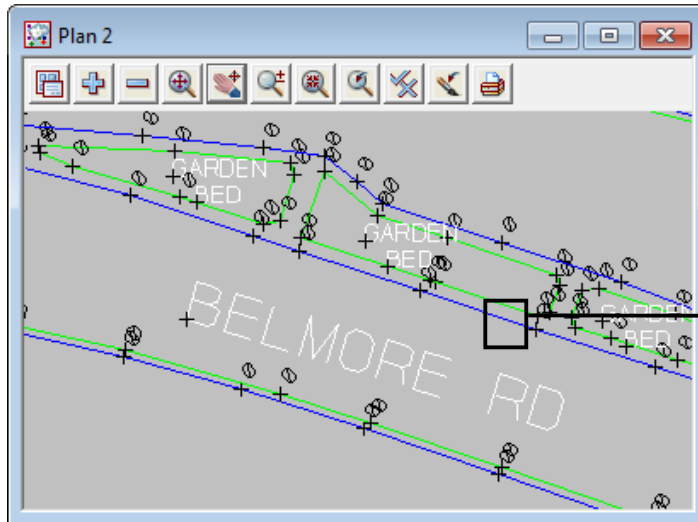
Vertices (Points)



Vertices (points) have been
toggled on

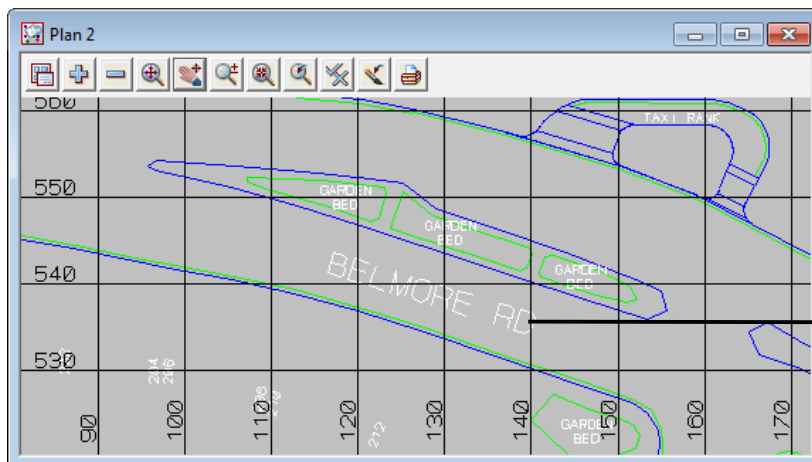


Z Values



Vertices (points) and **Z Values** have been toggled on

Grid



The **Grid** has been toggled on



STRING INQUIRE

Strings => Inquire is a very useful utility, which gives you information about the properties of a string by clicking on a string in the plan view. The **F2 button** on the keyboard is a shortcut.

The screenshot shows the 12d Model software interface with a plan view of a road layout. A 'String Inquire' dialog box is open, prompting the user to 'Please finish selection' with 'Pick', 'Finish', and 'Help' buttons. A mouse cursor is clicking on a string in the plan view. An 'Information' panel is open, displaying detailed properties of the selected string.

Choose **Strings=> Inquire** or Press **F2** then press **Pick**

Pick a string

Extensive information is displayed about the string you pick.

When you move the mouse, the information panel will close.

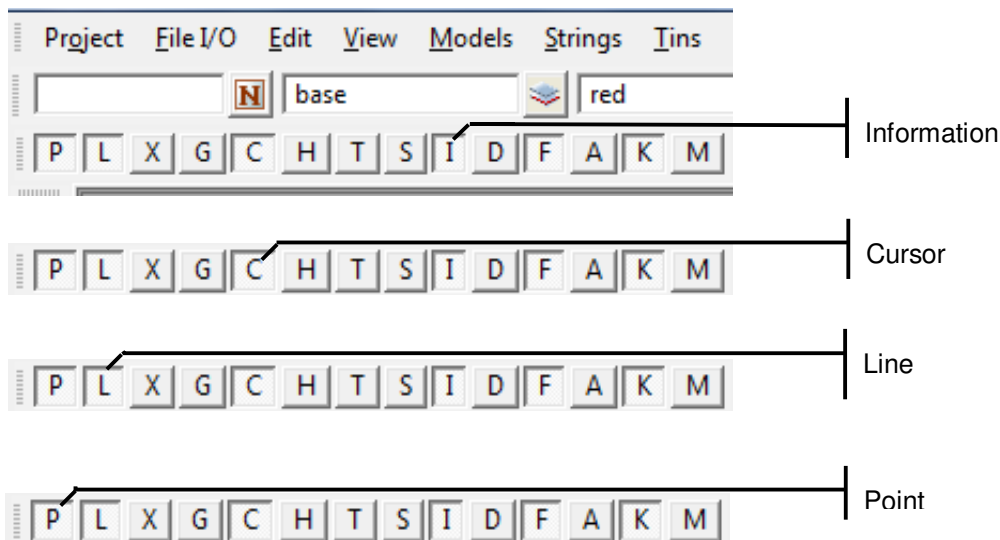
Function	
Type	File Input
Option	Read DWG DXF Data
Date	20 July 2012
Time	14h 50m 21s
General	
Model	RAILBDY
Name	RAILBDY
Type	Super
Type like	2d
Colour	acad 001
Line style	1
Pt/line	line
Weight	0.250mm
# pts	2
Length	9.269
Locks	Read (-1)
Line snap	
X	230.509
Y	507.468
Z	0.000
Prof ch	6.621
Prof z	0.000
Bearing	61°49'58.67"
+ve	
Segment	
Type	horizontal line
Length	9.269



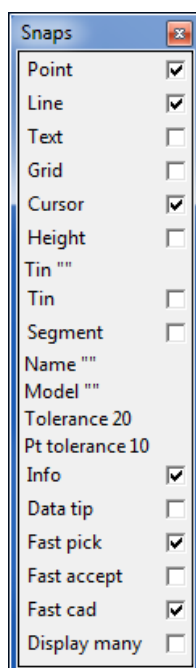
SNAPS

When 12d Model is started a snaps toolbars automatically appears under the main menu.

The snaps panel controls the type of snaps that can be picked from the screen.



A more extensive Snaps panel can be opened using: **Utilities => Snaps => Snaps**



The default 12d Model snaps are shown.

Point and **Line** to allow you to pick point and lines.

Cursor allows a freehand on-screen snap, and

Information gives extensive information about the entity that you pick.

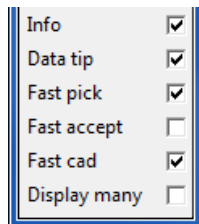
Point, **Line** and **Cursor** snaps are the most commonly used snaps in 12d Model, and these have been assigned to the **F3**, **F4** and **F5** keys respectively as shortcuts.



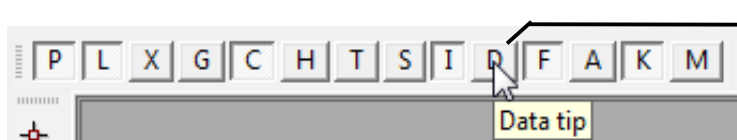
DATA TIP

Using **Strings => Inquire** gives extensive information about an entity that you pick.

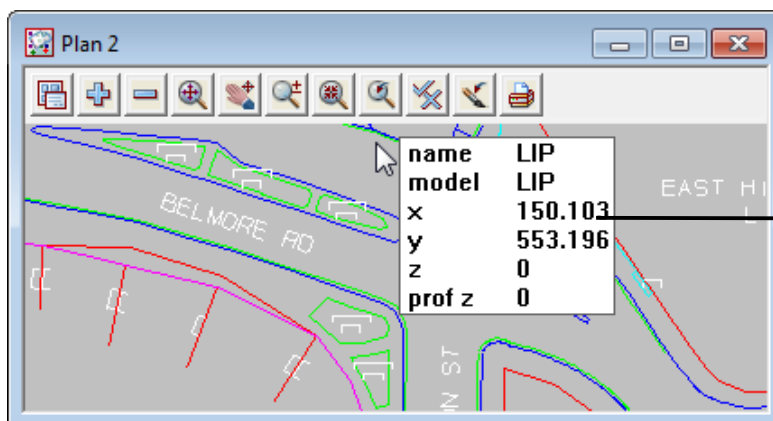
An alternative way to display limited information is to use **Data Tip**.



Data tip can be selected from the Snaps panel.



Data tip can also be selected from the Snaps toolbar.



When you hover the mouse over a string or point on the screen, an information panel will pop up.

This will remain on the screen until the mouse is moved.

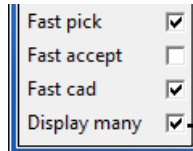
Exercises:

1. Untick all of the snaps, then try to do a **String => Inquire** of the strings in the project.
2. Click **Point** on, and try again. Toggle **Vertices** on, so that you can see the points that define the strings, and try to snap to one of the string segments.
3. Click **Line** on, and try again to snap to one of the segments.
4. Click **Info** on, and try again to snap to one of the strings. This time the information about the point will be displayed.

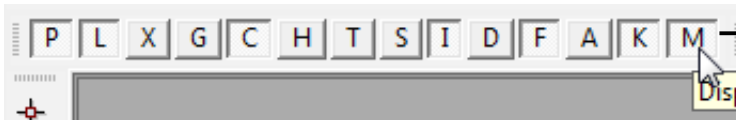


DISPLAY MANY

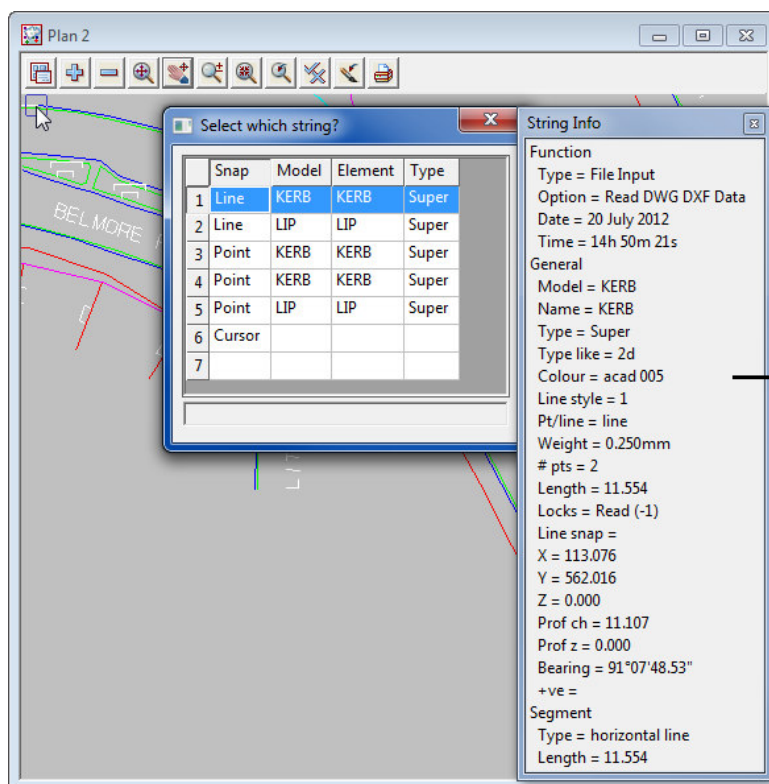
Display many will give information about all of the strings in a 20-pixel radius around the point you pick.



Display Many can be selected from the Snaps Panel.



Display Many can also be selected from the Snaps toolbar.



When you pick on any string a listing of all strings in a 20-pixel range is displayed

When you pick a line in the panel, the relevant string is highlighted, and information is displayed.

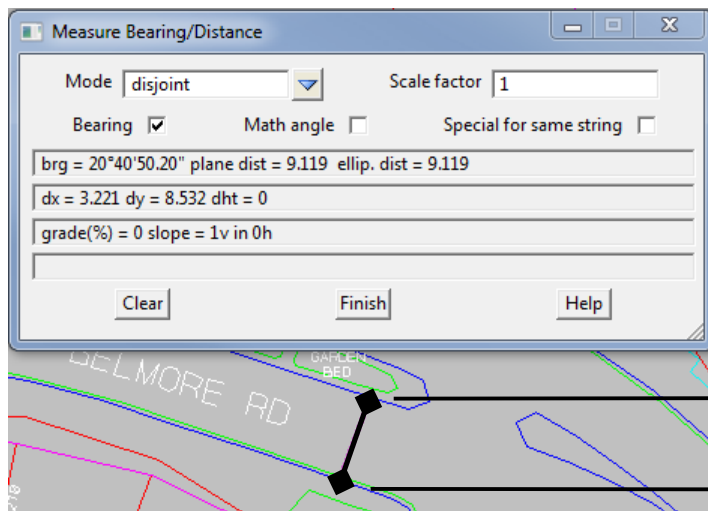
To accept the selection, double click on the line in the panel.



MEASURE – BEARING AND DISTANCE

12d Model provides an easy to use measuring tool for measuring bearing and distance between two points:

Utilities => Measure => Bearing/Distance



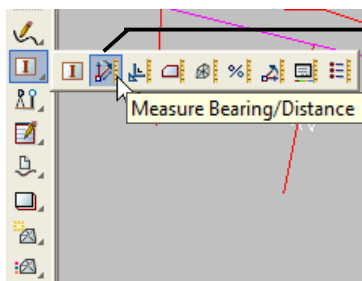
The **Measure Bearing / Distance** panel will display Bearing, Distance delta X, Y and Height

If the strings you pick have valid heights, the grade and slope of the measurement will also be calculated.

To measure, pick the start position, and accept.

Then pick the end point and accept.

Toolbar Option

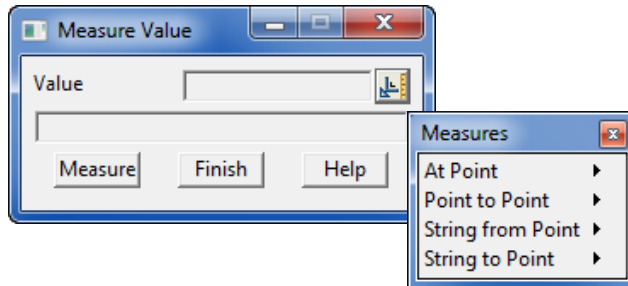


The **Measure Bearing / Distance** panel can also be opened from the toolbar



MEASURE – VALUE

From the Main Menu select: **Utilities => Measure => Value**



The **Measure Value** panel has a range of calculations.

They include selecting:

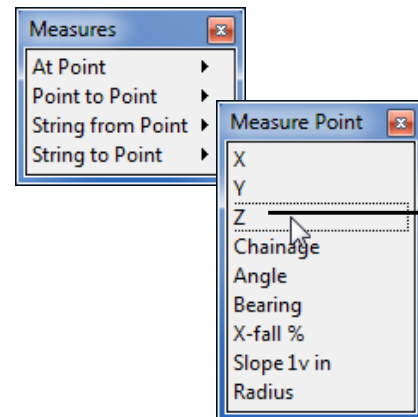
- At a Point
- From Point to Point
- To a String from a Point
- From a String to a Point

Then under each Measure Option there is a range of Values that can be measured including:

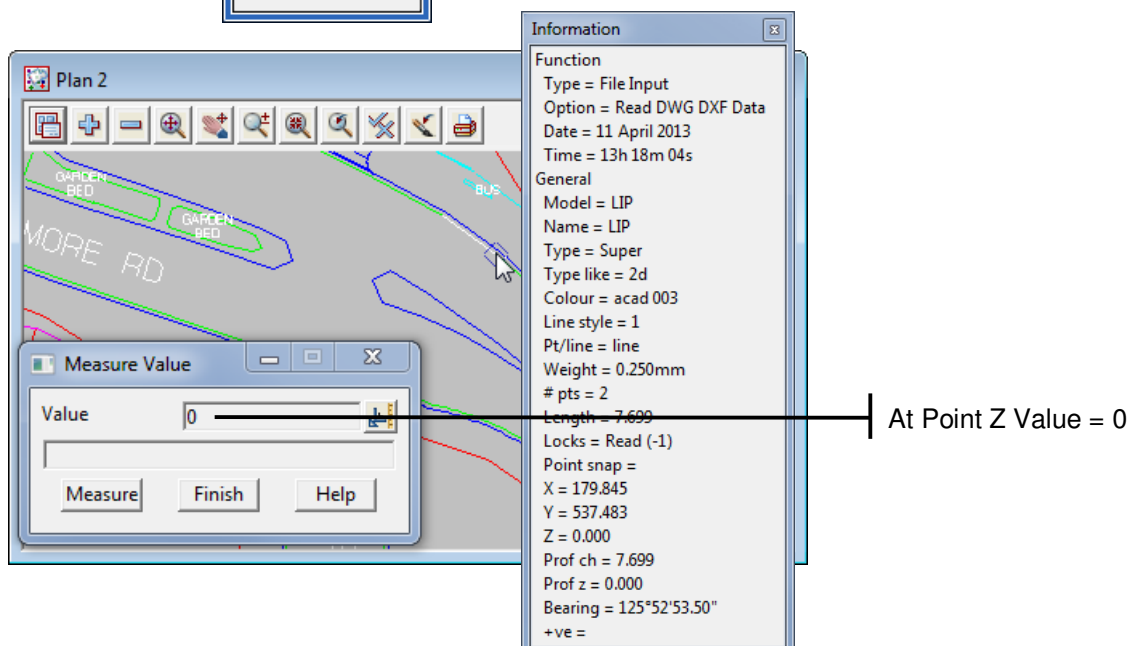
X, Y, Z, Chainage, Xfall %

DX, DY, DZ, Length, Length(3d), Xfall %, Bearing, Angle, Slope

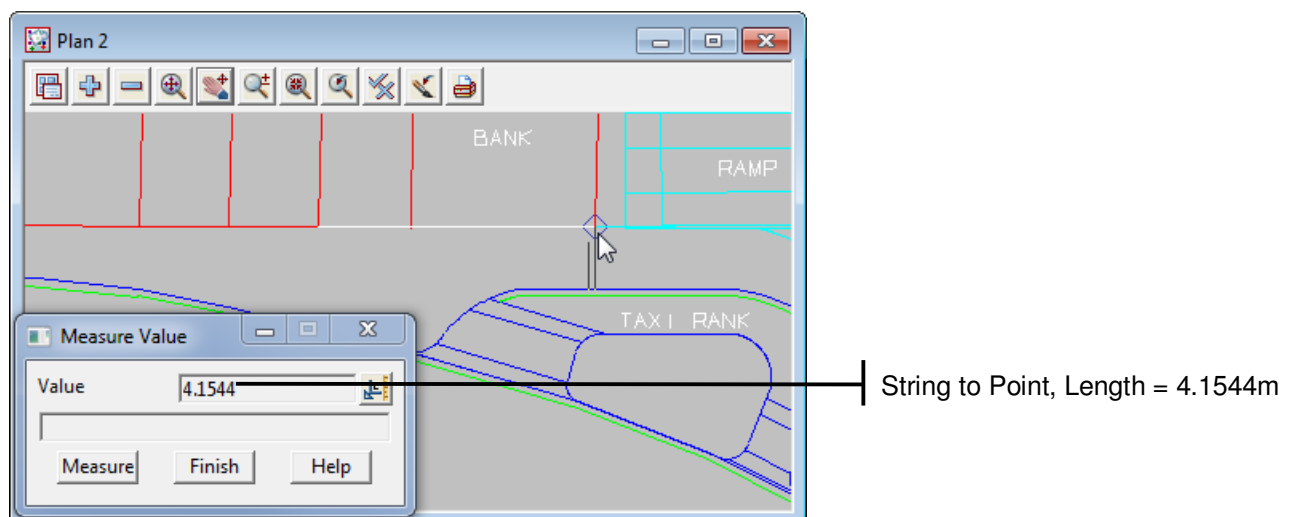
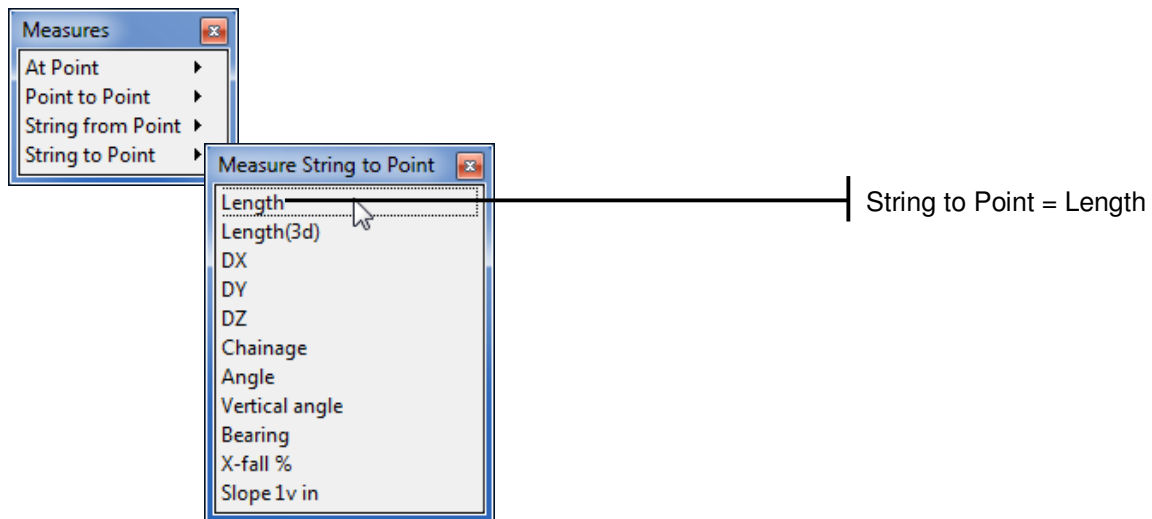
Commonly used Value Measures are:



At Point = Z Value



At Point Z Value = 0



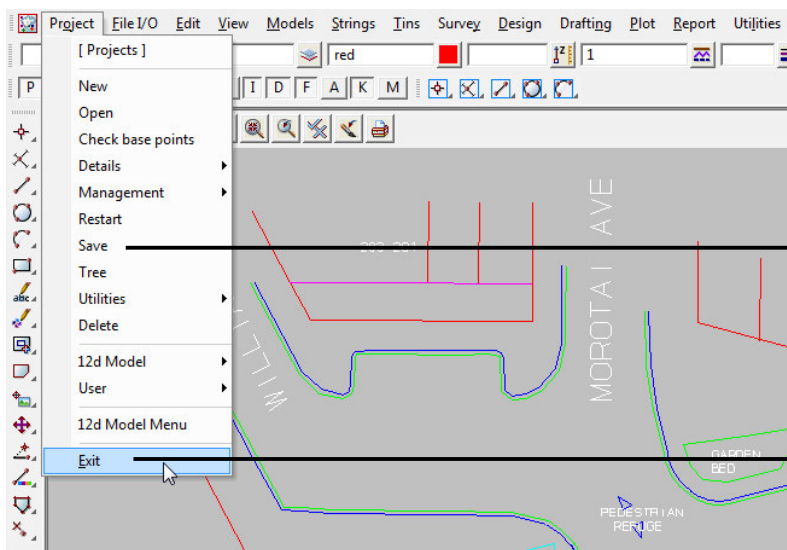


SAVE

Within 12d Model there are 3 ways to save project data to the hard drive.

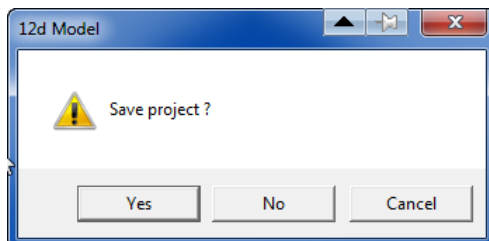
Selecting Save from the Main Menu, **Project => Save**, will save all data in the project modified since the last save.

Control "S" will do the same as above.



Select
Project => Save

Select
Project => Exit

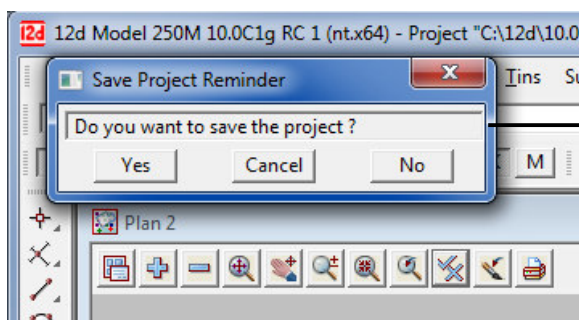


When Exit is selected from the Main Menu, **Projects => Exit** and a save is required, then the Save Project ? Yes-no panel is placed on the screen.

If **Yes** is selected, then 12d Model saves the project & exits.

If **No** is selected, then 12d Model does not save the project & exits.

If **Cancel** is selected, then the Exit command is aborted and 12d Model keeps the project open.



The **Save Project Reminder** will be displayed as a default every 15 minutes as a prompt to remind you to save your project.

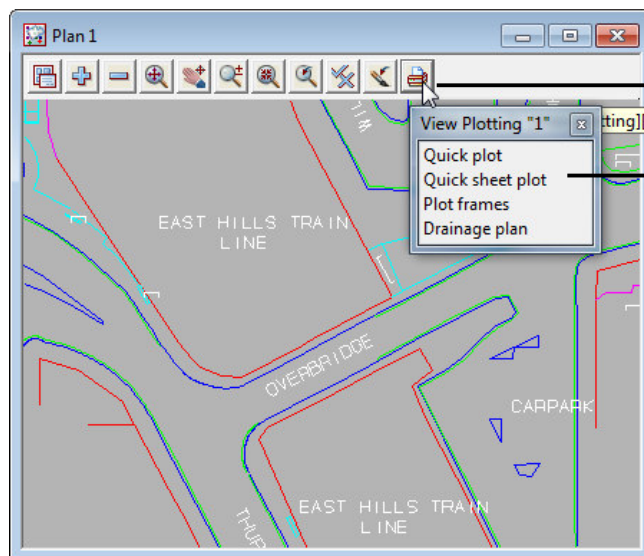


Description: Plan Plotting

Level: Fundamental

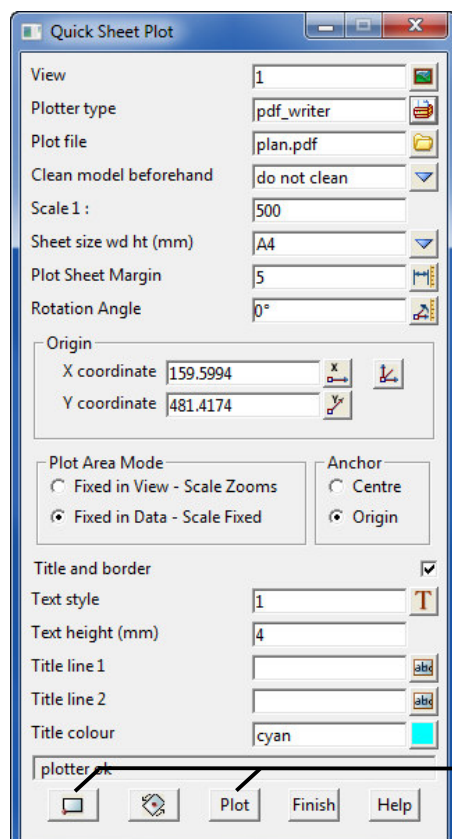
Outcomes: After completing this module you should be able to create plan plots from 12d Model.

PLAN PLOTTING



Pick the plot icon from the Plan View toolbar

Choose **Quick Sheet Plot**



Choose **pdf writer** and type in the name of the pdf file to be created

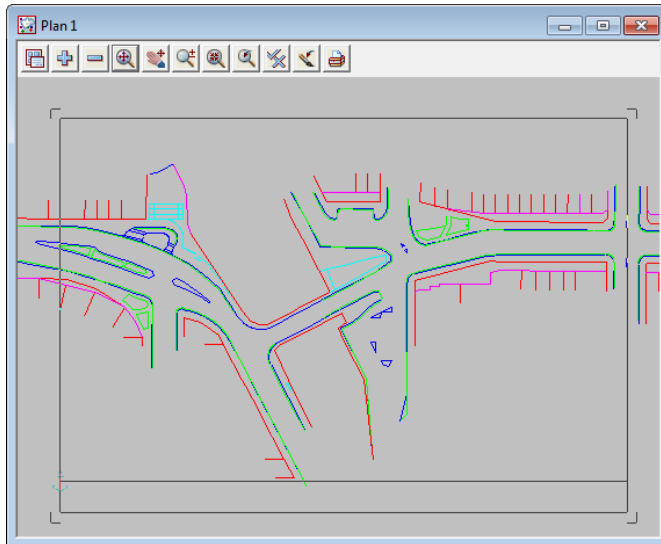
Choose a scale of 500 (that is 1:500) and a paper size of A4



Use the **Place rectangle** button to choose the area to be plotted.

Press the **Plot** button to create the plotted data



CHOOSING WHAT TO PLOT



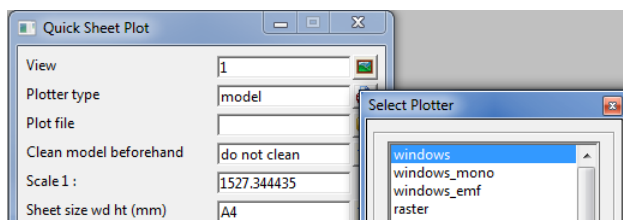
Use the  and  buttons on the view to add and remove models from the view you are plotting from. Use the toggle button to control the display of vertices and string names or elevations.

The plot is a 'what you see is what you get'.

The plot sheet is shown on the plan view, and shows that area to be plotted. The sheet size shown depends on paper size and plot scale.. If you set a larger sheet, you will plot more of the data. If you choose a larger scale (eg 1:100 instead of 1:500) the detail will be large, but you will only get a small area of land onto the sheet.

The position and rotation of the plot sheet is controlled using the buttons at the bottom of the panel.

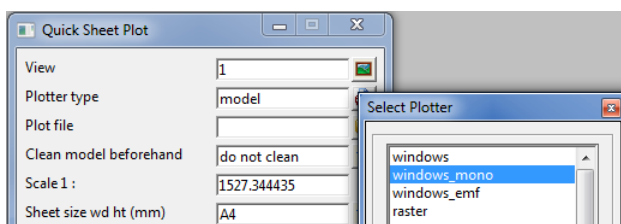
CHOOSING WHERE TO SEND THE PLOT



The **windows** Plotter will send your plot to a Windows printer, using the windows printer driver.

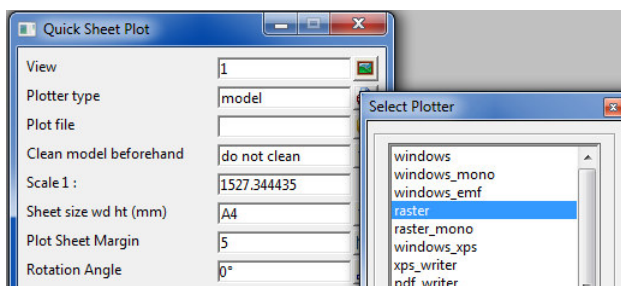
If you have a colour printer, the lines will be coloured. If you have a black & white printer the lines will be different shades of grey depending on the colour.

If you have images or aerial photos on the view, these will not be plotted.



The **windows_mono** Plotter will send your plot to a Windows printer, but will force all lines to be black.

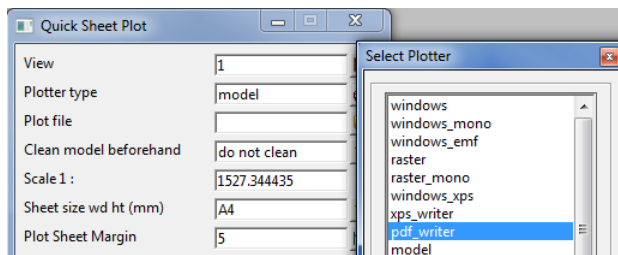
This is usually the best choice if you have a black and white printer.



The **raster and raster_mono** Plotters work the same way as **windows** and **windows_mono** but will also plot aerial photos.

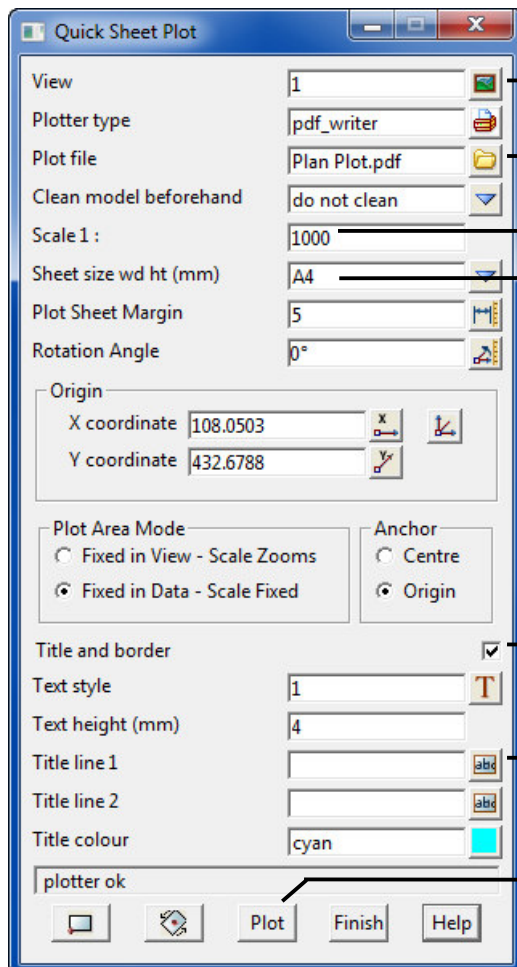
Pdf writer – what a good idea





The **Pdf writer** – what a good idea
We will choose the PDF Writer

The PDF Writer is smart enough to
change its settings for different paper
sizes, you do not need to change any
settings.



Ensure the **View** is correct – this is
the data that will be plotted.

Type in the **Name** for the PDF file.

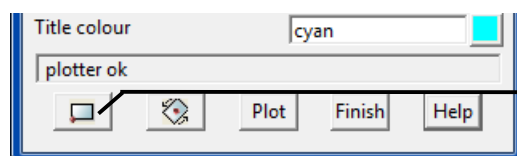
Type in the **Scale** for the Plot, then
press the enter key.


Select the **Sheet size** from the list

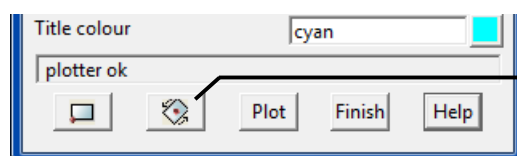
If you do not require a Border and
Title information for the Plot, **Untick**.


Type in Information for the Title if the
plot into these 2 lines, you can also
select **Text style**, **Text height** and
Title Colour for the Text and Border.

Press the **Plot** button to create the
PDF, it will be saved to the Working
folder.

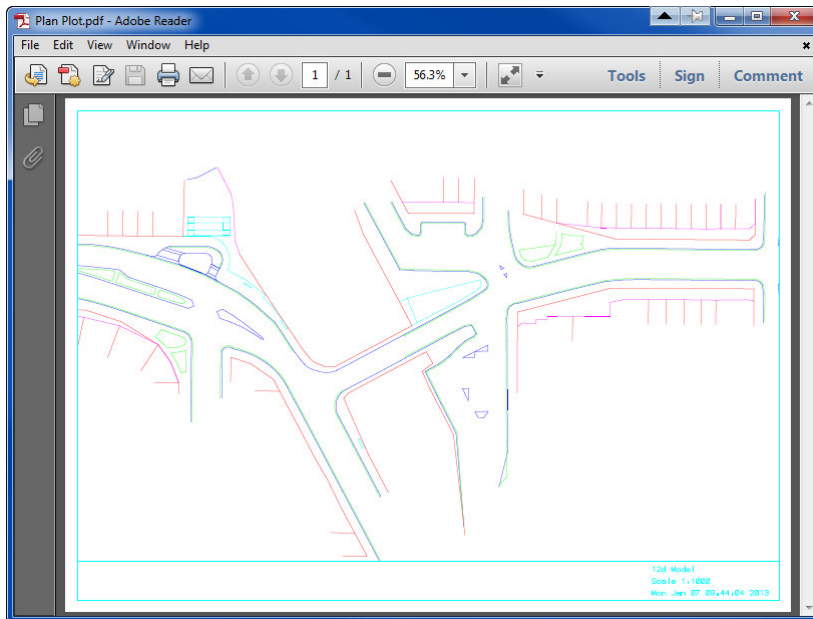


Use the  button to move the plot
sheet to the desired location, then
pick and accept to set the Origin.

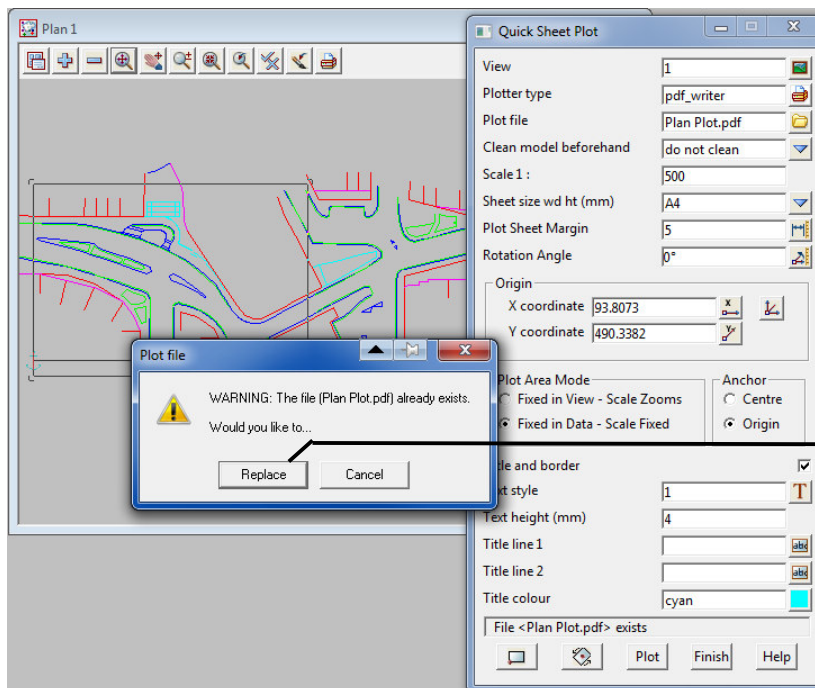


Use the  button to move and
rotate the plot sheet to the desired
location, then pick and accept to set
the Centre Point and Rotation.





The PDF file has been created.



To change the plot, here I have changed the Scale to 1:500, and repositioned the Sheet

When you press **Plot**, you will be warned that the PDF already exists. You can:

- Replace the existing File
- Cancel to keep the existing File
- Or go and change the name of the file for a new PDF file.



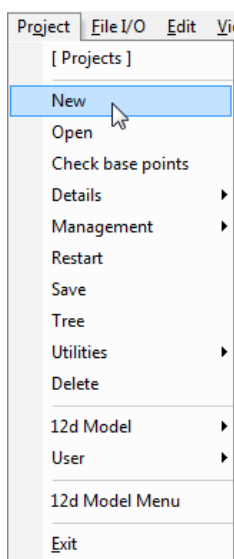
Description: Loading, Checking, Triangulating Data, and Editing a TIN

Level: Fundamental

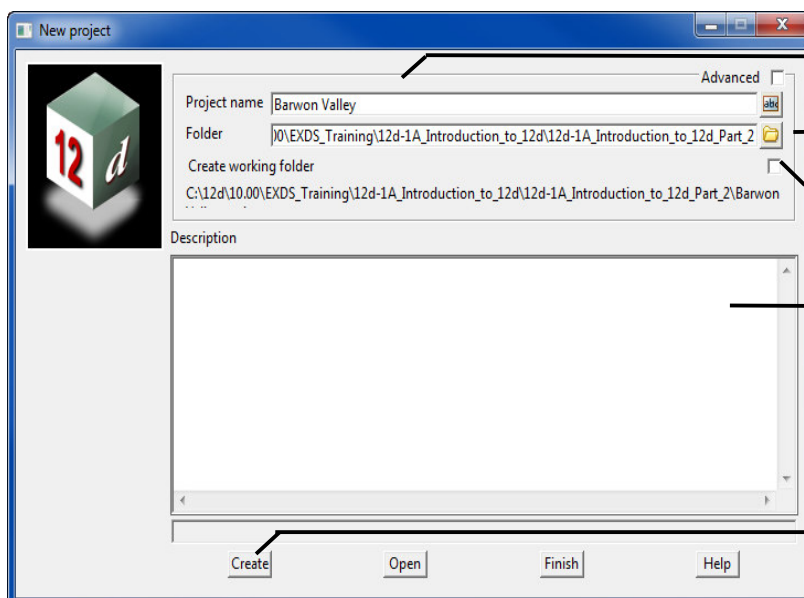
Outcomes: After completing this module you should be able to create a TIN (Triangulated Irregular Network) in 12d Model.

CREATE A NEW PROJECT

The folder: **12d-1A Introduction to 12d Part 2** will be the working folder and the Project will be named **Barwon Valley**



Use **Project => New** to create a new 12d Model Project



Type the name of the new project:
BARWON VALLEY

Browse to the working folder

Untick the option
Create Working Folder

Type a **Project Description** here
(see below)

Press **Create**

The Project description should include today's date, your name, the reason for creating the project a brief description of how you like your coffee, and anything else that might be relevant.

The description can be opened again for editing at any time using

Project=>Description.

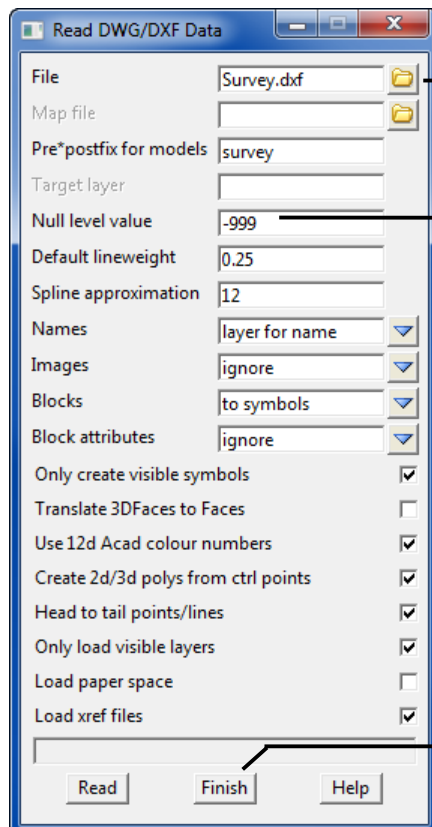




IMPORT DXF DATA

The data set for this project has been received from the surveyor in a file called **Survey.dxf**.

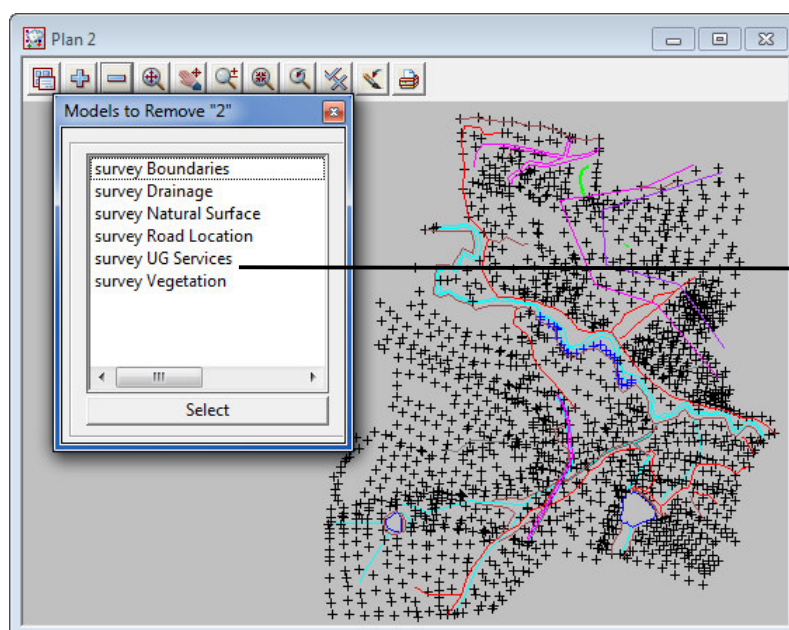
Use: **File I/O=>Data Import=>DXF/DWG/DXB.**



Click on the yellow folder, and choose **survey.dxf** from the list of available files

Type **survey** as a prefix for model names

Press **Read**, then press **Finish**



The model names all start with the word **survey**.

By typing **survey** in the Prefix box, 12d Model will place this text at the beginning of the model/s imported into the Project.

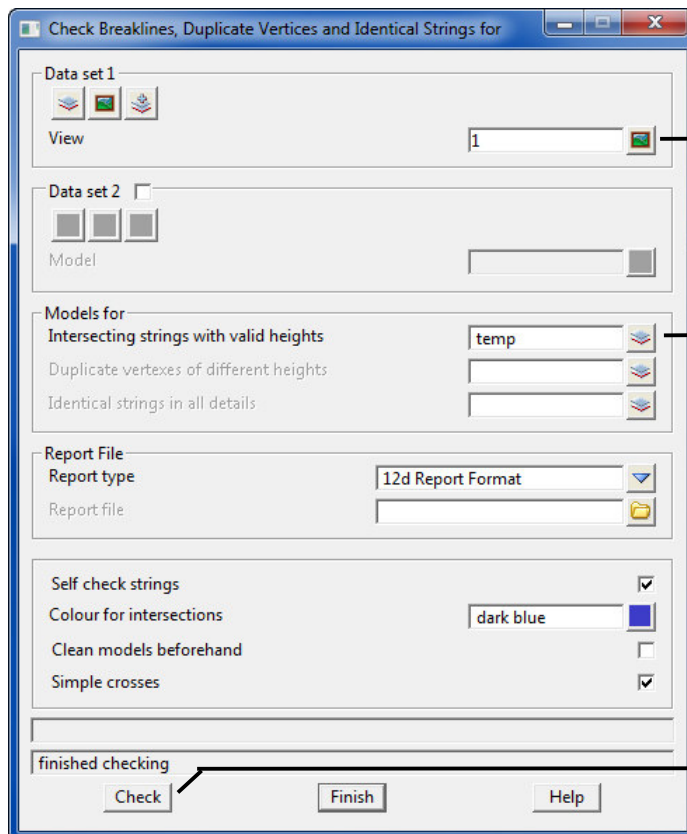
This groups them together in the Model List and identifies where the data has come from.



CHECK FOR CROSSING BREAKLINES

The survey data should be checked for crossing breaklines, and any found should be corrected before the TIN is created

Use: **Tins => Check Breaklines**



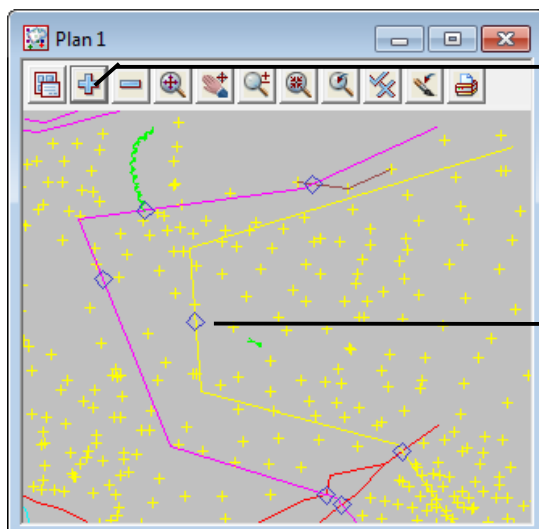
Make sure all of the survey data has been added to View 1, and then choose this view as Data set 1


Adding models to a view, then choosing that view as the Dataset is a convenient way to select a group of models.

Type in the name of a new (temporary) model.
12d will create this model and use it to store the results of the Check Breaklines operation.

Views are used often 12d Model to select data.
It is a lot easier to add the required data to a view and select that view in a panel, than choose a model or model list.

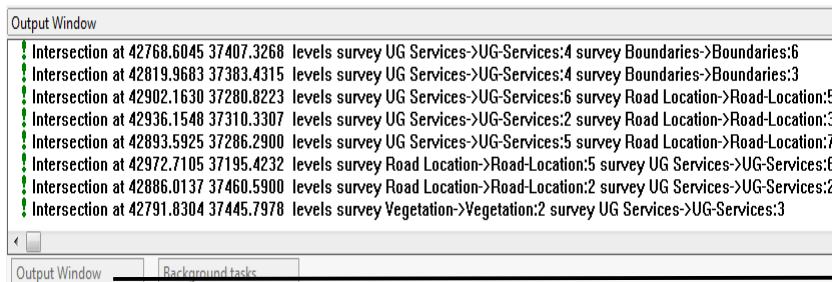
Press the **Check** button to check the crossing breaklines



Use the  button to add the new **temp** model to the screen.

Crossing breaklines are shown

Use **String=>Inquire** to find the reason for the crossing breaklines.

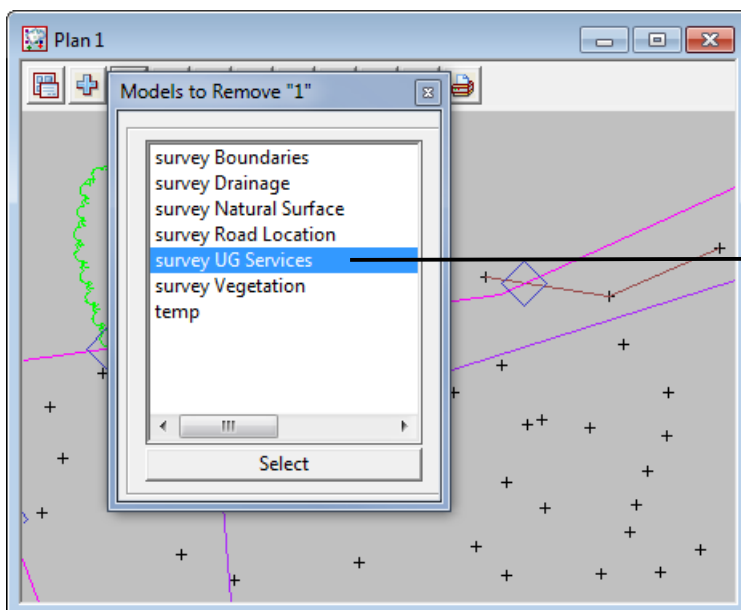


Displayed in the Output Window are the 8 crossing breaklines that were found in the data set.

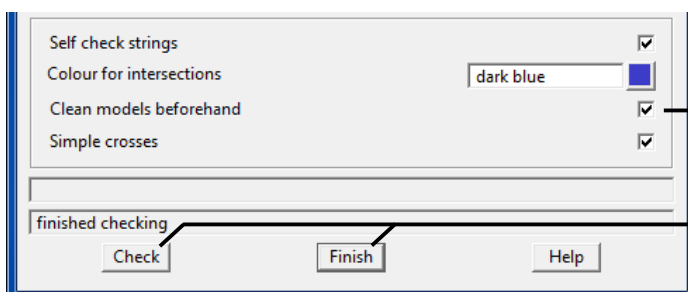
Use the **Output Window** to display any crossing breaklines that have been found.

The Information shown are the **Co-ordinates** for the intersection, along with the **Levels** of the breaklines at the intersection (interpolated levels), then the **Model and String Name** for the crossing breaklines.

The **survey UG Services** Model is listed in all the intersections found, so we need to remove it from the View 2 and re-run the Checking Breaklines options.



Remove **survey UG Services** Model from View 1 and re-run the Check Breaklines – but tick on **Clean models beforehand**.



Clean models beforehand will delete the contents of the **temp** model while still leaving the model in the project.

Press the **Check** button and the diamonds should be deleted from View 2.

The same command can be run on any model using **Models => Clean**

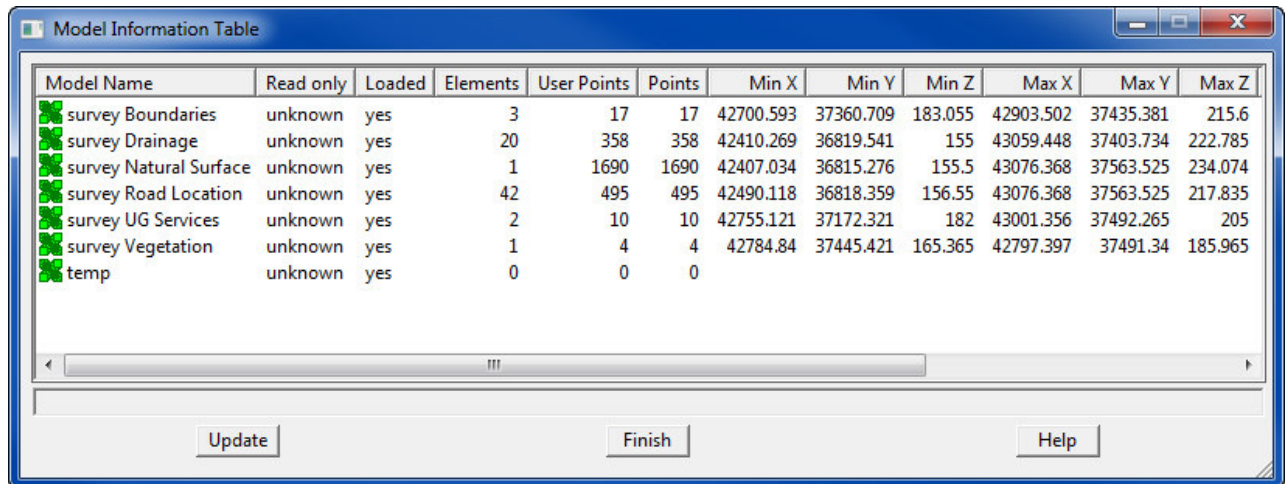




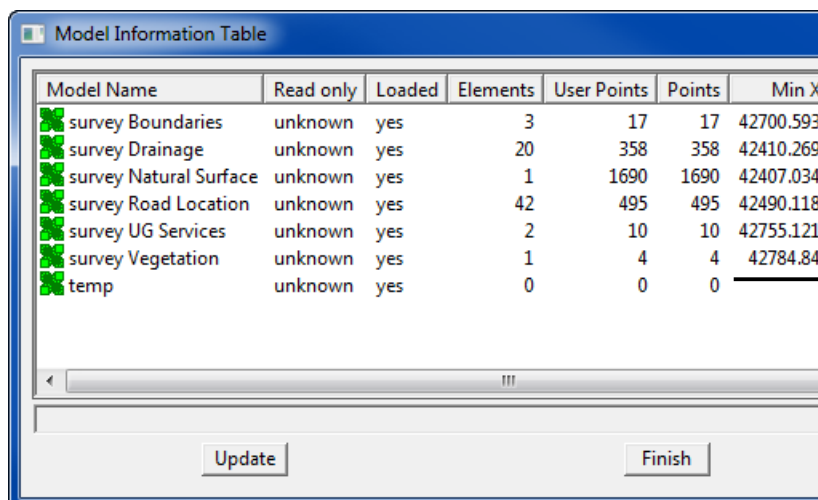
Then re-running the check Breaklines will clean the **temp** model and re-check the remaining models on Plan View 2.

To check that all the clashes were with the **survey UG Services** Model, refresh the screen and those clashes will be removed.

But also checking **Models => Model Information Table** is useful to show the contents and details of the Model, and by double clicking on the model, it will display the **String Information Table** and it shows that the model is empty – hence no crossing Breaklines.

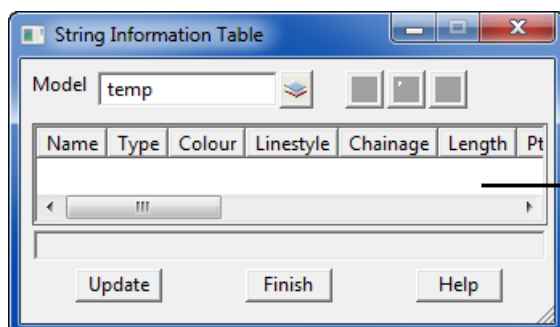


Model Name	Read only	Loaded	Elements	User Points	Points	Min X	Min Y	Min Z	Max X	Max Y	Max Z
survey Boundaries	unknown	yes	3	17	17	42700.593	37360.709	183.055	42903.502	37435.381	215.6
survey Drainage	unknown	yes	20	358	358	42410.269	36819.541	155	43059.448	37403.734	222.785
survey Natural Surface	unknown	yes	1	1690	1690	42407.034	36815.276	155.5	43076.368	37563.525	234.074
survey Road Location	unknown	yes	42	495	495	42490.118	36818.359	156.55	43076.368	37563.525	217.835
survey UG Services	unknown	yes	2	10	10	42755.121	37172.321	182	43001.356	37492.265	205
survey Vegetation	unknown	yes	1	4	4	42784.84	37445.421	165.365	42797.397	37491.34	185.965
temp	unknown	yes	0	0	0						



Model Name	Read only	Loaded	Elements	User Points	Points	Min X
survey Boundaries	unknown	yes	3	17	17	42700.593
survey Drainage	unknown	yes	20	358	358	42410.269
survey Natural Surface	unknown	yes	1	1690	1690	42407.034
survey Road Location	unknown	yes	42	495	495	42490.118
survey UG Services	unknown	yes	2	10	10	42755.121
survey Vegetation	unknown	yes	1	4	4	42784.84
temp	unknown	yes	0	0	0	

The **temp** Model is showing 0 Elements and Points.



Name	Type	Colour	Linestyle	Chainage	Length	Pt
------	------	--------	-----------	----------	--------	----

By double clicking in the **temp** Model above, the **String Information Table** is opened and shows no strings.



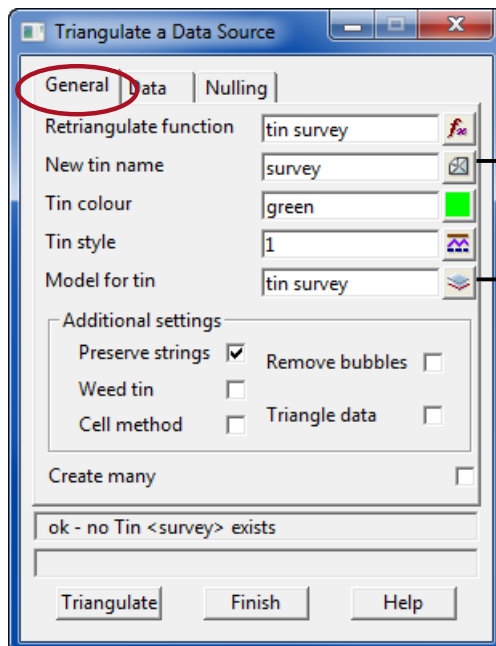


TRIANGULATE A DATA SET

A “Triangulated Irregular Network” (TIN) is used to find interpolated elevations at any location on the site.

Use: **Tins => Create => Triangulate Data**

General Tab

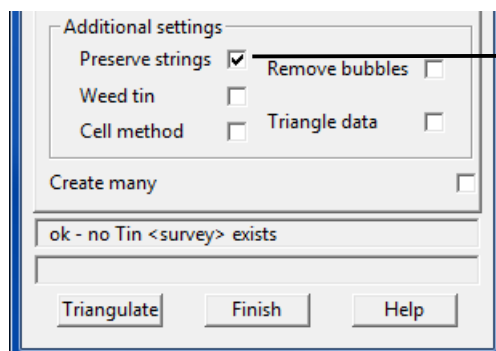


Type in a **New tin Name** we will use **survey** (tin name must be unique), then press the Enter key

The Model name for the new tin will be filled out once the Enter key is pressed.

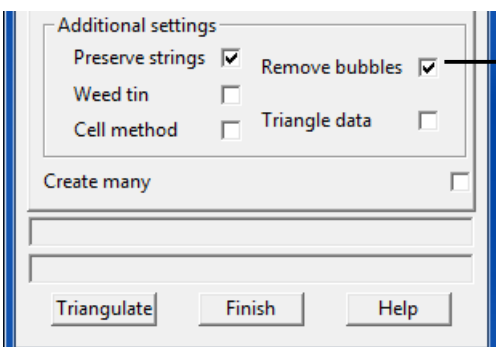
Copy the Model name **tin survey** to the Retriangulate function option

The additional settings:



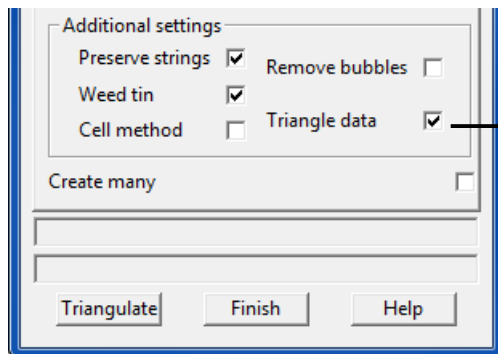
Preserve strings

Means that the strings in the project will be used as Breaklines in the triangulation, always ticked as a default.



Remove Bubbles

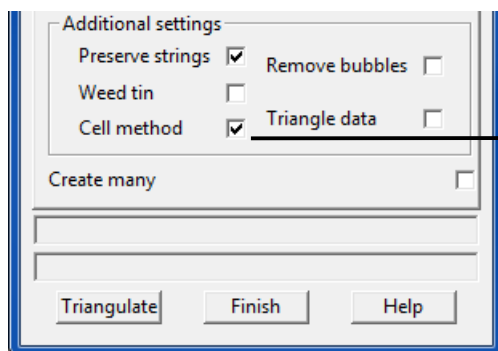
This will remove any flat areas created in the tins. Used mainly when triangulating contour strings, it means that a triangle will not be created with the three points connected to the same string.



Triangle Data

Is used when triangulating a set of triangle mesh data, this will also turn on the **Weed Tin** which will only use 1 point where there are multiple points at the one location.

This setting will NOT be used with the survey data.

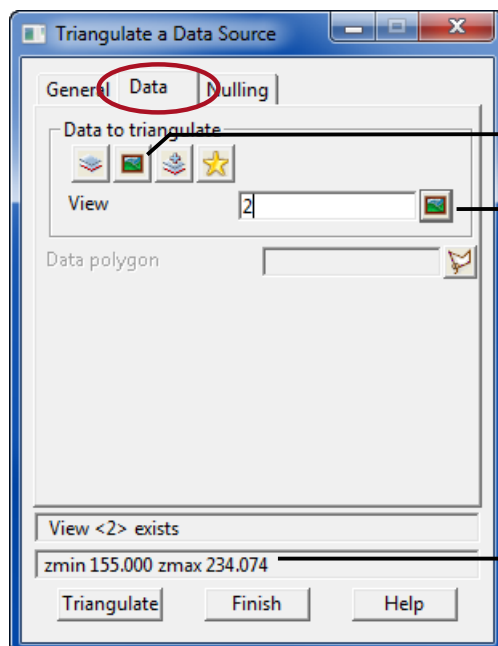


Cell Method

Is used for really large data sets, in the background 12d Model will split the data set into smaller sections and enable it to process faster, but this doesn't work at it's best until the triangulation reaches 1 million points.

This setting will NOT be used with the survey data.

Data Tab



Choose **View**

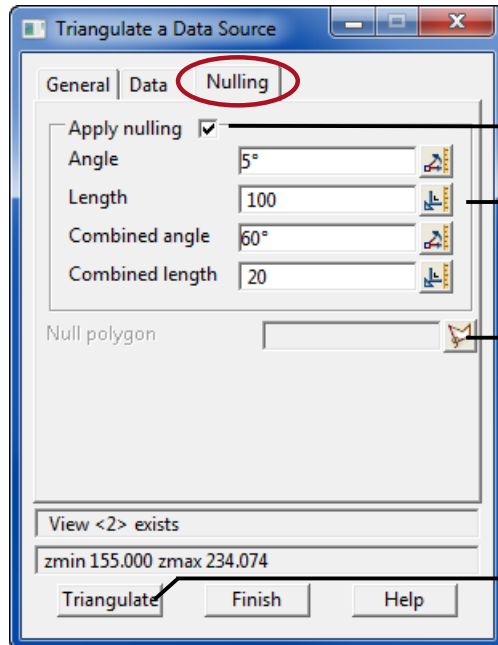
Select View 2, all of the data we wish to use is on View 2.

The minimum and maximum Z values are shown for the data that is to be triangulated – a good check!



Nulling Tab

Nulling by Angle & Length can be completed within the Triangulate a Data Source Panel.



To activate the **Nulling Tab** tick on **Apply Nulling**

12d Model default values that can be modified, experiment with different **length values**. Eg 10m and 50m

If you have a **Polygon** surrounding the area to Null then you can select the string here.

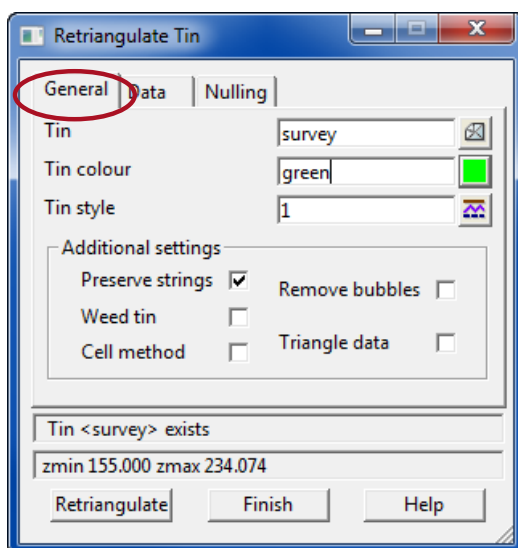
Press **Triangulate** to create the Tin

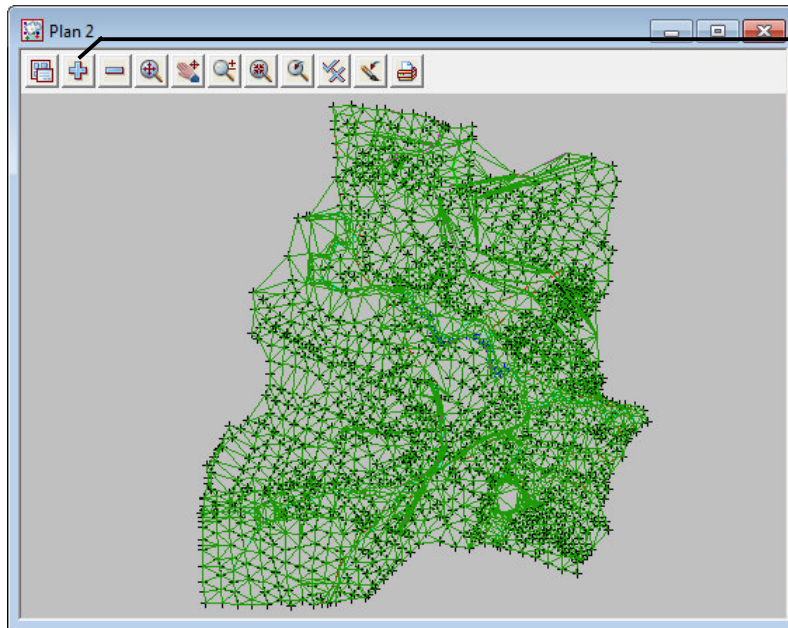
EDITING THE TIN

Once the Triangulation is created 12d Model automatically changes the Create Triangulate Panel to the Edit Retriangulate Panel, the View Data is changed to a Model List for future reference.

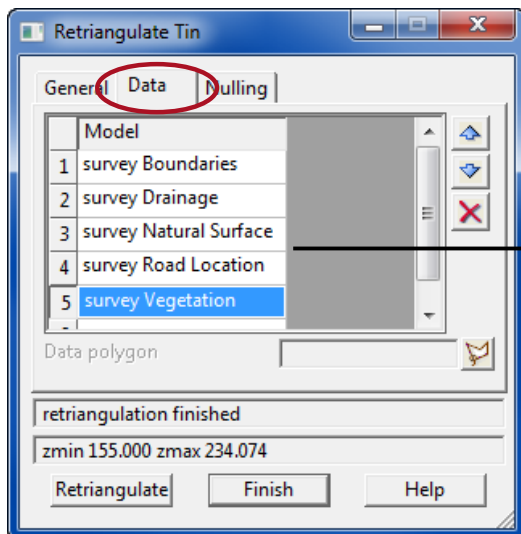
You are able to edit a tin at any time via,

Tins => Edit => Tin





Turn our new Model **tin survey** onto the plan view to display the Tin.



View Data has been changed into a Model List for future Reference.



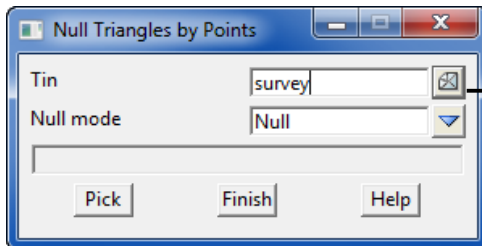


NULLING TRIANGLES BY POINTS

Before we go any further with this tin, we will null (remove) the unnecessary triangles from the Triangulation.

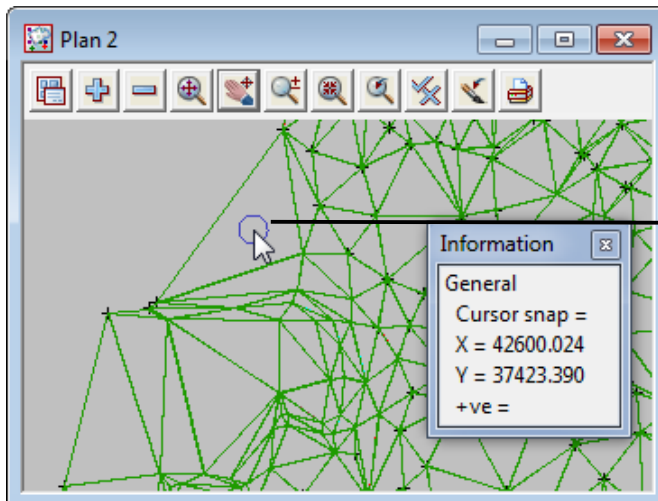
Use: **Tins => Null => by points**

This option allows single triangles to be nulled (removed) from the triangulation.



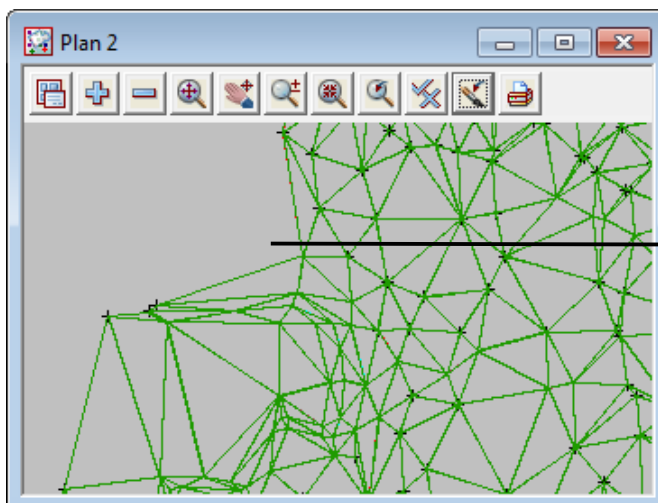
Select the Tin from where the triangles are to be nulled.

Before the Triangle is nulled.



Select with a Cursor Snap in the centre of the triangle to be nulled, and **Accept** the Pick to Null the Triangle.

After the Triangle is nulled.



The selected triangle has been nulled, and removed from the Triangulation.

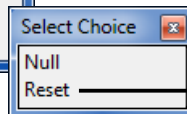
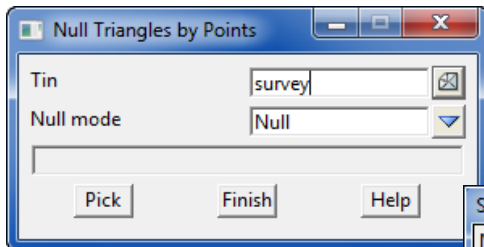
When 12d Model **Nulls** the Triangles they are not deleted, they are merely turned off.

The Nulling can be continued until all the triangles have been nulled as required.

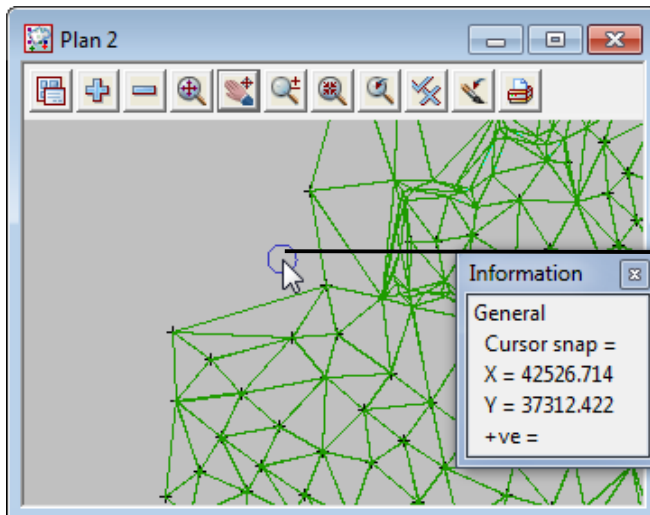


RESTTING TRIANGLES THAT HAVE BEEN NULLED

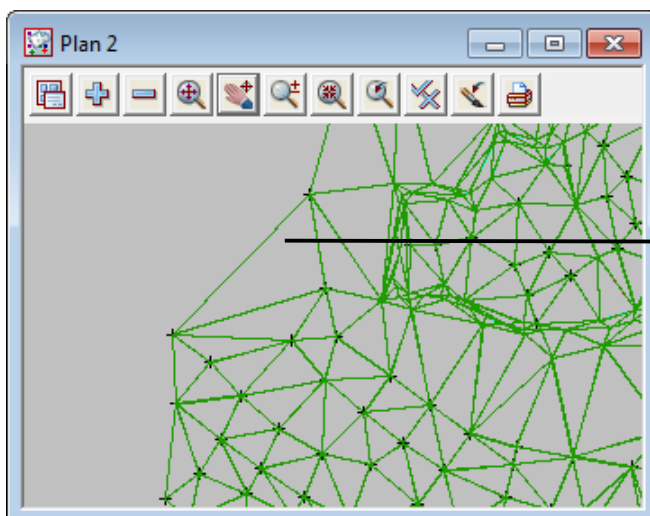
The Null Triangles by Points Panel will also enable you to **Reset** any triangles that have been Nulled from the Triangulation.



Select **Reset** to bring back the nulled Triangles.



Select with a Cursor Snap in the centre of the nulled triangle, and **Accept** the Pick to **Reset** the Triangle.

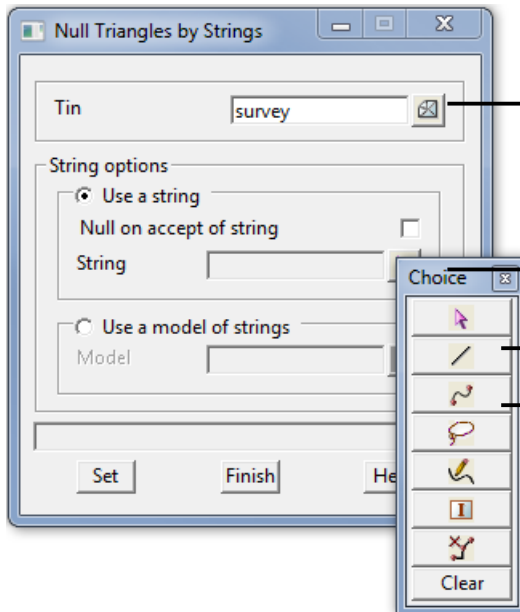


The triangle, has been **Reset**.

NULLING TRIANGLES BY STRINGS

This option allows multiple triangles to be nulled (removed) from the triangulation at a time.

Use: **Tins => Null => by strings**



Select the survey tin to be nulled.

Right click on the String Option.

Select the Line option to draw a line through the triangles to be nulled.

Select the Polyline option to draw a squiggly line through the triangles to be nulled.

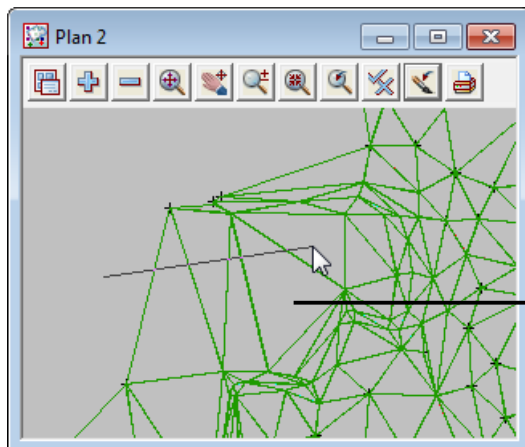
To Increase the speed if this panel

Tick on **Null on accept of strings.**

This means you do not have to press the set button for every null.

Warning: there is no Undo.

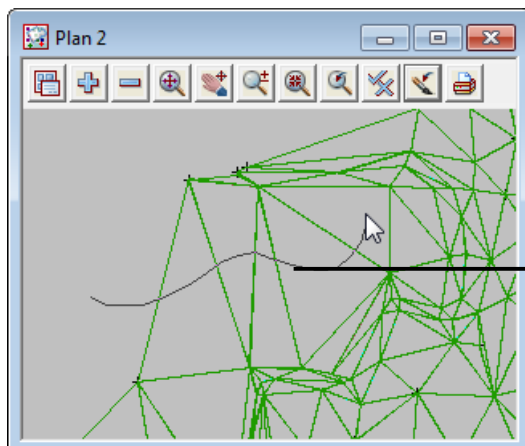
(But you can RESET the triangles – see previous page)



The Line Option

Hold the Left button down and drag the line through the triangles to null.

Once the line is drawn press the **Set** button to Null the triangles.



If you wish to speed up the Nulling process, tick Null on accept of String, you do not have to press Set every time you

The Polyline Option

Hold the Left button down and drag the polyline around and across the triangles to null.

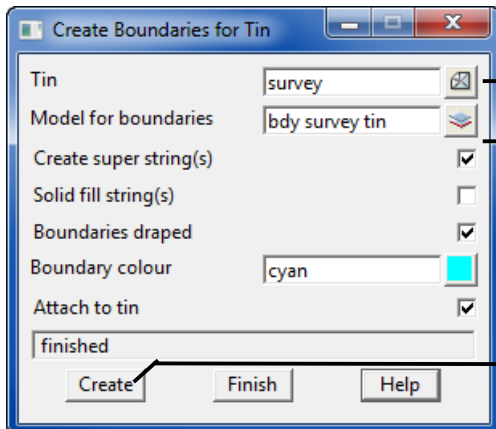
Once the polyline is drawn press the **Set** button to Null the triangles.



ADD A BOUNDARY AROUND THE TIN

When the unacceptable triangles around the edges of the tin have been nulled, we can create a boundary around the tin. The boundary will save the settings completed **by strings** or **by points**, to be saved if the triangulation has to be retriangulated.

Use: **Tins => Boundary**

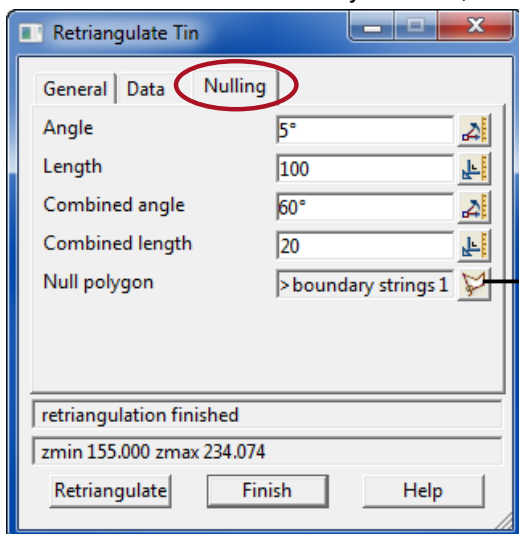


Select the **survey tin**

Type in the **New Model Name**.

Press **Create** to create the boundary.

You are able to edit a tin at any time via, **Tins => Edit => Tin**

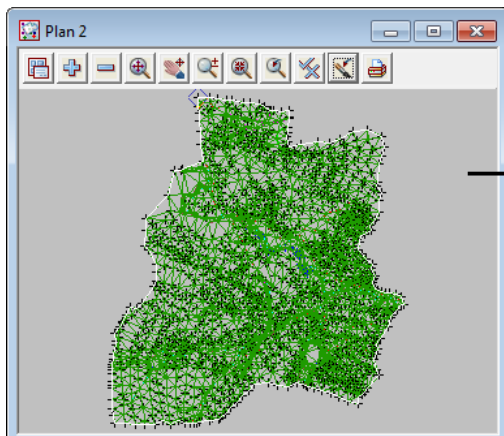


The **Tin Boundary** can then be used in the Retriangulate Tin Panel, by selecting it as the Null Polygon, when retriangulating the Tin.

Select the newly created boundary string.

NOTE: If you Retriangulate the TIN the nulling you did with Points and Strings will be lost.

The Boundary string set for **Null Polygon** allows you to keep the settings.

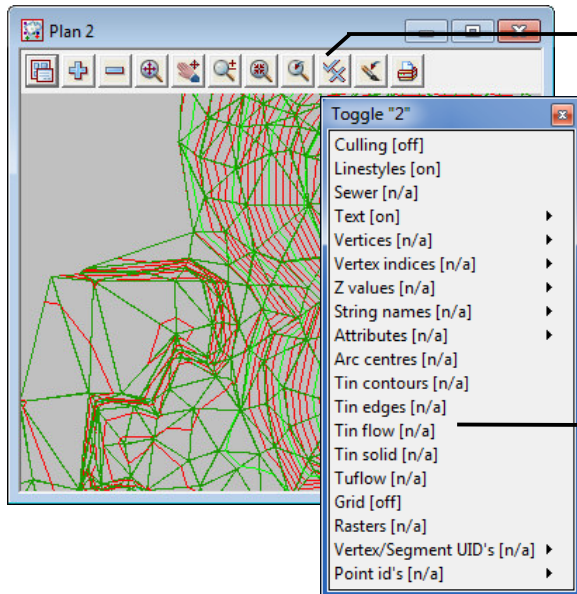


All the nulling is completed to the selected boundary.



ADDITIONAL TOGGLES FOR TINS

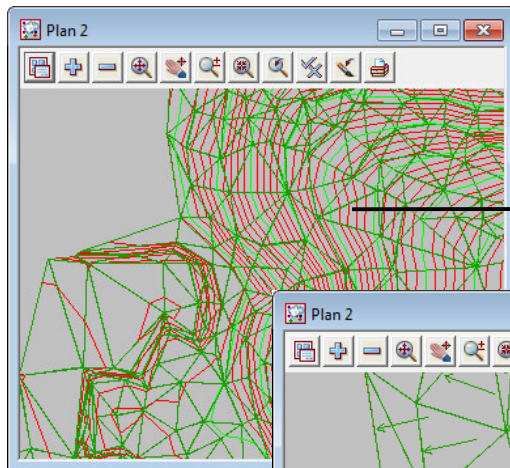
Also experiment with the Tin commands – these are found under the Plan View Toggle Button Menu.



The **Toggle Button**

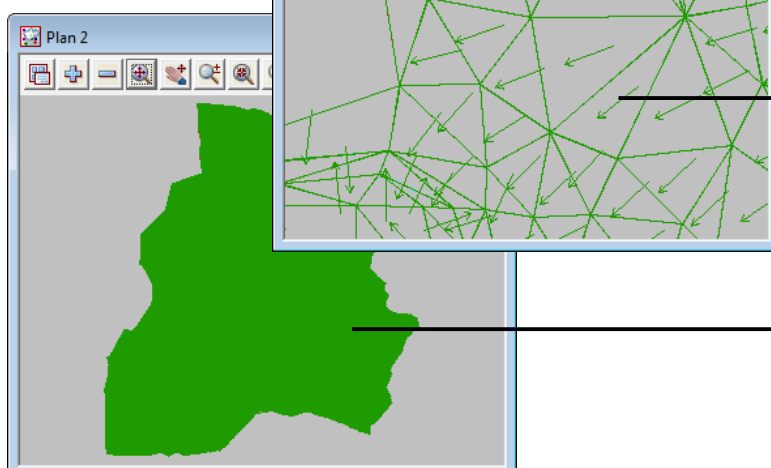
There are four options

- Tin contours
- Tin edges
- Tin flow
- Tin solid



Tin Contours and Tin Edges

These are great tools for quickly viewing the tin on the screen



Tin Flow and Tin Edges

Tin Solid

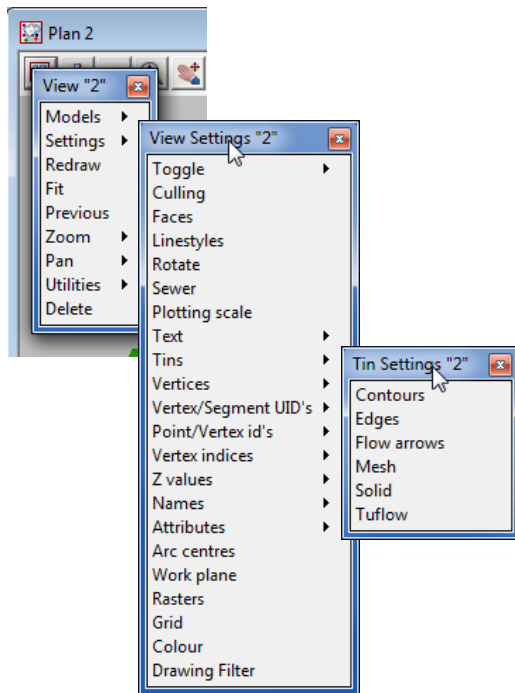




TINS

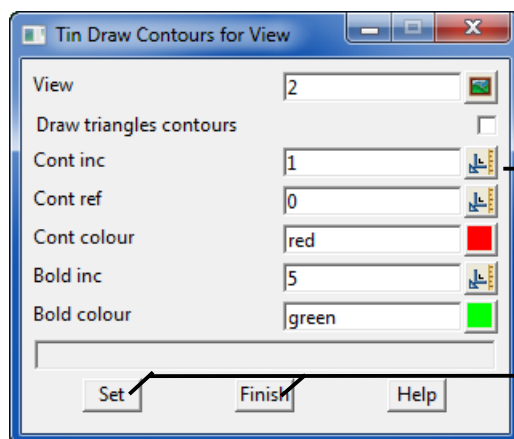
The Toggle settings can be changed for the Contours, Edges, Flow Arrows, Mesh, Solid and Tuflow when viewing the Tin.

These can be found under the: **View Menu => Settings => Tins**



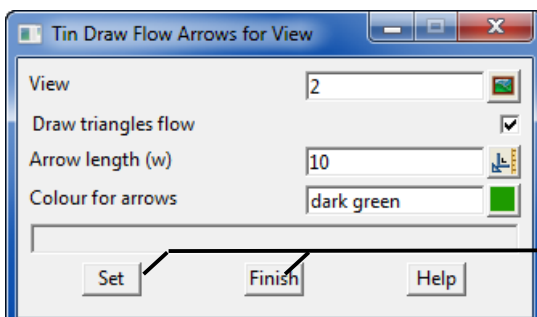
These setting under the **View Menu** will only be associated and applied to the current **Plan View**

Or Use **F11** on your keyboard



Change the **Contour Intervals** and the **Contour Colours** here

Press **Set & Finish** to activate the settings



Change the **Flow Arrow Length** and the **Flow Arrow Colour** here

Press **Set & Finish** to activate the settings



Description: Create Contour Strings and Labelling

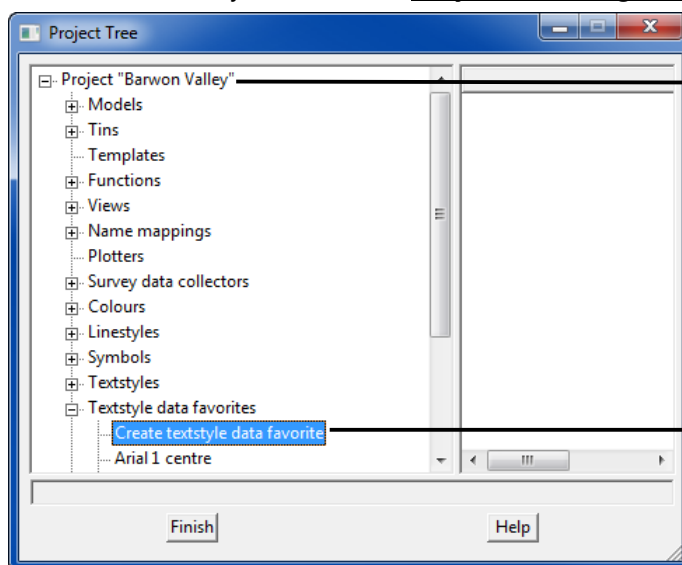
Level: Fundamental

Outcomes: After completing this module you should be able to create a new Textstyle for use in all projects and create Contour Strings and text for a TIN.

SETUP OF TEXTSTYLE DATA FOR LABELLING CONTOURS

Create a Textstyle that will be used to label the contours.

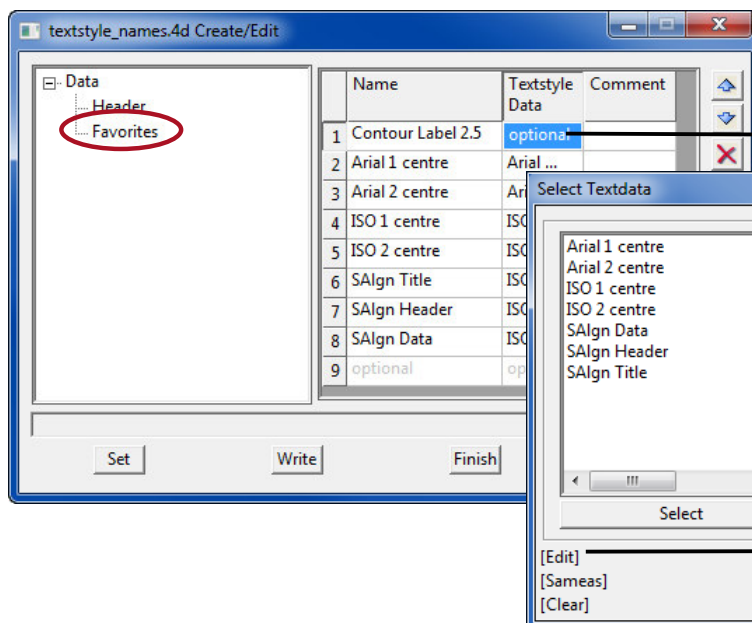
To Create a Textstyle use: **Project => Management => Tree**



Double click on the **Project** to open the **Project Tree**

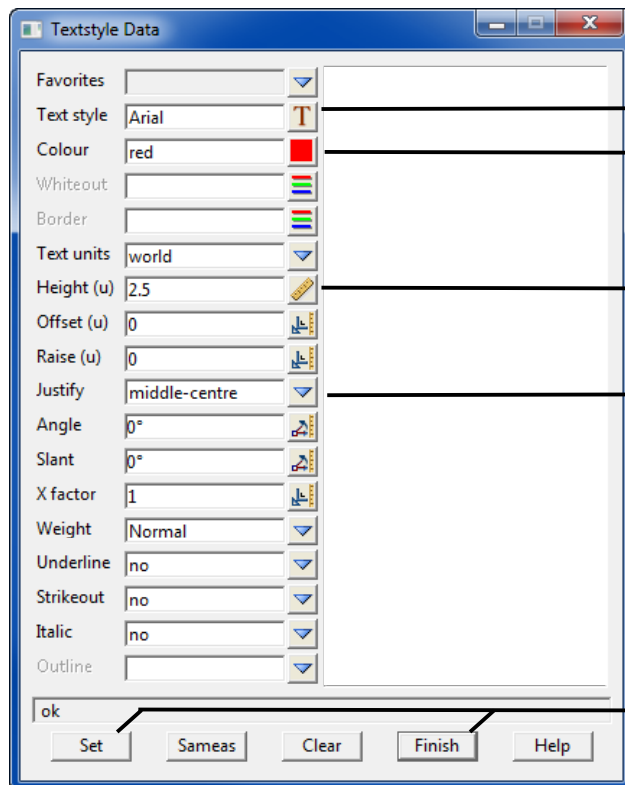
Double click **Create Textstyle data favourite** to open the Create/Edit Textstyle Panel

Under Favourites create a New row and type in the new Textstyle Name = **Contour Label 2.5**



Right click on the **Textstyle Data** will display the menu choices for creating a Textstyle

Press on **Edit** to open the **Textstyle Data Editor**



Select the **Textstyle**

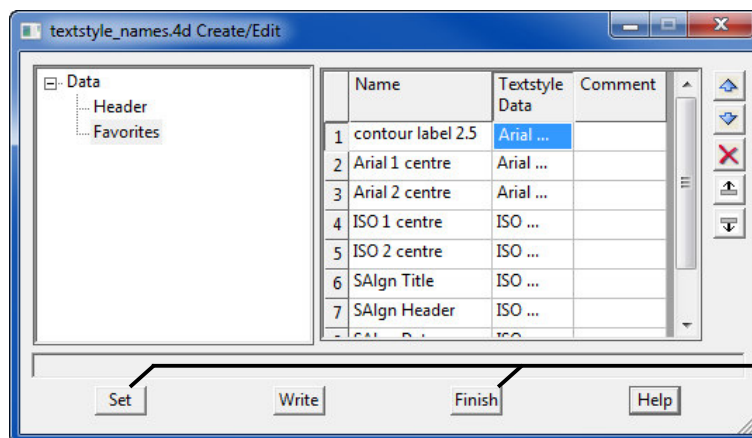
Select the **Colour**

Select the **Height**

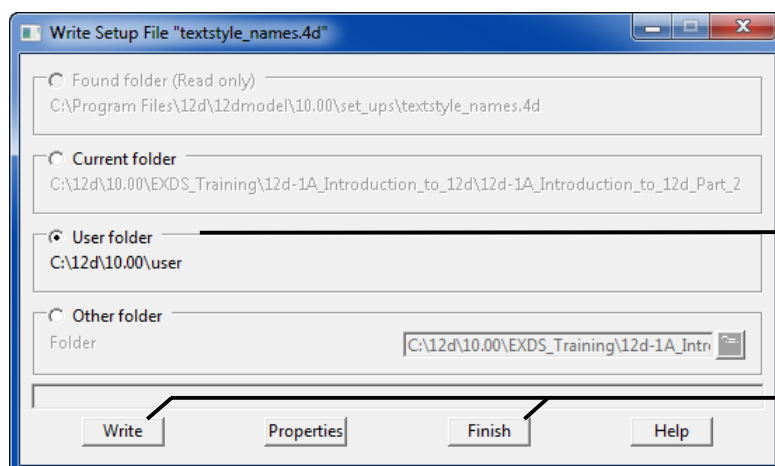
Select the **Justification**

You can set up as many **Textstyle Favourites** as you like – they need to be saved so that they can be accessed for all subsequent projects.

Press the **Set** button to save the Textstyle settings, **Finish** to close the panel



Press the **Set** button to save the new Textstyle, **Finish** to close the panel.



Textstyles saved to the **User Folder** will be accessible to all projects on your computer

Select the **User Folder**

Press **Write** then **Finish**





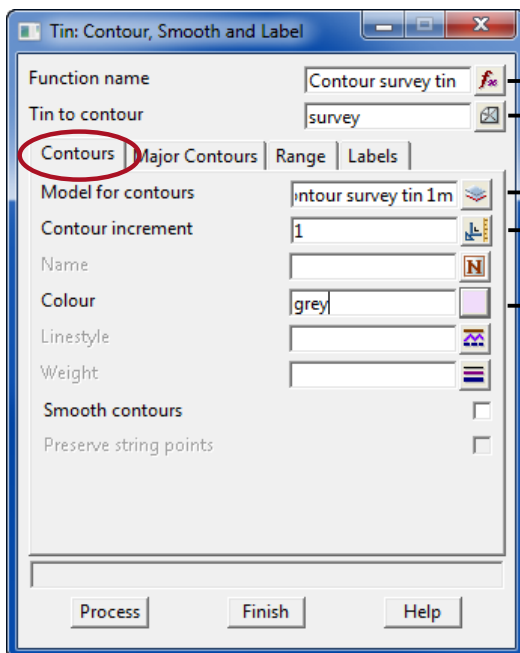
CREATING CONTOUR STRINGS

The contours created using the Toggle Button from the View Menu are just display contours; they are **NOT Contour Strings**.

Display contours cannot be exported or labelled, if you try to do a string inquire you will find you cannot select them – that's because they are not strings.

To create Contour Strings for export or plotting, go to: **Tins => Contour => Contour, Smooth and Label**

Contours Tab



Type a **function name** – this will remember all your settings

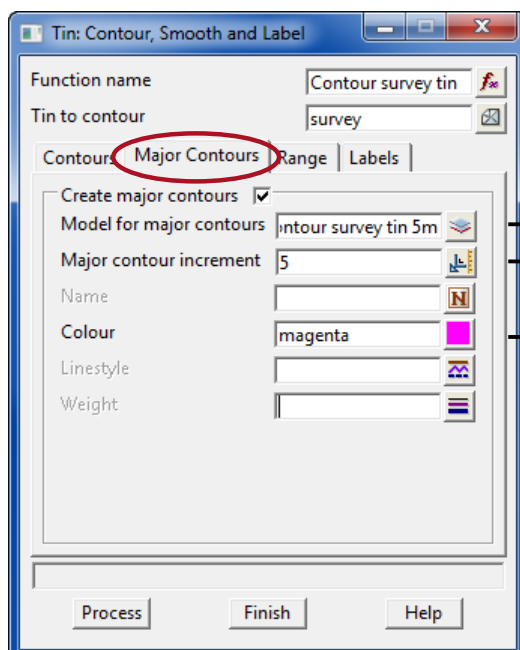
Select **Tin to Contour**

Type a new Model name, (not done elsewhere)

Type in the **Contour Increment**

Select the **Colour**

Major Contours Tab



Tick on to create **Major Contours**, (if un-ticked the major contour and minor contour strings are saved in the same model).

Type a new **Model name**,

Contour survey tin 5m

Type in the **Major Contour Increment**

Select the **Colour** for Major Contours



Range Tab

A **Minimum and Maximum Contour Level** can be specified, if left blank the TIN's minimum and maximum values are used

A **Height Range File** can be selected to colour the contour strings

Labels Tab

Tick on to create **Contour Labels**, if un-ticked no contour labels are created.

Label Major Contours Only

Type a new **Model name**,
Contour survey tin Labels

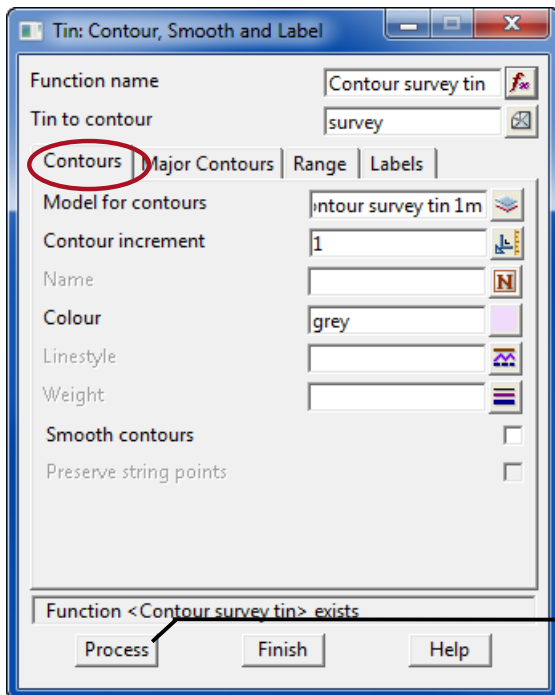
See Page 48 and 49 for a full description of the Label Methods

Type the number of **Decimal Places** for the Contour Labels

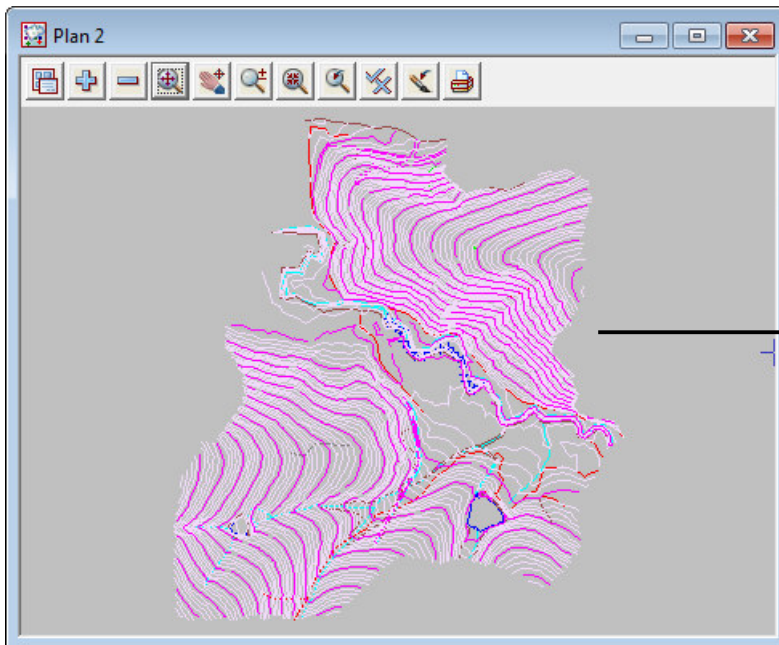
Select the **Textstyle** (previously created)

The **Start Distance** and **Separation** is the distance along the string the label will be placed

Label start and end will also place the contour label at the start and end of the string



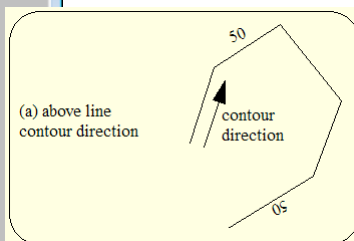
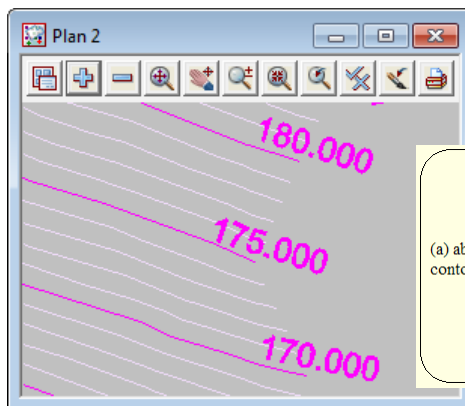
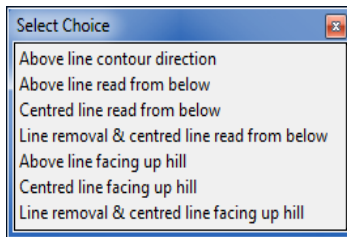
Press **Process** to create the contour strings and labels.



The created Contours and Labels.

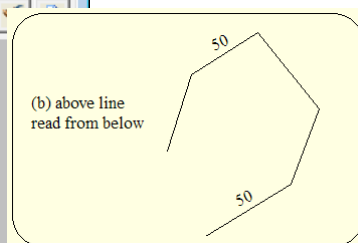
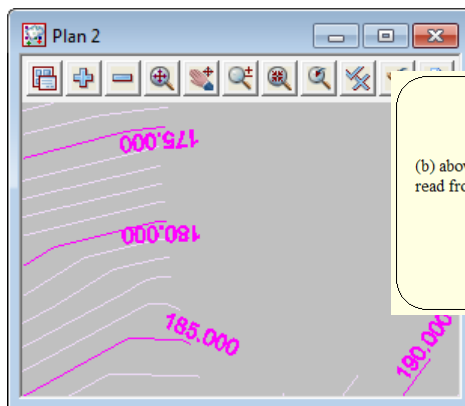


Descriptions of the labelling Methods that can be used for contour labelling



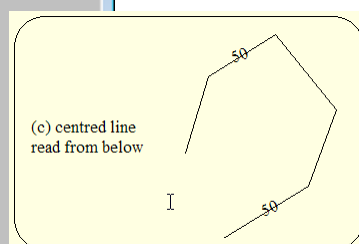
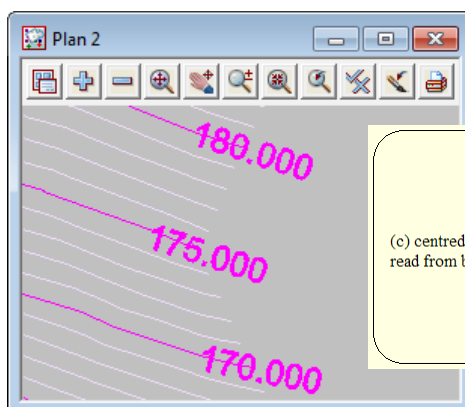
Above Line Contour Direction

Text is placed above the contour string and follows the string direction.



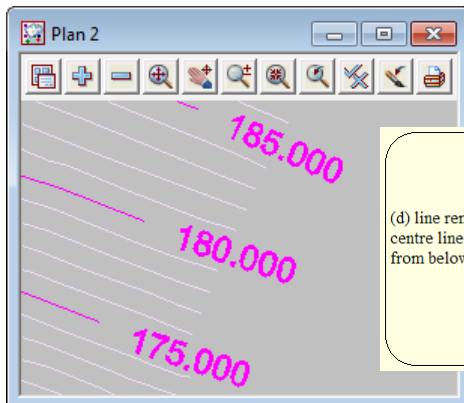
Above Line Read From Below

Text is placed above the contour string, but is created so it can be read from the bottom of the plotted sheet.

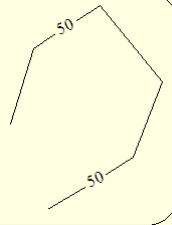


Centred Line Read From Below

Text is centred on the contour string, but is created so it can be read from the bottom of the plotted sheet.



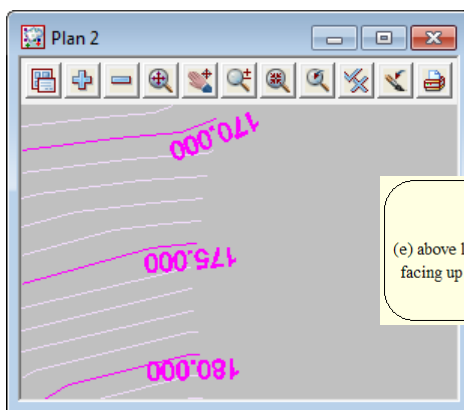
(d) line removal and
centre line read
from below



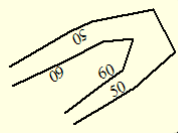
Line Removal and Centre Line Read From Below

Text is centred on the contour string, but is created so it can be read from the bottom of the plotted sheet.

The Contour string is removed from behind the Label Text.

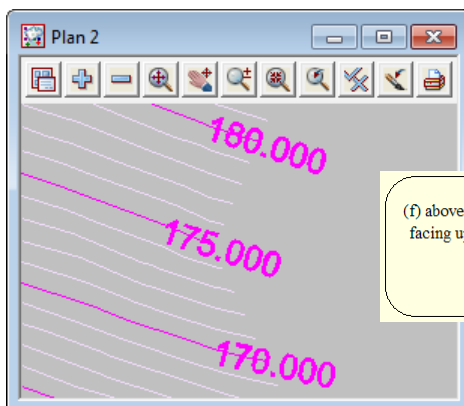


(e) above line
facing up hill

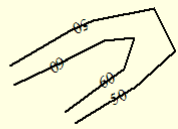


Above Line Facing Up Hill

Text is placed above the contour string, but is orientated so it faces up-hill.

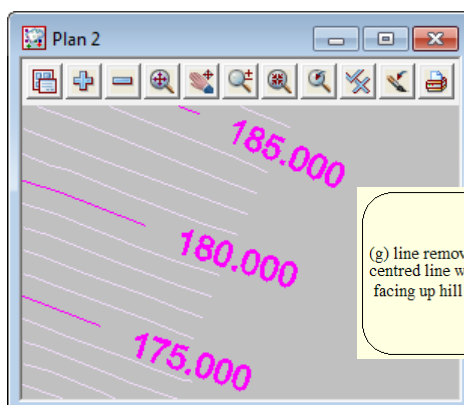


(f) above line
facing up hill

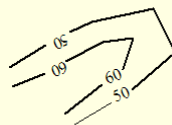


Centre Line Facing Up Hill

Text is centred on the contour string, but is orientated so it faces up-hill.



(g) line removal and
centred line with labels
facing up hill



Line Removal and Centre Line with Labels Facing Up Hill

Text is centred on the contour string, but is orientated so it faces up-hill.

The Contour string is removed from behind the Label Text.



Description: Exporting Data to CAD

Level: Beginner

Outcomes: After completing this module you should be able to create a new DWG or DXF file for use in a CAD program.

EXPORTING DATA TO CAD

To Export the Survey Data and Natural Surface Contours to CAD,

Use: **File I/O => Data output => DWG/DXF/DXB => DWG/DXF/DXB**

Turn all the required models to be exported onto the plan view

Select the **Plan View** to export the data

Select the **Format** for the File

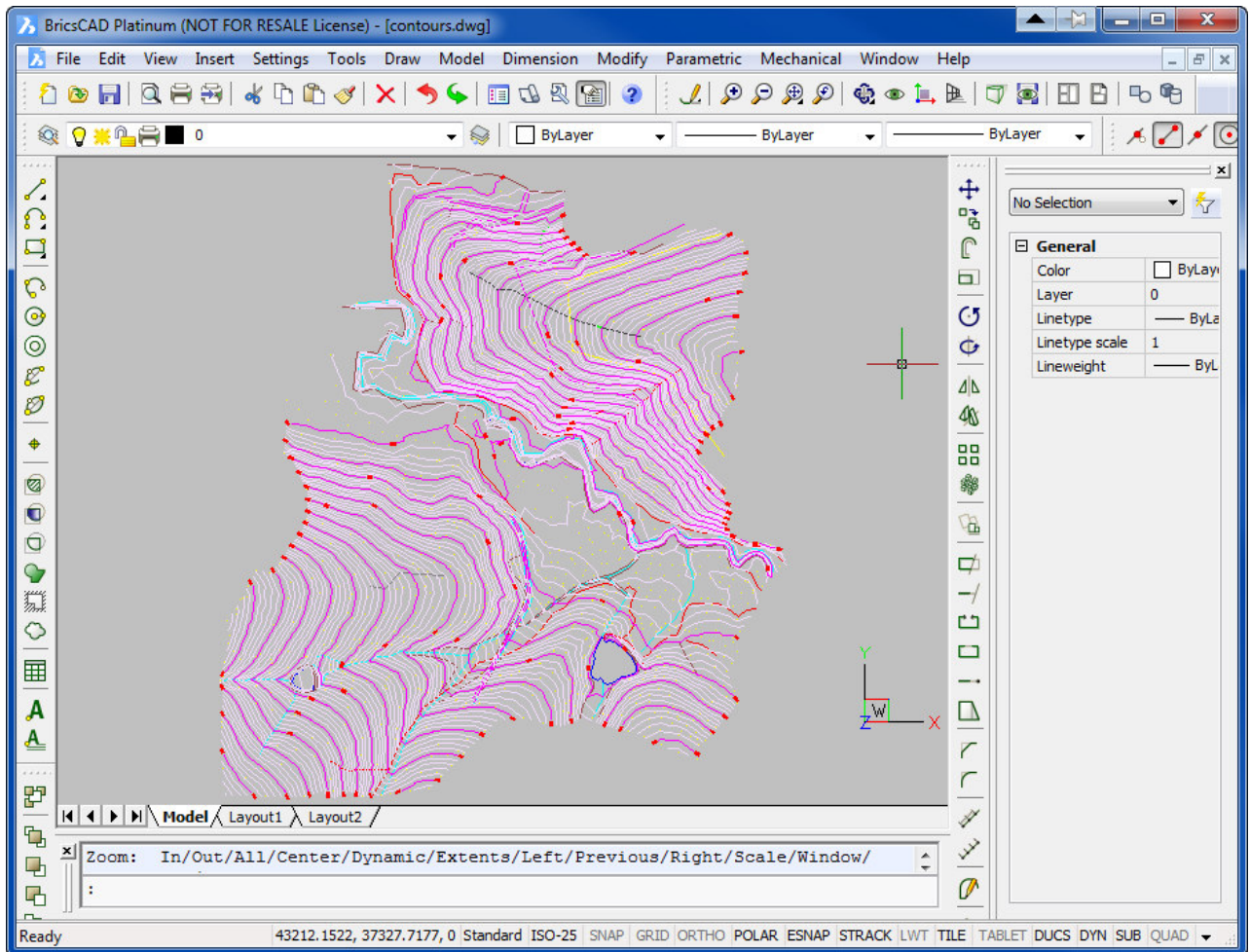
Type in the new File Name for the DWG file

Select the **Dimension** – we'll use the **2d & contours(3d)**

Press **Write** to create the DWG file, then **Finish** to finish the Panel



The exported Survey Data and Natural Surface Contours shown in CAD below.



Notes:






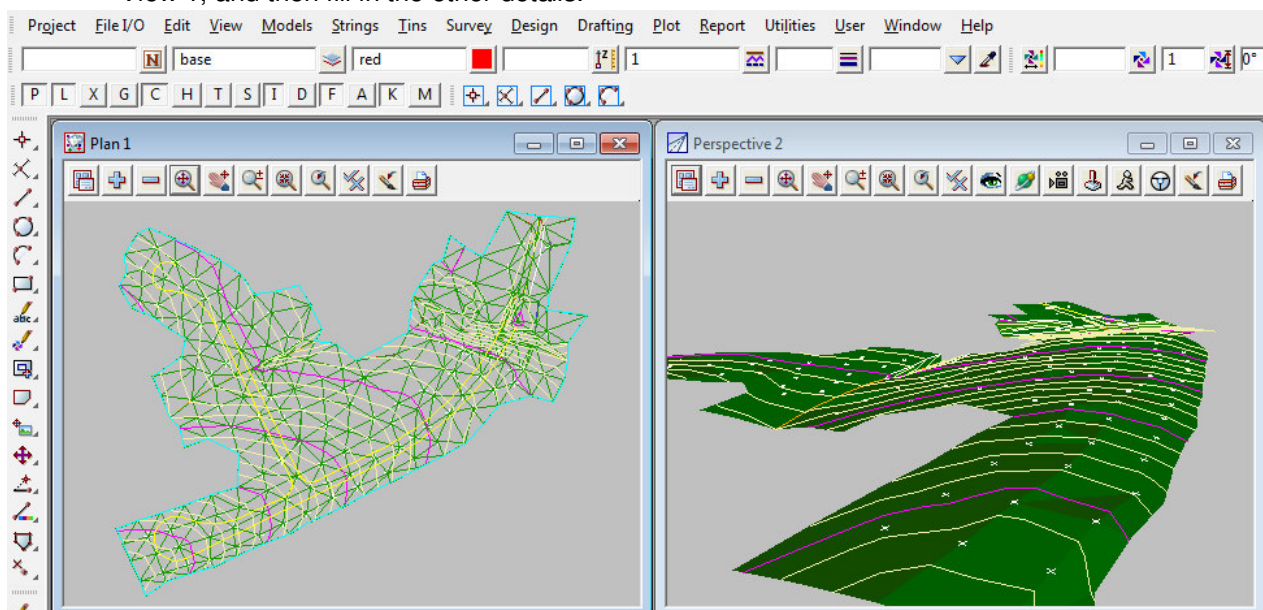
Description: Exercise No.1 – Triangulation and Contour Strings

Level: Beginner

Outcomes: After completing this module you will have reinforced the techniques covered in the Introduction to 12d Model (pages 5 to 48) You should be able to import and triangulate survey data supplied in CivilCAD .as5 format, create Contour Strings and Export to CAD.

EXERCISE NO. 1

- Start 12d Model and go to the New Project option. Type in a New Project name and browse to **C:\12d\10.00\EXDS Training\12d-1A Introduction to 12d\12d-1A Introduction to 12d Part 1** – this is the **Working Folder**. Start a new project in this folder.
- Load the CivilCAD ascii file **02170.as5**. Use **File I/O => Data Input => CivilCAD**
- Turn the Models onto the Plan View. Investigate the models and coordinates of the data. Use **Strings => Inquire** or the F2 button.
- Check for crossing Breaklines. Use **Tins => Check Breaklines**
- Triangulate the data. Use **Tins => Create => Triangulate Data**. Use the Nulling Tab to null the triangles by Angle and Length when the triangulation is being created.
- Null by Points or strings. Use **Tins => Null => By Points** or use **Tins => Null => By Strings** to remove any unnecessary triangles and create a Boundary around the Nulled Triangulation.
- View the Tin by using the options under the Toggle Button,  Tin Contours, Tin Edges, Tin flow and Tin Solid.
- Create the natural surface contour strings, use **Tins => Contour => Contour, Smooth and Label** select the Major Contour Tab and the Label Tab to complete all in one go. Turn the contour strings onto the Plan View.
- Export the survey and the contours to CAD a .dwg file. Use **File I/O => Data Output => DWG/DXF/DXB => DWG/DXF/DXB** – in the Data to Write panel, select the View (green button), View 1, and then fill in the other details.





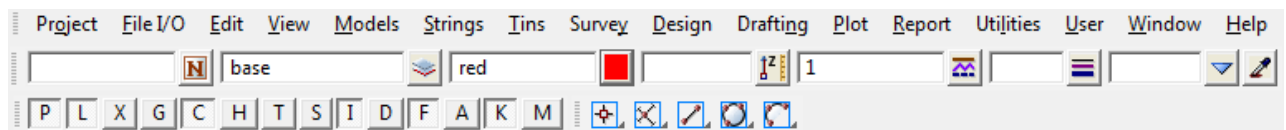
Description: String Creation and Modification

Level: Beginner

Outcomes: After completing this module you should be able to create new Super strings and modify the strings by moving, extending, inserting points. Also you should be able to Parallel, Offset, Joining and Deleting strings.

CAD CONTROL BAR

Fill out the CAD Control Bar before creating any strings, this way their Properties will already be set.



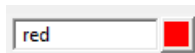
Name of the String

Type a string name or select from the list



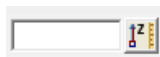
Model Name - base

Is the default but you have the option to type a name for the new model or select from the model list.



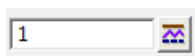
Colour of the String

Type in a colour or select from the list.



H = Height above sea level

Optional, but you can type in an elevation for the points of the string. If a height is entered here, all points will have this height.



Linestyle

The default is 1 (continuous) or select from the list.



Weight

The thickness of the string when plotted



Tunable

Is the string contourable?



Same as

Select a string to populate with its properties.

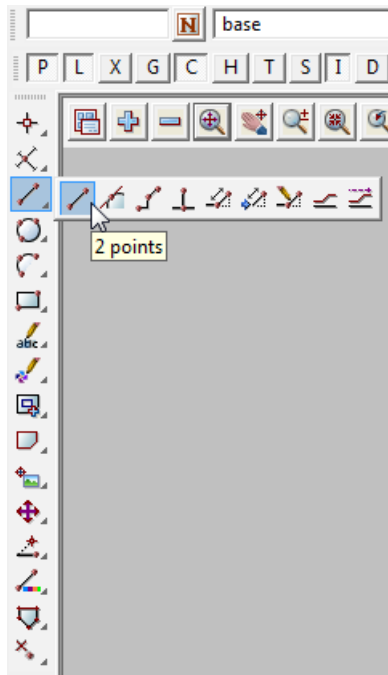


STRING CREATION – SUPER STRINGS

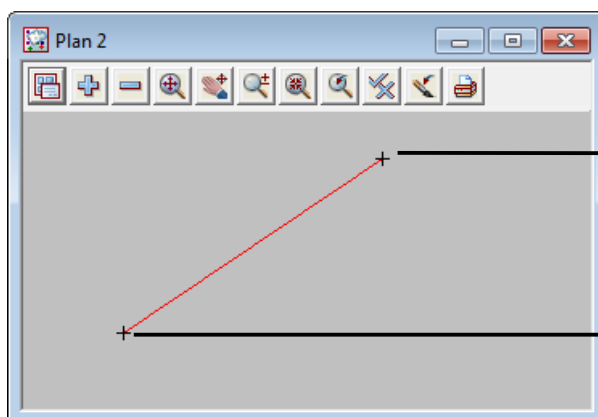
Create a Single String

Use the CAD Toolbar on the left hand side of the 12d Model screen.

Click and hold the left button down then move the pointer to the required selection, release the button to invoke the selection.



To create a single line between two points, select the **2 Points** option.



Click on the Plan View to create the first point on the line. Either an existing point or a cursor location (and click the middle button to accept)

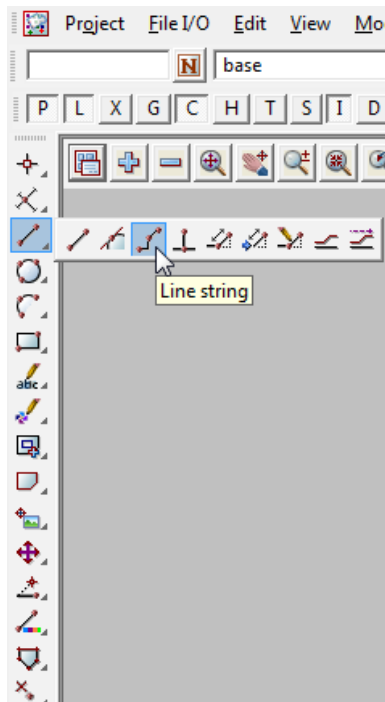
Then click on the Plan View where the line is to end (and click the middle button to accept).

The 2-point line has been created.

If the String Points are not displayed, then the **Vertices** have not been activated as yet on the current Plan View, it will be displayed **Vertices [n/a]**, once it is activated it will display **Vertices [on] or [off]**

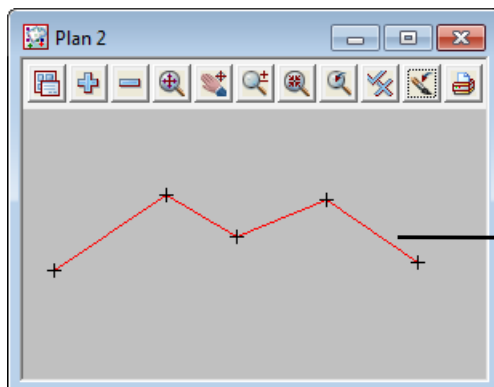


Create a Line String

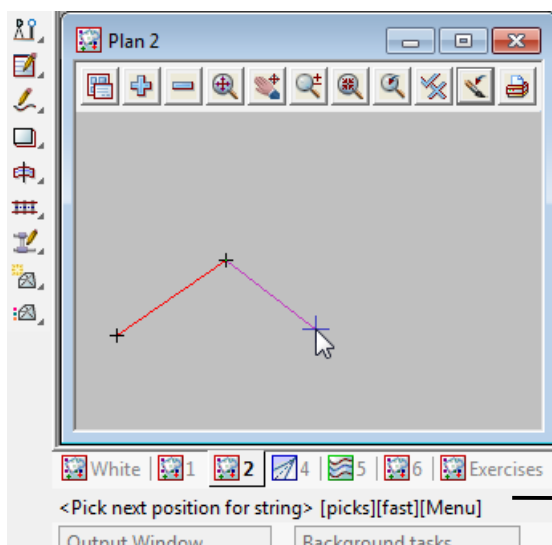


To Create a Line String (with many points), select the **Line String** option.

This is similar to a Polyline in your CAD drafting package.



Start the Line String by clicking on the Plan View where the String is to start (and click the middle button to accept), then click the location of the next point (and accept) and continue this process. To end the string, press the ESC Button.



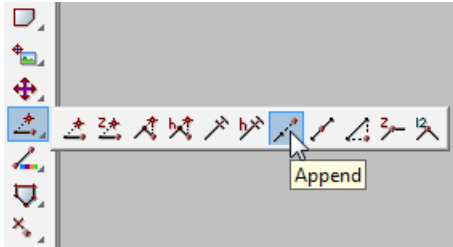
When creating or modifying super strings from the Toolbars, the **status bar** will always display what is required for the command





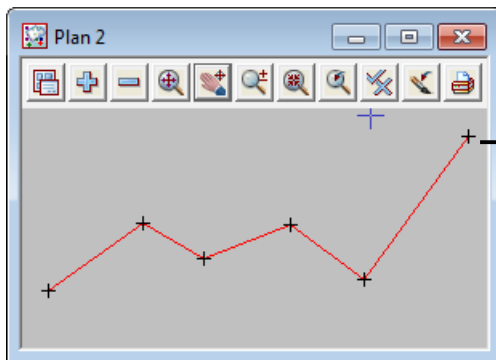
STRING MODIFICATION – POINT EDITS

Points Append (adding to the End of a String)



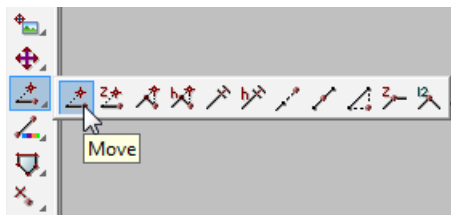
Select the **Append Point** button, then click on the required end of the string and accept, then position the cursor where the new point/s are required and accept.

The **Append** command will add new points to either end of the existing string.

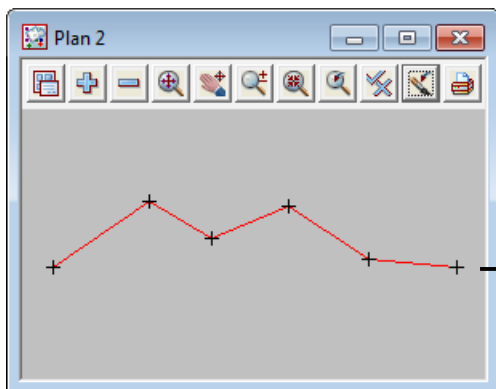


Additional Point appended to the end of the string

Move Points



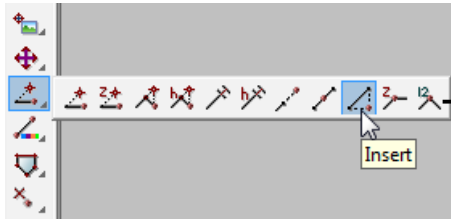
Select the **Move Point** button, and then click and accept on the point to be moved, then select the new position for the point and accept.



Point on the end of the string that was moved

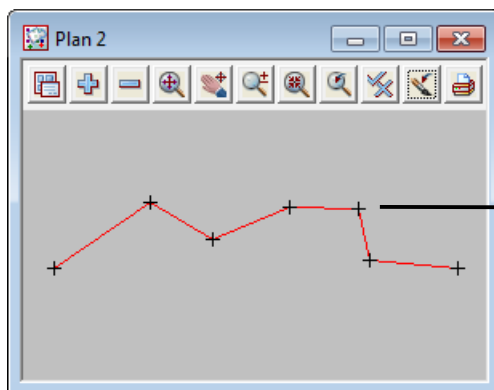


Insert Points (along an existing string segment)



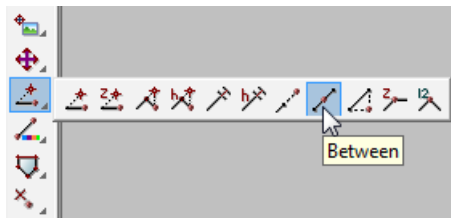
To Insert a Point within a segment of an existing string, select the **Insert Point** button.

Click on the segment where the point is to be inserted and accept to start the insertion, then click at the new location and accept.



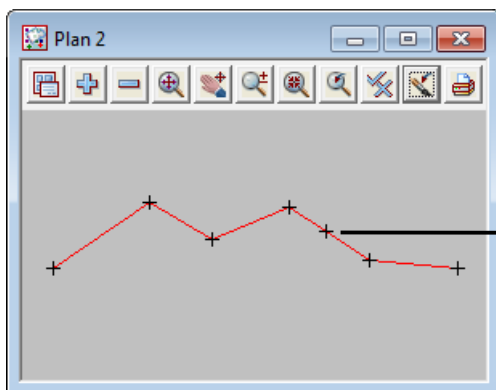
Newly Inserted Point along the existing string

Add Points Between Points



Similarly, to **Add a Point Between Points on a String**, select the **Between Point** command and click the segment that the point between is to be inserted within.

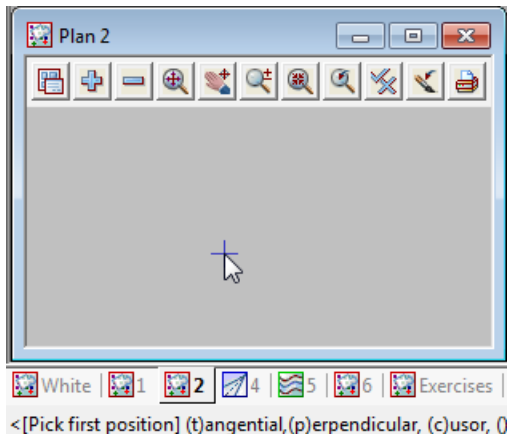
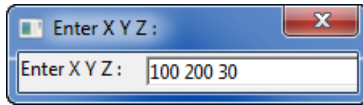
(NOTE: The existing bearing of the existing segment will be kept)



Newly Inserted Point Between 2 points



Inserting Points with Exact Coordinates



To locate points when the coordinates are known, the **Typed Input Box** can be used.

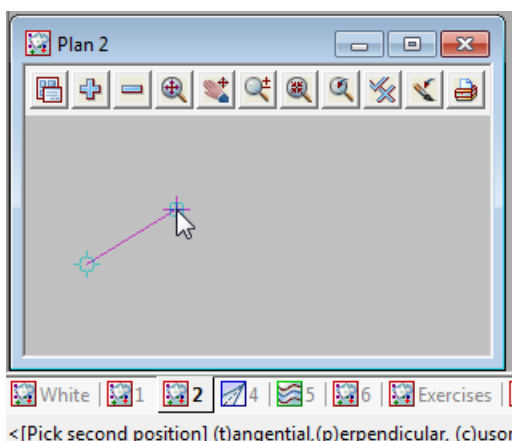
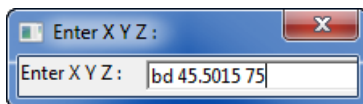
Select your command, Create Line, the command line is asking 'pick first position'.

Start typing in the X coordinate and the **Typed Input Box** will appear.

Enter the X, Y and Z coordinates with a space between them (this is the delimiter) and press **Enter Button** (if you don't have a Z coordinate just enter the X and Y).

Note: The Z Values from the Cad Control Bar will be used instead of the value that you type. To set your new Z value make the Cad Control Bar blank.

Inserting Points with a known Bearing & Distance



After creating the first point, a bearing and distance measurement can be used to produce the next point on the string.

This is achieved by entering the prefix of "bd(space)" to override the XYZ coordinate entry in the **Typed Input Box**.

The bearing and distance can then be typed in; the bearing is entered with the degrees followed by a decimal point, then the minutes and seconds.

The minutes and seconds need to be placed in pairs, eg 0505 for five minutes and five seconds.

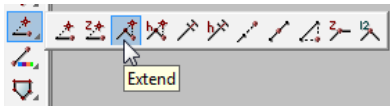
Eg: 45.5015 ie 45° 50' 15"

A space is required to delineate between the bearing and distance, then the distance can be entered and press the **Enter Button**.

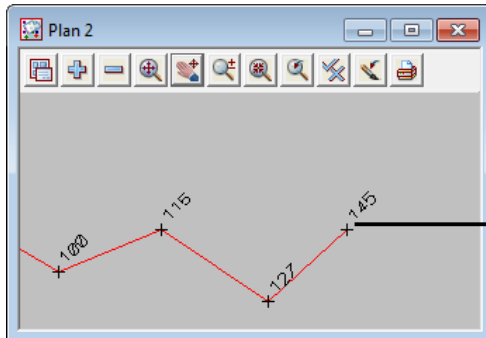




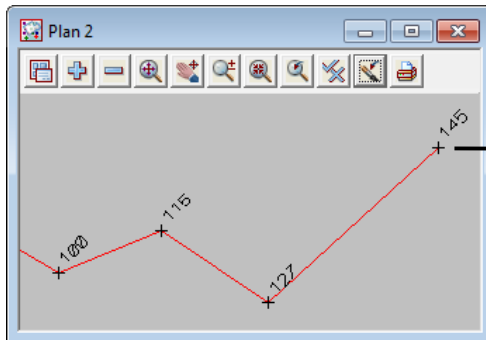
Extend Point



The **Extend Point** command will extend a point, but keep the elevation/s unchanged; therefore the slope/grade between the two points will change. The Bearing of the segment is unchanged.

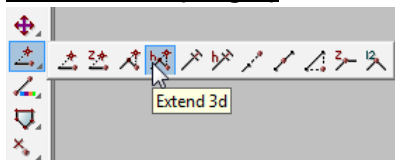


The Point before it is modified / extended



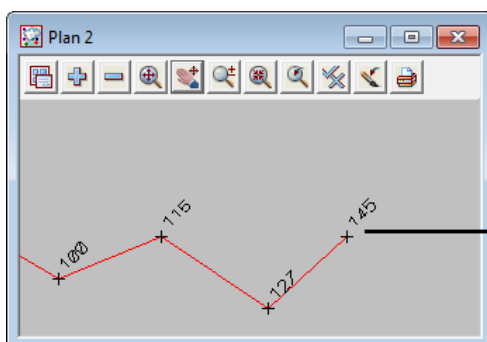
The Point has been extended, and the height has stayed the same

Extend Point (Height)

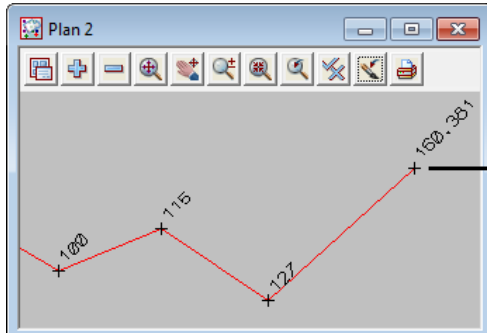


The **Extend Point (Height)** command will adjust the elevation (height) of the point during the extend operation, so that the slope/grade of the string will remain unchanged.

Note: Extend Point (Height) is the same as Extend but will change the height of the extended string.



The Point before it is modified / extended



The Point has been extended, and the height has changed to maintain the slope/grade of the segment

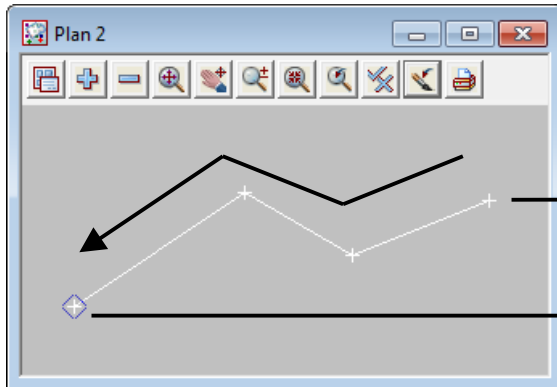




STRING MODIFICATION – STRING EDITS

Picking with Direction

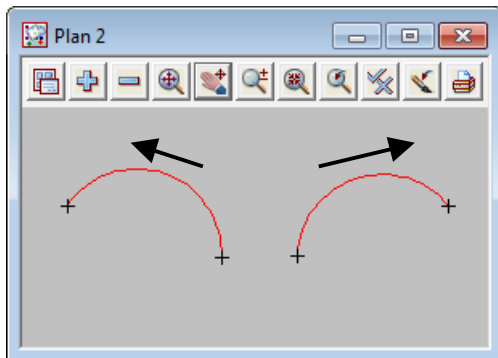
All strings in 12d Model have a start and an end, therefore a chainage 0 and an end chainage.



Start Chainage 0.000

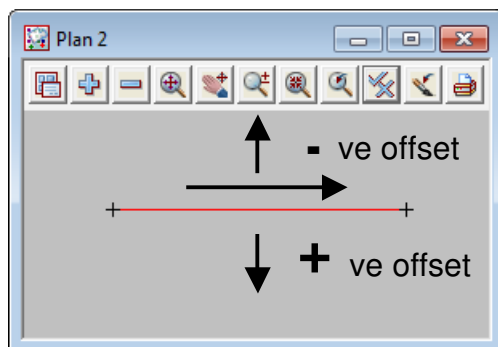
End Chainage 699.162

Positive and Negative Arc Radii



12d Model uses positive and negative values for creating arcs.
Eg a positive (+) radius is an arc created in a clockwise direction, and a negative (-) radius is an arc created in an anticlockwise direction.

Positive and Negative Parallel Direction



This positive and negative methodology is used for offsetting/parallelling strings as well.
A positive offset value is to the right (off the direction of the string), and a negative offset value is to the left (off the direction of the string).



How to use Picking with Direction for Paralleling a String

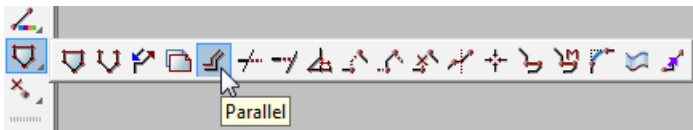
This selection method **Pick with Direction** is extremely useful for a lot of commands within 12d Model.

You are able to make 12d Model use a direction you specify for a particular command where you need to know which side of the string you are offsetting for example.

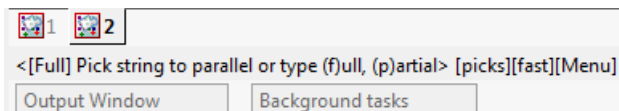
This means that you don't have to find the direction of the string before you start.

We will use the String Parallel option to explain the process.

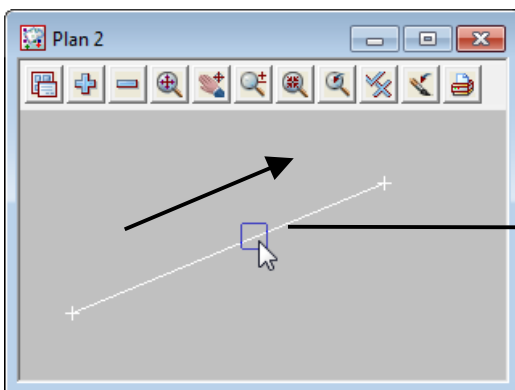
String Parallel – Full



To parallel a string select the **String Parallel** command from the Toolbar.



12d Model's default is to Parallel the **FULL** string. (If you wish to parallel only part of the string then select (p) on the keyboard to activate it) We will use the default.



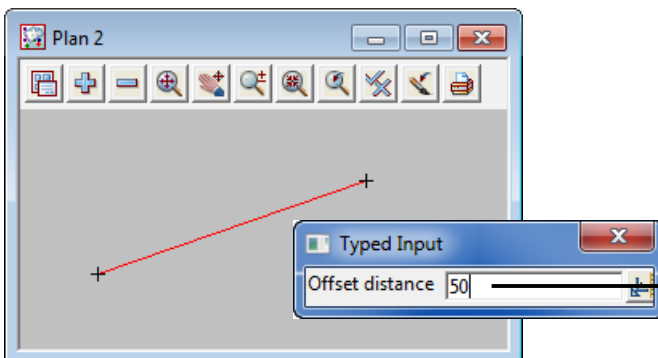
To Parallel this string we will use **Pick with Direction**.

To use **Pick with Direction** in 12d Model, hold the left button down and move the cursor along the string in the direction you would like the string to behave.

Remember that the right side is for a positive offset and the left side is for a negative offset.

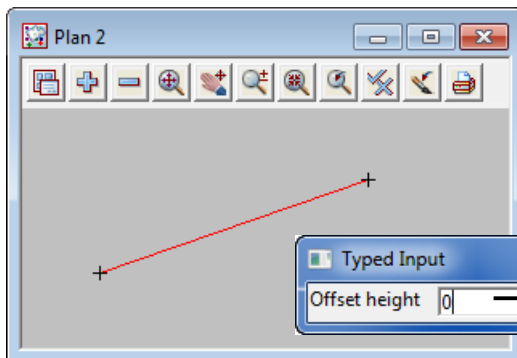
Then accept the string.

The **Pick with Direction** over-rides the direction of the string for this single command.

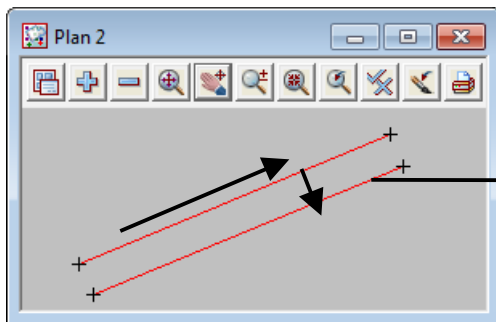


The Parallel command continues as normal.

Then enter the **Offset distance** for the parallel string and press the Enter key.



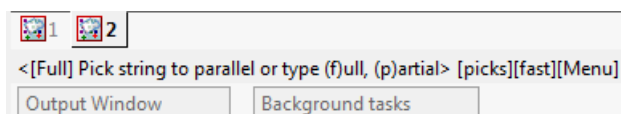
Another box is displayed to enter an **Offset height** for the paralleled string. The **Offset height** option is to change the height of the new string, (leave as 0 if you don't require the height/elevation to be changed.) the height is a delta height difference from the original string.



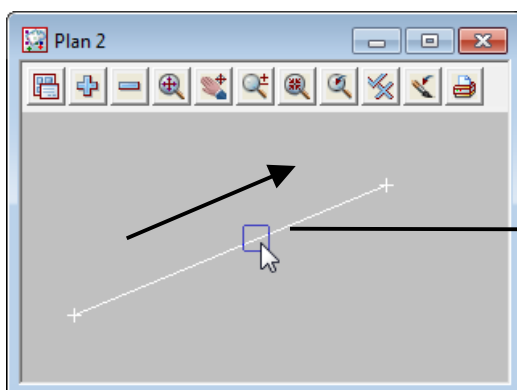
A new string will be created parallel and offset to the right based on the direction picked along the original string.

OR

String Parallel – Partial



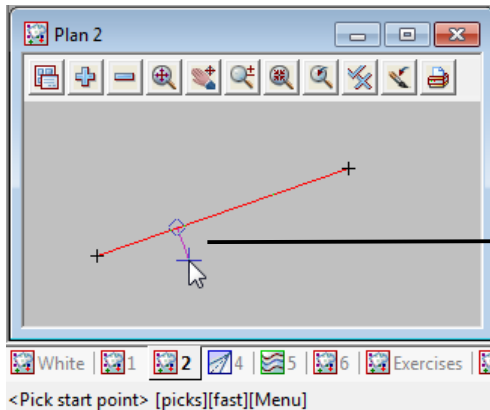
If only part of the string needs to be paralleled then the Partial (p) needs to be entered at the start of the command.



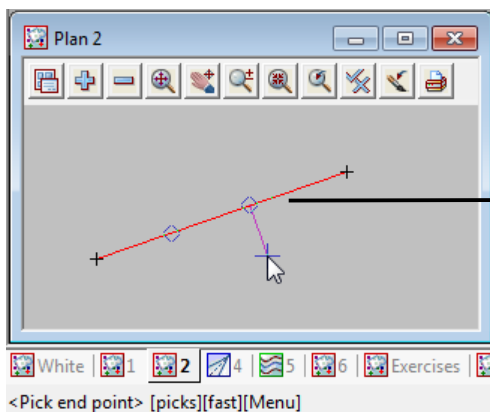
Use **Pick with Direction** to select the string in the direction you would like the string to behave.

Remember that the right side is for a positive offset and the left side is for a negative offset.

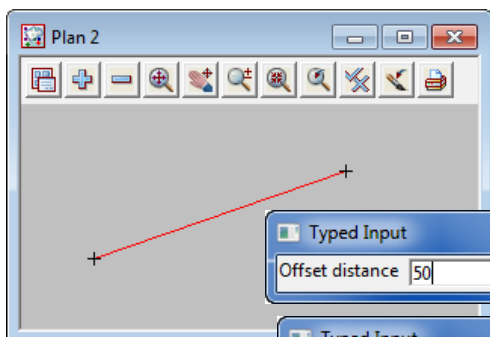
Then accept the string.



Pick the **Start Point** for the parallel string.



Pick the **End Point** for the parallel string.

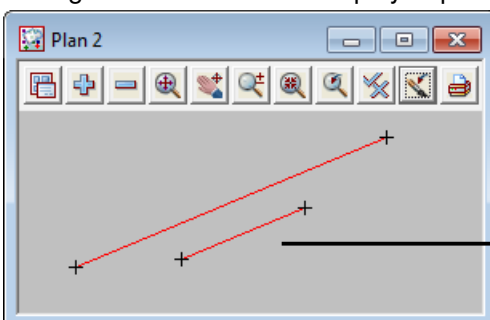


The Parallel command continues as normal.

Enter the **Offset distance** for the parallel string and press the Enter key.

Enter the **Offset height** for the parallel string and press the Enter key.

A string will be created and displayed parallel to the selected string but only the length that you selected.

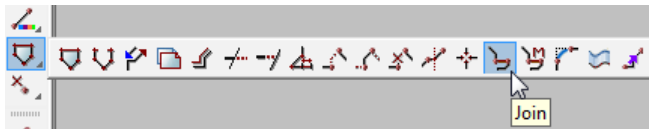


NOTE: String Parallel can also be assessed from the Main Menu:
Strings => Strings Edit => Parallel

A new string will be created and displayed at the parallel distance specified to the selected string.

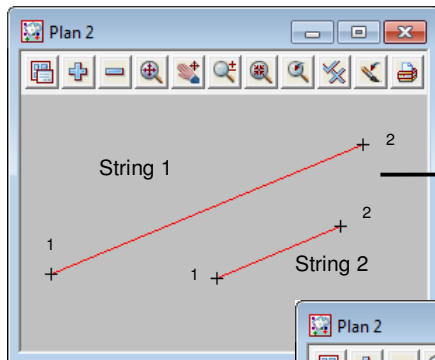


String Join

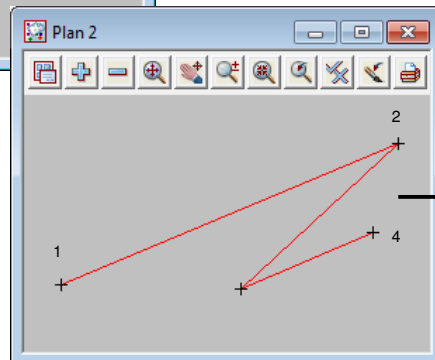


To join strings use the **String Join** command from the Toolbar.

Using the String Join command without using Pick with Direction.



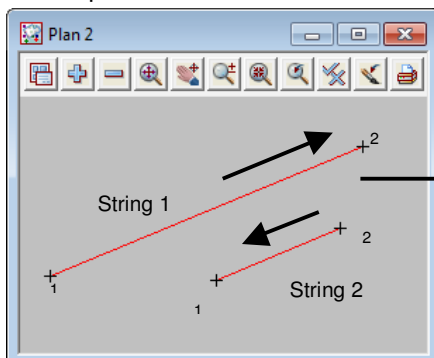
Pick String 1 first then String 2.



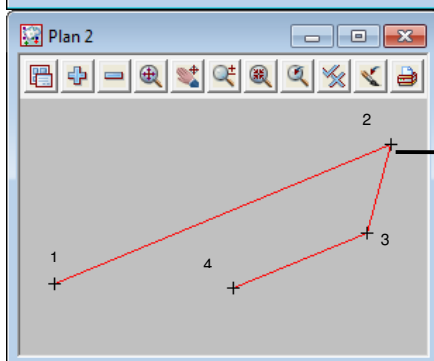
The **String Join** command joins the strings together starting from the **end of the first string** to the **start of the second string**.

By using **Pick with Direction** to select the strings to join, allow the strings to be joined in the method you want require.

3



Pick first string, then the second, with **Pick with Direction**

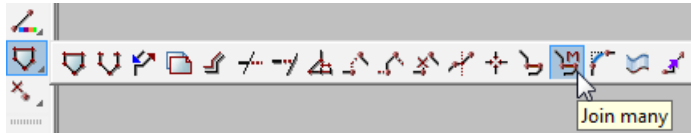


The **String Join** command joins the strings together starting from the end of the first string to the start of the second string except Pick with Direction will over-ride the direction of the strings.

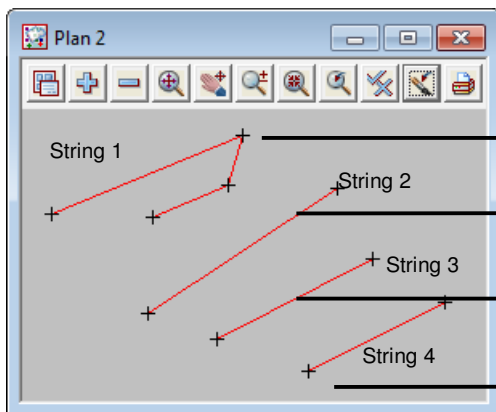


String Join Many

If you have many strings to join, the **String Join Many** is a great command where you don't need to re-select the first string. **Pick with Direction** is required to join the strings in the order needed.



To join many strings use the **String Join Many** command from the Toolbar.

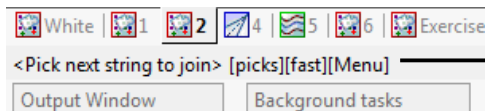


Pick the First string by using Pick with Direction

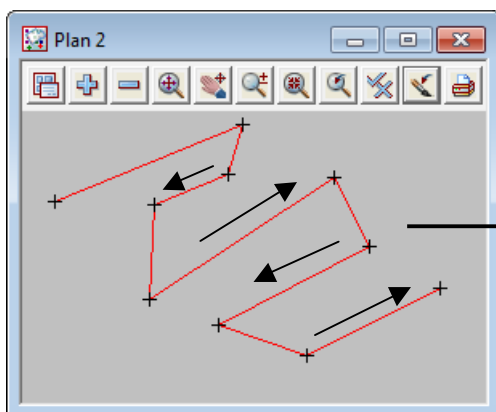
Pick the Second string by using Pick with Direction

Pick the Third string by using Pick with Direction

Pick the Fourth string by using Pick with Direction



The **Join String Many** command will continue to join as many strings as you pick, and will keep asking you to pick the next string.

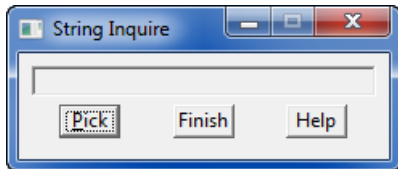


The strings were picked with the direction of the arrows shown.



STRING MODIFICATION – USING THE STRING INQUIRE

To edit strings using the String Inquire command use: **Strings => Inquire**

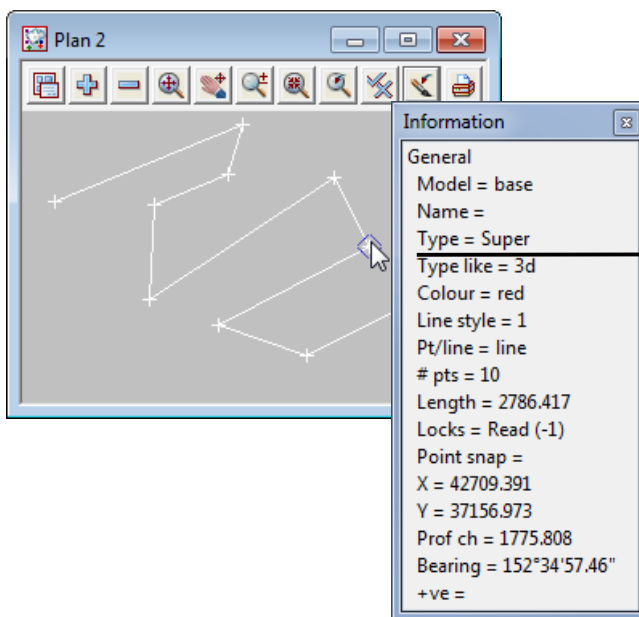


To edit strings use:

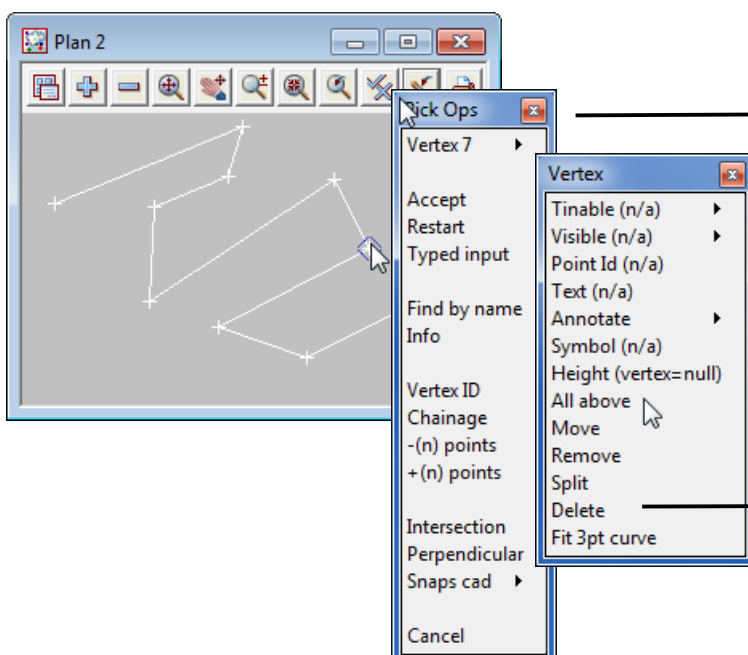
Strings => Inquire or the **F2 Button**

To open the **String Inquire** panel.

Vertex/Point Editing



Firstly pick a vertex (Point Snap – remember it is a diamond snap) for the point to edit.

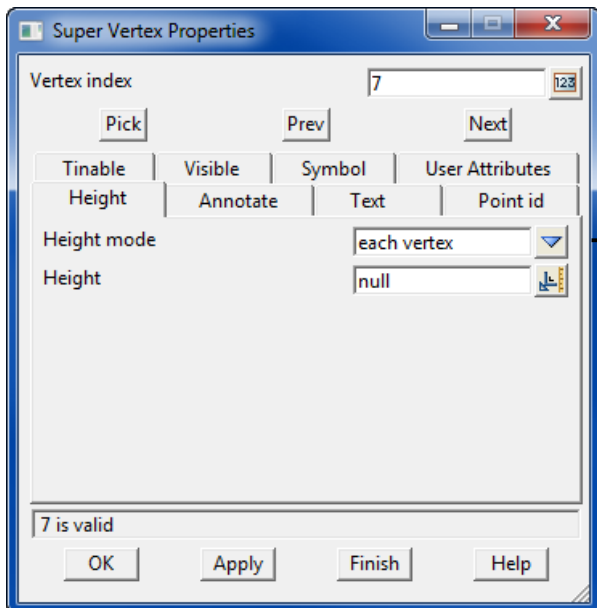


Then **Right Click** to bring up the Pick Options menu for the vertex (point) you choose.

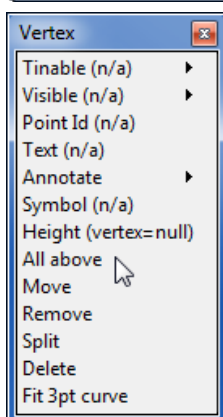
Walk right on the Vertex (number)

This will reveal the entire vertex modifying options available to be applied to the point on this string.

Firstly open the **All Above** option.



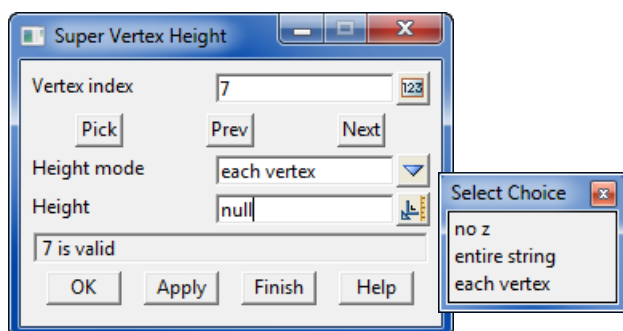
Point /Vertex Properties for the String have been opened in the 1 panel.



If you select any of these options at the top of the list, you will open a small panel just for editing that option.

Modifying options are also available for the point/vertex you have picked.

Example Height (vertex =)



The Super Vertex Height options allows the options

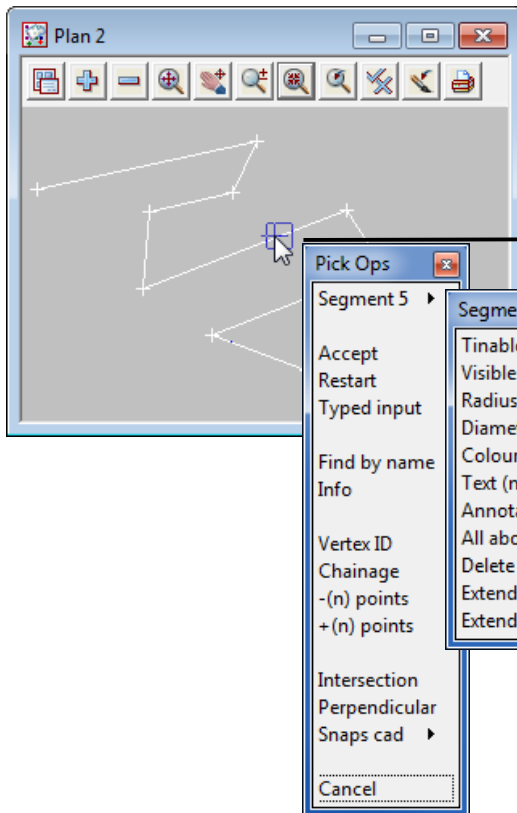
- No Z
- Entire String
- Each Vertex

These modifying options all allow you to apply nothing or a value to the entire string or to each individual vertex.

Always press the **APPLY BUTTON** before moving onto the next vertex or it will NOT BE SAVED!!!!



Segment/Line Editing

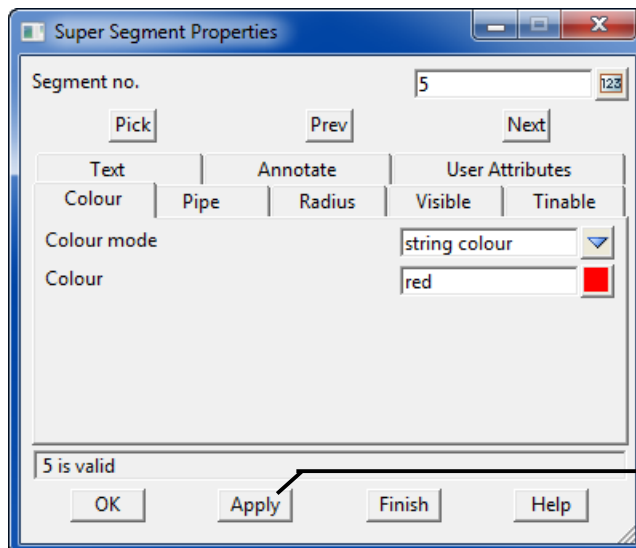


Firstly pick a Segment (Line Snap – remember it is a square snap) for the segment/line to edit.

If you select any of these options at the top of the list, you will open a small panel just for editing that option.

Modifying options are also available for the segment/line you have picked.

Firstly open the **All Above** option.



Segment/Line Properties for the String have been opened in the 1 panel.

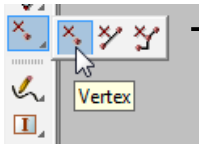
Always press the **APPLY BUTTON** before moving onto the next segment or it will NOT BE SAVED!!!!



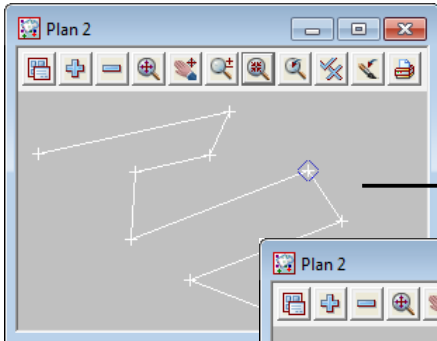


DELETE A VERTEX (POINT), A SEGMENT OR A STRING

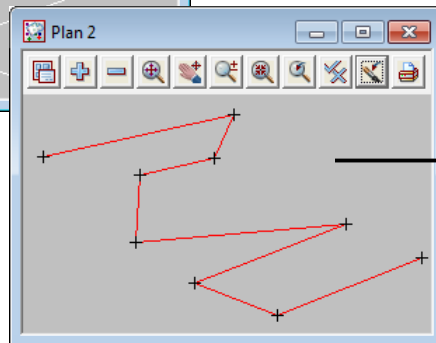
Vertex Delete



To delete a Vertex/Point use the **Vertex Delete** command from the Toolbar.

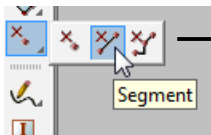


Pick the Point to be deleted

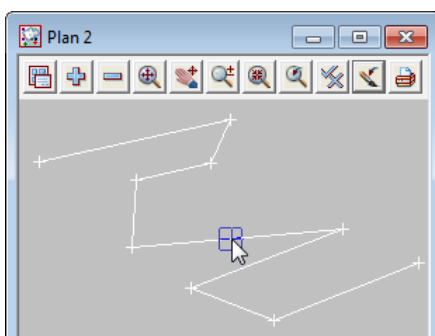


The Point has been deleted, and the string is still joined together.

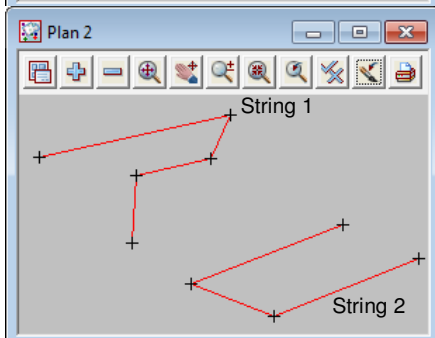
Segment Delete



To delete a Segment/Line use the **Segment Delete** command from the Toolbar.

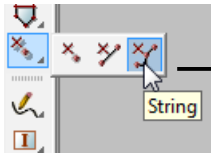


Pick a Segment, to delete from the string (part of the string between two points) then accept.

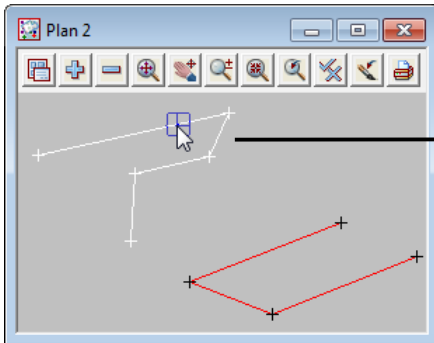


NOTE: The string that has the segment deleted from it will become two separate strings upon accepting the **Segment Delete** option.

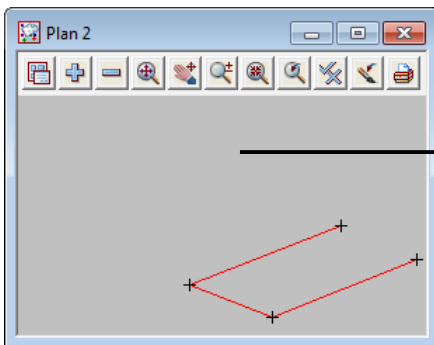
String Delete



To delete a String use the **String Delete** command from the Toolbar.



Pick the String to be deleted



The entire String has been deleted.

Notes:

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are approximately 20 lines visible. The paper has a slight shadow on its right side, suggesting it's resting on a surface.



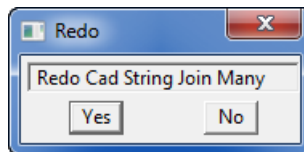
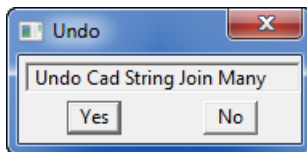
UNDO AND REDO COMMANDS

To Undo or Redo commands in 12d Model Use:

Edit => Undo (Ctrl Z on keyboard)

Edit => Redo (Ctrl Y on keyboard)

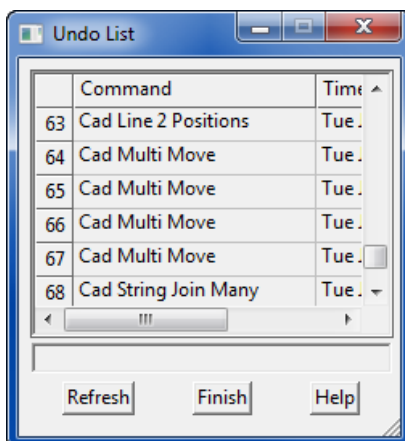
The Undo and Redo commands **do not** UNDO or REDO all options within 12d Model. Only changes to the data can be undone (You cannot undo Zooms).



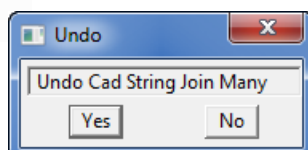
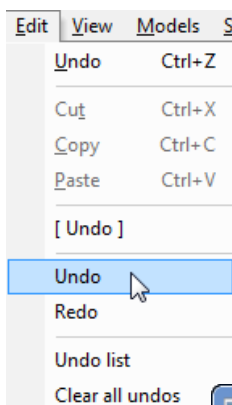
Caution must be used when using the Undo and Redo commands.

To check what is available to Undo in your 12d Model project, Use:

Edit => Undo List



The **Undo List** will display the commands that are able to be Undone within the Project.



A more useful command is the 3rd Undo in the Edit Menu will show you a prompt for what is going to be undone – making sure that you know what is going to be undone.

The **Edit => Redo** Command will automatically Redo what has just been undone in the Project.



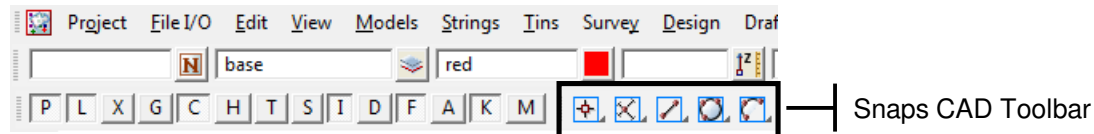
Description: CAD Snaps

Level: Beginner

Outcomes: After completing this module you should be able to create Super strings and use the CAD Snaps options for placing points in the correct location.

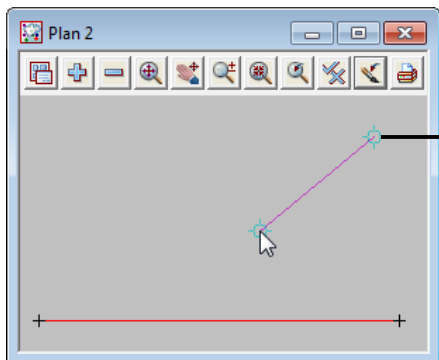
CAD SNAPS

The Snaps CAD Toolbar allows a snap to be selected at anytime during a drawing command to assist the user place the point in the correct location.

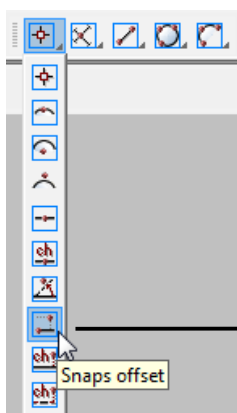


Snaps Offset

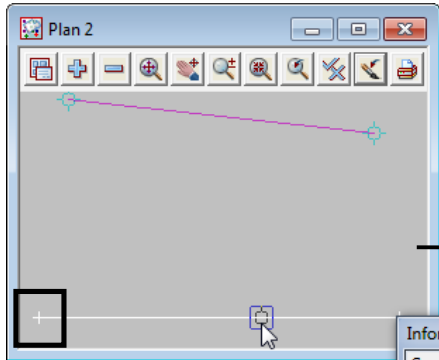
Snaps CAD **Offset**, this is where a point on a string can be drafted to be a specific distance along an existing string to a specific offset from the same string.



1. Select the **Create Line** command, pick and accept the first point.

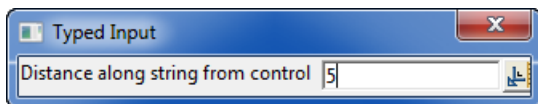


2. Select the **Snaps Offset** from the toolbar.

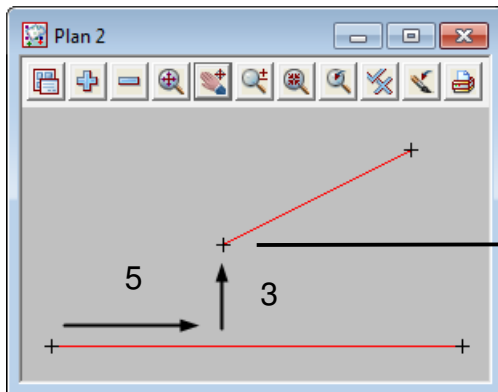


3. Select and accept the string where the offset will be measured from.

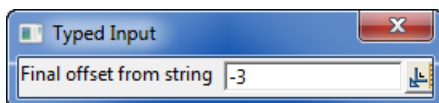
4. Select the point on that string that the offset will be measured from (Control Point).



5. Type the distance from the Control Point along the selected string and press Enter.



New Point created at the offset location defined by the values given.



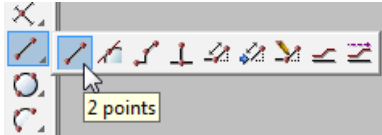
Offset distance from the selected string.

REMEMBER: Positive (right) and Negative (left) Offsets Apply here.

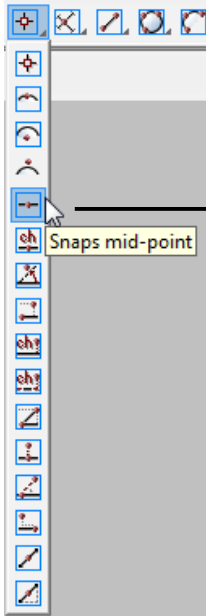


Snaps Mid-Point

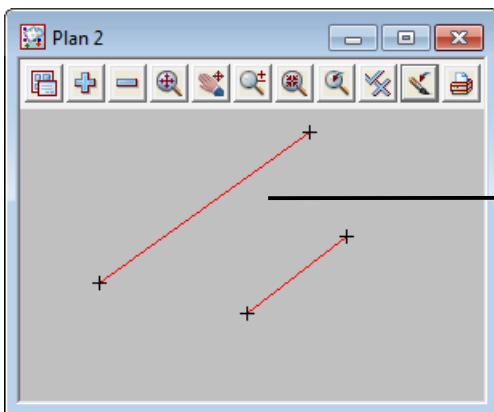
Snaps CAD **Midpoint** allows a point on a string to be created at the midpoint of 2 other points.



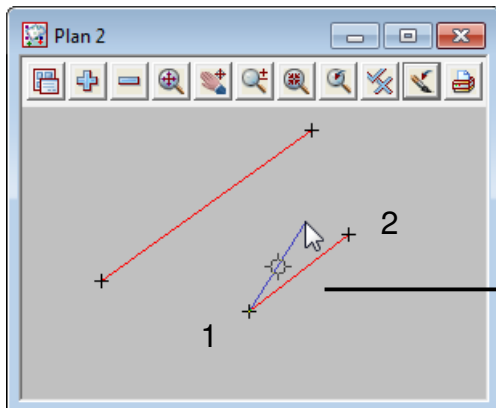
Create Line command



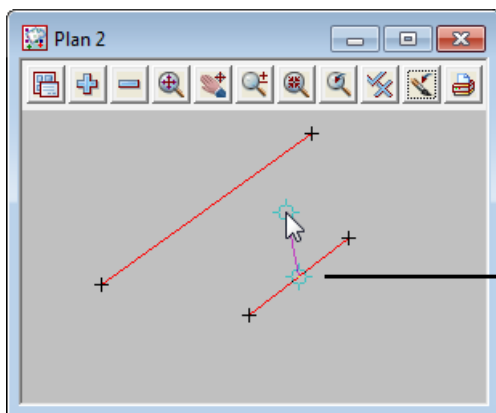
Select **Snaps Midpoint** from the Toolbar.



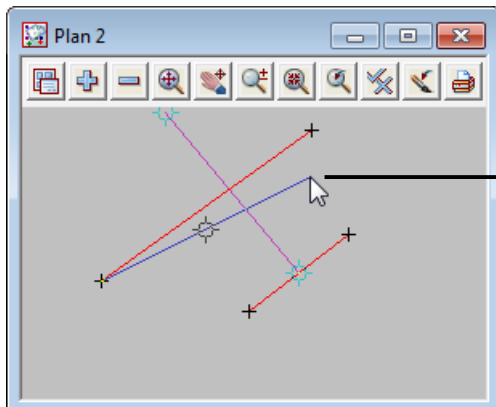
Create a String from the midpoint of the first string to the midpoint of the second string



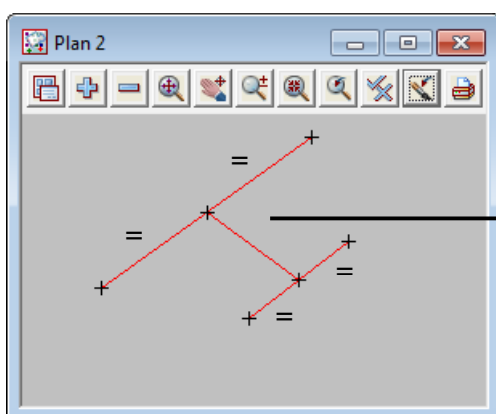
Select points 1 and 2 to find the **Midpoint**. This locates the first point of the string.



First point created midpoint between the two points you chose.



Repeat the **Midpoint Snap** and then select the 2 points where the midpoint is to be located for the second point of the string.

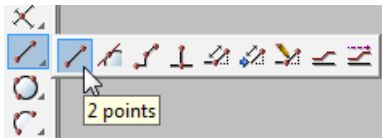


The new line is created between the midpoint of the first and midpoint of the second strings.

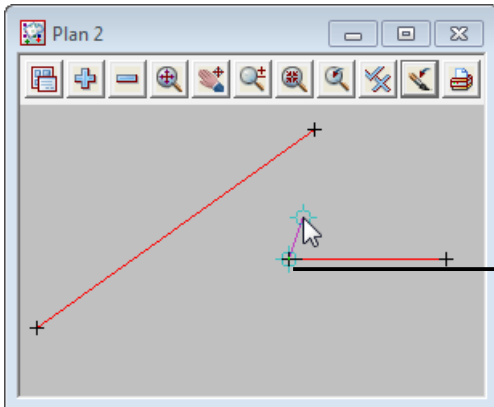


Snaps Perpendicular

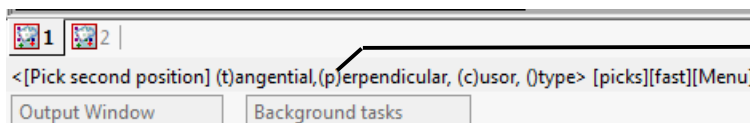
Snaps CAD **Perpendicular**, this is where a point on a string can be drafted to be perpendicular from a string to a specific point.



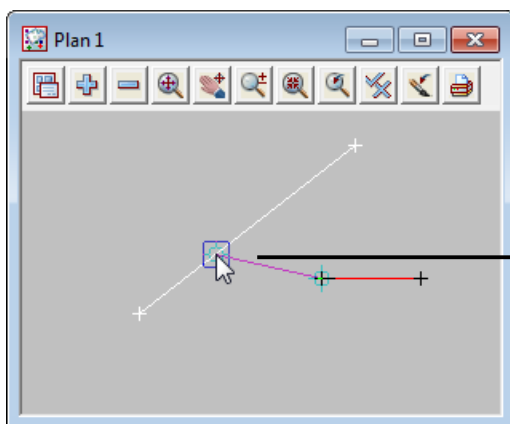
Create Line command



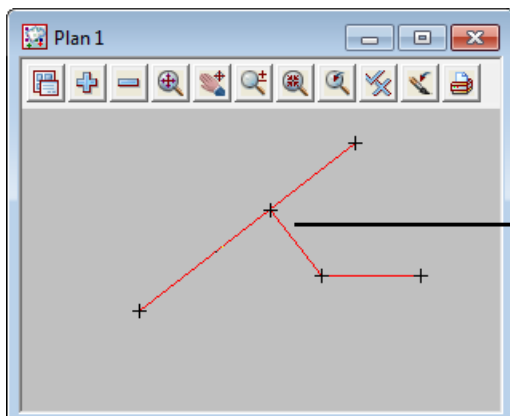
Pick and accept the first point of the line.



Select the **Perpendicular** (p) on the keyboard.



Pick and accept anywhere on the string for the second point.

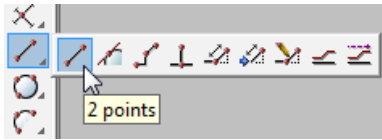


The second point of the string has been created perpendicular to the selected string.

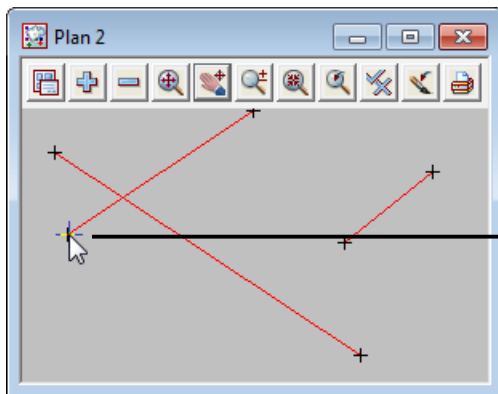


Snaps Intersection

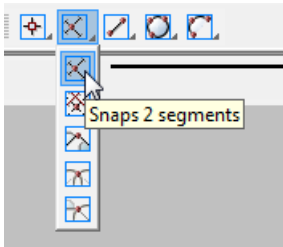
Snaps CAD **Intersection**, this is where a point on a string can be drafted to be at the intersection of two other strings.



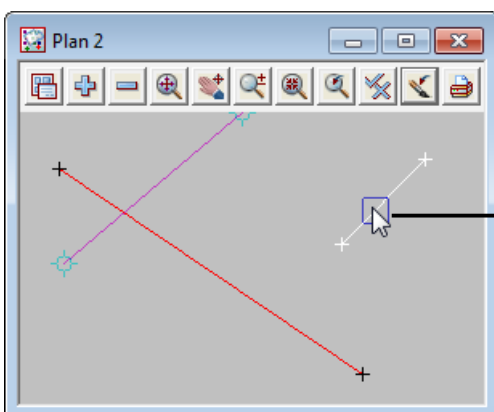
Create Line command



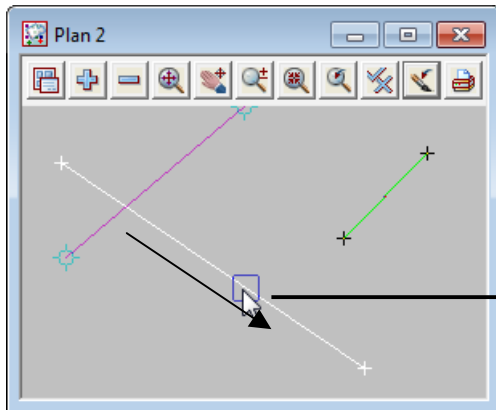
Pick and accept a point on the screen for the first point of the line.



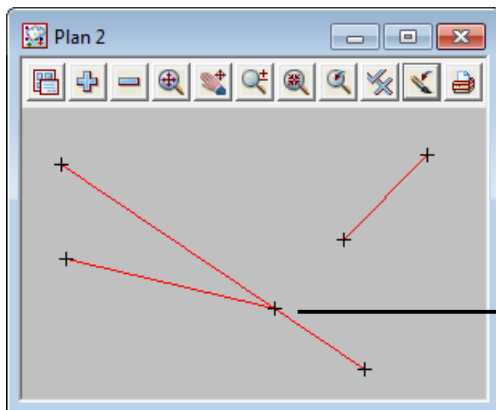
Select the **Snaps 2 Segments Intersect** from the Toolbar.



Pick & Accept the first segment of the intersection.



Pick & Accept the second segment of the intersection.



Point has been created at the intersection of the two segments

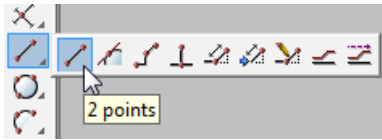
Notes:

[illegible]

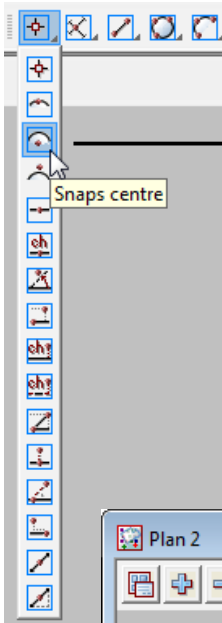


Snap Centre

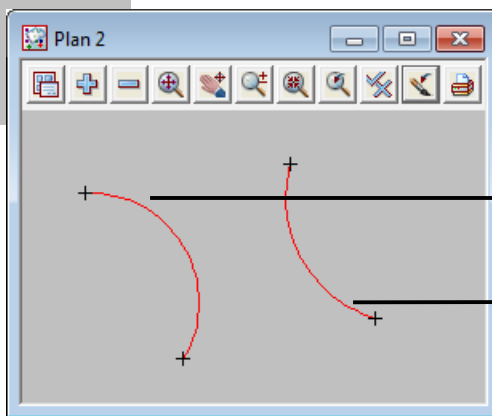
Snap CAD **Centre**, this is where a point on a string can be drafted to be at the centre point of a circle or an arc. In this example we will draft a 2 point string to the centre of the 2 points of the two arcs.



Create Line command

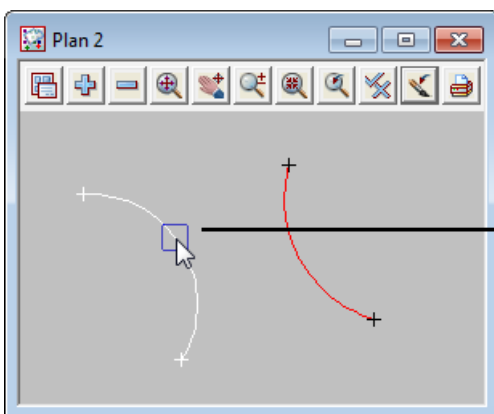


Select the Snap Centre from the Toolbar.

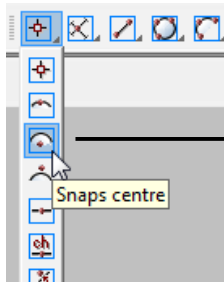


First Arc

Second Arc

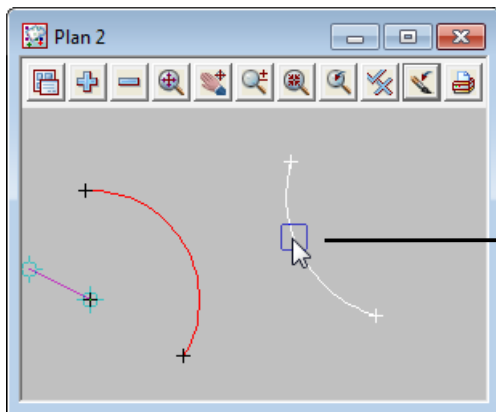


Pick & Accept on the first arc, the point will be created

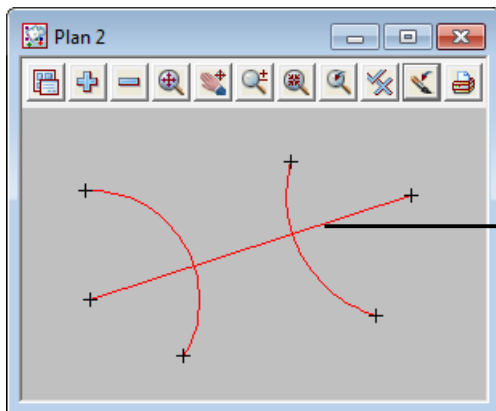


Select the **Snaps Centre** from the Toolbar.

To Activate the Snap again for the second point it needs to be selected again.



Pick & Accept on the second arc, and the point will be created



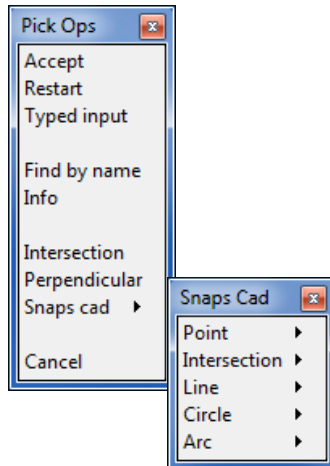
The new Line is now created between the centre of the 2 arcs

Notes:

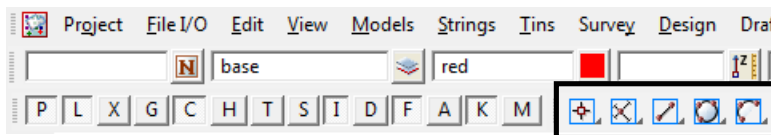


Snap CAD Menu

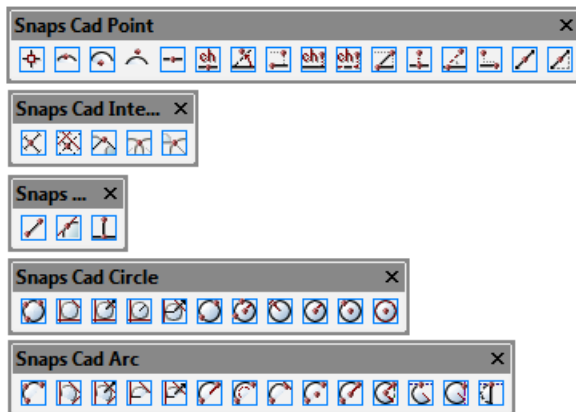
The Snap CAD Menu, is found by Right clicking at the time you require a Snap for placing the proposed point. The Snap options are the same on the Toolbar or the Menu Panel.



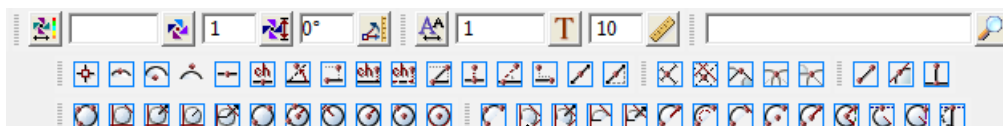
All the Snap Options are available from either the **CAD Snap Toolbar** or the **Right Click Menu**.



Snap CAD Toolbars - Docking



Snaps CAD Toolbars can be opened and placed on the screen in the 12d Model Projects so they can be accessed quickly.



Snaps CAD Toolbars can also be docked on the screen in the 12d Model Projects so they can be accessed.



Description: TIN Analysis

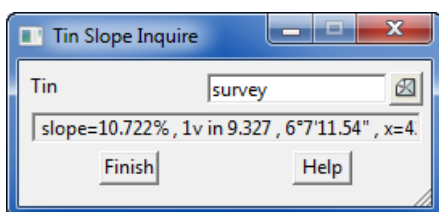
Level: Fundamental

Outcomes: After completing this module you should be able to Inquire around the TIN, and create Analysis Results for the Slope and Aspect of a TIN.

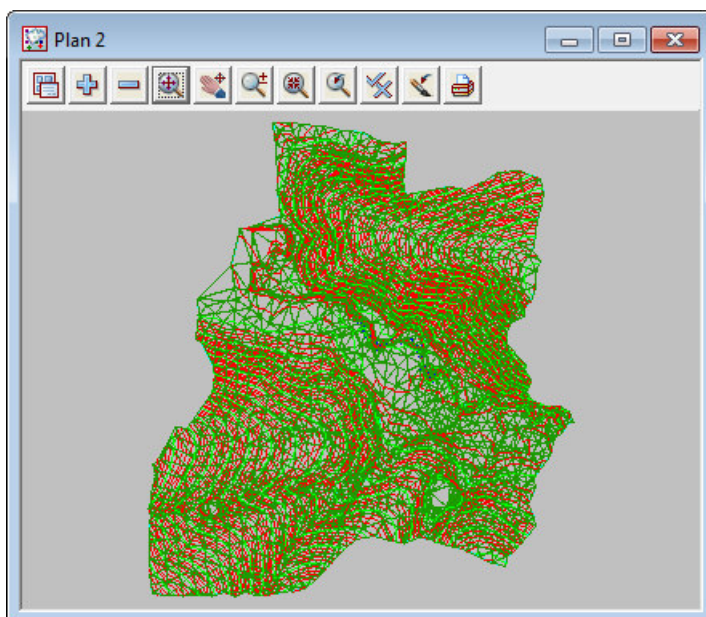
SLOPE ANALYSIS – INQUIRING

The Inquiring options for the TIN are used to determine the Slope, Height and Aspect of a TIN.

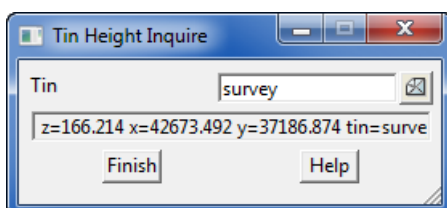
Use: **Tins => Inquire => Slope**



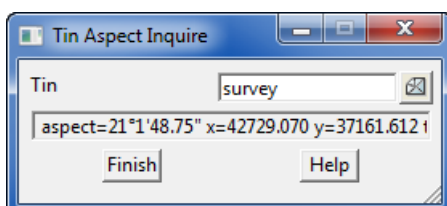
Select the tin and move the mouse across the tin.
As the cursor is moved about the tin, the slope of each triangle is indicated.



The TIN Slope Inquire is useful to get a quick idea of the areas which might be suitable for development.



The Height at any location on the TIN can be measure in the same way.
Use: **Tins => Inquire => Height**



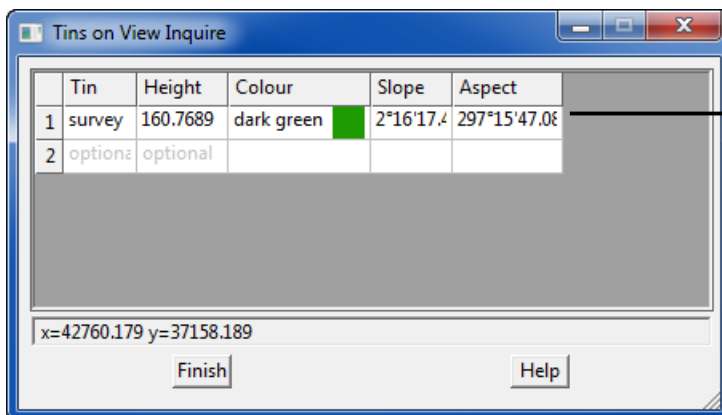
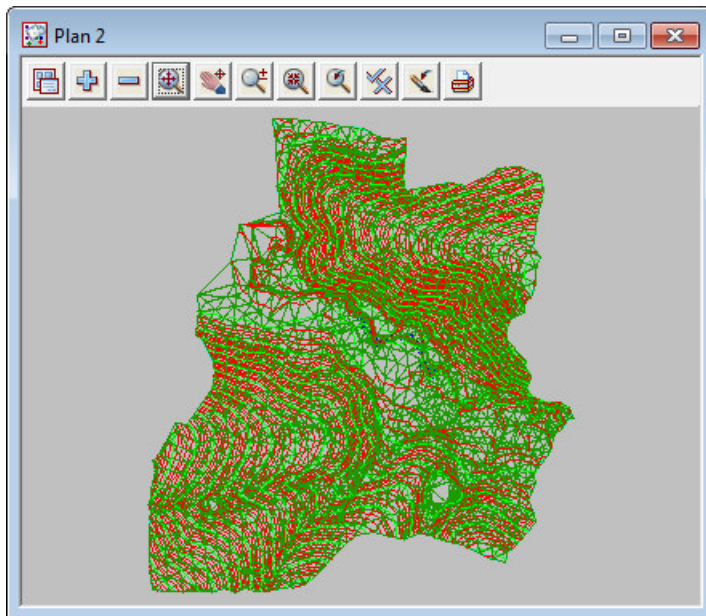
The Aspect (direction of fall) of each triangle can be measure in the same way.
Use: **Tins => Inquire => Aspect**



ANALYSIS – INQUIRING

To combine the Inquiring options for the TIN.

Use: **Tins => Inquire => Tins on a View**



The **Tin on View Inquire** will report the height, slope and aspect (direction) as you move the mouse across the tin in one panel.



SLOPE ANALYSIS

We will use 12d Model's capabilities for slope analysis to determine a suitable area for creating a building platform.

We would prefer to build our pad on ground with a slope between 3 and 6 percent.

This will ensure that the adjacent land will drain, and that the pad will be constructed with a minimum amount of cut and fill.

To get a better picture of the likely areas, we will use the Slope Analysis option.

Use: **Tin => Tin Analysis => Slope => Slope Analysis**

The image shows two screenshots of the 12d Model software interface. The top screenshot shows the 'Slope Analysis' dialog box with the following settings: Tin: survey, Range file: Ground Slope.srf, Slope type: percent cross fall, Plan view to paint: 2, Model for faces: (empty), Clean faces model beforehand: (unchecked), Report file: (empty), Poly: (empty). The 'choice ok' button is highlighted. A callout line points to the 'survey' text in the Tin field with the label 'Pick the Tin'. Another callout line points to the 'Ground Slope.srf' file in a file selection window with the label 'Pick the Ground Slope.srf file'. This window also lists various file operations like [Lib], [User Lib], [Browse], etc. The bottom screenshot shows the same 'Slope Analysis' dialog box with the same settings. Callout lines point to the 'percent cross fall' dropdown with the label 'Slope Type=**Percentage Crossfall=%**', the '2' in the 'Plan view to paint' field with the label 'View 2 will be painted with the colours from the range file (NOTE: Explained on next page)', and the 'Slope' button with the label 'Press **Slope**'.

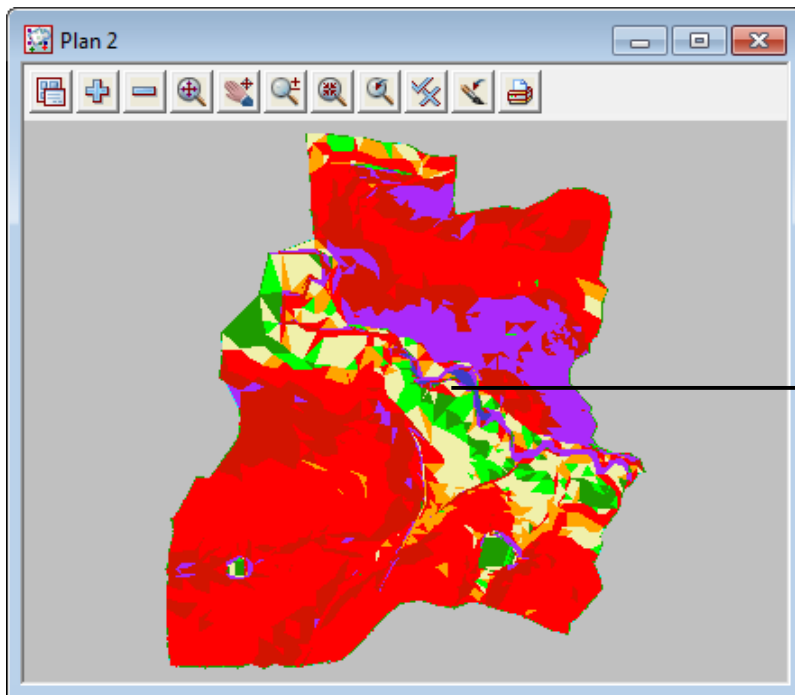
Pick the Tin

Pick the Ground Slope.srf file
This is supplied with the dataset for the course and will be edited in the next section.

Slope Type=**Percentage Crossfall=%**

View 2 will be painted with the colours from the range file
(NOTE: Explained on next page)

Press **Slope**

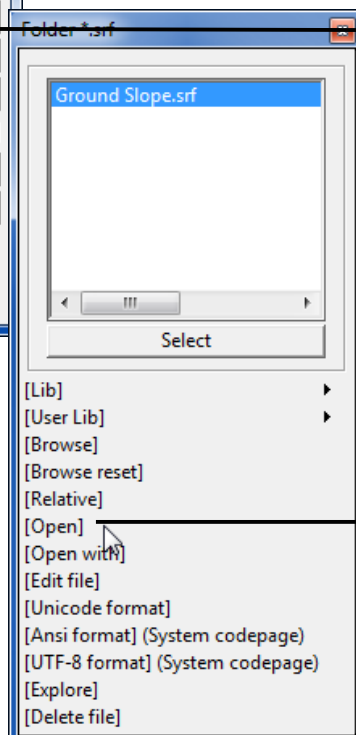
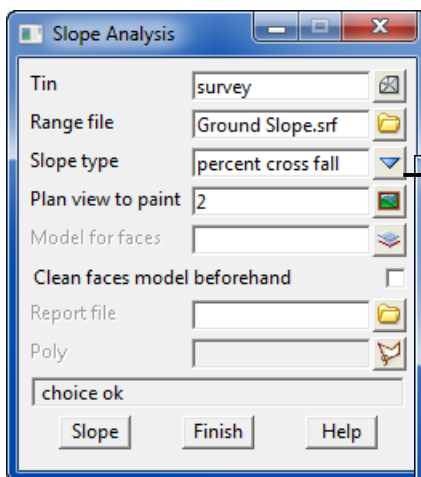


The Slope Analysis panel will **paint** the tin based on the slope ranges given in the Slope Range file **Ground Slope.srf**

Painting the Tin does not save the results shown, it is just a viewing tool. The colours will disappear when the view is refreshed or zoomed.

To see what colours relate to which slope ranges, lets look at the slope range file.

The .srf (slope range file) can be viewed by clicking on the folder icon and open.

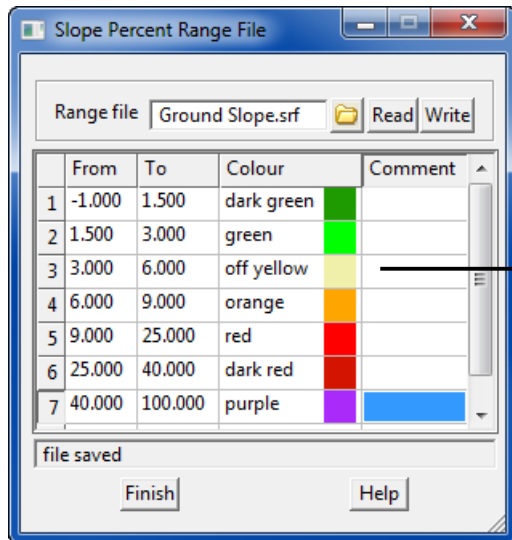


Click on the **Yellow Folder**

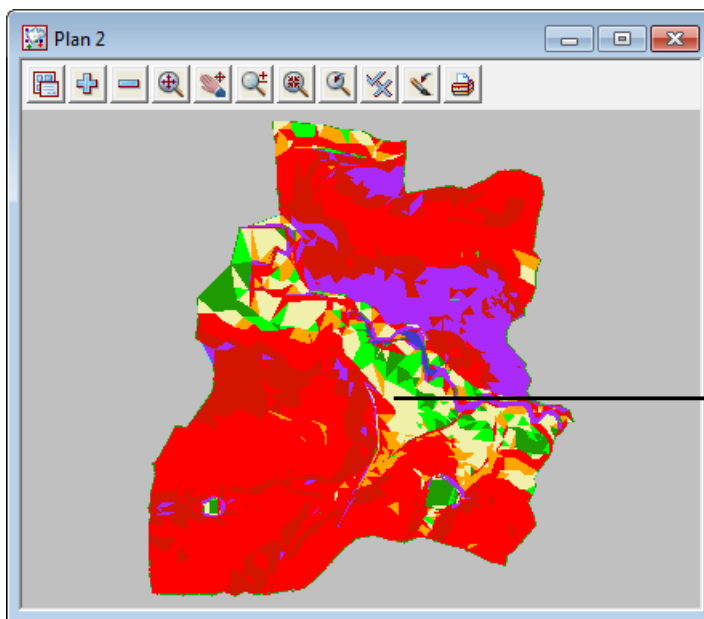
Click on the **Open** option. The file shown in the main panel (Slope Analysis) will open for editing.



The Slope Range File.



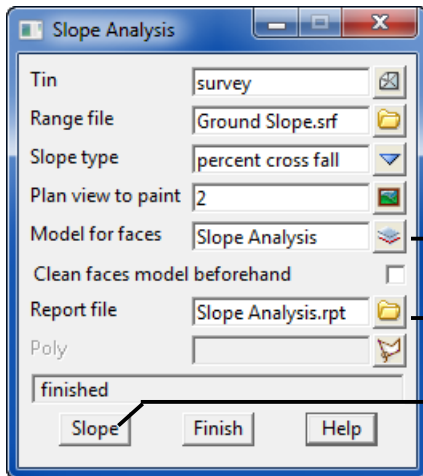
Slope Percentage Crossfalls to shade with colour.
3% - 6% off yellow



The results of the slope analysis using the Slope Range File (.srf) are shown above.
This area looks suitable for the building pad construction.



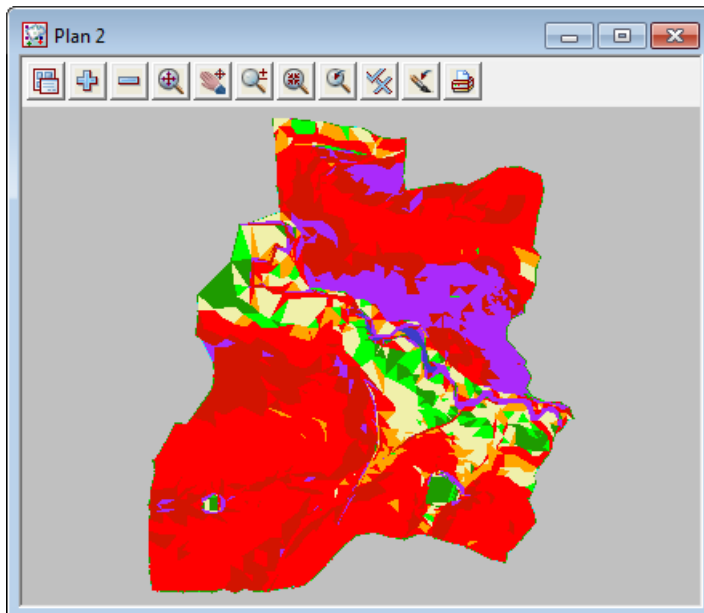
To save the Slope Analysis results we will create a new Model and Report file.



New Model = **Slope Analysis**

Report file for the results to be documented.

Click the **Slope** button to create the colour shading.



A **Polygon** can be selected to restrict the Analysis within the Polygon.

The coloured areas are saved if a model is given for **Model for faces**. Create a model if you wish to export or plot the depth colours.

A Report file can be produced if a name is entered for the report. Do this, and take a look at the report.

Slope Analysis.rpt - Notepad

File Edit Format View Help

slope analysis for tin "survey" - (with no plan polygon)

slope range (% crossfall)			slope area	% of total	plan area	% of total
-1.0	to	1.5	12054.064	3.4%	12053.577	3.5%
1.5	to	3.0	12058.770	3.5%	12055.621	3.6%
3.0	to	6.0	27805.082	8.0%	27777.043	8.2%
6.0	to	9.0	16468.856	4.7%	16422.509	4.9%
9.0	to	25.0	159411.658	45.7%	156805.454	46.4%
25.0	to	40.0	76710.500	22.0%	73248.881	21.7%
40.0	to	100.0	44664.831	12.8%	39446.109	11.7%

Total slope area is 349173.762
Total plan area is 337809.194





EXPORTING ANALYSIS RESULTS

We now need to produce output for drawings or reports.

The colour faces produced from the slope analysis can be exported as a dwg or a dgn file,

Use: **File I/O => Data Output.**

Before we export the faces, we will create a legend for the plan.

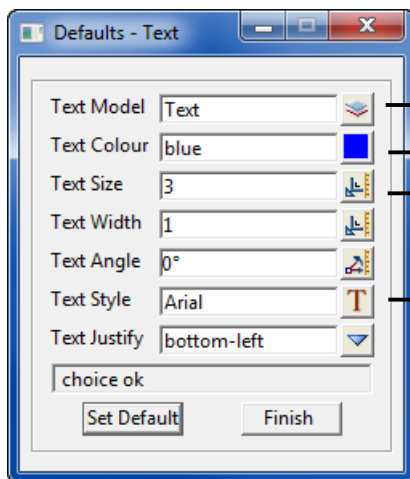
Two steps are required for creating a legend:

Defining a default text style to be used for the legend

Creating the legend.

To open the **Defaults-Text** panel, use **Drafting => Text and Tables => Defaults**

The **Defaults – Text** panel sets the default text values in this project.



Text will be created in the model called **Text**.

The Text will be Blue in colour.

The Text will be **3mm high**.

The Textstyle is **ISO**.

Change the default style from **ISO** to **Arial**, by clicking on the  button, and choosing **Arial** from the list.

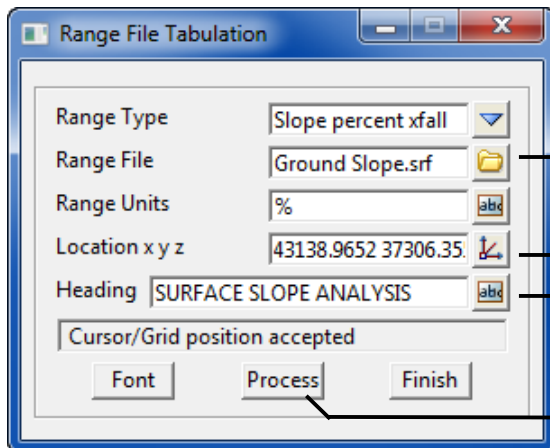
Any true font available from Windows can be used, but it is outside the scope of this course to import different fonts available in this Project.

Notes:



CREATE THE LEGEND – TABULATE RANGE FILE

To create a Legend, use: Drafting => Text and Tables => Tabulate Range File



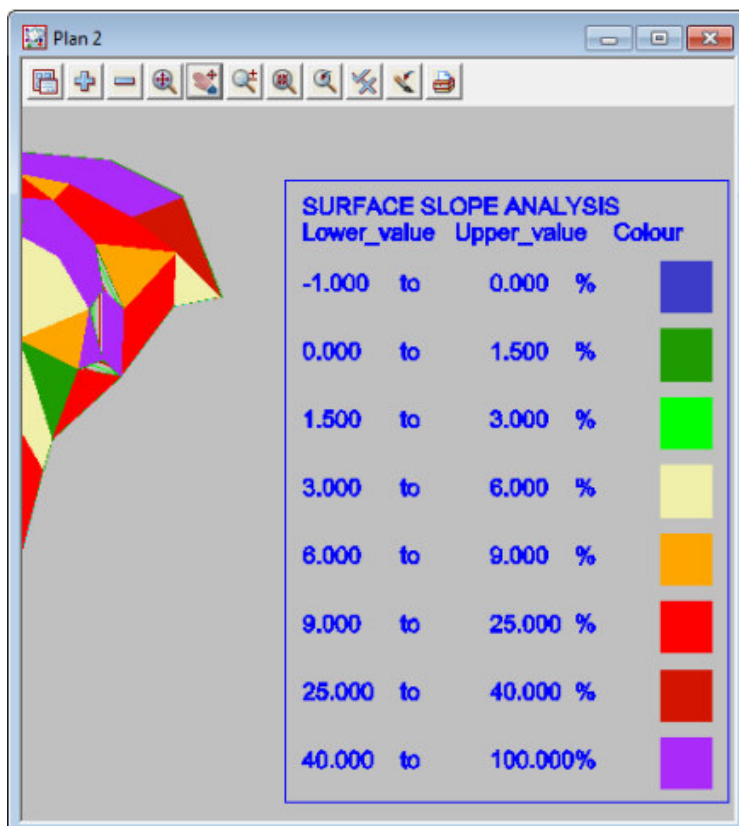
Select the Range File.

Select a screen location (x,y) for the Legend (Top left corner of table).

Type in a Heading for the Legend.

Press **Process** to create the Legend.

You can also access the Text defaults here under the Font button.



As can be seen, the text

Surface Slope Analysis and the % sign are brought into the table.

The colour of the lines around the table will be the same as the colour of the text.

The table size is computed from the text size. To change the table size you will need to delete it, change the text size and recreate it.

This can be done by Cleaning the Model, using:

Models => Clean

The location of the table is set by the Location xyz field, which fixes the top left corner of the table.

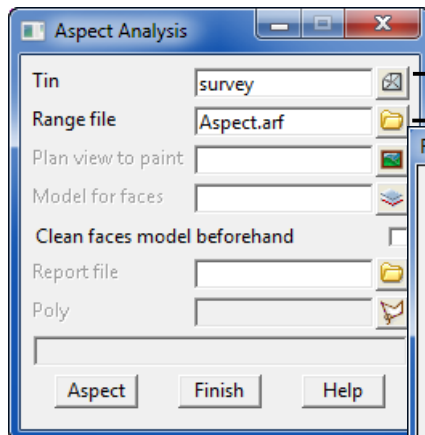


ASPECT ANALYSIS

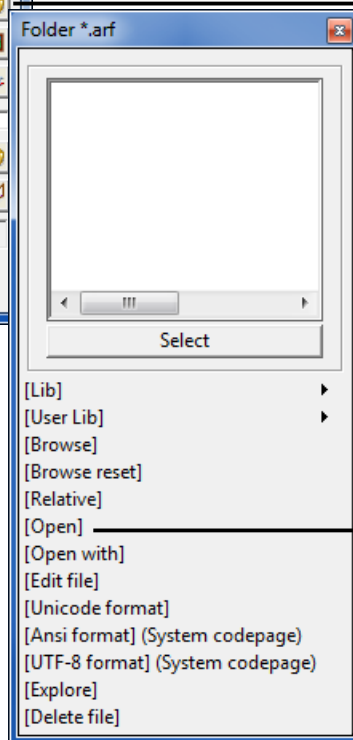
In a similar way to the Slope Analysis option we can calculate the Aspect of a tin surface.

Use: **Tin => Tin Analysis => Slope => Aspect Analysis**

1. Create an Aspect Range File



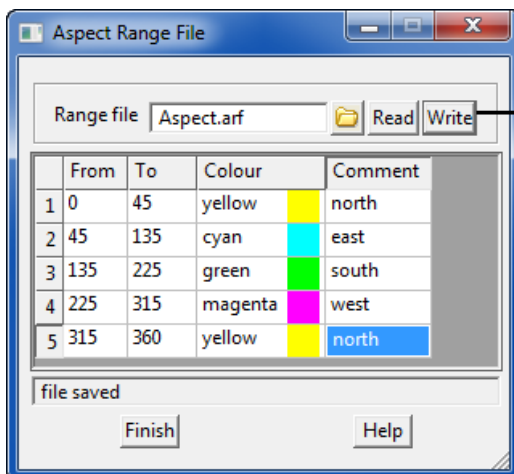
Select the **survey** tin.



Type in the Range file name = **Aspect.arf**
Select the **Yellow Folder**.

Select the folder, and select the **Open** option

Fill out the Aspect Range File as shown below:

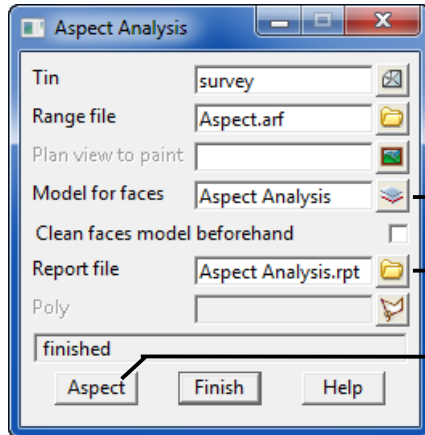


Click the **Write** Button to save the file.

Fill out the Panel as per image.



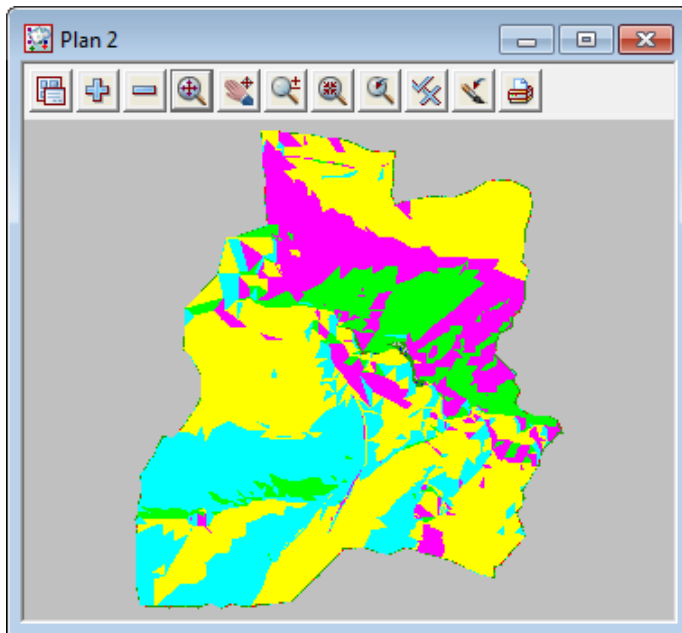
2. Create Aspect Analysis



New Model = **Slope Analysis**

Report file for the results to be documented.

Click the **Aspect** button to create the colour shading.



The coloured areas are saved if a model is given for **Model for faces**. The Model can be exported or plotted.

A Report file can be produced if this panel is filled out. Do this, and take a look at the report.

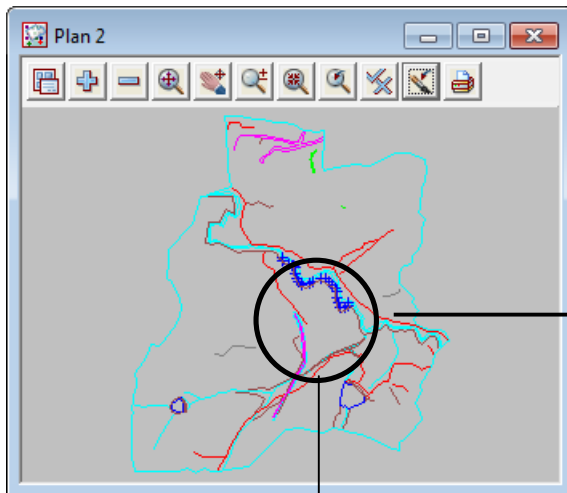
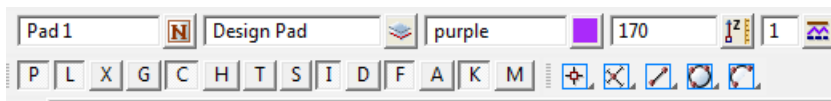
Aspect analysis for tin "survey" - (with no plan polygon)				
aspect range	slope area	% of total	plan area	% of total
0°00'00" to 45°00'00"	87617.303	25.0%	85474.519	25.2%
45°00'00" to 135°00'00"	83388.267	23.8%	81387.788	24.0%
135°00'00" to 225°00'00"	44839.947	12.8%	41393.790	12.2%
225°00'00" to 315°00'00"	64296.151	18.3%	61667.481	18.2%
315°00'00" to 360°00'00"	69150.758	19.7%	67530.562	19.9%
Total slope area is 350388.741				
Total plan area is 338550.455				



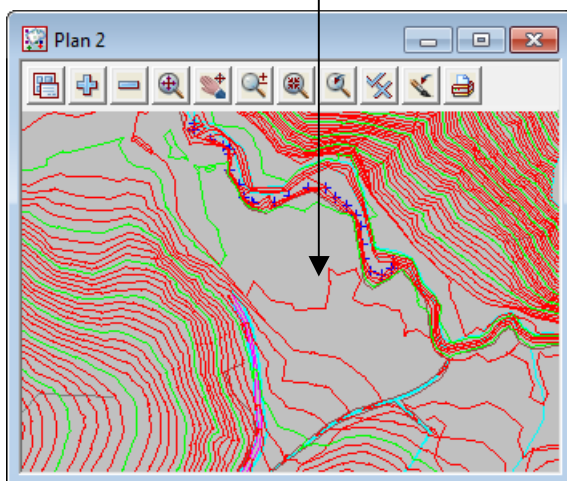
Description:	Exercise No.2 – Building Pad
Level:	Fundamental
Outcomes:	After completing this module you should be able to create a Building Pad with an Interface (Cut and Fill Batters) to the existing survey TIN. Create a Design TIN, and calculate Volumes for Cut and Fill.

CREATE DESIGN PAD STRING

We will create a string defining the location of the top of a building pad – we will set up the **CAD Control Toolbar** as per below:



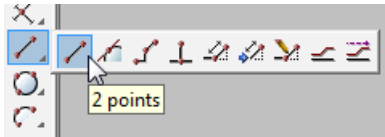
Area to create the Building Pad.





Create Line String

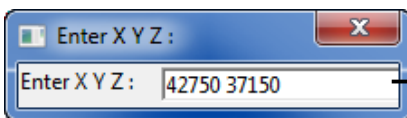
We are going to use the CAD lines option to create the southern side of the building pad.
This string will be located by entering coordinates.



Select the **Create Line** option.

Push the **space bar** to open the typed coordinate input panel.

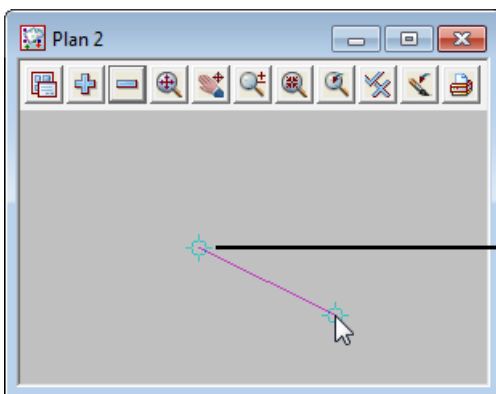
Note: that pushing any key will open the panel.



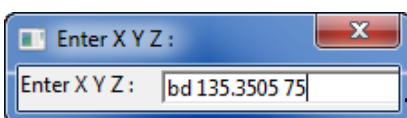
Type the following easting and northing coordinates (**X**) **42750**, (**Y**) **37175** as shown, the coordinates are separated by a space.

Note: that a height (**Z**) does not have to be entered.

Push enter to accept and the first point of the string will be created at the coordinates above.



Point 1 is created

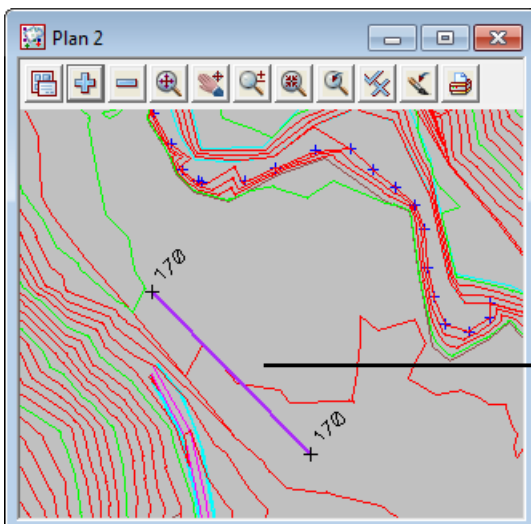


Push the **space bar** to open the typed coordinate input panel again and we will enter a bearing and distance to create the second point on the string.

We need a prefix of **bd (space)**

Then enter the bearing of 135° 35' 05" and the distance is 75m, this is separated by a space.

Push enter to accept the second point of the string.



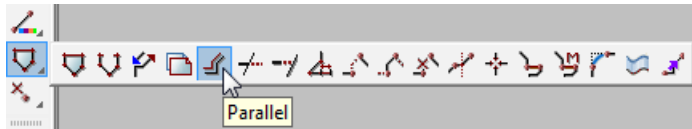
First String has been created



String Parallel

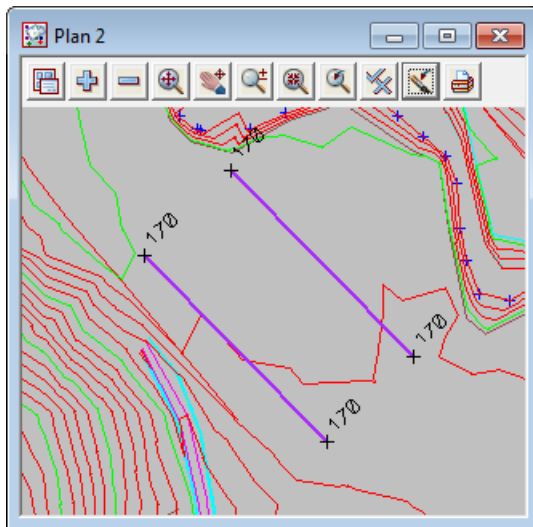
The building pad is going to be a rectangle with a width of 35 metres.

To create the other side of the building pad we are going to parallel the string to the right by 35 metres.



Select the **Parallel** option.

Use the instructions at the bottom left of the screen in the status bar to run you through the process.



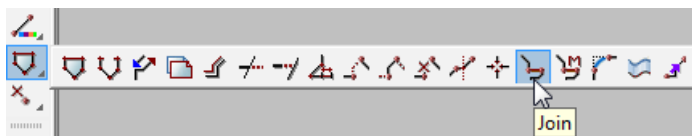
Pick the **Design pad string** to parallel (With Direction).

Choose to parallel the whole string.

Parallel distance = 35 to parallel to the right side of the string.

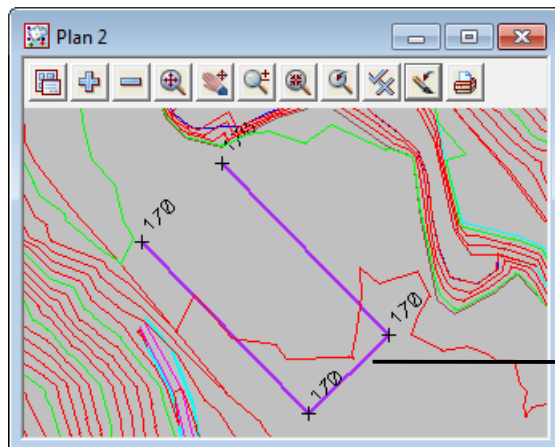
Offset height is 0 as the height will be the same as the existing string (parent).

String Join



Use the **String Join** option to join the 2 strings together, remember to use **Pick with Direction**.

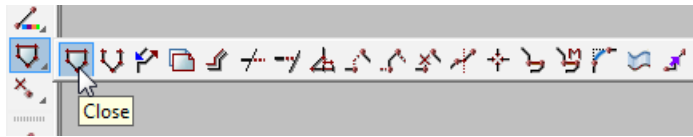
Use the instructions at the bottom left of the screen in the status bar to run you through the process.



String has been joined together.

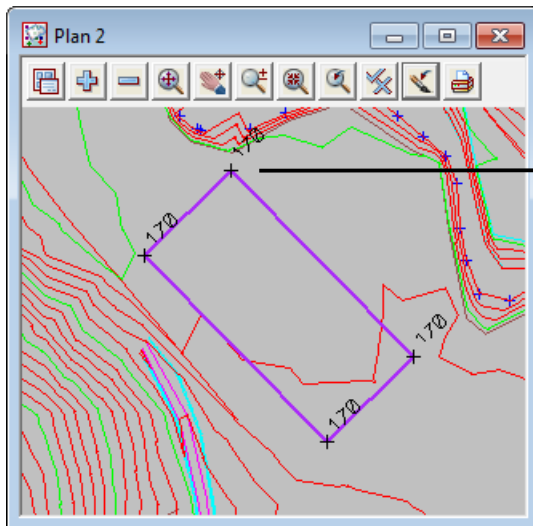


String Close



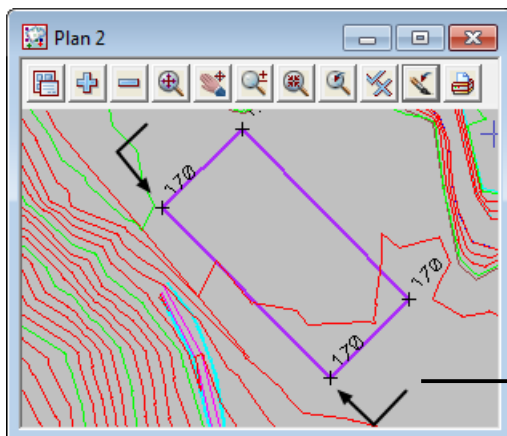
Select the **Close** option.

Use the instructions at the bottom left of the screen in the status bar to run you through the process.

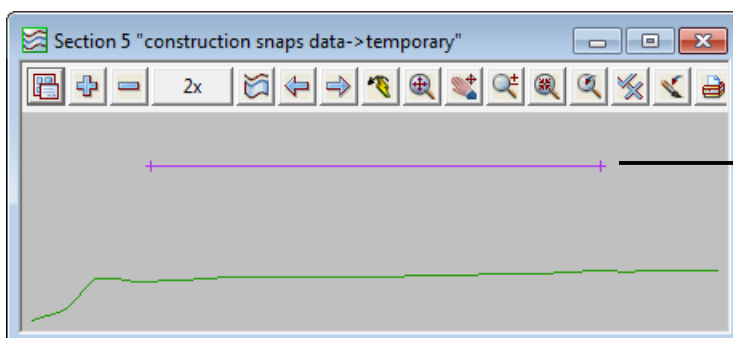


Pick the String and accept to close it.
The string only has 4 vertices/points.

Section View of Design Pad



The **Section** cut for the Design Pad.



The Design Pad at the RL 170.0

The survey Tin showing the natural surface levels.

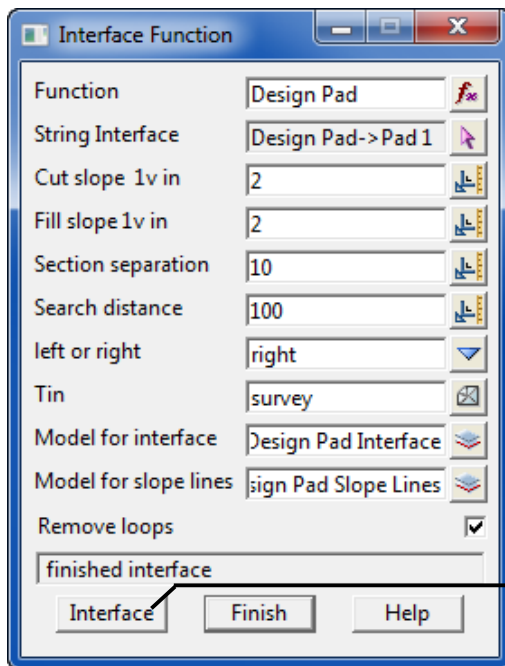


INTERFACE FUNCTION FROM THE PAD TO THE NATURAL SURFACE

Creating Batters

To create a batter in 12d we use the Interface function. The Interface function is used to calculate Cut and Fill batters from a design string at a design level to a natural surface tin at a specified slope.

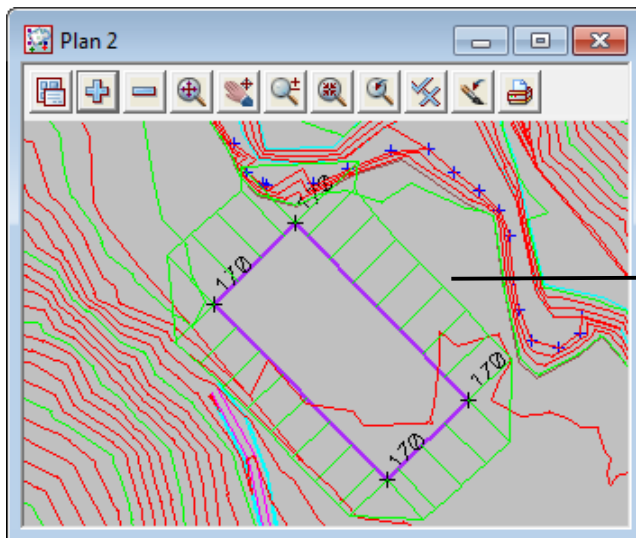
Use: **Design => Apply => Interface**



Fill out a **Function Name** = Design Pad
Pick the **String to Interface**
Fill out the **Slope for Cut and Fill**

Pick the **Tin to Interface** to = survey
Fill out the **Model for Interface**
Fill out the **Model for Slope Lines**

Press **Interface** to create the Batter



The Batter has been created all around the Design Pad, it is green, which means that it is all in Fill.

The Interface Function calculates the specified slope at right angles to the control string until either the natural surface tin is cut or a fixed (plan) distance is travelled.

The slope of the line is dependent on whether the control string is below the tin (cut) or above the tin (fill).

The slope lines are calculated first at the specified section distance, and then the interface string is joined together from the end point of the slope lines.

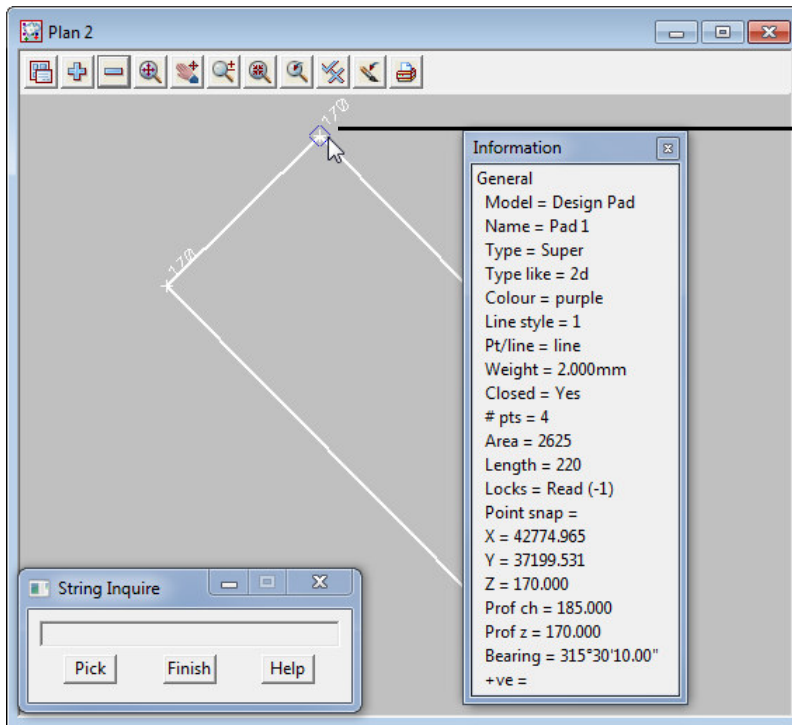


Pad Elevation

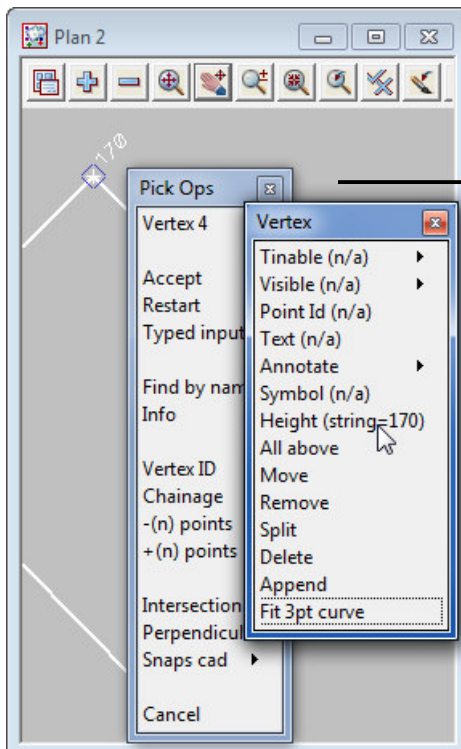
The pad outline that we created currently has a level of 170.

We will use the **F2 button, String Inquire** to change the height for the pad.

We will change the entire string to have a height of **161.50m**.

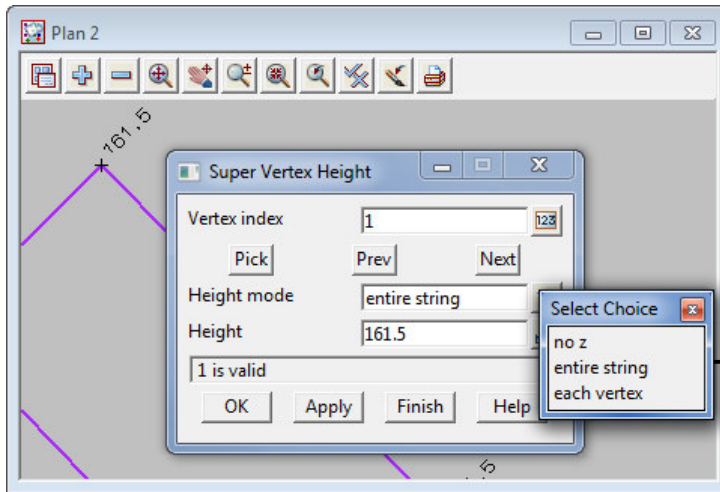


Press the **F2 Button** and select one of the points on the string (at one of the corners) make sure that a diamond is shown.

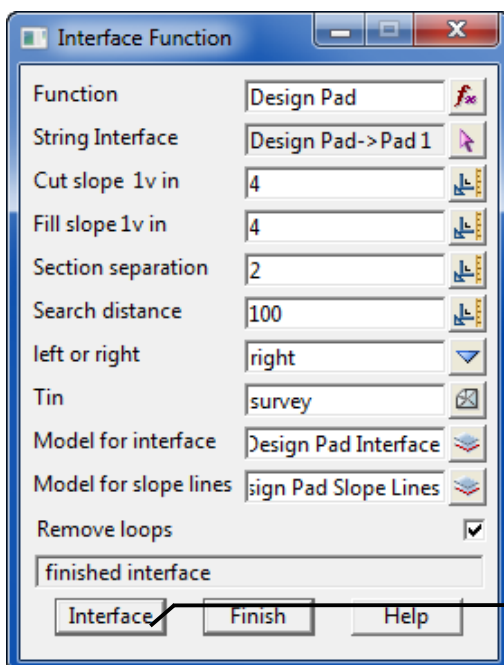


Then **right click** the mouse to bring up the **Pick Ops List**, walk right on Vertex (number) to reveal the **Vertex Panel** and select the **Height** Option.





Set the **Height Mode** to **entire string** and the height to **161.5m**.



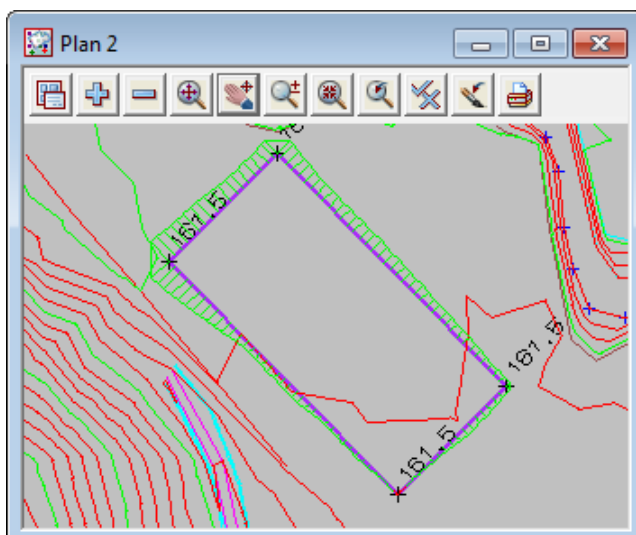
We want to change the Design Pad Batters, so that they are calculated at 1:4 Slopes for both Cut and Fill.

To get a more detailed interface, change the section separation to every 2 meters.

The Interface Function calculates the specified slope at right angles to the control string until either the **survey** tin is cut or a fixed (plan) distance is travelled – default is 100m.

Press the **Interface** button, every time the Interface Function is re-run, the old data is deleted and the new modified data is recalculated.

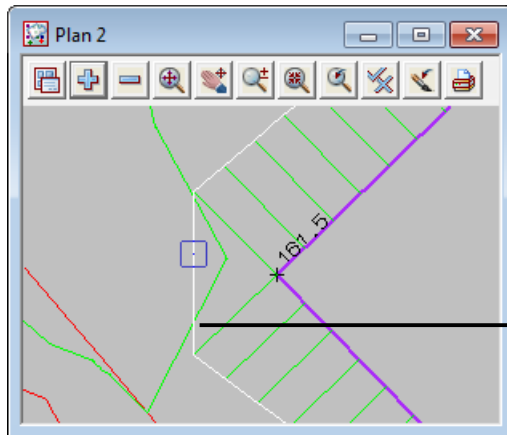
This is one of the great things about the function inside 12d



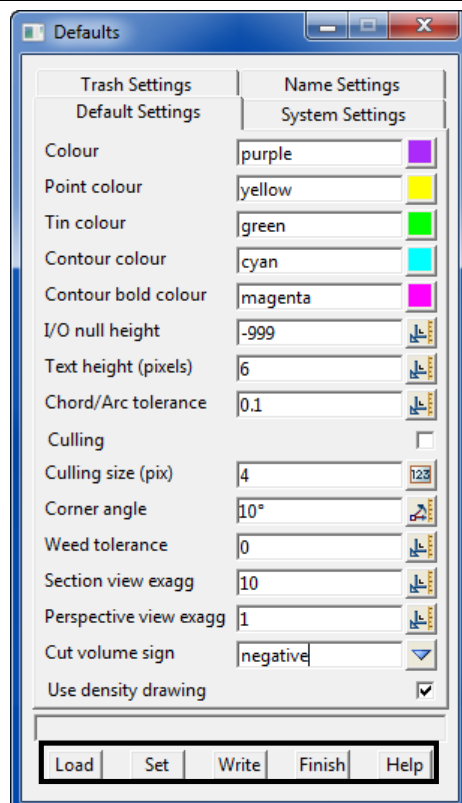
After the Interface Function has recalculated the specified slope the Interface string is created to show new batters.



Corner Angle



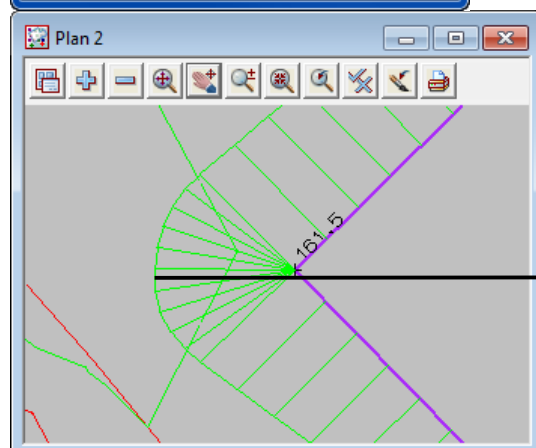
The Interface string is being created, by joining to the slope lines, but with straight lines, so the corners are not modelled correctly....



Use: **Project => Management => Defaults**

The corner angle determines how often a section is cut around a corner.

10° was specified here, so the angle of the corner 90° is divided by 10° and a section is cut at every 9°, so there are 9 extra sections cut – allowing a better calculation for the Design Pad Interface around the corner.



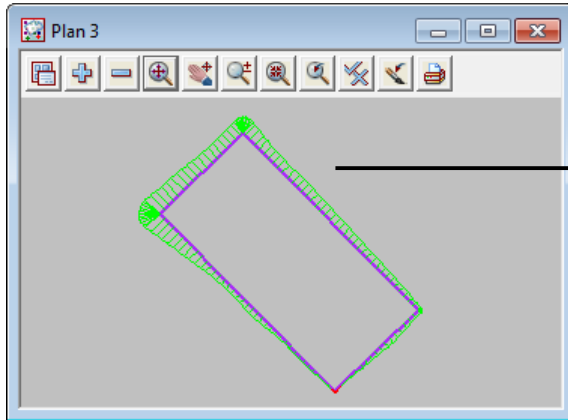
The extra Slope lines have been created and the Interface string has been joined around, hence a better calculation for Volumes.





TRIANGULATE THE DESIGN PAD

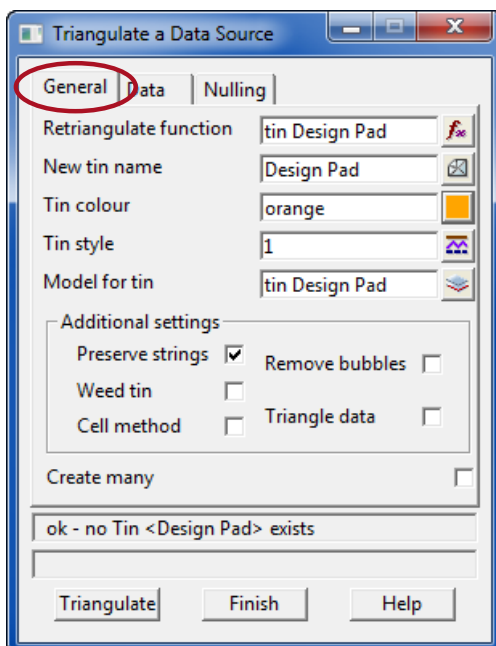
To create a Triangulation of the Design:



Open a new **Plan View**, and turn the 3 Design Pad Models onto the view.

- Design Pad,
- Design Pad Interface &
- Design Pad Slope Lines

Use **Tins => Create => Triangulate Data**



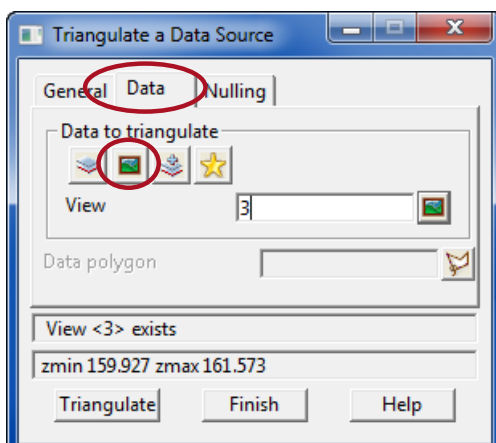
On the General Tab:

Type in **New tin Name** = Design Pad (remember to press enter) so that 12d automatically fills out the model as **tin Design Pad**

Copy and Paste the Model Name into the Retriangulate Function field.

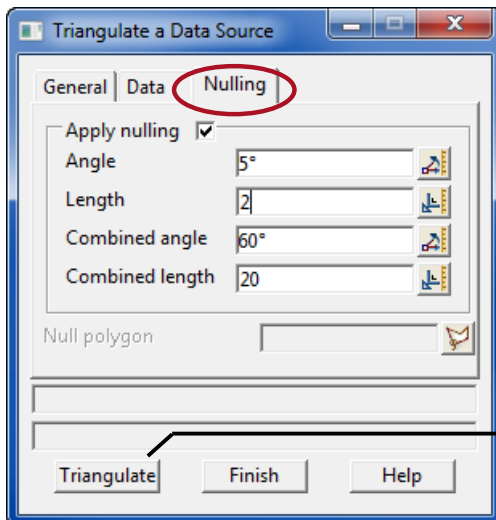
Pick a different colour than the survey tin

Copy the Model name to the Function Name at the top.



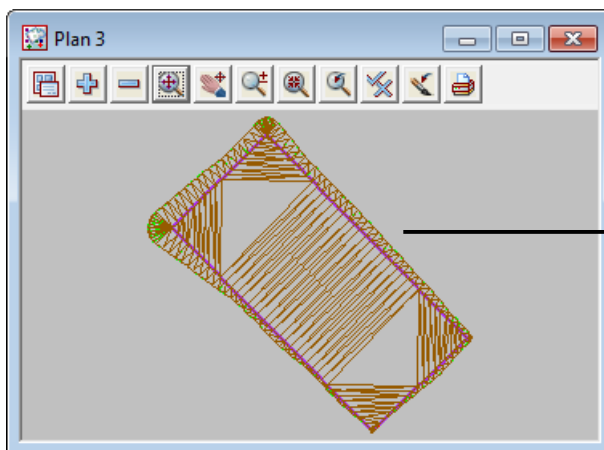
On the Data Tab:

Pick the Plan View that contains the data to be use to create the triangulation



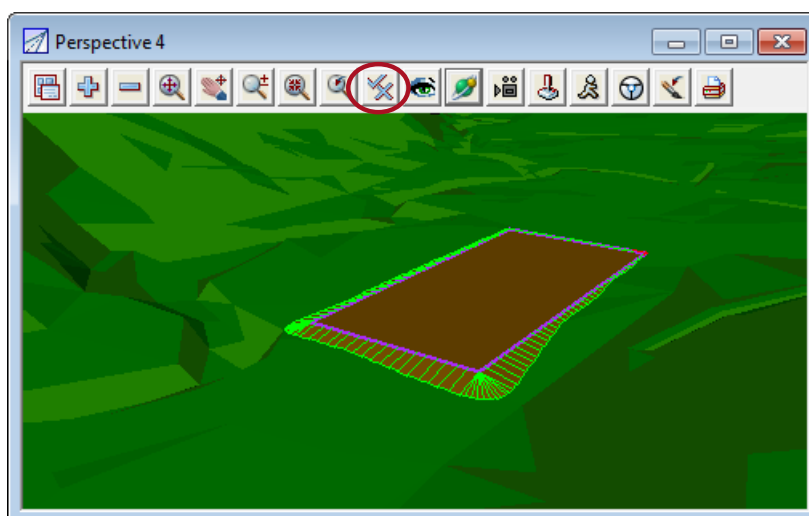
On the Nulling Tab:
Set the Nulling Length to 2m.

Press **Triangulate** to create the Design Pad tin



Add the model **tin Design Pad** to the view.

Perspective View



Open a new **Perspective View**, and turn the following models in the order:

- Survey tin
- Design Pad tin
- 3 Design Pad Models

Use the **Toggle Button** to turn on the **Shade** option.

NOTE: By turning the Survey tin on first, then the Design Pad tin and the Models the Design Pad will be displayed on top of the Survey tin.



Description: Section View

Level: Beginner

Outcomes: After completing this module you should be able to create a Section View and profile a string and TINS for a Longitudinal or Cross Sectional View of the data.

SECTION VIEW

So far the data has been viewed in Plan and Perspective Views, the third type of view in 12d Model is the Section View.

Using the Section View allows the user to do two things:

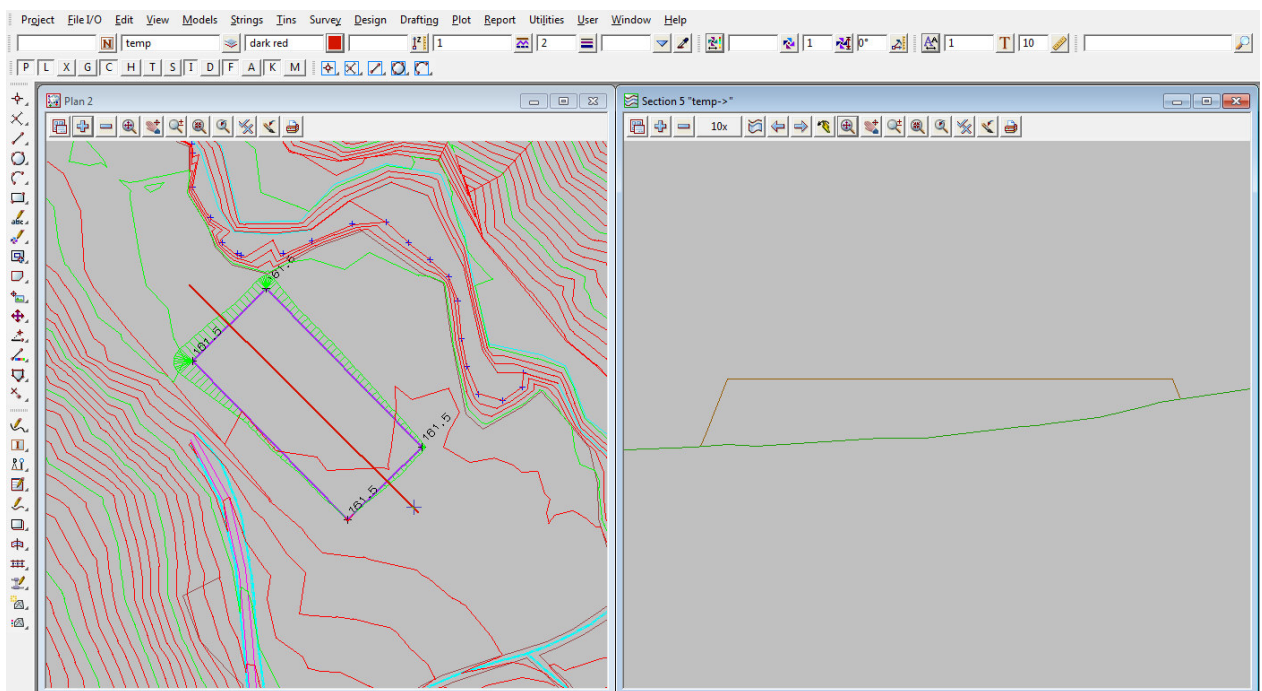
View the longitudinal section of ANY string in 12d Model.

The string that you see in the view is referred to as the **PRIMARY STRING**.

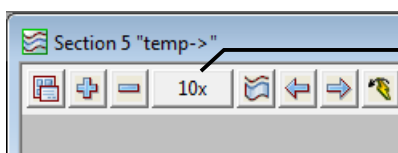
View the relative locations of other strings

WHERE THEY ARE CUT BY THE PRIMARY STRING.

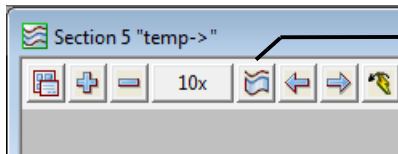
Open a new Section View, use: **View => New => Section.**



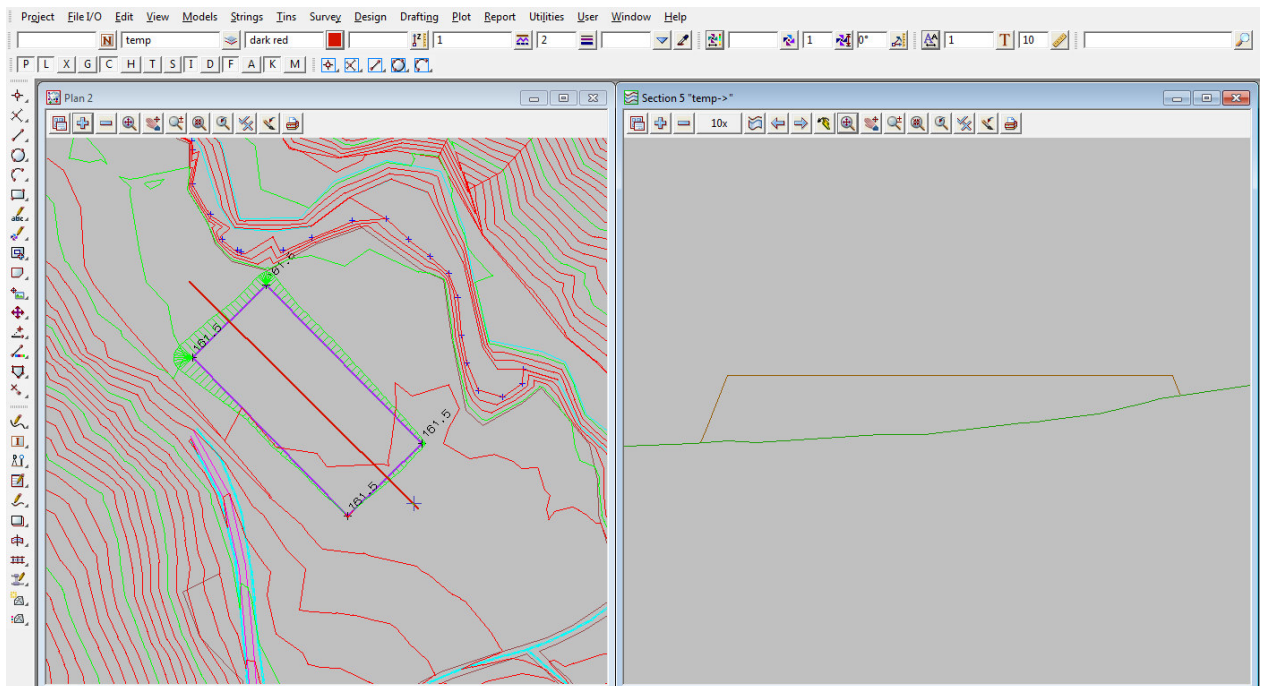
NOTE: By highlighting the Plan View (dark blue) before **Window => Tile Vertical** the Plan View will sit to the top left corner of the screen.



Vertical Exaggeration



Profile Button



1. Draft a **Create Line** 2-point String through the Design Pad (remember to fill out the CAD Control Bar, Model and Colour etc).
2. Select the **Profile Button** from the Section View, then go to the Plan View and pick and accept the 2-point temporary string.
3. This string will have a z value of 170, unless you change the CAD Control Bar.
4. In the Section View, profile the temp string, it's height of 170 will be shown, then use the Plus Button to turn on the Survey tin and Design Pad tin Models (if there is nothing displayed on the Section View then press the **View Fit** Button).
5. The **Vertical Exaggeration** Button will allow the vertical exaggeration of the Section View to be changed.

NOTE: The Models that you display in the Section View will only be shown if the **PRIMARY STRING CUTS** them.
Hence you only see data that is relevant to the Primary String



Description: Volume Calculations

Level: Fundamental

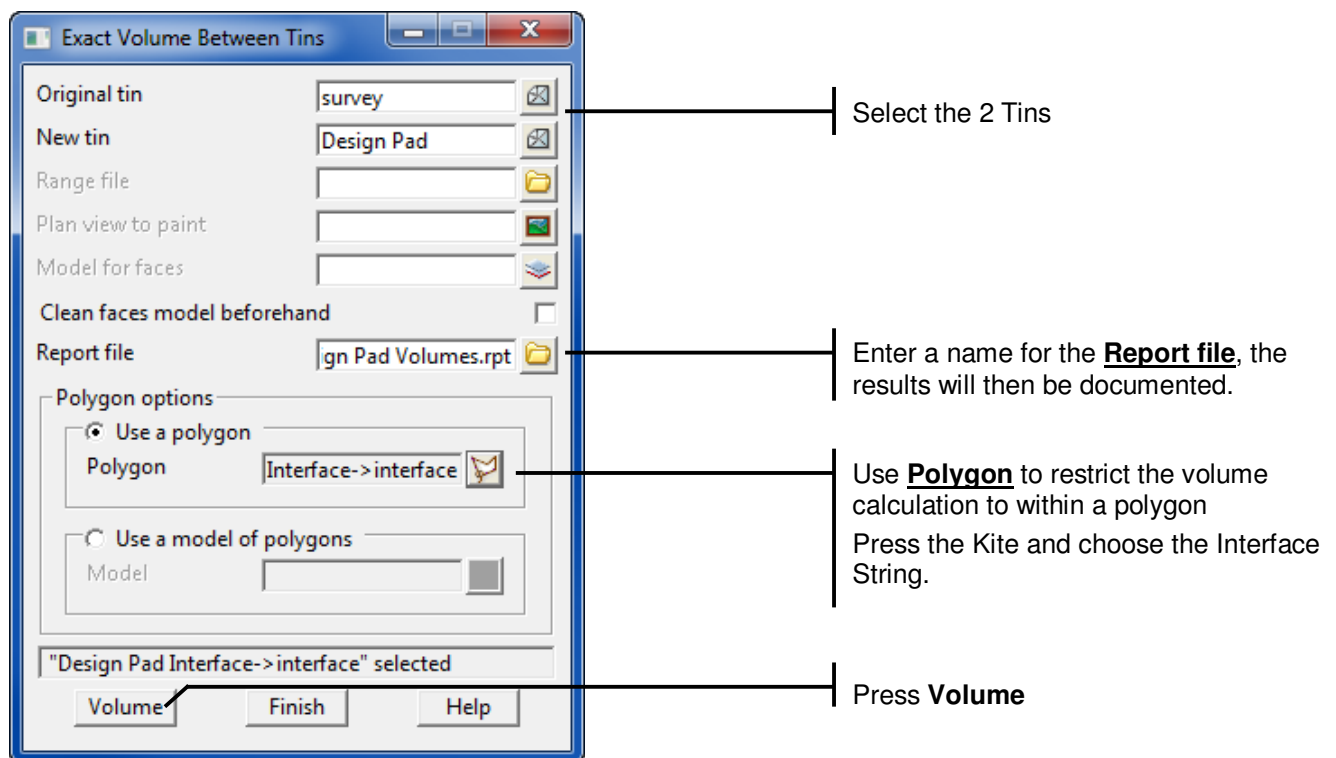
Outcomes: After completing this module you should be able to Calculate both Exact and End Area Volumes for the Design Pad and Balance the Design Pad Volumes.

DESIGN PAD VOLUMES

Now that we have two tins, we can do a **Tin – Tin Volume** calculation.

Use: **Design => Volumes => Exact => Tin to Tin**

This will calculate a **volume between the two tins using an 'exact' method** (also called the 'prismoidal' method).



12d Model will calculate the volume within the polygon, and if the tins do not intersect, will assume vertical walls between the two tins.

A **depth range file** can be used to calculate different depths of fill and cut calculated from the new tin surface to the existing tin surface. These depth ranges can also be shaded in a similar manner to the slope range file used earlier.

Important: If a depth range file is used, 12d Model will only calculate the volume for the depth ranges given in the file. This can be very useful if you require volumes for cut and fill quantities for different height increments.

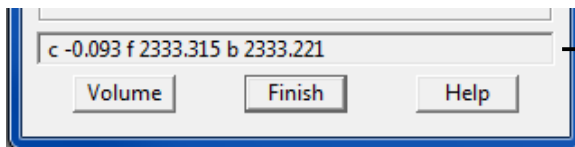


BALANCED EARTHWORKS

We are now in a position to balance the earthworks on this job.

We will move the pad up and down until the cut and fill volumes are equal (or very close).

At present the volume calculation has produced the following results:

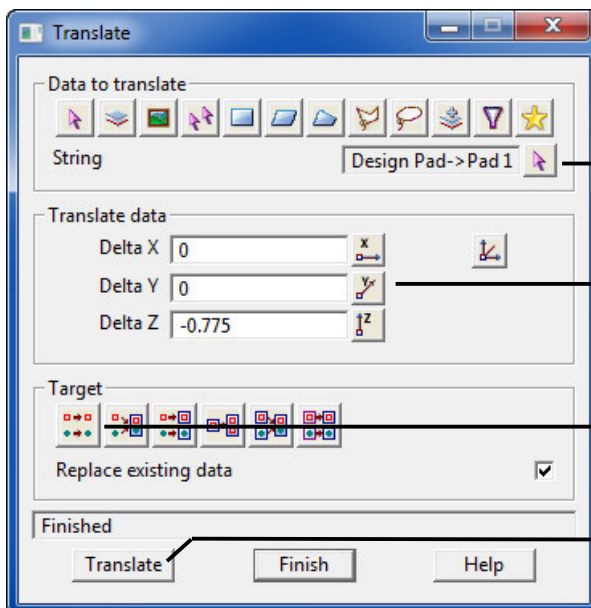


Cut	-0.093
Fill	2333.315
Balance	2333.221

Clearly the height of the pad string is too high.

Use: **Utilities => H-Z => Translate** to move the string down.

The translate panel is generic, and can be used to translate a string, a model of strings, or all of the data in a view etc, and can move the data in the **X** and **Y** directions as well as the height **Z**.



Pick the Design Pad String

Type translation values into the dX dY dZ panel. (Note: All the dX, dY and dZ values are compulsory).

Use Replace existing data, this will translate the string only.

The data is translated when you press the **Translate** button. Press it twice and it will translate the data twice (-ve is down).

After the Design Pad data is translated, we need to recalculate the interface function, re-triangulate the tin for the pad and recalculate the volumes.



AUTOMATIC PAD BALANCING

The procedure that we have used before to find a level for the Design Pad – which really requires us to guess a pad level, then run three operations to determine the earthworks quantities for that pad level.

This series of operations has been brought together into a macro. The macro creates slope lines; interface lines, triangulates (and nulls) the interface data and calculates the tin to tin volume. You can then adjust the height of the pad and re-run it again.

The Macro produces a tin named **pad** in a model named **tin pad**.

It also creates models called **pad slope** and **pad interface**.

Use: **Design => Pads => Dynamic Pad**

Fill out the panel as shown

Press **Process** and the Interface is created, along with the tin, the data is added to the view, and volumes are calculated.

In this case the pad is clearly too high. The height increment box is used to translate the pad height up and down. Type -1 into this panel and press '**Process**'.

The pad has been translated down by 1.0m (+ve is up and -ve is down) and the volume recalculated.

If you press **Process** again, the pad will be moved down ANOTHER metre, and the volume recalculated.

Note that the height increment is a relative height change to the pad level, determined by the last height increment that was undertaken.

Note: Undo will reset the pad to it's level at the start of the balancing operation.

Translate will..... well just try it for yourself !

To see the results of your work, open a Perspective Open GL view, and then add the natural surface triangulation (tin survey) and the triangulation of the pad (tin pad).



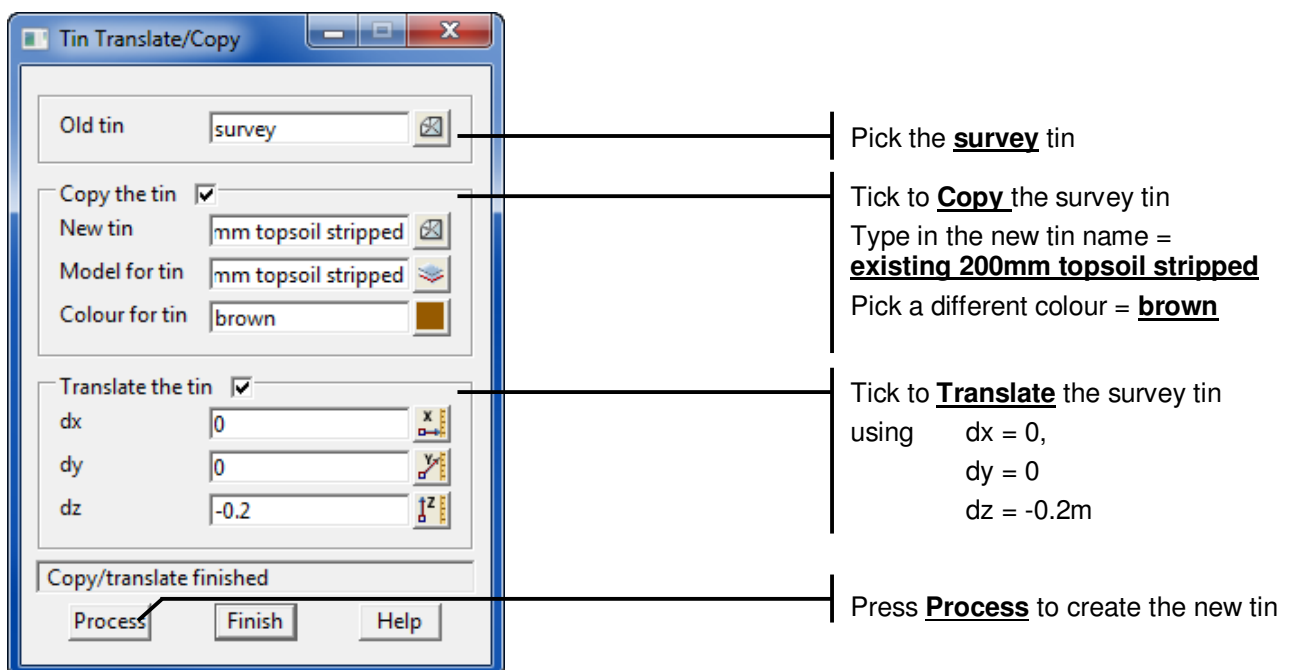
EXERCISE – ALLOW FOR TOPSOIL STRIPPING

So far all of our Volume calculations have been done assuming that there would be no stripping of topsoil from the site. This is not very realistic and we will now allow for stripping of 200mm of topsoil.

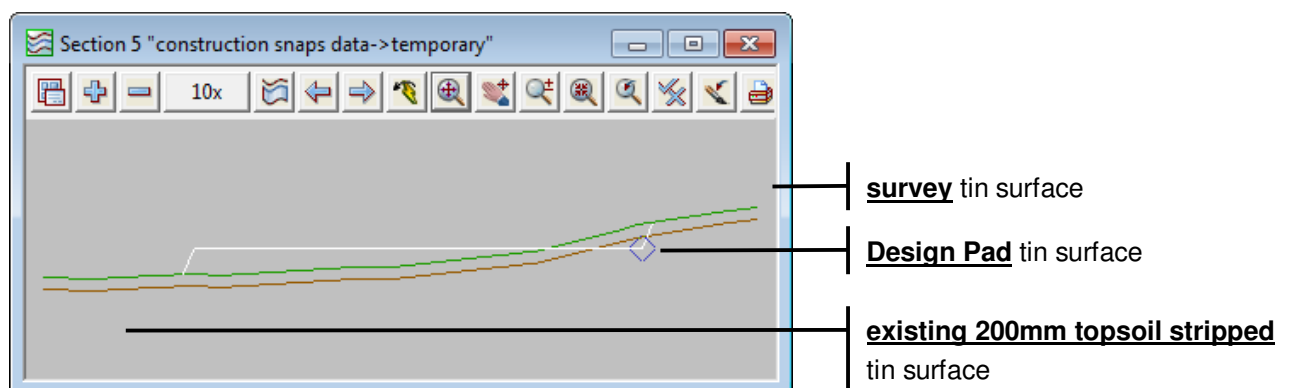
We will not worry about where this will be stockpiled, or where it will eventually be placed. The easiest way to allow for topsoil stripping is to make a copy of the existing survey tin, and to translate it down by the strip depth.

We can then use the tin of the 'stripped' surface for our volume calculations, instead of the existing surface.

Use **Tins => Utilities => Translate/Copy**



Here is a Section View to see the new stripped tin, 200mm below the survey tin.





Description:	Exercise No. 3 – Water Quality Basin
Level:	Fundamental
Outcomes:	After completing this module you should be able to create a Basin with an Interface (Cut and Fill Batters) to the existing survey TIN. Create a Design TIN, and calculate Volumes for Cut and Fill.

CREATE A DESIGN WATER QUALITY BASIN LAYOUT

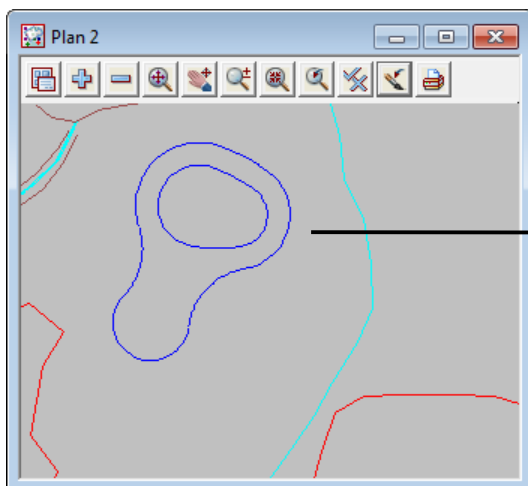
Water Quality basins generally have two requirements:

A storage volume.

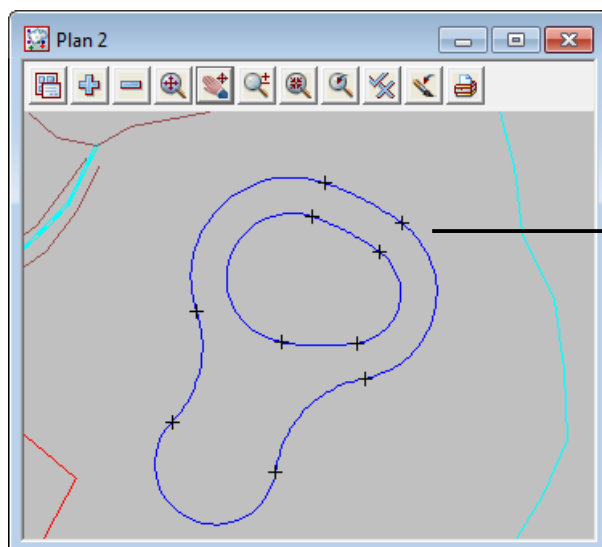
A shallow area, where macrophytes can develop.

Sketch designs have been done for the basin, and an outline of the top and bottom of the deep area has been provided.

Read in the **DWG file** of the floor of the basin from **basin floor outline.dwg**.



DWG file has loaded the two basin strings that represent the deep area.



The **Vertices** have been toggled onto the view.

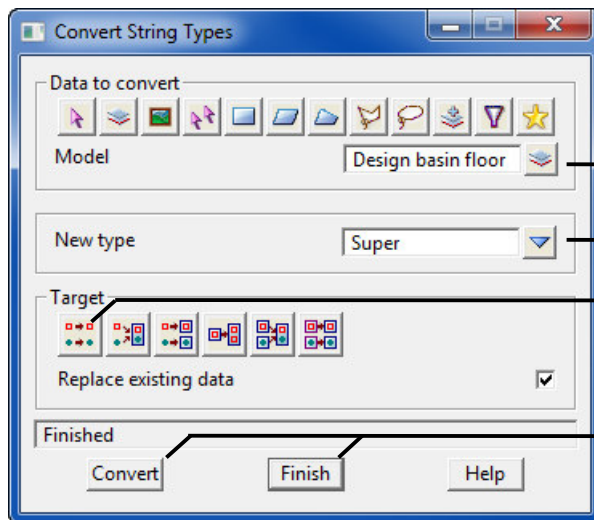
Zoom in on the basin and take a look at the vertices, which make up the strings and the elevations.
The two strings are 5.0m different in elevation.



ADDING HEIGHTS TO THE WATER QUALITY BASIN

The strings from the DWG file need to be converted to Super Strings.

Use: **Utilities => A-G => Convert => Convert**



Select the Model: **Design basin floor**

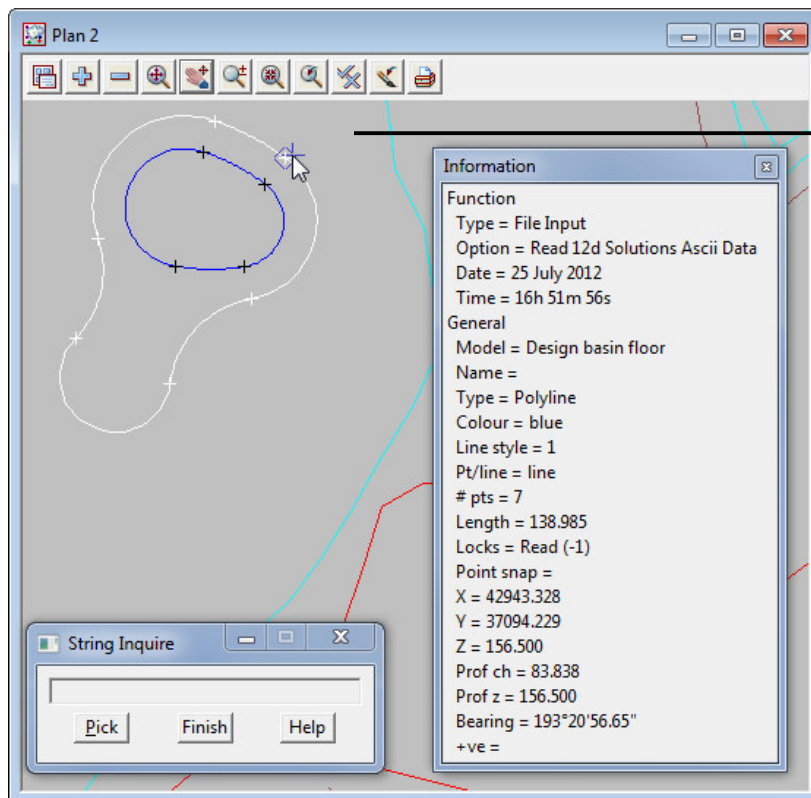
Select the New String Type: **Super**

Select **Replace existing data**

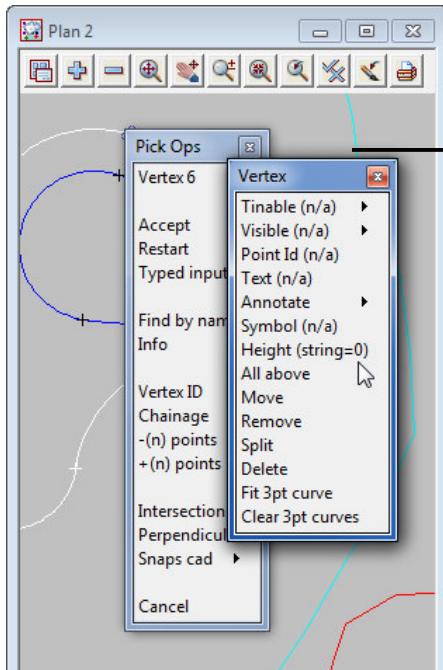
Press **Convert** and **Finish**

We will use the **F2 button, String Inquire** to change the height for the pad.

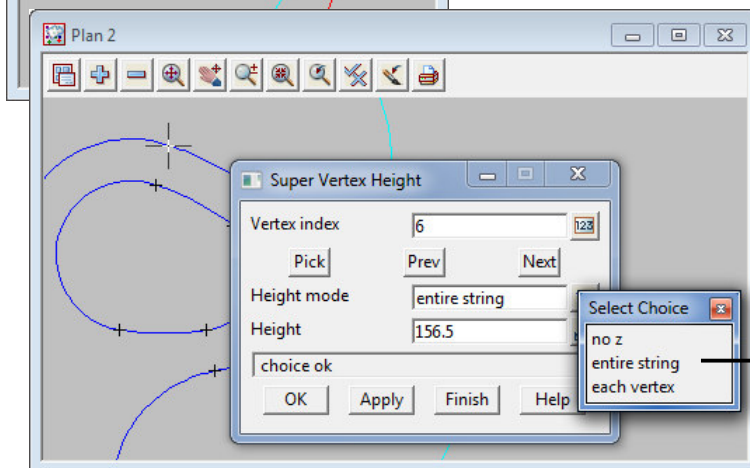
We will change the outside string to have a height of **156.50m**.



Press the **F2 Button** and select one of the points on the string (at one of the vertices) make sure that a diamond is shown.

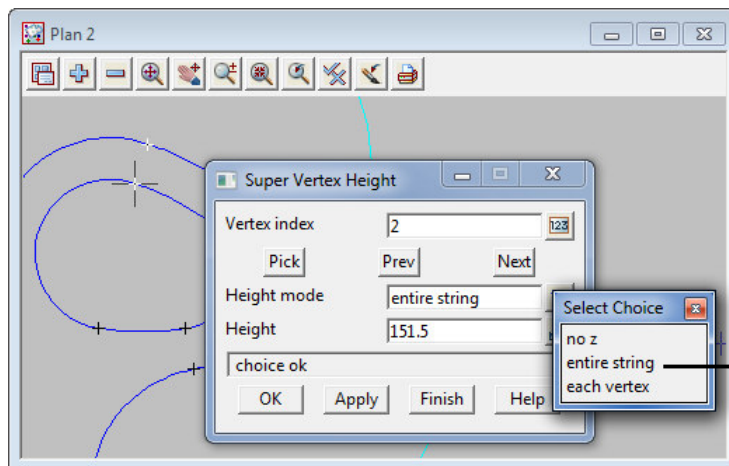


Then **right click** the mouse to bring up the **Pick Ops List**, walk right on Vertex (number) to reveal the **Vertex Panel** and select the **Height** Option.



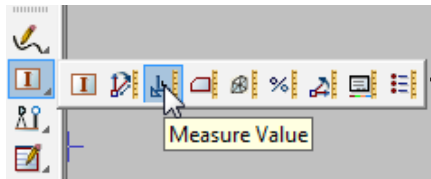
Set the **Height Mode** to **entire string** and the height to **156.5m**.

Now do the same for the inside string, use the **String Inquire** to set the height to 151.5m

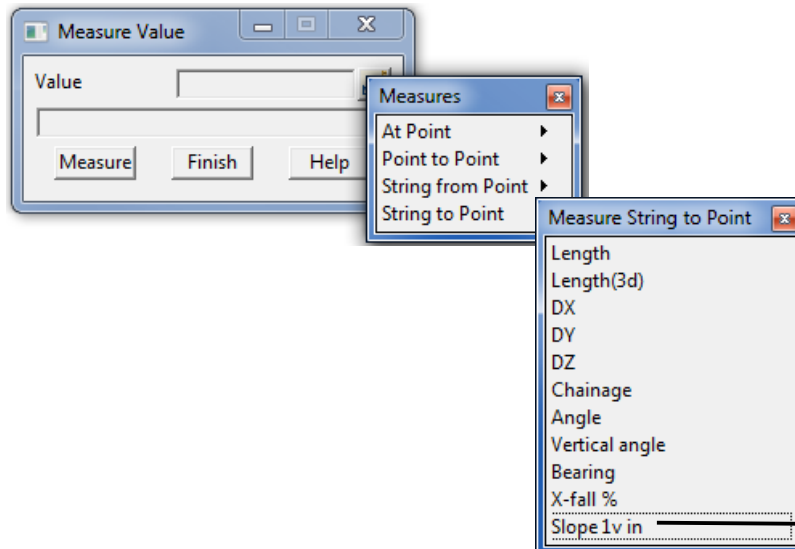


Set the **Height Mode** to **entire string** and the height to **151.5m**.





Use the **Measure Value** option under the CAD toolbar.

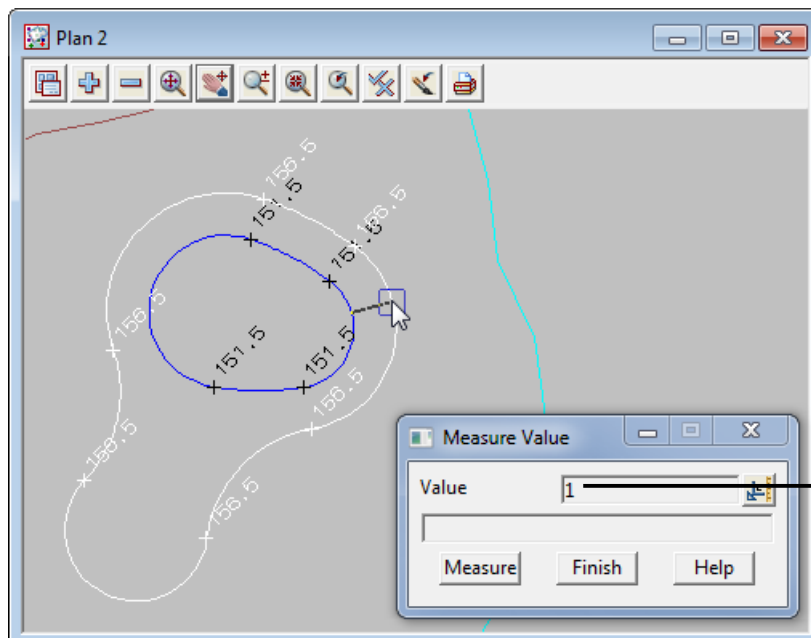


Choose String to Point.

This will measure perpendicularly from a string you choose to another point.

If you pick another string you can dynamically move the point around the other string and see if the Slope changes between the 2 strings.

Measure the **Slope** between the two basic strings to check that the slope is 1 in 1 (NOTE: the width should be 5m and the xfall should be 100%).



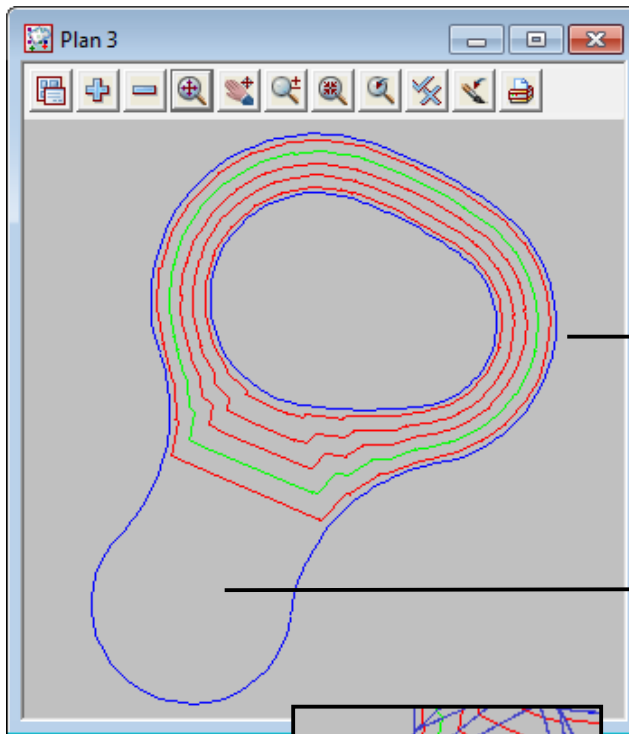
The **Slope** is 1:1



TRIANGULATE THE BASIN FLOOR

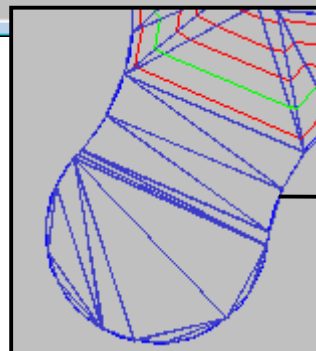
Triangulate the basin floor strings.

Use: **Tins => Create => Triangulate Data**

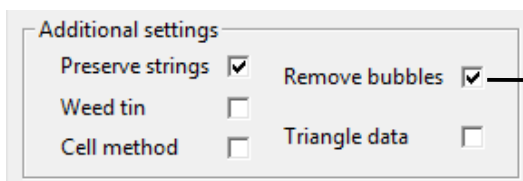


Add the triangulation to the view and **Toggle** on the contours.

The contours show that the lower part of the basin floor is flat (check in a section view too), while the intention is to have the floor slope evenly from one string to the other.

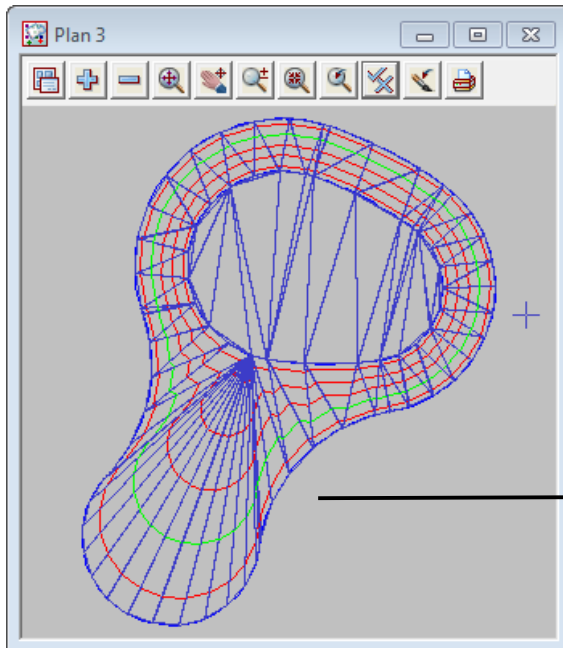


The triangles also give it away as all points are created from the 1 string, which has a constant height.



We will use the **Remove Bubbles** feature of the triangulation operation to rearrange the triangles.

If you have closed the tin panel, this can be reopened under **Tin=>Edit=>Tin**. (We cannot use create because the tin already exists).



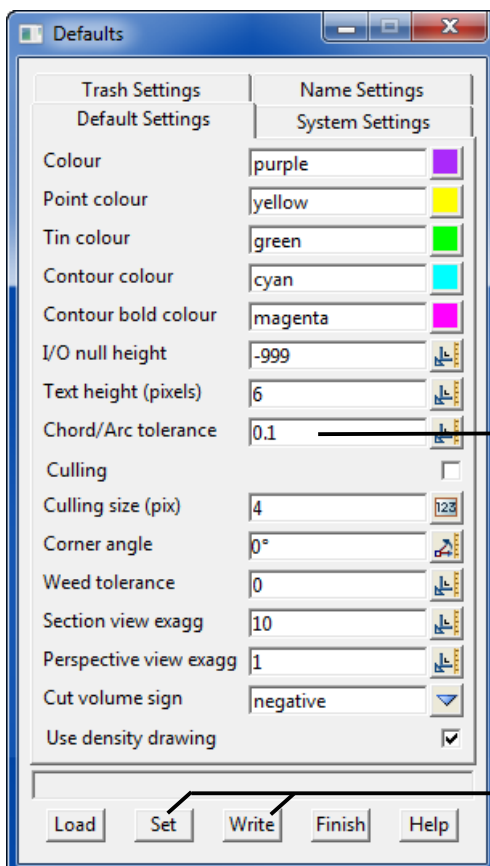
Tick on **Remove Bubbles**. This will force 12d to create the triangles using two different strings (the three points of the triangle can not be from the same string if possible).

These contours better represent the desired shape, but there are still some incorrect wiggles.

Note: also that there are triangle corners on the curved parts of the string, despite there being no points on the curves.

This is due to the chord to arc tolerance, which is set using:

Project=>Management=>Defaults



Setting a low chord to arc tolerance will create more triangles around the curves, and the resulting contours being smoothed.

Set the Chord/Arc Tolerance to 0.01 (10mm)

Press **Set** to use in the project.

Press **Write** to save the file for use in other projects.

Retriangulate the Basin and look at the Contours

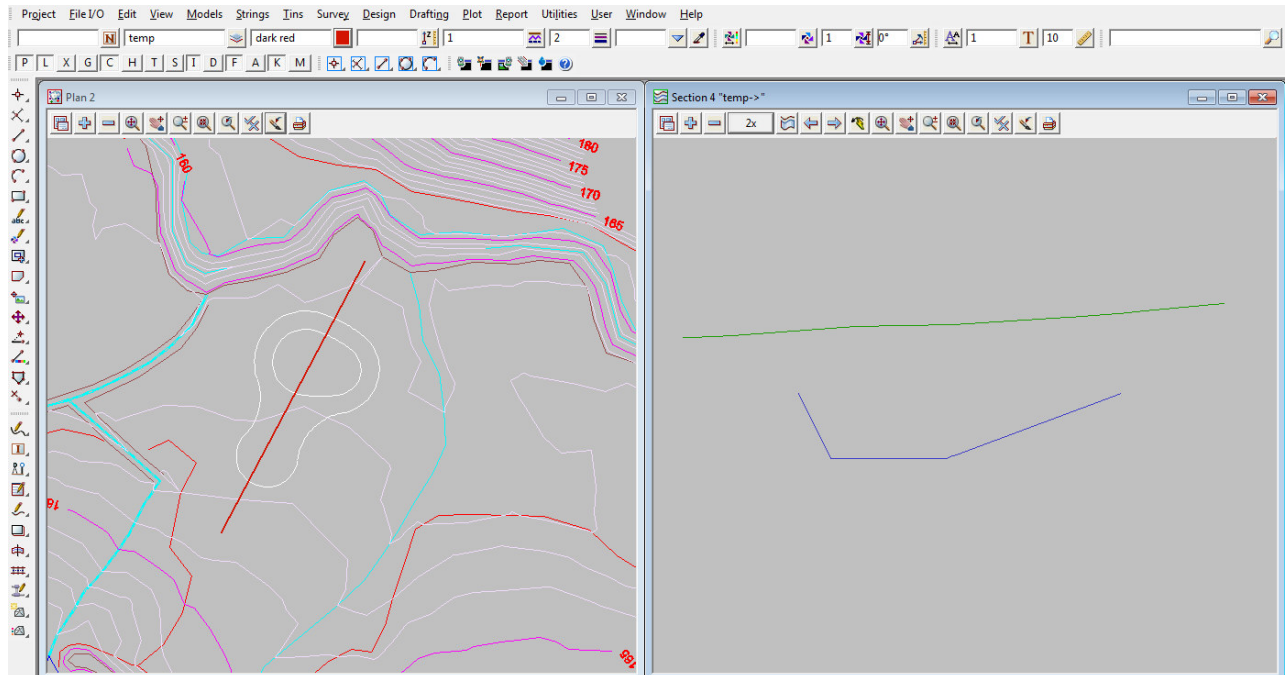




CHECK A SECTION THROUGH THE BASIN

A section through the tin/basin looks like this.

Open a new Section View, use: **View => New => Section.**



1. Draft a **Create Line** 2-point String through the Design Basin (remember to fill out the CAD Control Bar, Model and Colour etc).
2. Select the **Profile Button** from the Section View, then go to the Plan View and pick and accept the 2-point temporary string.
3. This string will have a z value of 0, unless you change the CAD Control Bar.
4. In the Section View, profile the temp string, it's height of 0 will be shown, then use the Plus Button to turn on the Survey tin and Design Basin tin Models (if there is nothing displayed on the Section View then press the **View Fit** Button).
5. The **Vertical Exaggeration** Button will allow the vertical exaggeration of the Section View to be changed.

NOTE: The Models that you display in the Section View will only be shown if the **PRIMARY STRING CUTS** them.
Hence you only see data that is relevant to the Primary String

Notes:

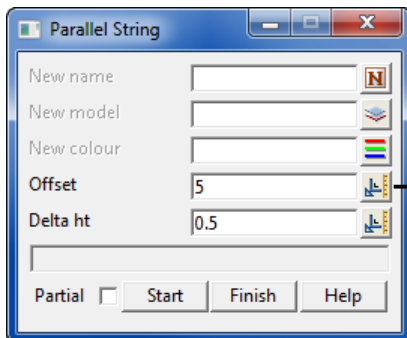




ADD A SHALLOW AREA TO THE BASIN FLOOR

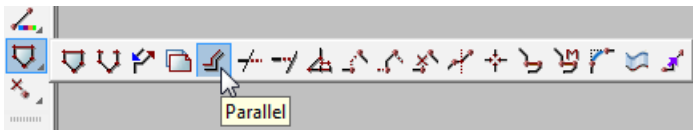
We want to add a shallow area to the basin before we create an interface to the surface.

The shallow area will be 5 metres wide and slope toward the basin at 10% and will be created by paralleling (offset) the outer Basin String.

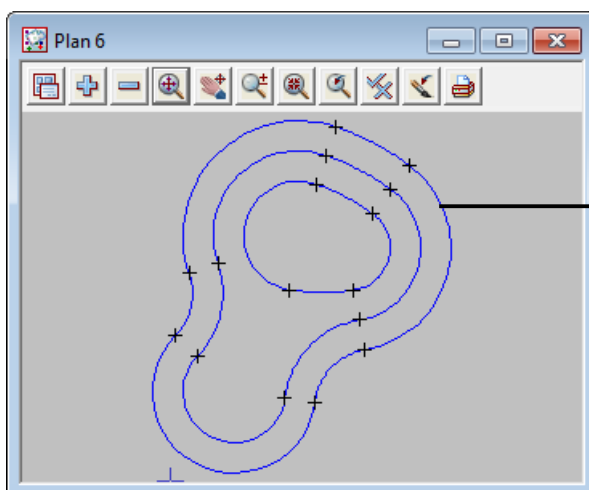


The **Strings=>Strings Edit=> Parallel** command gives you the option of giving the string a new name, model and colour. If these panels are left blank, the new string will copy the attributes from the existing string.

OR



The **Parallel** option can also be found on the CAD Toolbar

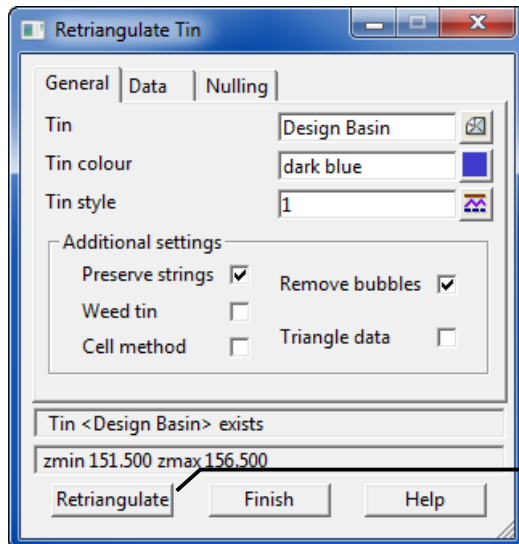


When the string has been **paralleled** it looks like this.



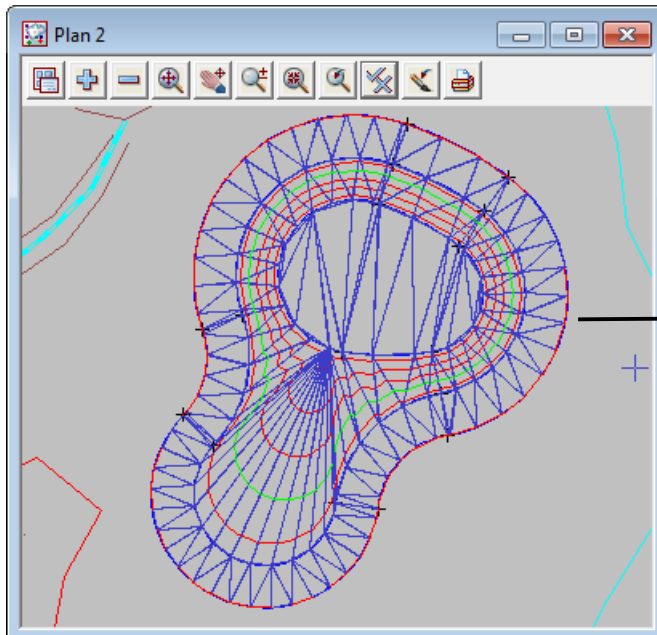
To Retriangulate the Design Basin tin use:

Use: **Tins => Edit => Tin**



The new string for the Design Basin is in the same model, so it is an easy matter to Retriangulate the tin of the basin.

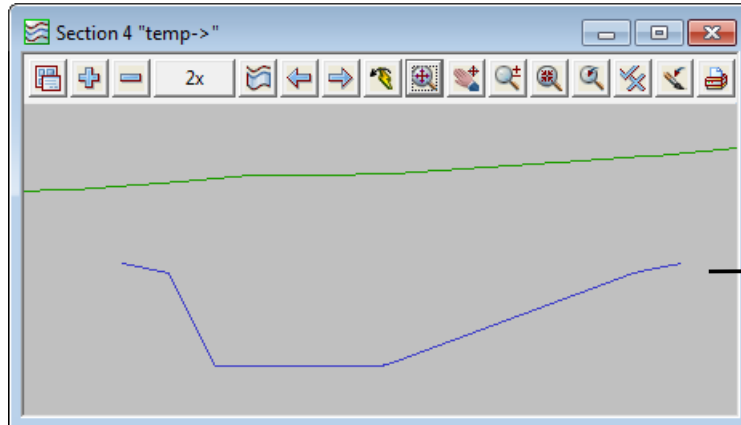
Press **Retriangulate**



The new string has now been included in the Triangulation for the Basin.



CHECK THE DESIGN BASIN CROSS SECTION



Once the final underwater shape has been defined and the TIN retriangulated, here it displays the new 5m wide planting area in the Section View.

INTERFACE FOR FINAL BASIN BATTER

Batters will be created to meet the Natural Surface, to do this we will use an **Interface function**.

Use: **Design=>Apply=>Interface**.

Type in a **Function Name**.

Pick the **String** to Interface from.

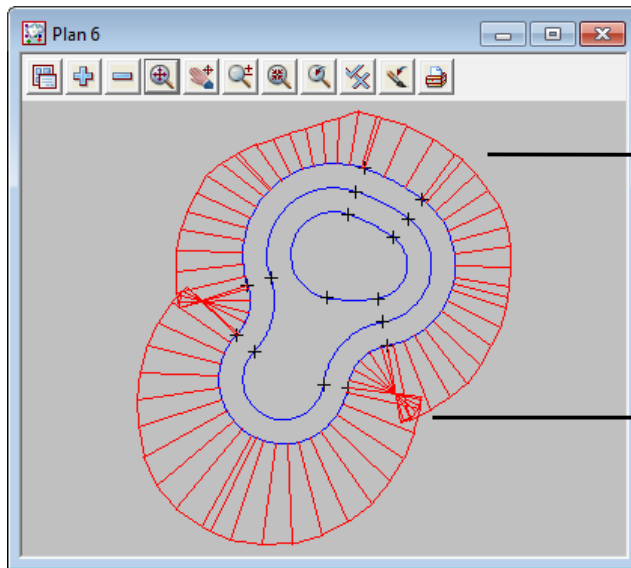
Fill out the **Fill and Cut Slopes**

Section separation = 5m

Select the **Tin** to Interface too

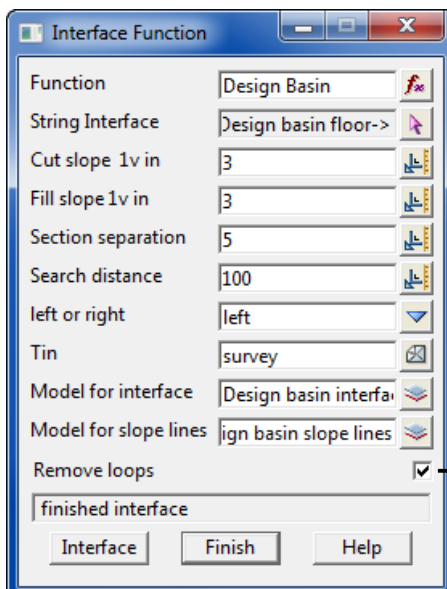
Type in the Model names for the **Interface** and the **Slope Lines**

Press the **Interface** button, every time the Interface Function is re-run, the old data is deleted and the newly modified data is recalculated.

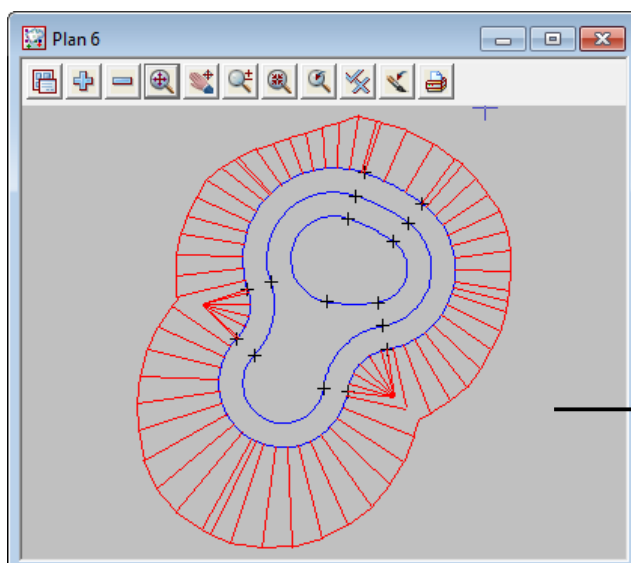


The resulting interface string and slope lines are shown below.

PROBLEM: The Interface String has looped around itself. When the Interface string and slope lines are long and loop, crossing each other – this is a problem as this is not a correct solution.



SOLUTION: The **Remove loops** option needs to be selected and the Interface function recalculated.



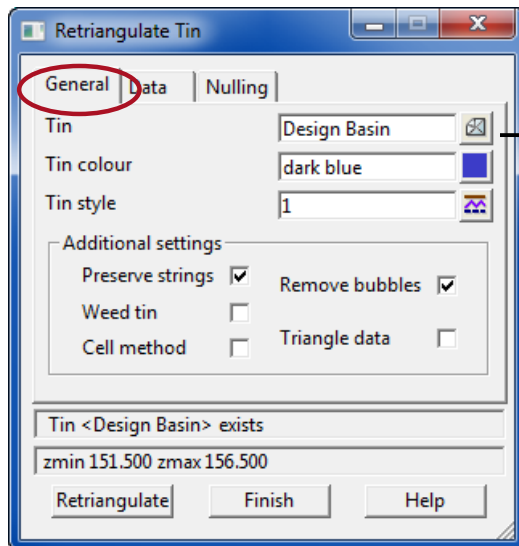
SOLUTION: The **Remove loops** option has removed the crossing sections and Interface String.



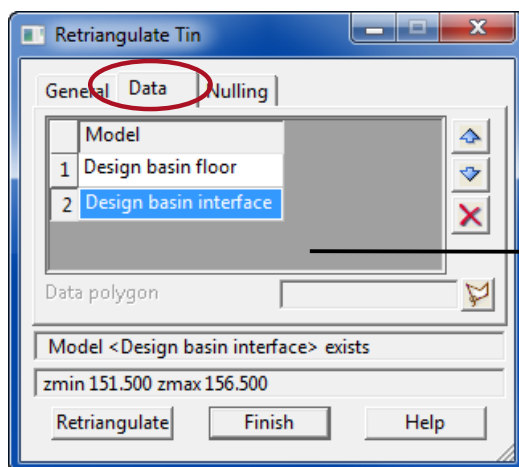
INTERFACE FOR FINAL BASIN BATTER

The newly created Interface string will be used in the tin.

Use: **Tins => Edit => Tin** to open the Retriangulate Tin Panel



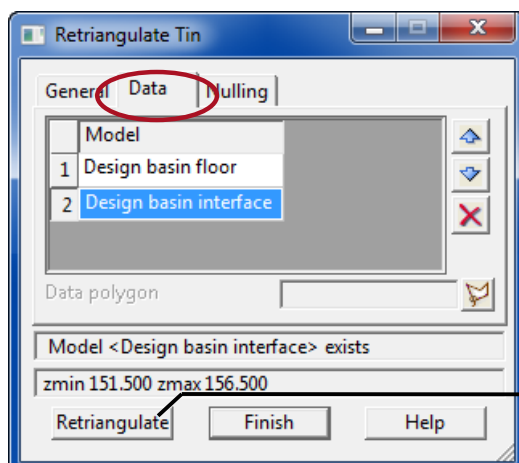
Select the **Design Basin** tin



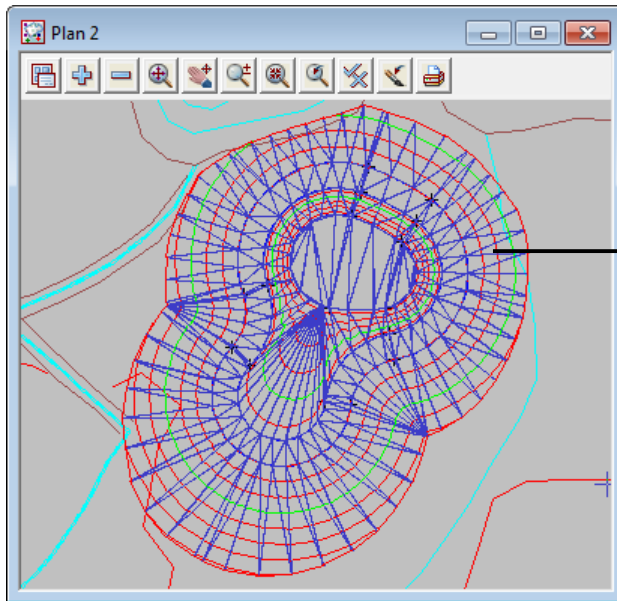
This string is in the model = **Design Basin Interface**, and we will use **Tins=>Edit=>Tin** to include this model in the triangulation.

Pick the Basin from the tin box and then select the **Data** tab and enter the model **Design Basin Interface** in box 2.

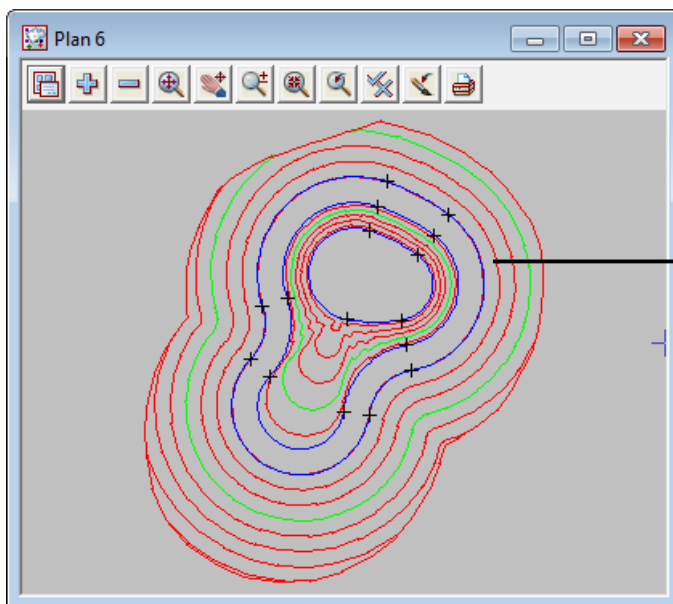
NOTE: You can left click in the box and then right click to list all the models in the job, and then select the model from the list.



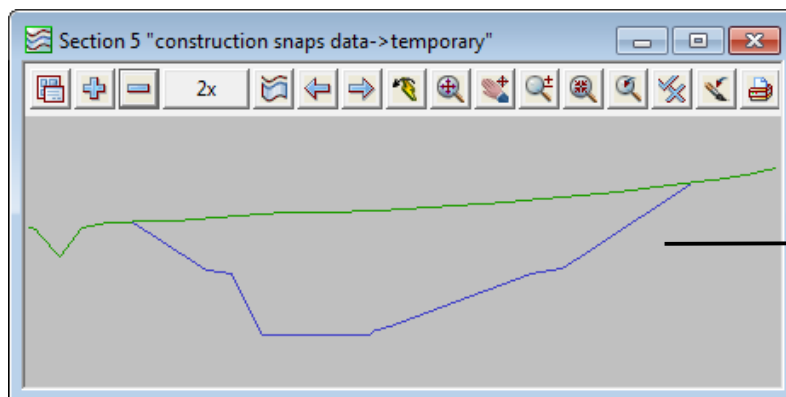
Retriangulate the Tin



The updated Basin Tin and contours



TIN has been updated and is reflected by the contours.



Updated **Section View** to show the Cross section through the Design Basin



FIND THE MAXIMUM WATER LEVEL IN BASIN

If our existing surface was perfectly flat, we could now calculate the volume for the water to be stored in the basin. The ground is not flat (as shown above), and therefore we need to determine the lowest height on the interface string.

There are a couple of ways to find the lowest level of the interface string.

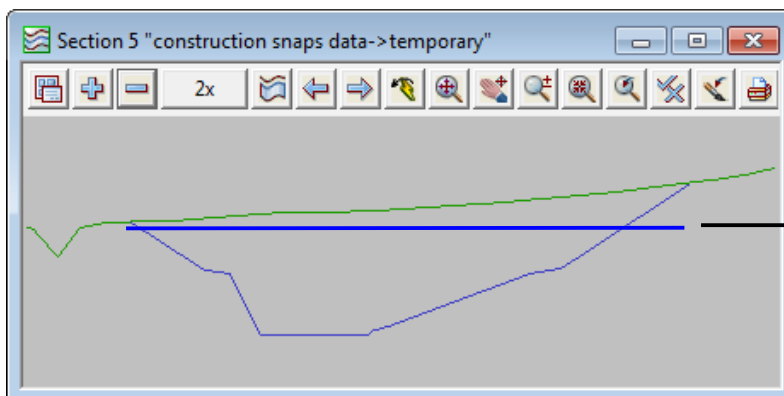
Use: **Models=>String Info Table**

Choose the model **Design Basin Interface** and all the strings contained within that model will be displayed. The minimum Z value will show the maximum water the basin can maintain, before it would overflow.

Name	Type	Colour	Linestyle	Chainage	Length	Pt/Line	User Points	Points	Min X	Min Y	Min Z	Max X	Max Y	Max Z
interface	Super	red	1	0	262.6825	line	60	60	42887.063	37026.482	159.647	42964.771	37116.374	164.205

Min X	Min Y	Min Z	Max X	Max Y	Max Z
42887.063	37026.482	159.647	42964.771	37116.374	164.205

The Minimum level of the Design Basin Interface string is **RL 159.647**



The Line represents the maximum water level for the **Basin RL 159.647**

The other method of finding the minimum level of the basin interface string is to use the

Project=>Tree, and display the **Design Basin Interface** model.

Name	Type	Colour	Linestyle	Chainage	Length	Pt/Line	User Points	Points	Min X	Min Y	Min Z	Max X	Max Y	Max Z
interface	Super	red	1	0	262.6825	line	60	60	42887.063	37026.482	159.647	42964.771	37116.374	164.205

The **Project Tree** allows extraction of all the different types of data associated with the project, and utilities for setting up text favourites.



MAXIMUM WATER LEVEL STRING

Once again the minimum z value for the **Design Basin Interface** string is **RL 159.647m**.

We now wish to create a line on the basin tin at the maximum water level.

We will have a 300mm freeboard for the basin; therefore the max water level will be **RL 159.35m**.

As the water level will be flat, it can be thought of as the contour around the basin tin at **RL 159.35**.

Use: **Tin=>Contour=>Contour, Smooth & Label** function to create the single water level contour.

Type in a **Function Name**.
Pick the **Tin to Contour**.

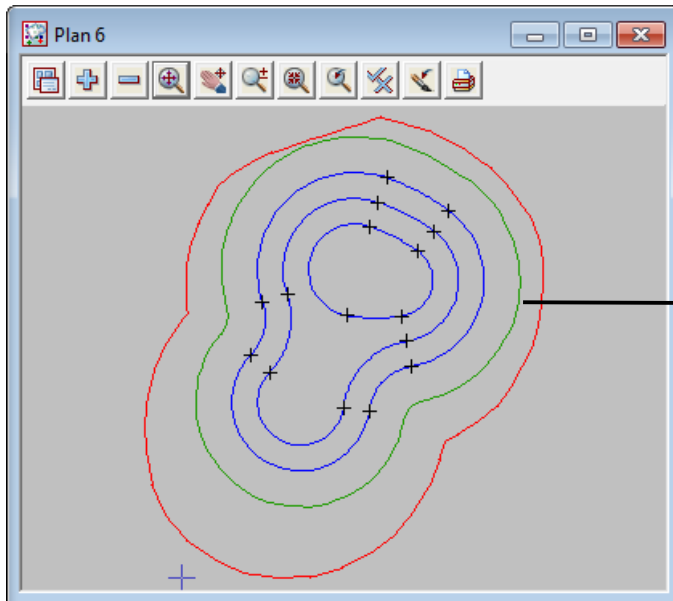
Fill out the **Model for Contours**.
Contour Increment = 1m
Pick the **Colour** = dark green.

The **Major Contours** and **Labels** tabs can be turned off by not ticking the box at the top

Under the **Range tab**, enter the contour minimum, maximum and reference as the maximum water level of 159.35.

This will only generate one contour at the level of 159.35.

Press the **Process** button to create the Water Level String



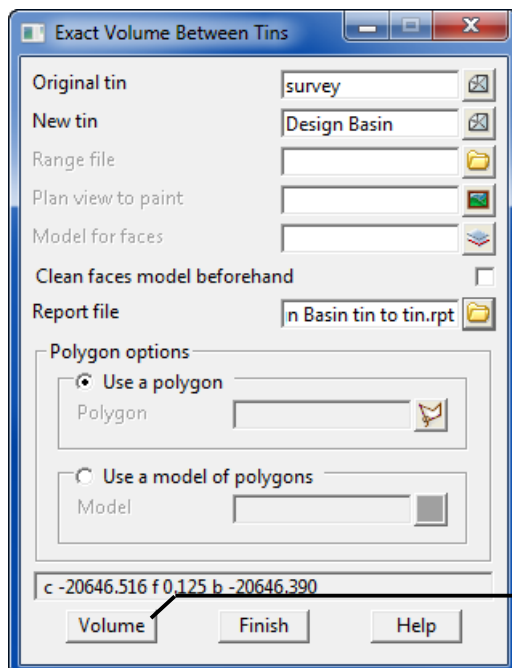
159.35 RL Contour String

VOLUME CALCULATIONS

Total Volume of Excavation

The total volume of excavation can be found by doing a Tin to Tin volume calculation.

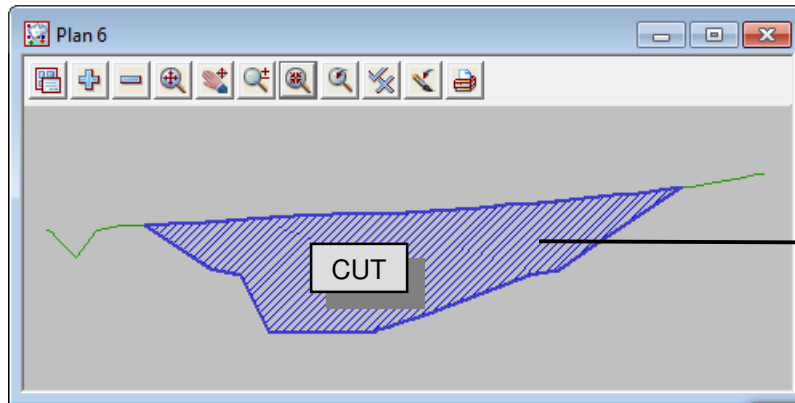
Use: **Design=>Volumes=>Exact=>Tin to Tin.**



Original Tin = **survey tin**
New Tin = **Design Basin tin**

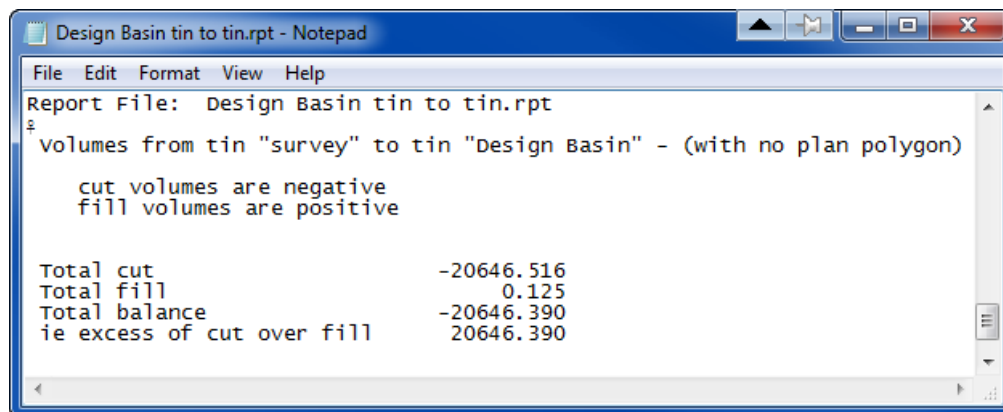
Enter a report file name of **Design Basin tin to tin.rpt** to keep a record of the excavation volumes.

Press **Volume** to calculate the volumes between the 2 tins.
The Total Cut (c), Fill (f) and Balance (b) are listed at the bottom of the panel.



Total Excavation of Cut for the Basin

The Design Basin tin to tin.rpt Report will show the total volumes for Cut, Fill and Balance.



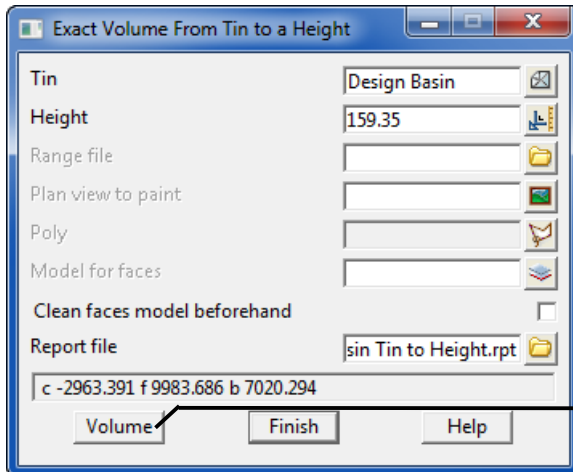
Notes:



TOTAL VOLUME OF WATER STORED

The total volume of water can be found by doing a Tin to Height volume calculation.

Use: **Design=>Volumes=>Exact=>Tin to Height.**



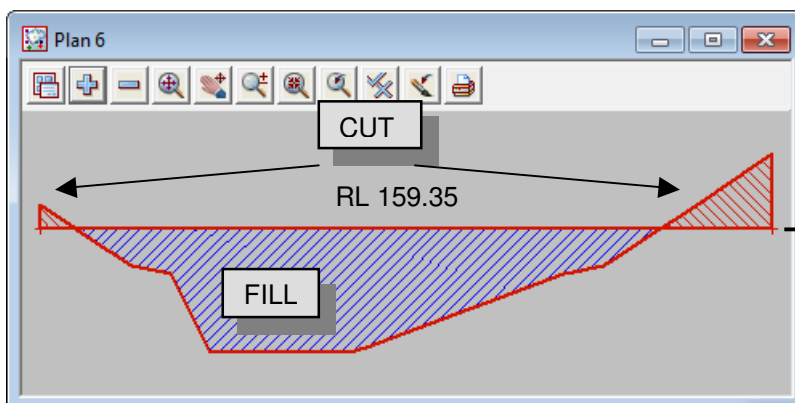
Pick the **Tin** = Design Basin

We know the maximum water level is RL 159.35, so we can use the value in the panel as shown.

Enter a report file name of **Design Basin tin to tin.rpt** to keep a record of the excavation volumes.

Press the **Volume** button to calculate the volumes.

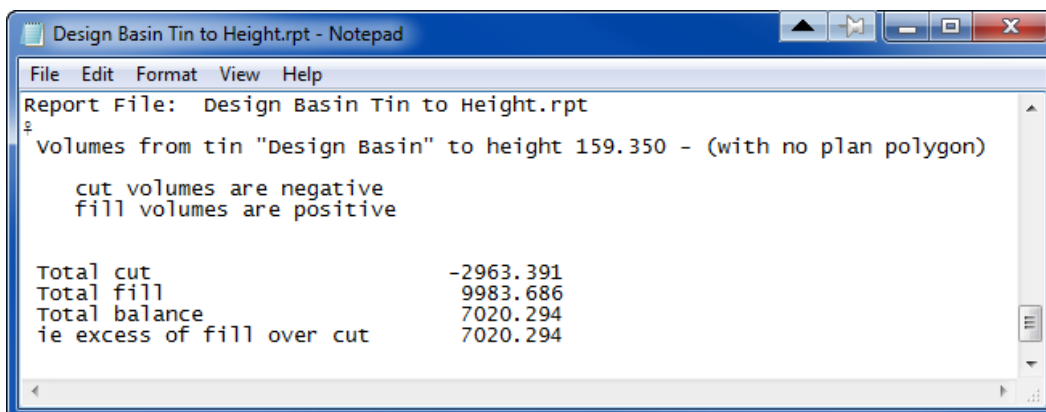
The Total Cut (c), Fill (f) and Balance (b) are listed at the bottom of the panel.



This calculation assumes that the tin **Design Basin** represents the existing ground, and calculates the earthworks required making the ground flat at the specified level.

The fill value is the volume of water stored in the basin at a maximum water level height of RL. 159.35.

The cut amount is determined by assuming a vertical wall from the edge of the tin to the user specified height.

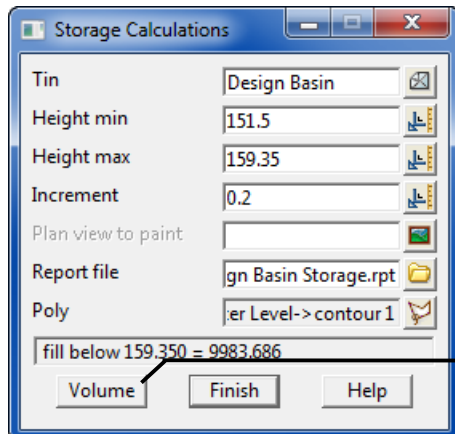




STORAGE CALCULATIONS

Depending on the use of the basin, it may be necessary to determine the storage provided at different water levels. This information can easily be obtained using **Storage Calcs**.

Use: **Design=>Volumes=>Exact=>Storage Calcs**.

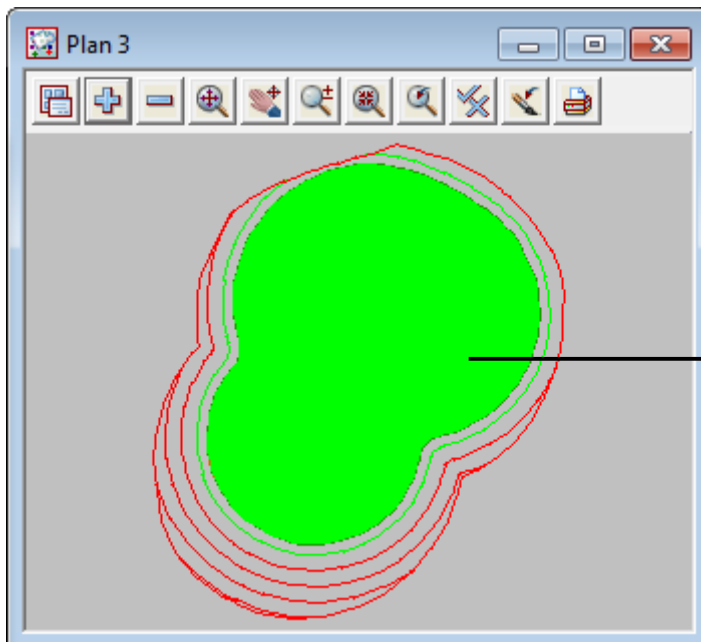


Pick the **Tin** = Design Basin
Type in the **Height min** = 151.5
Type in the **Height max** = 159.35
Type in the **Increment** = 0.2m
Enter a **Report File** name
Select the **Polygon**, the contour string at the water level 159.35

Press the **Volume** button to calculate the volumes.

The Total Cut (c), Fill (f) and Balance (b) are listed at the bottom of the panel.

NOTE: Boundary polygons can be used to restrict the extent of a volume calculate to the specific area defined by the polygon. We will use the Water Level Contour string we created earlier.



Hatched area is the water level at RL 159.35



Design Basin Storage.rpt - Notepad

File Edit Format View Help

Storage calculations to tin "Design Basin" - (with plan polygon "Basin water Level->contour 1")

cut volumes are negative
fill volumes are positive

Height	Delta Ht	Vol to Height	Delta vol	Plan Area	Delta Area	Slope Area	Delta Area
159.350		9983.686		3231.625		3494.423	
159.200	0.150	9506.127	477.559	3136.028	95.597	3393.649	100.774
159.000	0.200	8891.512	614.615	3010.493	125.536	3261.318	132.331
158.800	0.200	8301.783	589.729	2887.160	123.333	3131.313	130.005
158.600	0.200	7736.501	565.282	2766.030	121.130	3003.633	127.680
158.400	0.200	7195.224	541.276	2647.102	118.928	2878.279	125.355
158.200	0.200	6677.513	517.711	2530.377	116.725	2755.249	123.029
158.000	0.200	6182.927	494.587	2415.855	114.522	2634.546	120.704
157.800	0.200	5711.024	471.902	2303.536	112.319	2516.167	118.379
157.600	0.200	5261.366	449.659	2193.419	110.117	2400.114	116.053
157.400	0.200	4833.510	427.856	2085.505	107.914	2286.386	113.728
	0.200		406.493		105.711		111.403

As can be seen, the report gives considerable information about the physical dimensions and properties of the basin at levels, which increase by 200mm increments.

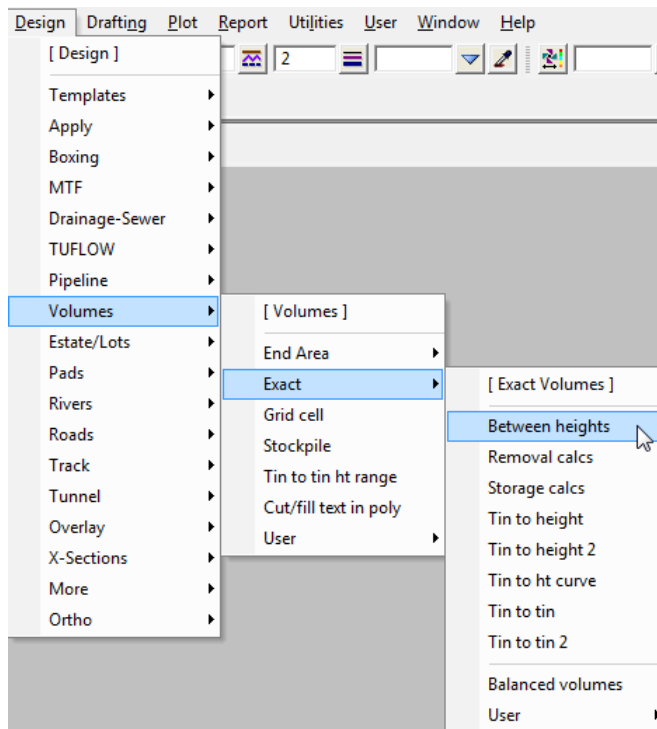
Notes:



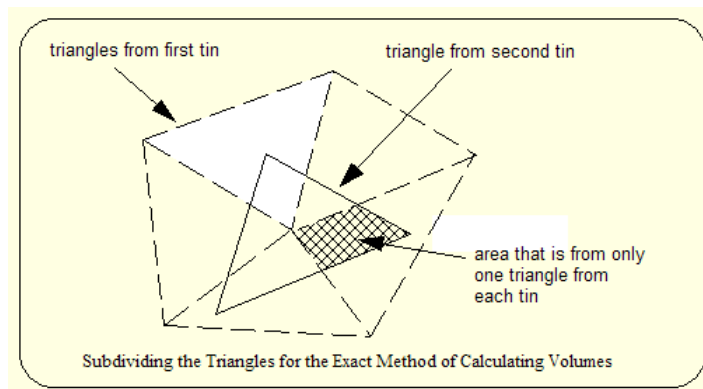


VOLUME CALCULATIONS

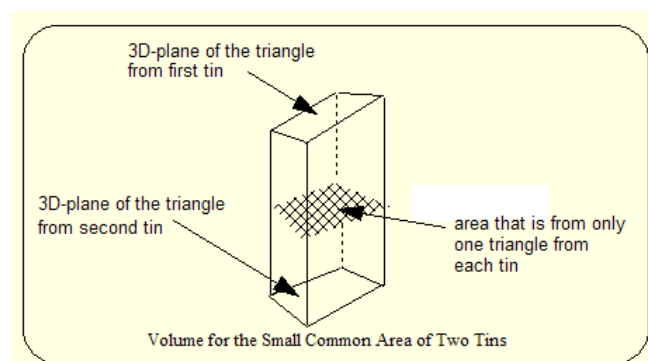
Detailed below is a summary of some of the different volume calculations available inside 12d Model under the **Exact Volume** options.



This method calculates the exact volume between two triangulated surfaces (tins), or between one triangulated surface and a plane of constant height.



The volumes are calculated by mathematically subdividing the triangles from both tins into areas that contain only one triangle from each tin.

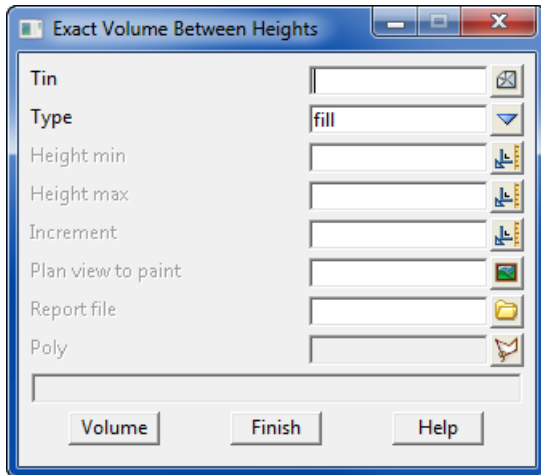


In three dimensions, these areas represent well-defined polygons with the plane of the triangle from one of tin as its top and the plan of the triangle from the other tin as its bottom.



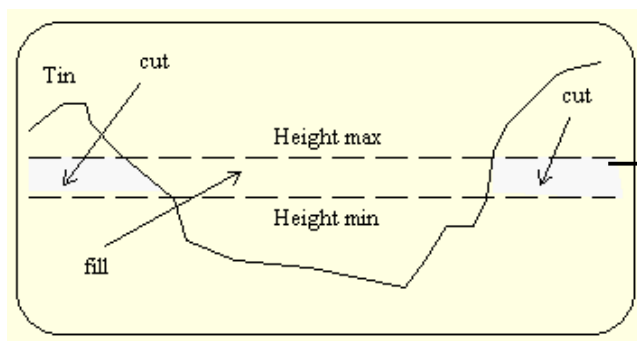
Exact Volumes Between Heights

This option is used to calculate the volume between two heights (height min and height max) on a given tin.



Under the **Type**, you specify if the volume calculation will be for fill or cut. If fill is selected then the volume figure calculated will be the fill volume between the given heights for that tin.

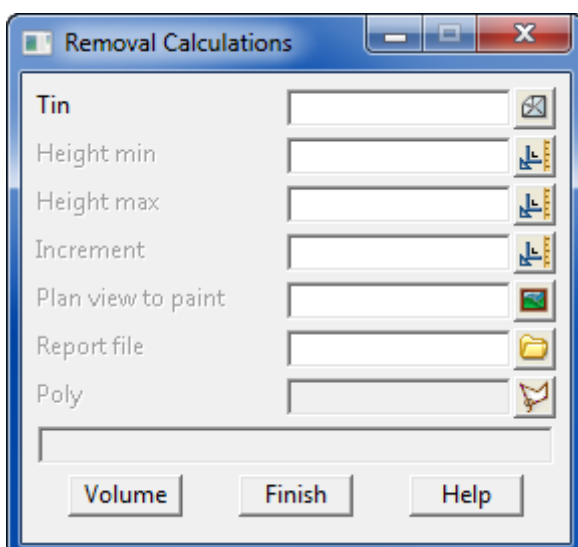
The calculation can be restricted to within a **Polygon**, or if no polygon is selected the entire tin is used.



The Cut and Fill between the 2 Heights is displayed.

Removal Calculations

This option will calculate the cut volume from a user specified range of heights to a given tin, for the region of the tin exposed by cutting to the height.



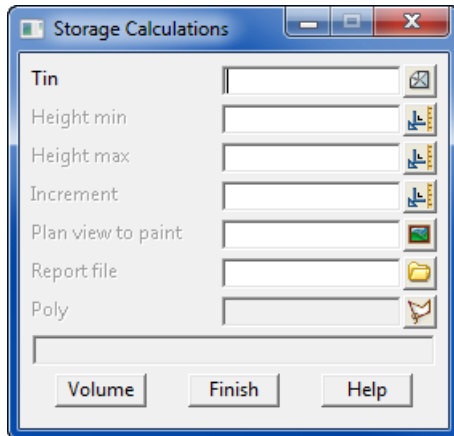
The user specified height range is controlled by a height min and max and a height increment between the min and max. The plan and slope areas are also calculated for each height.

The calculation can be restricted to within a polygon, or if no polygon is selected the entire tin is used.



Storage Calculations

This option will calculate the fill volume from a user specified range of heights to a given tin, for the region of the tin filling to the height. The user specified height range is controlled by a height min and max and a height increment between the min and max.



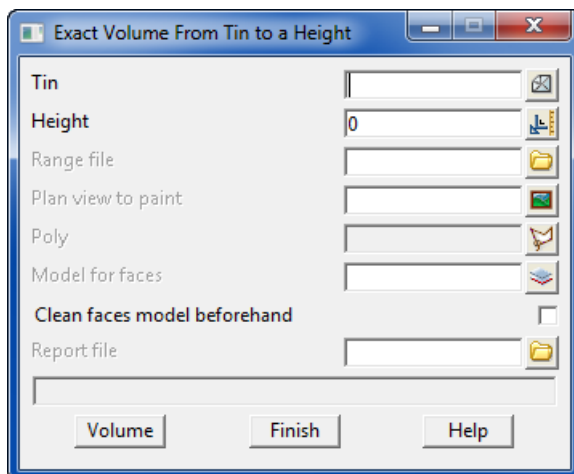
The plan and slope areas of the Water Level are calculated for each height.

This option is used largely for **basin storage** calculations, as per Page 120 of these course notes.

The calculation can be restricted to within a polygon, or if no polygon is selected the entire tin is used.

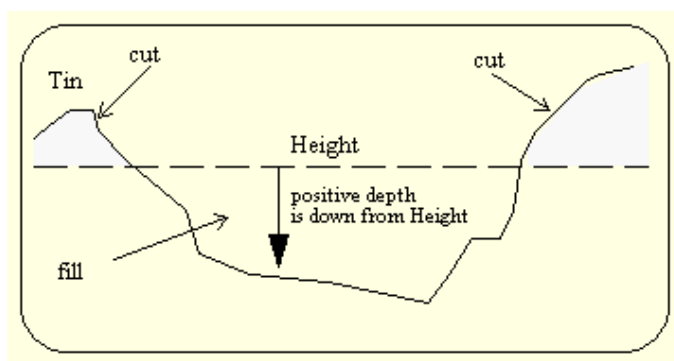
Exact Volume from Tin to a Height

This option will calculate the fill volume from a user specified range of heights to a given tin, for the region of the tin filling to the height. The user specified height range is controlled by a height min and max and a height increment between the min and max.



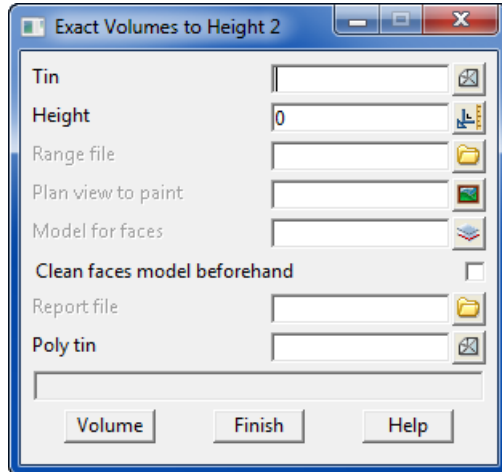
This option is used to calculate the volume between a tin and a given height.

The calculation can be restricted to within a polygon, or if no polygon is selected the entire tin is used.





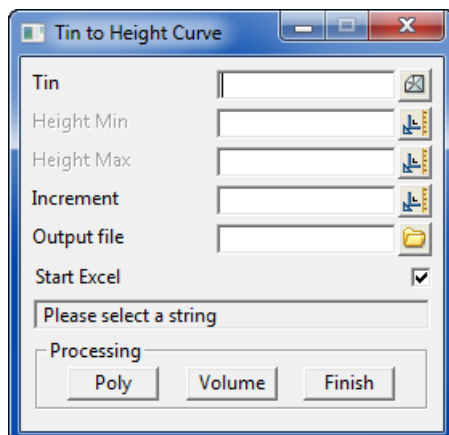
Exact Volumes Tin to Height 2



This option is used to calculate the volume between a tin and a given height, but the calculations are restricted to only the regions defined by another tin rather than the volume tin or a polygon.

The calculation is restricted to the extent of another tin.

Tin to Height Curve

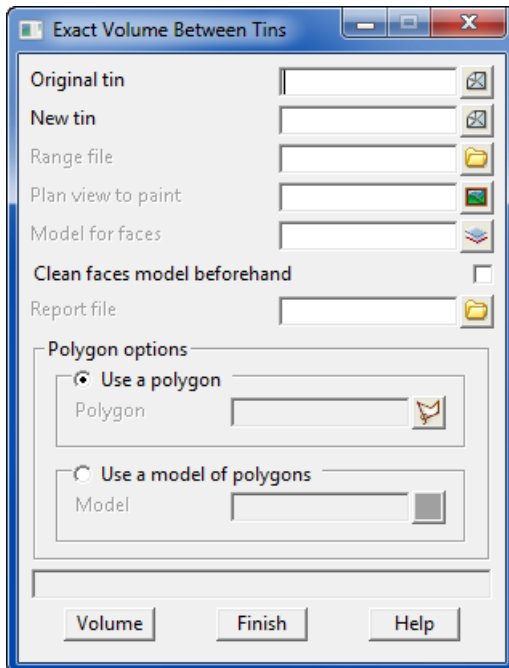


This option is used to calculate the volume between a tin, but between minimum and maximum heights and writes out a report on the volumes.

The volumes are calculated between heights differing by the given increment, and writes out a report.



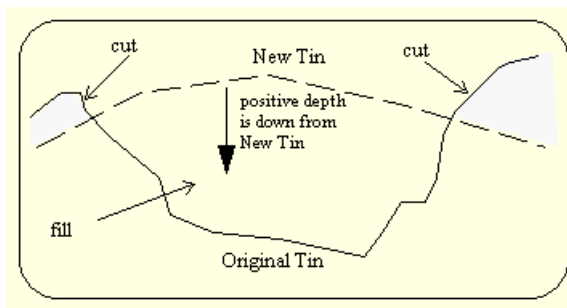
Exact Volume Between Tins



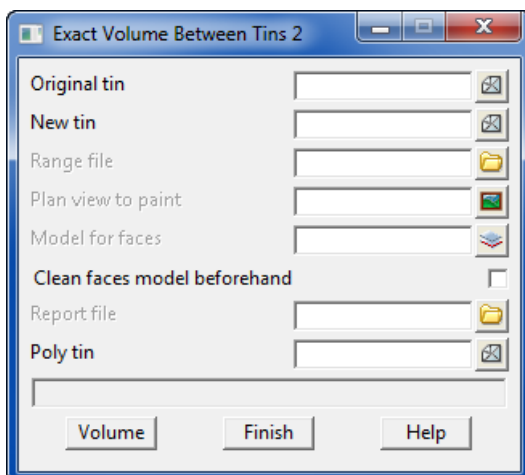
This option is used to calculate the volume between two tins using the exact method.

This option is probably the most used volume calculation option that you will use.

The calculation can be restricted to within a polygon, or if no polygon is selected the entire tin is used.



Exact Volume Between Tins 2



This option is used to calculate the volume between two tins using the exact method but the calculations are restricted to only the regions defined by another tin rather than to a polygon.

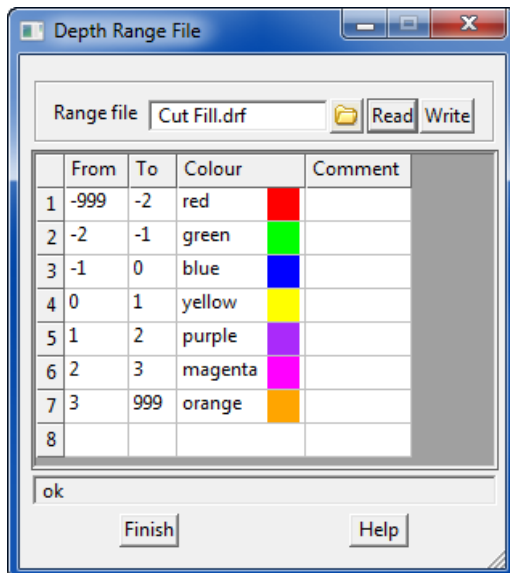
The calculation is restricted to the extent of another tin.





Range File

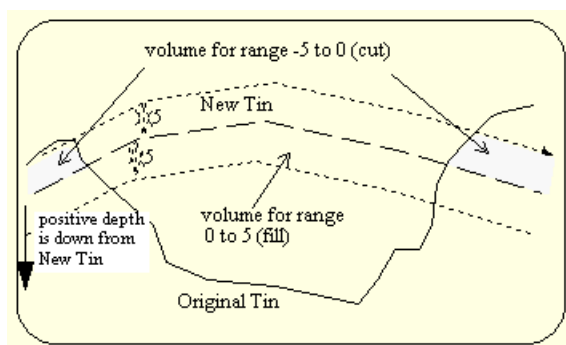
The above calculations (apart from the removal and storage calculations) can be produced and reported on over a user specified depth ranges.



As shown in the picture, the fill ranges are positive and the cut ranges are negative from the new tin surface.

This is an example of a depth range file. The negative values are cut depth intervals from the new tin surface and the positive values are fill depth values from the new tin.

If the above range file was used in a tin to tin calculation, volume calculates and a report file will be produced for the different cut and fill intervals specified in the range file.



As shown in the picture, the fill ranges are positive and the cut ranges are negative from the new tin surface.

For example, the cut volumes from the new tin to the original tin will be calculated for the intervals of;

	From	To	Colour	Comment
1	-999	-2	red	
2	-2	-1	green	
3	-1	0	blue	

-999 to -2 metre interval from the new tin.
-2 to -1 metre interval from the new tin.
-1 to 0 metre interval from the new tin.

The fill volumes from the new tin to the original tin will be calculated for the intervals of;

	From	To	Colour	Comment
4	0	1	yellow	
5	1	2	purple	
6	2	3	magenta	
7	3	999	orange	

0 to 1 metre interval from the new tin.
1 to 2 metre interval from the new tin.
2 to 3 metre interval from the new tin.
3 to 999 metre interval from the new tin.

Note: The volumes totals are only for the depths in the range file. If the depth ranges don't cover the entire depth difference then the totals will not be the volume between the two tins. Therefore, to insure that you calculate the entire volumes when using a range file, it is recommended that the final interval is large enough to include all depths (a interval of 999 metres was used in the range file above).



Description: Exercise No.4 – Additional Exercises

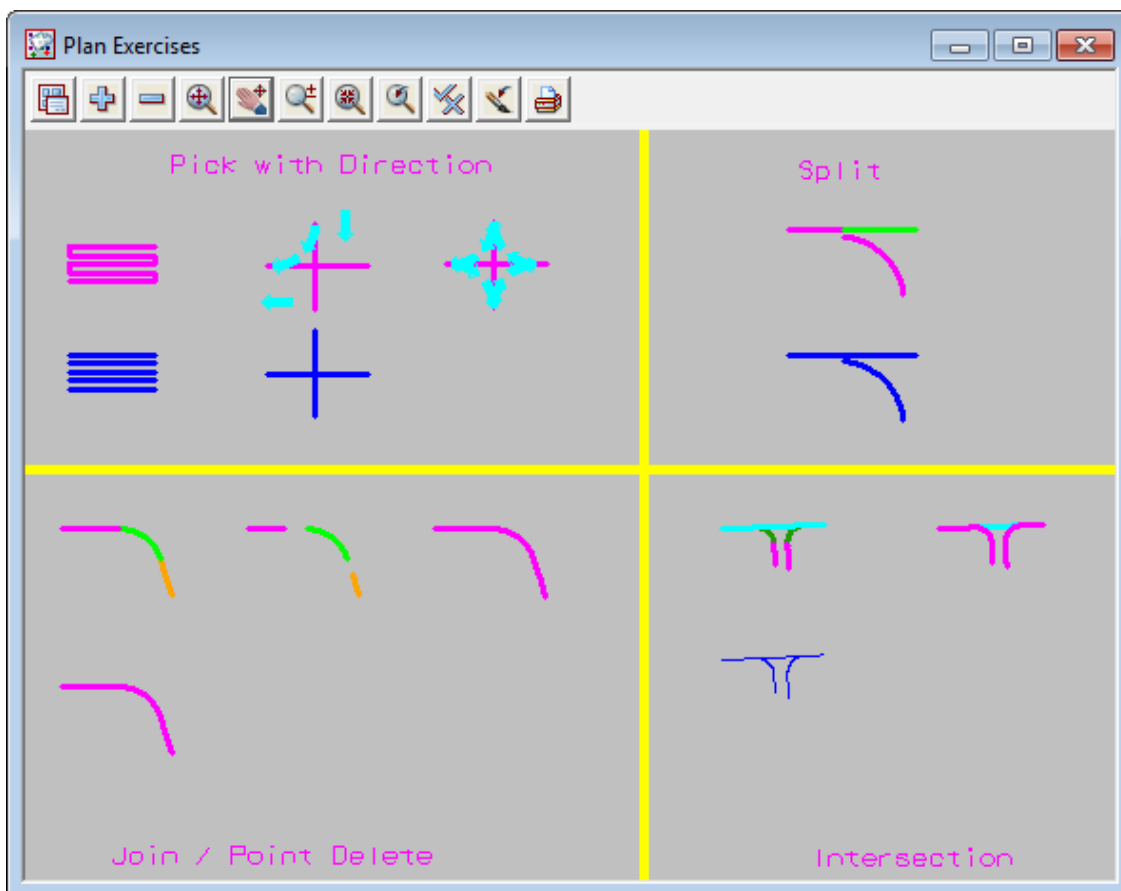
Level: Fundamental

Outcomes: After completing this module you should be able to modify Super Strings to change them to the required shape.

ADDITIONAL EXERCISES

Read in the 12da File, **exercises.12da** into the project.

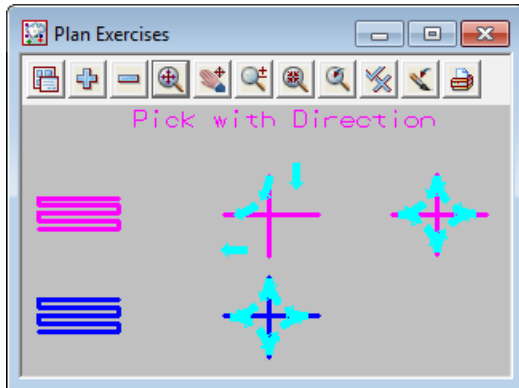
Use: **File I/O => Data Input => 12da/4da Data**





These exercises are to reinforce the commands required to set up the boxing strings from the road design strings.

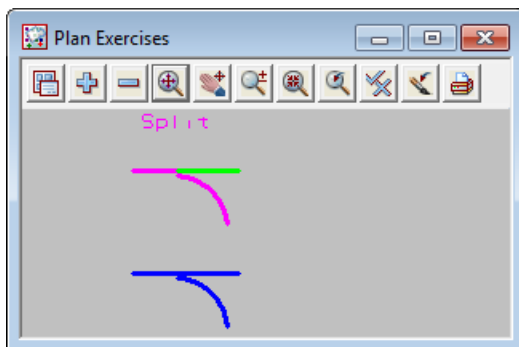
Picking with Direction is an extremely useful tool especially with the following options we are going to use to set up the boxing strings. Note, the top of the examples is the finished strings. When pick with direction isn't used when selecting strings, 12d uses the original direction of the string.

**Exercise Number 1 – String Join.**

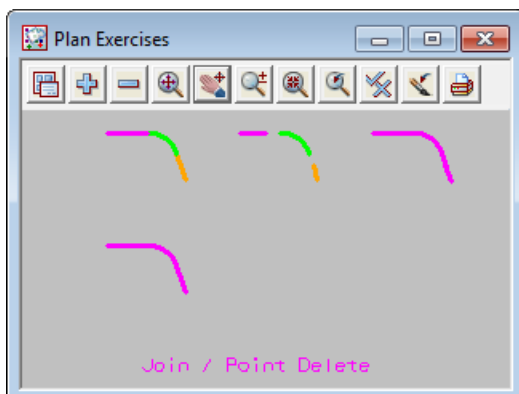
The aim of this exercise is to join the strings in the configuration shown, by using the pick with direction method.

Exercise Number 2 – Fillet/Arc.

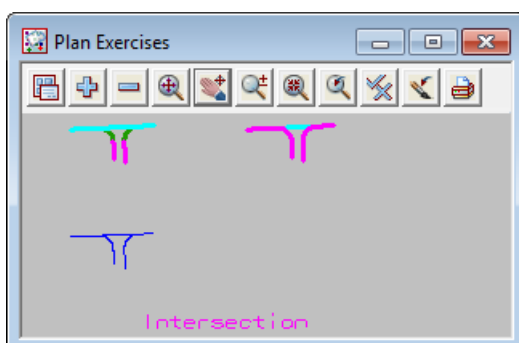
The aim of this exercise is to create Fillets/Arcs in the required quarter of the cross shown, using the pick with direction method is the quickest way to achieve this.

**Exercise Number 3 – String Split.**

The aim of this exercise is to split the string perpendicular to a specific point.

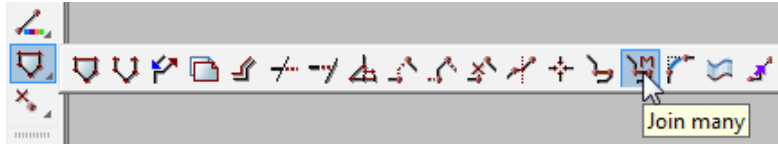


Exercise Number 4 – String Join and Point Delete. The aim of this exercise is to join the strings in the configuration shown, and not have any extra and unnecessary points on the string.

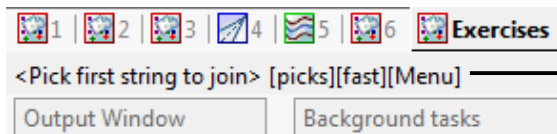


Exercise Number 5 – Intersection Strings. The aim of this exercise is to use the previous commands to create the edge of road strings needed to create boxing/subgrade strings.

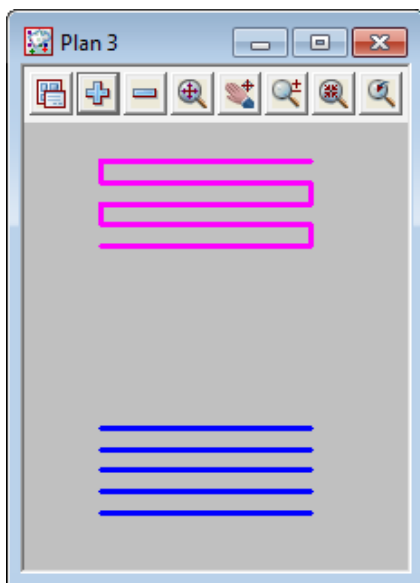


**EXERCISE NUMBER 1 – JOIN STRING MANY**

Use the **String Join Many** command under the **Cad String** Toolbar.

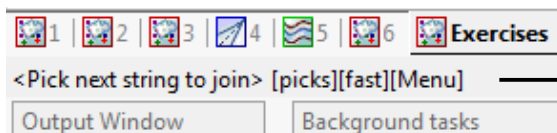


Then follow the instructions on the status bar (this is at the bottom left corner of 12d Model)

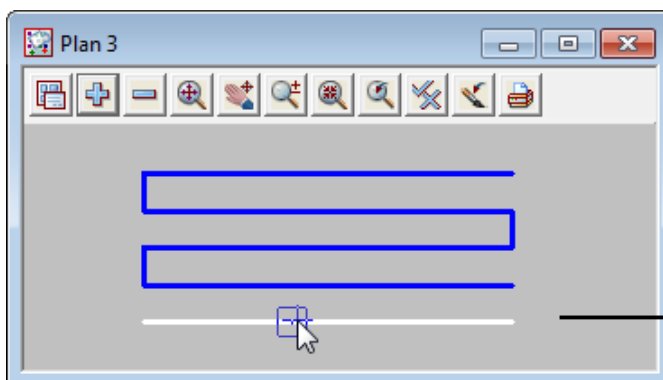


This is the **Solution**, the finished joined string

This is the **Start of the exercise**, with 5 individual strings, you need to join them together using pick with direction.

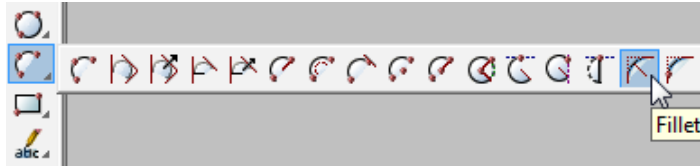


Once you have pick the first string, 12d will then ask you to pick the next string.

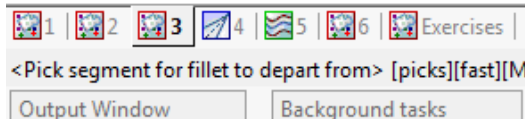


Here is the last string being selected to join the 5 strings together.

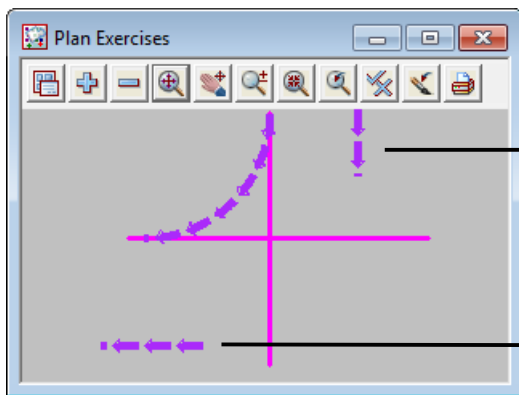
EXERCISE NUMBER 2 – FILLET / ARC



Use the **Fillet** command under the **Cad Arcs** Toolbar.

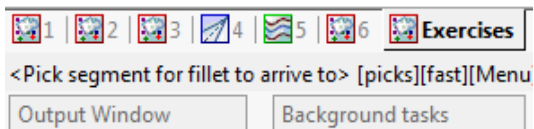


Then follow the instructions on the status bar (this is at the bottom left corner of 12d Model)



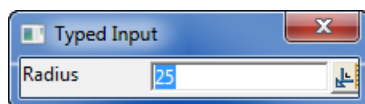
The **Arrows** are showing the direction for the segment to depart from

The **Arrows** are showing the direction for the segment to arrive to

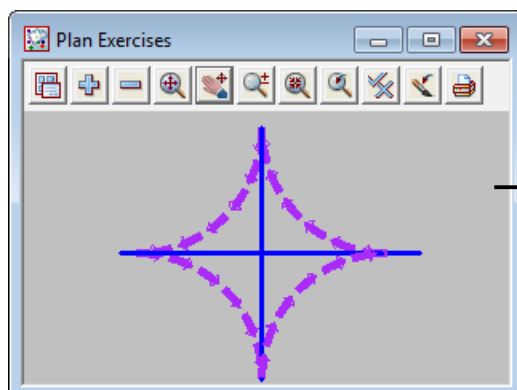


Note:

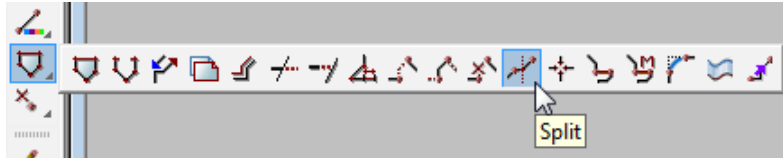
Positive Radii are drawn in a clockwise direction and negative radii are drawn in an anticlockwise direction.



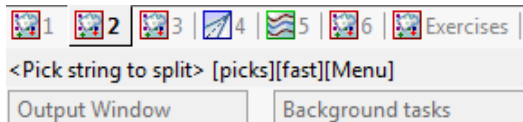
Enter the **Radius** and Press Enter



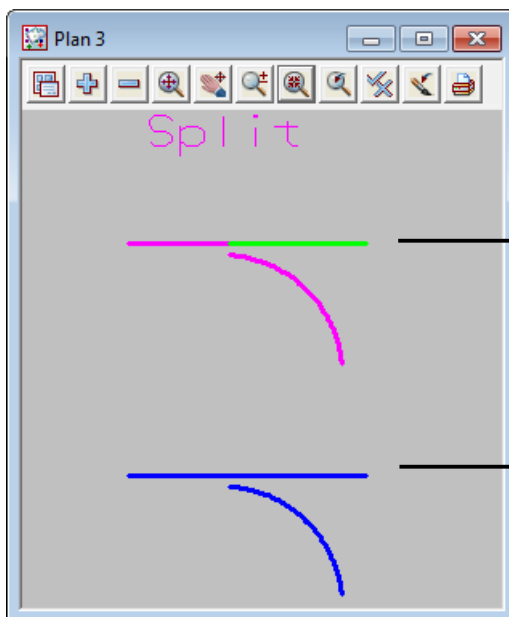
The **Solution**, an Arc in each quadrant.

**EXERCISE NUMBER 3 – STRING SPLIT**

Use the **String Split** command under the **Cad String** Toolbar.

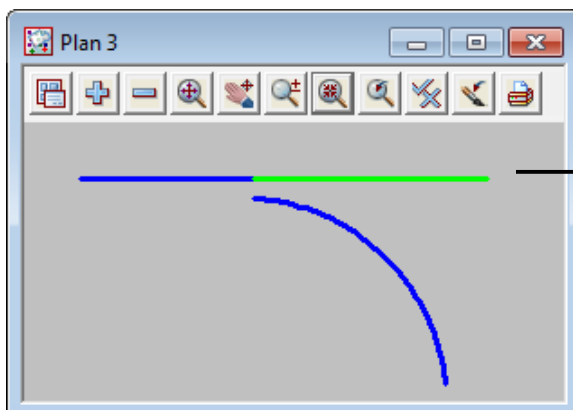
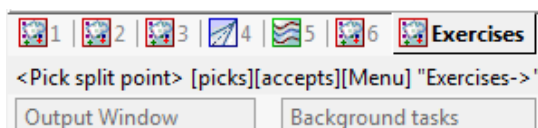


Then follow the instructions on the status bar (this is at the bottom left corner of 12d Model)



This is the **Solution**, the finished Split string

This is the **Start of the exercise**, with 2 strings, you need to split the top one at the end of the Arc.

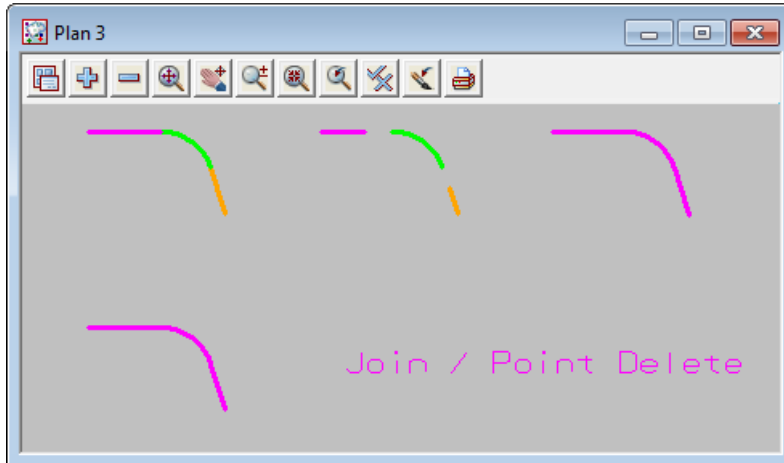


There are now 2 strings, after the original string was split at the end of the arc.

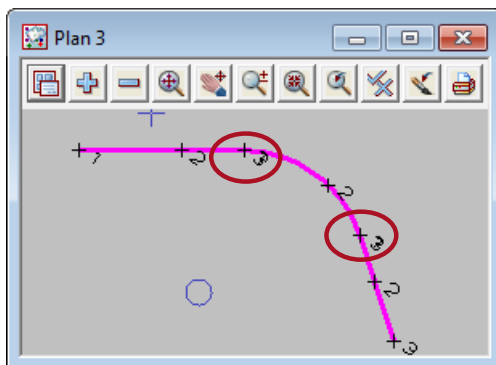


EXERCISE NUMBER 4 – STRING SPLIT

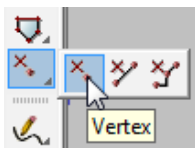
This exercise is going to look at joining the strings without any extra points.



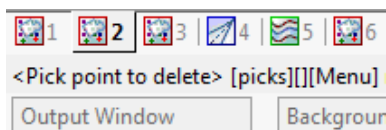
Using the **String Join** and **Vertex Delete** commands.



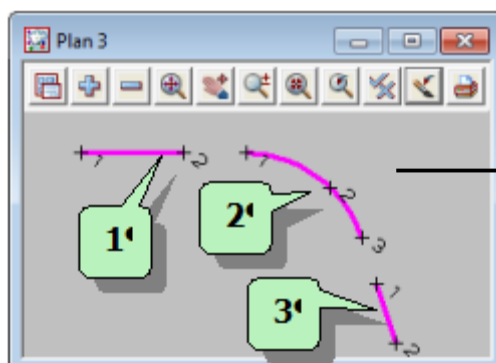
These are the 2 areas where the strings have duplicate points, these duplicate points need to be removed before the 3 strings can be joined together.



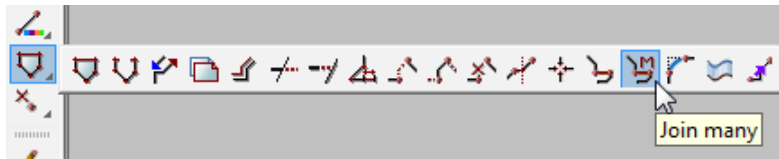
Use the **Vertex Delete** command under the **Cad Delete** Toolbar.



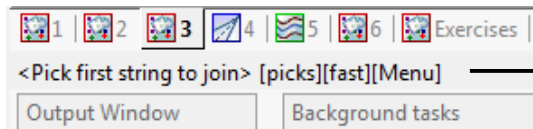
Then follow the instructions on the status bar (this is at the bottom left corner of 12d Model)



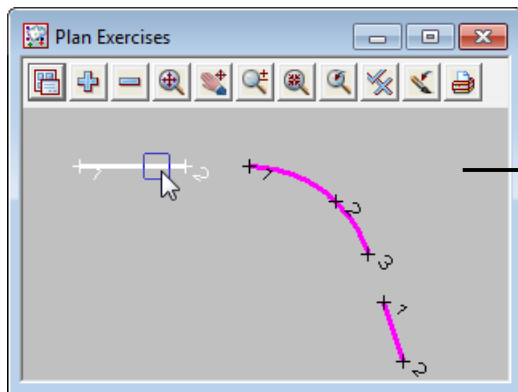
Delete the duplicate points from strings 1 and 3, so they look like this.



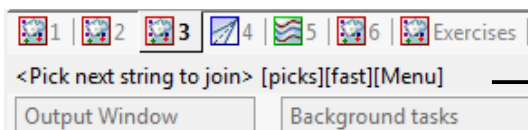
Use the **String Join Many** command under the **Cad String** Toolbar.



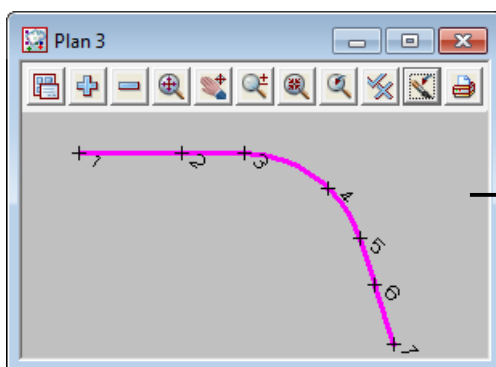
Then follow the instructions on the status bar (this is at the bottom left corner of 12d Model)



Select the first string with direction.



Then select the next 2 strings to join the 3 strings to 1 string.



The joined string should only have 7 vertices, as shown.

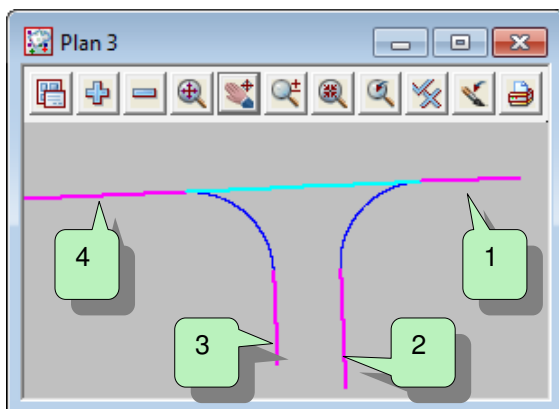
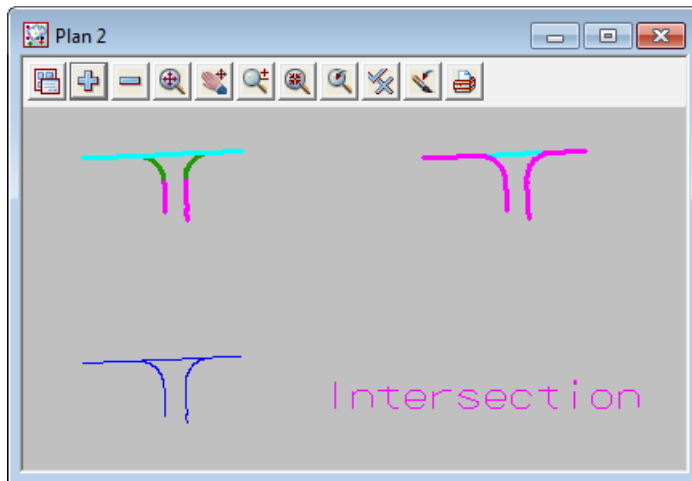
Notes:



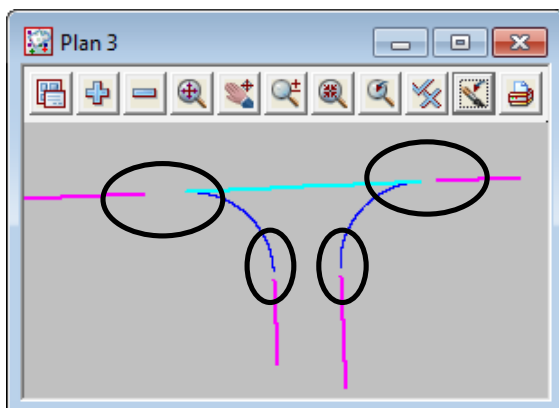
EXERCISE NUMBER 5 – INTERSECTION STRINGS

The aim of this exercise is to use the previous commands to create the edge of road strings required to create boxing/subgrade strings.

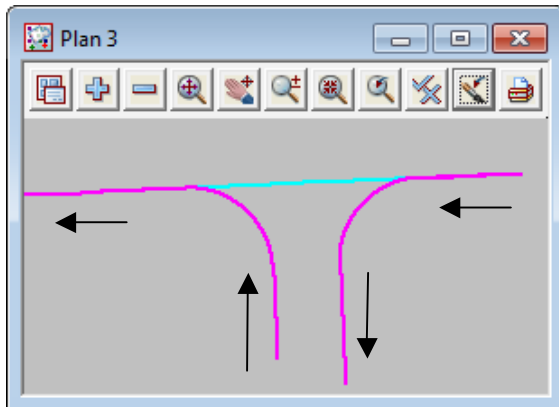
Using the **String Split**, **Vertex Delete**, and **String Join** commands.



Firstly **Split** the through carriageway string at the end of the kerb fillets, creating 3 separate strings, as shown.



Delete the first vertices on strings 1, 2, 3 & 4 by using the **Vertex Delete** so there is a clear definition between the strings (they are the vertices next to the kerb fillets).



Using **String Join Many** now join the 3 strings on each carriageway to create a singular string as shown (the strings are generally joined in the direction of the way a motorist would drive around the corner of the intersection).

Notes:

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



Description: Exercise No.5 – Boxing / Sub-grade Development

Level: Fundamental

Outcomes: After completing this module you should be able to create Sub-grade Pavement Strings to Triangulate. These are used to calculate the Volumes of new pavement.

BOXING / SUB-GRADE DEVELOPMENT OVERVIEW

Boxing is excavation of the subgrade required to allow a road pavement (concrete or gravel) to be built to the finished design levels. 12d Model will allow users to apply boxing as part of a road template, and this refinement allows bulk earthworks quantities to be accurately calculated.

It can also allow the designer to provide the builder with level information for the subgrade construction.

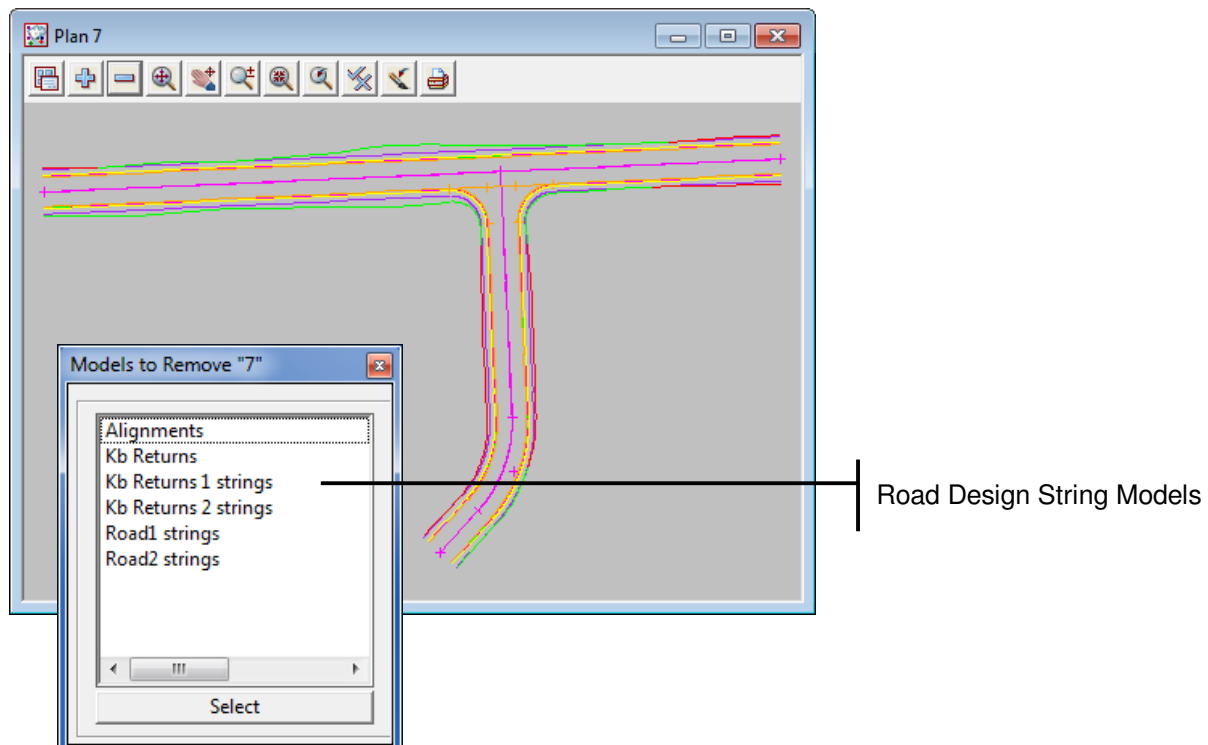
Boxing should be thought of as a series of copied cross sections commands, beneath the road finished surface level and joined to produce a surface or surfaces.

CREATING BOXING / SUB-GRADE STRINGS

Import a 12da file called road vol.12da

Use: **File I/O => Data Input => 12da/4da Data**

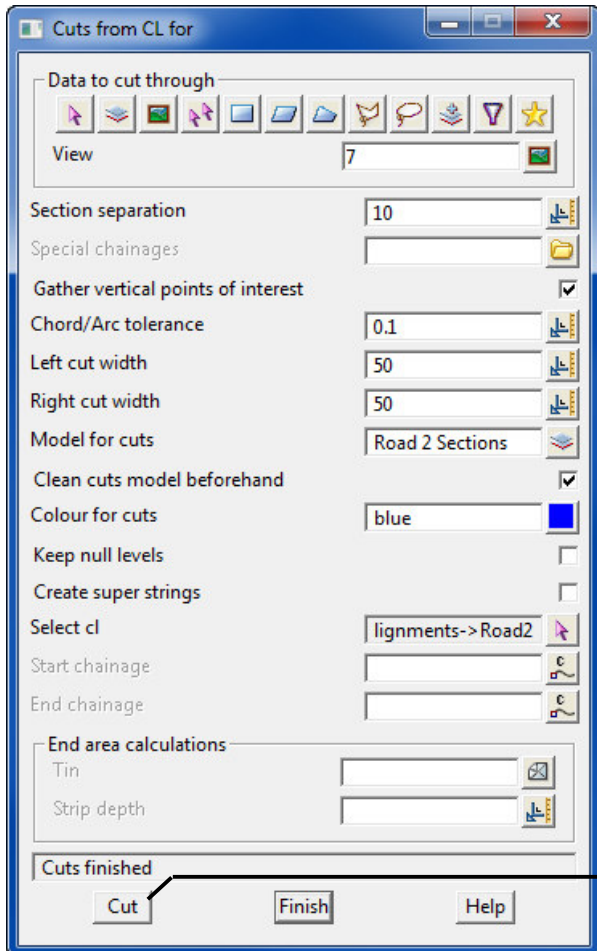
Turn off the **Lot Bdys** and **tin Ex surf** from the view as shown.





We need to create Cross Sections from these Road Design Strings.

Use: **Design => X-Sections => X-sections from cuts through strings**



Pick the View that has the Road Design turned onto.

Section Separation = 10m

Left Cut Width = 50m

Right Cut Width = 50m

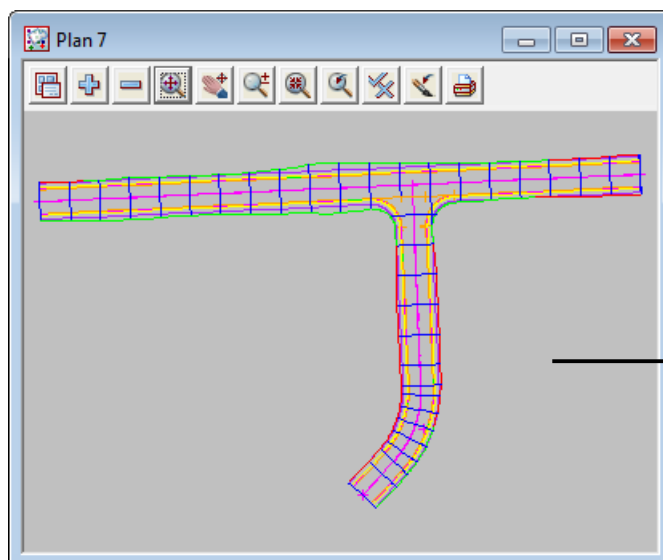
Model for cuts = Road 2 Sections

Colour for Cuts = Blue

Select CL = Road 2

Press **Cut** to create the Cross Sections

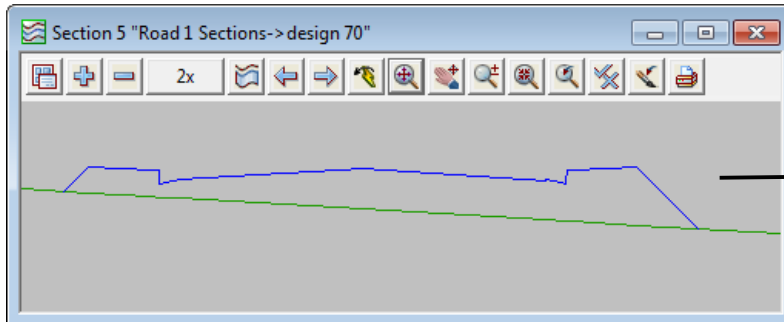
Then Select the **Road 1 CL** and cut the Cross Sections for Road 1



The data to cut the cross sections from are the Road and Kerb Return Strings along with the Alignments.



Open a New Section View, use: **View => New => Section**

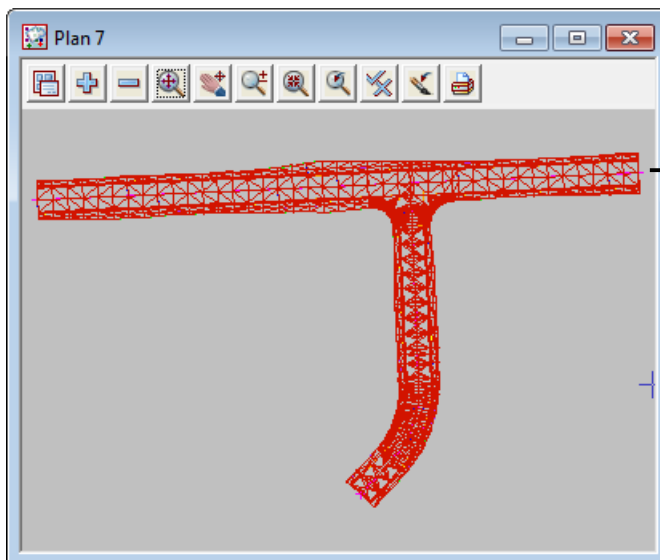


Profile one of the Road Section strings as shown.
The Ex surf tin has also been added to the view.

TRIANGULATE THE DESIGN DATA

The Road Design now needs to have a triangulation created to form a surface for the Road Design.

Use: **Tins => Create => Triangulate Data**



Use the Road Design Data, strings and sections to create the triangulated surface.

Notes:

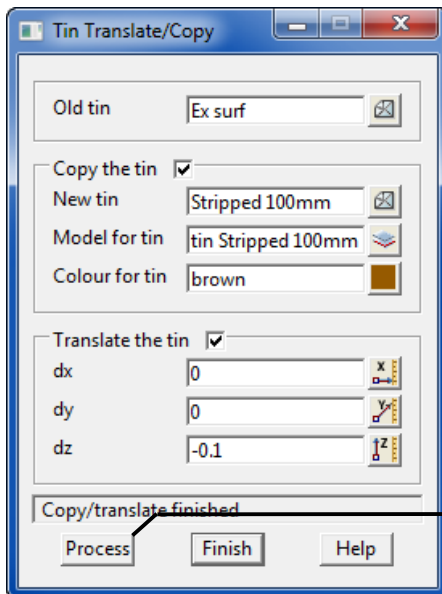


CREATE THE STRIPPED SURFACE

Next a Stripped surface of 100mm Topsoil removal is required.

Use: **Tins => Utilities => Translate/copy**

This panel allows you to copy an existing triangulation and translate it all within one panel.



Select **Old Tin** = Ex Surf

Copy the Tin = Yes

Type in a New Tin name, press Enter, then pick a colour.

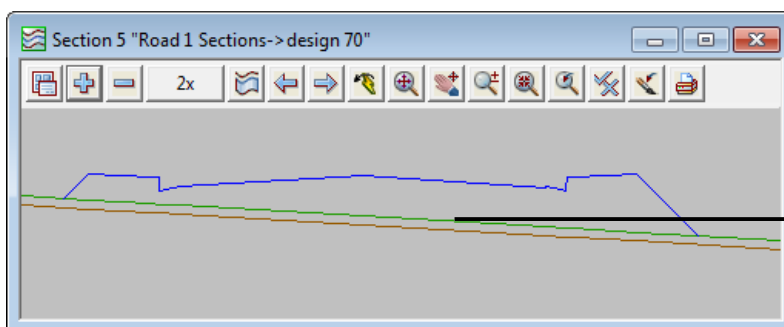
Translate the Tin = Yes

dx = 0

dy = 0

dz = -0.1

Press **Process** to create the new Translated Tin



Stripped 100mm Tin

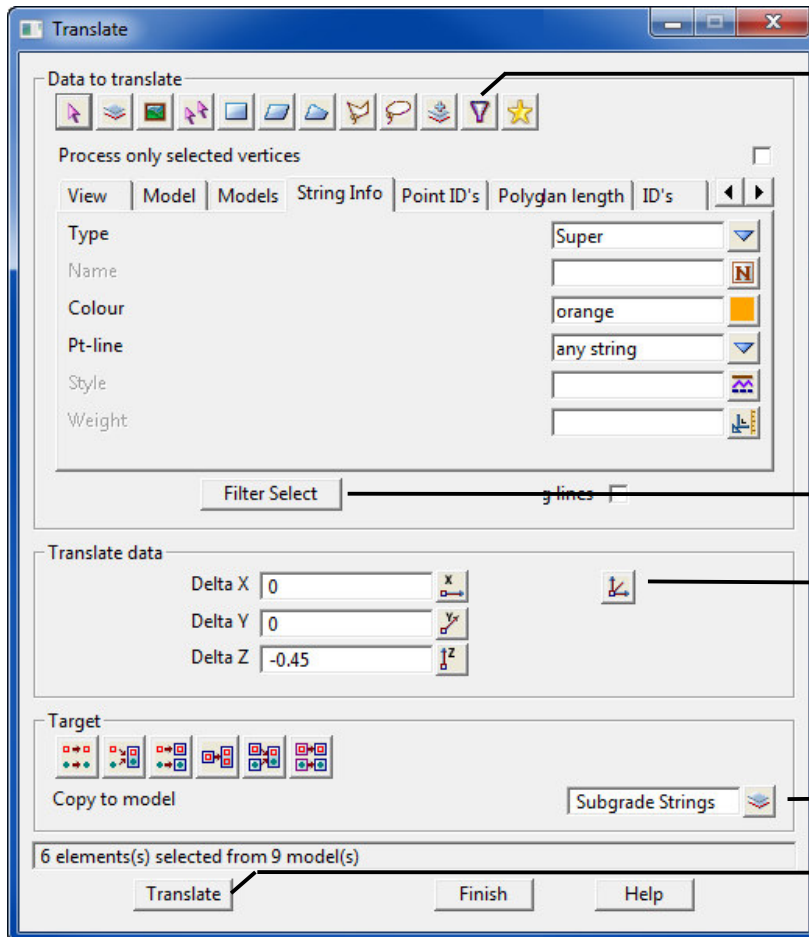


CREATING THE SUB-GRADE PAVEMENT DESIGN

The Sub-grade pavement design will be a thickness of 450mm.

To create the Sub-grade pavement strings we will use:

Utilities => H-Z => Translate



We will use the **Filter Button** to select the data.

Use the **String Info** Tab to select the required data to translate.

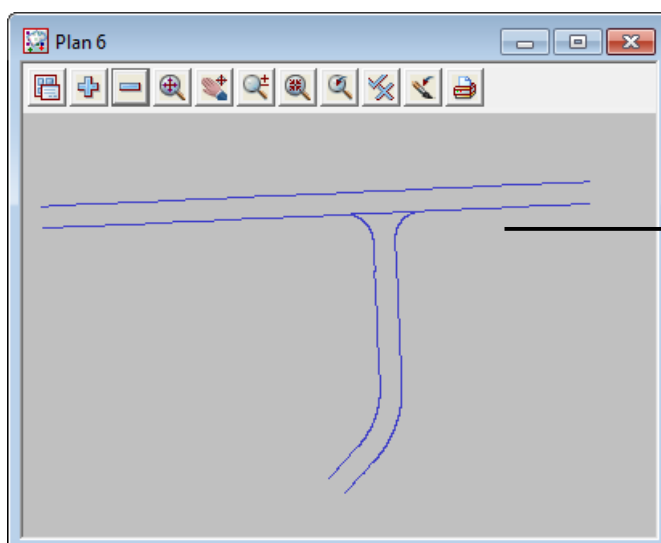
Select all the **Orange** Strings

Select **Filter Select** – the found strings will be highlighted on the screen, plus the number of elements selected and shown at the bottom of the Panel

Enter the Delta X, Y and Z as shown. Use the **Pick Button** if you want to measure the values from the screen.

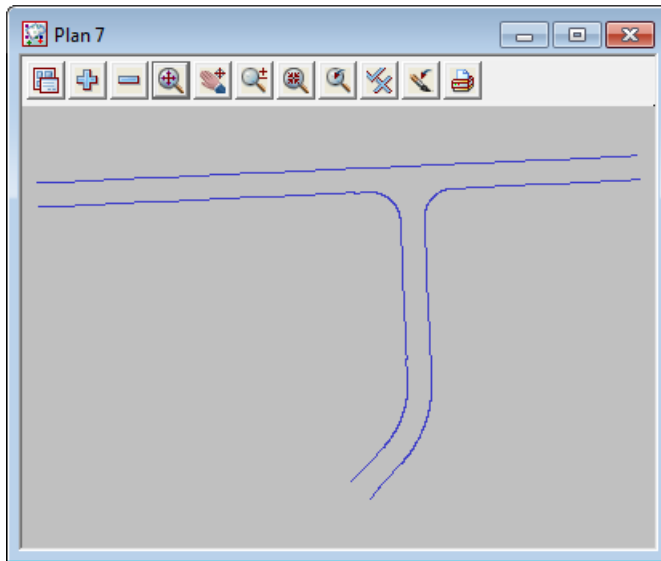
Copy to Model = Subgrade Strings (type in a new model name)

Press the **Translate** Button to copy and translate the data.

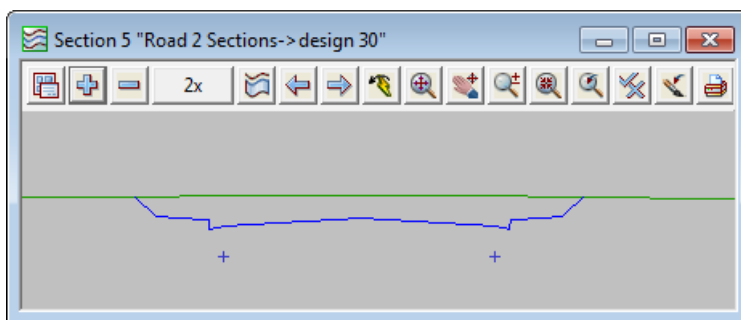


Translated Road Design Strings

Now to amend these strings to be 3 lip of kerb strings. The strings need to be Split, and Joined to form the 3 strings.



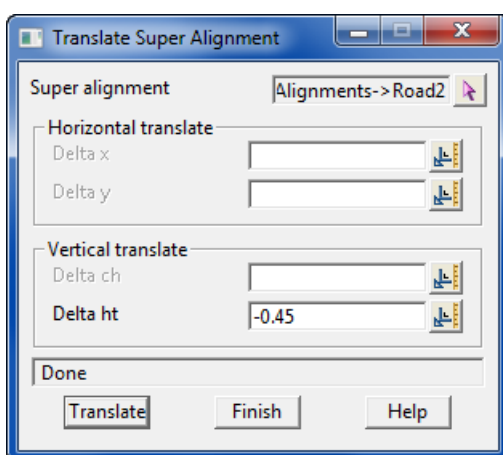
NOTE: You can refer back to the exercises in Exercise 4 to see examples of how to Split and Join Strings.



When you profile the Sections and turn on the "Subgrade Strings" Model you can see the translated strings.

The Road Centreline strings are a special type of string called a **Super Alignment** and can be translated using the Super Alignment Translate option. Super Alignments cannot be translated in the usual way like Super strings or polylines.

Use: **Strings => SA Tools => Translate**

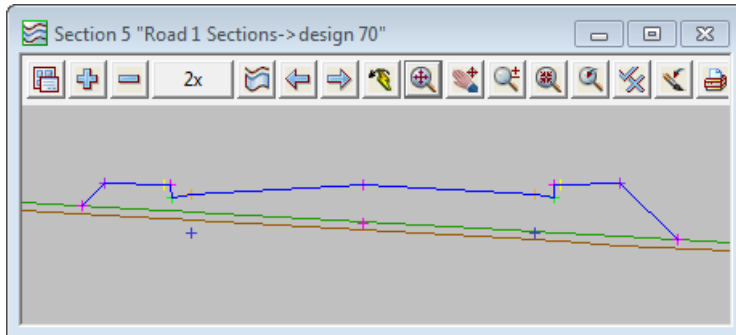


Pick the Super Alignment String

Type in the Delta Height for the pavement thickness

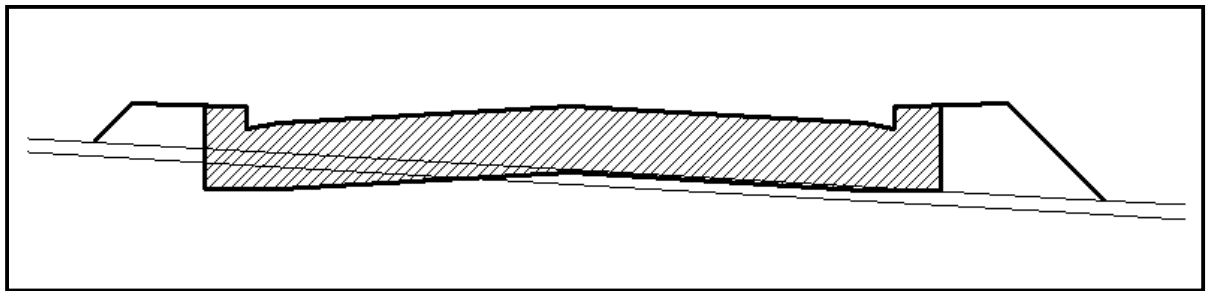


Move the 2 Super Alignments that have been translated (as they were translated into the original model) into the **Subgrade Strings** Model.



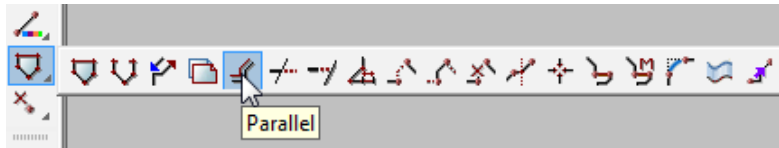
The Translated Super Alignment has been added to the Subgrade Strings Model.

The Pavement Design will be comparable to the sketch below:

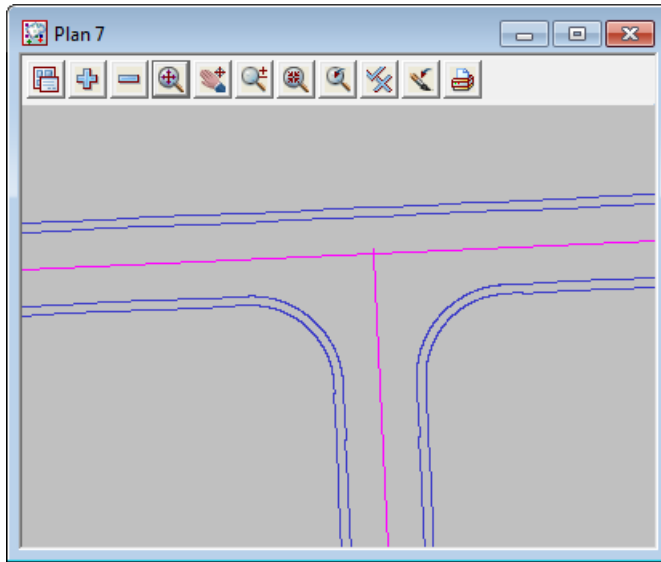




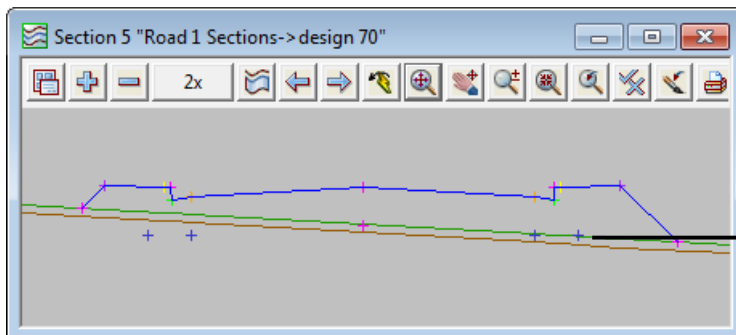
Now the lip of kerb strings need to be **paralleled** 1 metre to represent the base of the kerb.



Use the **String Parallel** from the **Cad String** Toolbar.



Parallel the Subgrade kerb strings by 1m and a delta height difference of 0m height.



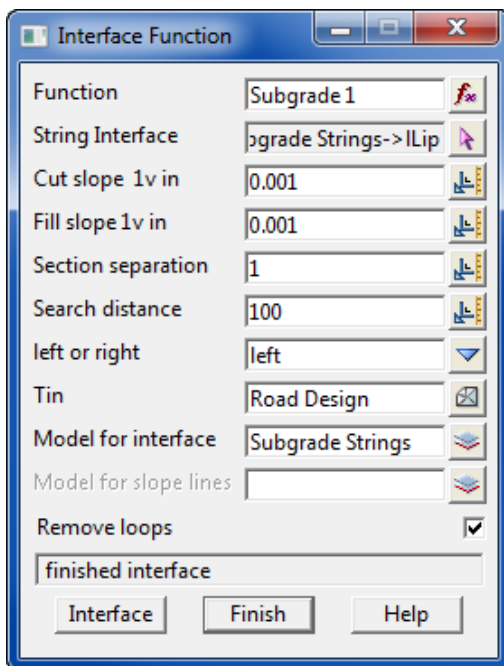
Paralleled strings under the kerb.



Now to finalise the pavement strings we need to calculate where the pavement will interface with the design road surface, somewhere on the footpath above the paralleled strings.

We will use the Interface Function, so we will use: **Design => Apply => Interface**

We will set up 3 Interface functions, 1 for each edge of the subgrade pavement. These strings will be near vertical with a slope of 1 to 0.001 and will interface to the Road Design tin.



Function Name: Subgrade 1

Pick the newly paralleled Subgrade strings

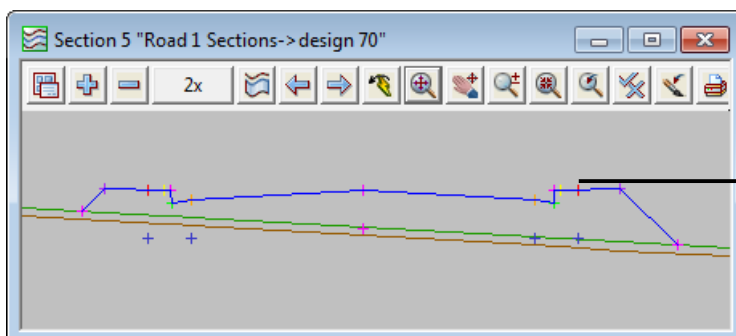
Cut Slope = 0.001

Fill Slope = 0.001

Section Separation = 1m

Tin = Road Design

Model for Interface = Subgrade Strings

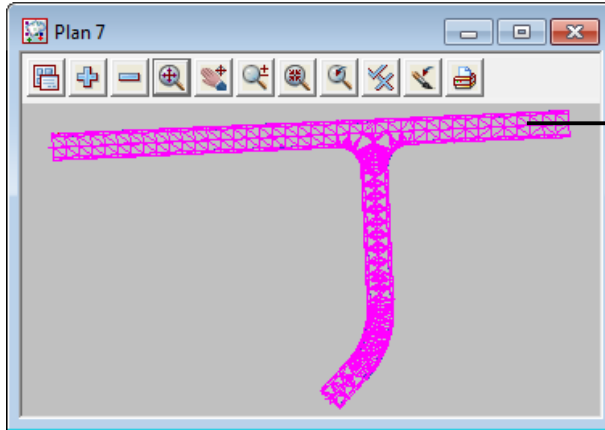


Interface Strings now taken up to the Design Section.

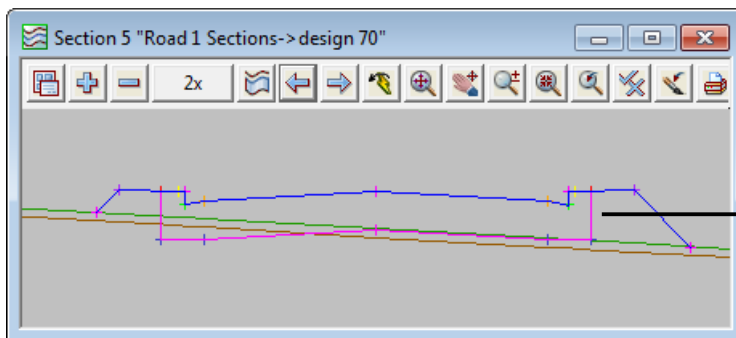


We now have the required strings to calculate the subgrade volume calculations, so we can create a triangulation of the subgrade surface.

Use: **Tin => Create => Triangulate Data**



Triangulation of the Subgrade Strings Model.

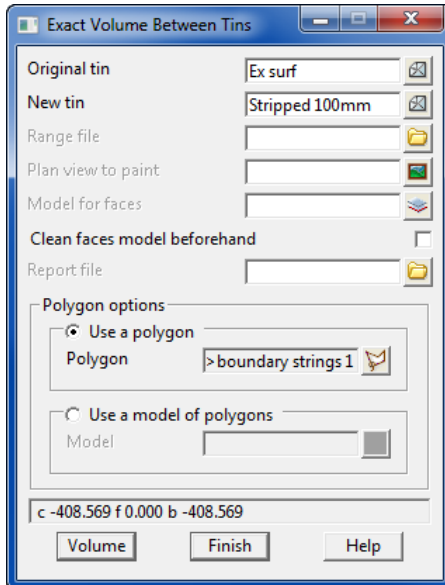


The new **Subgrade Tin** can then be turned onto the Section View and see that it matches the Subgrade strings we created.



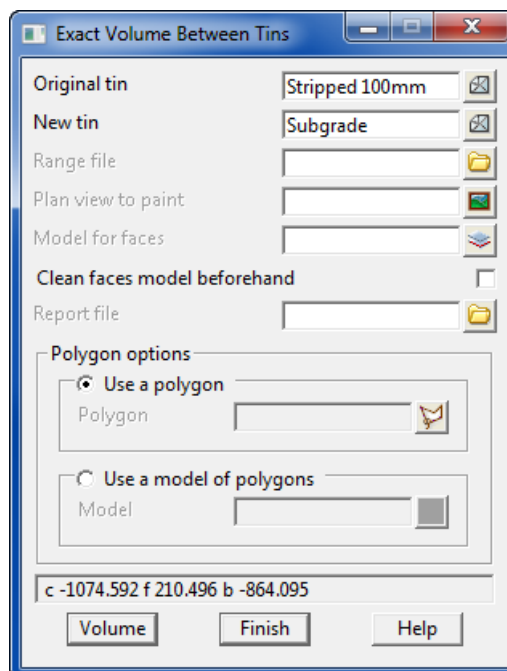
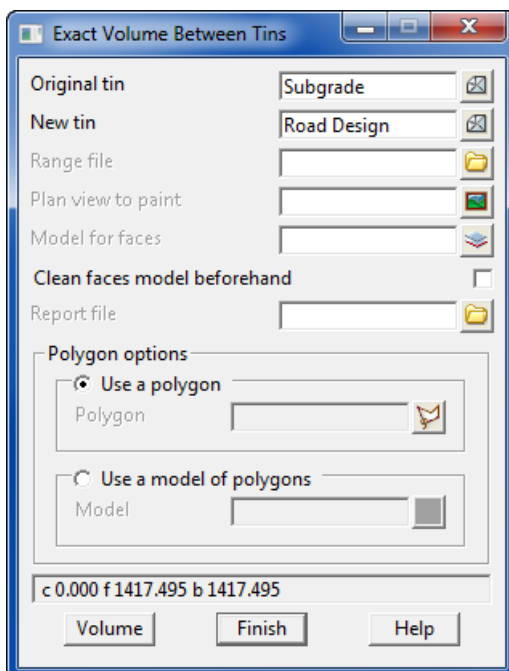
With this new Subgrade surface we can then calculate the pavement volumes for the road design.

Use: **Design => Volumes => Exact => Tin to Tin**



The volumes can then be calculated between the:

- **Ex surf** tin and **Ex surf Stripped 100mm** tin for the topsoil stripping volume
- **Ex surf Stripped 100mm** tin and **Subgrade** tin for the excavation quantities to get the site ready for the pavement to be constructed.
- **Subgrade** tin and **Road Design** tin to calculate the amount of pavement material required for the Road Design.





Appendix – Description of the Training Data

Create “Introduction to 12d” Project

- Import “**belm1mar01.dwg**” AutoCAD Drawing.
- Add the imported data onto the **Plan View**.
- **Toggle** on the Vertices, Vertex Indices, and z values.
- **Measure Tools**.
- **Plan Plotting** to a Printer, a Model and an AutoCAD Drawing.
- **Project Description Panel**

Alternative Create “Introduction to 12d” Project

- Import “**103001.as5**” CivilCAD File.
- Add the imported data onto the **Plan View**.
- **Toggle** on the Vertices, Vertex Indices, and z values.
- **Measure Tools**.
- **Plan Plotting** to a Printer, a Model and an AutoCAD Drawing.
- **Project Description Panel**
- **Triangulate** the survey data, then look at the Nulling by angle and length.

Create “Barwon” Project

- Import “**Survey.dxf**” file.
- Check **Crossing Breaklines** in the survey data.
- Create a **Triangulation** called tin survey and **Null** the long triangles.
- Create a **tin boundary**.
- Use the tin toggles to view the tin toggle options, **tin contours**, **tin flow** and **tin solid**.
- Create **Contour Strings**.
- **Export** survey data and contour strings to AutoCAD.

Exercise No. 1

- Triangulation and Contour Strings

String Creation & Modification

- Create Line, and Line Strings.
- Move points, insert points, extending points and add points between points.
- Add points with exact coordinates, and bearing and distances.
- **Pick with Direction**
- Adjust string height with the **F2 Button**.
- String Parallel, String Join and Join Many.
- Delete a string, segment and vertex.
- Undo and Redo Commands.
- Snaps CAD Toolbar with Offsets, Midpoints, Perpendicular, Intersection and Centre.





Tin Analysis

- **Slope Analysis Inquiring.**
- Create **Slope Analysis** data of the Barwon Data Triangulation.
- **Exporting** Slope Analysis Results.
- **Tabulate Range File** – Creating a Legend.
- **Aspect Analysis** - Creating.

Exercise No. 2 – Building Pad

- Open the “**Barwon**” **Project** again.
- Create Building Pad outline.
- **Interface Function** to create the Cut and Fill Batters to the Natural Surface Tin.
- Adjust the height of the string (**F2 Button**).
- Re-run the Interface Function.
- Add **Corner Angle** in the Project Defaults.
- Create new Plan View and Add the 3 Design Pad Models.
- **Triangulate** the Design Pad.
- Open a Perspective View & turn on the NS tin, Design Pad tin & Design Pad Models.
- Open a Section View, draft a line through the Design Pad and Profile the 2 tins.

Exercise No. 3 – Water Quality Basin

- Open the “**Barwon**” **Project** again.
- Import the Basin Floor strings – **basin floor.12da**.
- **Interface Function** to create the Cut and Fill Batters to the Natural Surface Tin.
- Adjust the height of the string (**F2 Button**).
- Re-run the Interface Function.
- Add **Corner Angle** in the Project Defaults.
- Create new Plan View and Add the 3 Design Pad Models.
- **Triangulate** the Design Pad.
- Open a Perspective View & turn on the NS tin, Design Pad tin & Design Pad Models.
- Open a Section View, draft a line through the Design Pad and Profile the 2 tins.

Appendix A – Additional Exercises

- Import the Exercises.12da file.
- Follow the exercises for additional picking with direction.

Appendix B – Boxing/Sub-grade Development

- Import the Road vol.12da file.
- Cut Cross Sections of the Design strings. Create a Design tin.
- Translate and copy the survey tin to show the stripping surface.
- Translate the lok strings, join them together and translate the Alignment CL strings.
- Parallel the translated lok strings for under the kerb area
- Interface back to Design surface tin.
- Create a tin of the Subgrade and calculate volumes for the subgrade.

