2009 Roads and Bridges Conference

GW1

DTM Analysis and Site Visibility tools for GEOPAK

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Lesson Name: Create DTM using Data Acquisition tools

LESSON OBJECTIVE:

Using the ***Data Acquisition*** toolset, build a digital terrain model for future analysis exercises

Data Acquisition toolset

The Data Acquisition toolset is designed (at release – V8i SELECTseries 1) to provide the User with an alternate set of tools to gather data from various sources, and then edit, merge, append and manipulate that data to build a composite surface to begin the Civil Design process.

Supported data sources at this first release are:

Raw Survey (many formats)

Current Bentley DTM formats (DTM, TIN, FIL, LandXML)

Lidar Data (LIS and XYZ)

Raster data: SDTS, USGS DEM, TIF, Spot Dimap, NTF, Erdas IMG, BIL, ECW, DTED0, DTED1, DTED2

The list of data sources will grow as the toolset matures.

The simplified workflow and interface, and the intuitive nature of the tool operations reflect a glimpse into the future of Bentley Civil's plans for better tools that provide more focused functionality and are easier to use.

EXERCISE: OPENING DATA ACQUISITION TOOLS

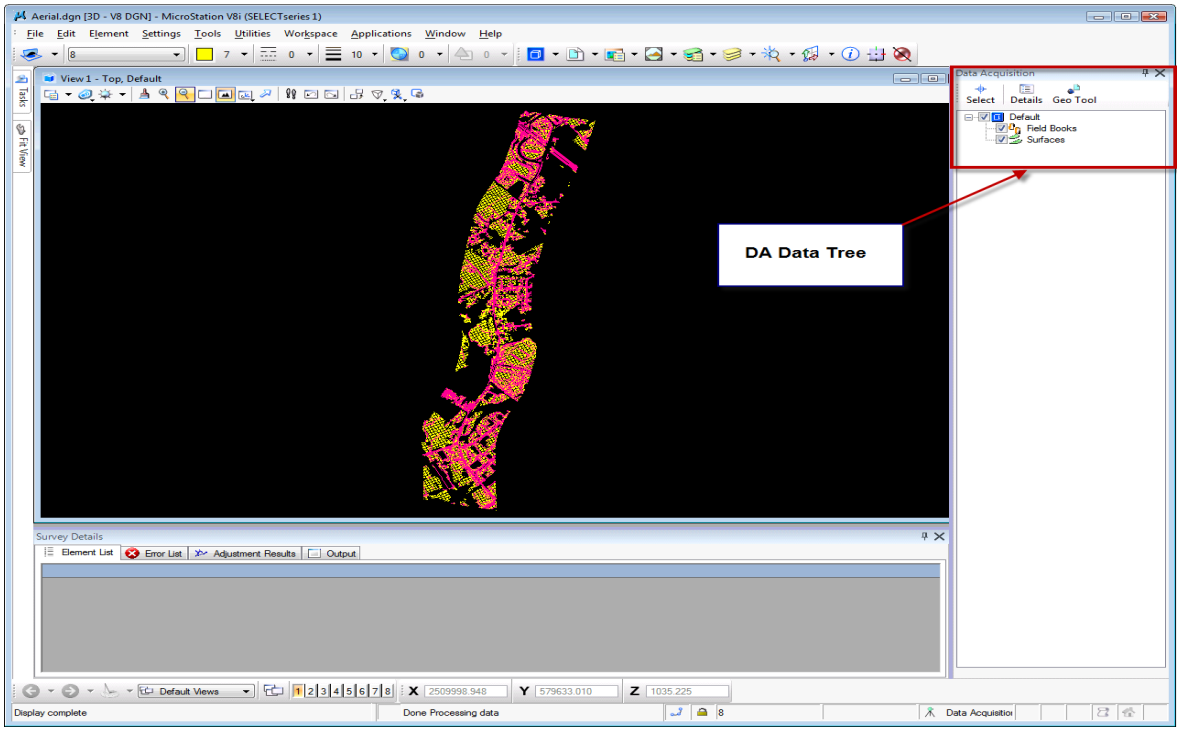
This exercise will guide you through the steps activate the Data Acquisition toolset.

1. Open MicroStation from the desktop icon
2. Open the DGN file … *C:/2009 RBC/GW1/DATA/Aerial.dgn*
3. Activate GEOPAK. *(Applications Menu>GEOPAK>Activate GEOPAK)*.

   GEOPAK may already be activated – in which case skip step 3

4. Select the **Data Acquisition** tool (*Task menu>Data Acquisition>Data Acquisition*)

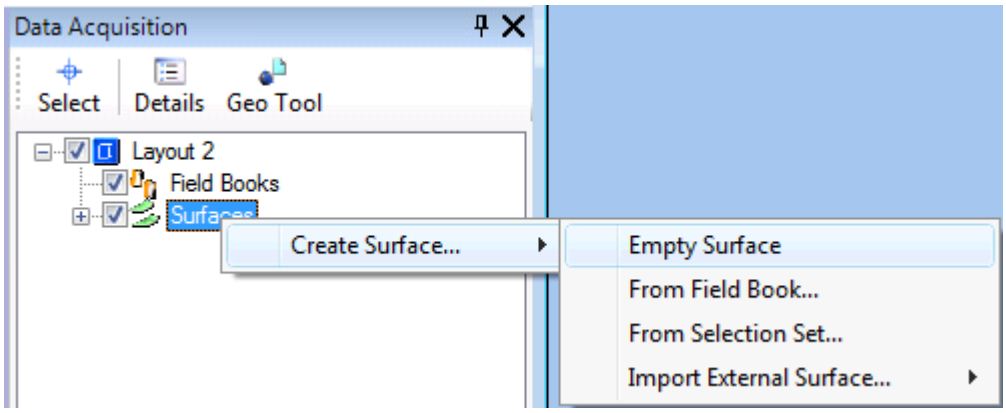
   Two new panels will open. The Data Acquisition data tree and the Data Acquisition Details panel. These panels should both be docked. Location of the panels is a personal preference. The image of the docked panels will provide an example arrangement.



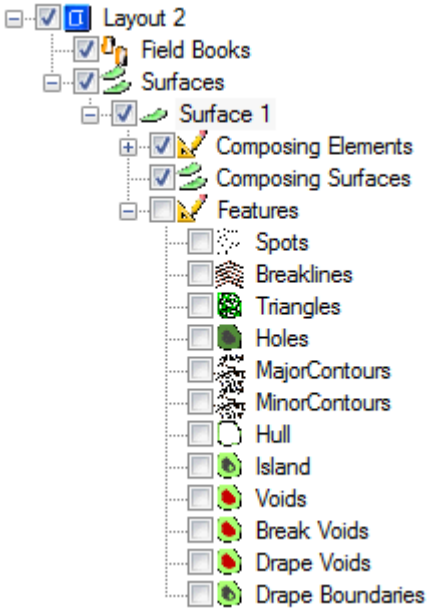
EXERCISE: CREATE DATA ACQUISITION SURFACE FROM AERIAL DATA

This exercise will guide you through the steps to build a DA Surface from graphical data. In this scenario, the data has been supplied from an Aerial photography company. Similar steps would apply to the creation of a surface from any graphical 3D data.

1. Focus on the DA Data Tree.
2. Right Click on “Surfaces” folder.
3. Create Surface>Empty Surface.

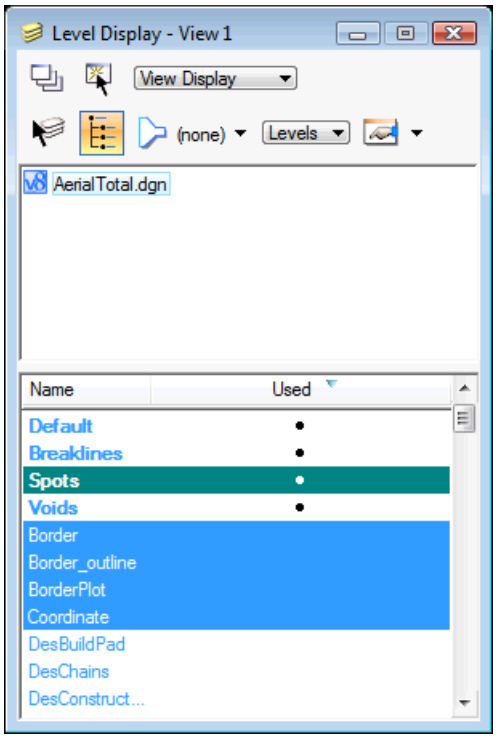


4. A new surface will be created in the DA Data Tree: Surface 1
5. Drill down the Surface 1 data structure until you see the Surface feature list.



We can now select the graphical data that corresponds to the different feature types and import that data into the DA Surface.

6. Select **Level Display**. *(Settings>Level>Display)*.
7. Disable the display for Breaklines and Voids levels



8. Select all of the "Spots" graphical data
9. Return your focus to the **Surface 1>Features** list.
10. Right click on **Spots** label
11. Select **Import Selection**.

The selected graphical spot data has now been imported into the DA Surface.

12. Disable the display for the Spots level and enable the display for the Breaklines levels
13. Select all of the “Breakline” graphical data
14. Return your focus to the **Surface 1>Features** list.
15. Right click on **Breaklines** label
16. Select **Import Selection**.

    The selected graphical Breakline data has now been imported into the DA Surface.

17. Disable the display for the Breaklines level and enable the display for the Voids levels
18. Select all of the “Void” graphical data
19. Return your focus to the **Surface 1>Features** list.
20. Right click on **Drape Voids** label.
21. Select **Import Selection**.

    The selected graphical Void data has now been imported into the DA Surface.

22. Enable the display for all levels. (*Settings>Level>Display*)

EXERCISE: ENABLE DISPLAY FOR DA SURFACE FEATURES

This exercise will guide you through the steps to display surface features of a DA Surface

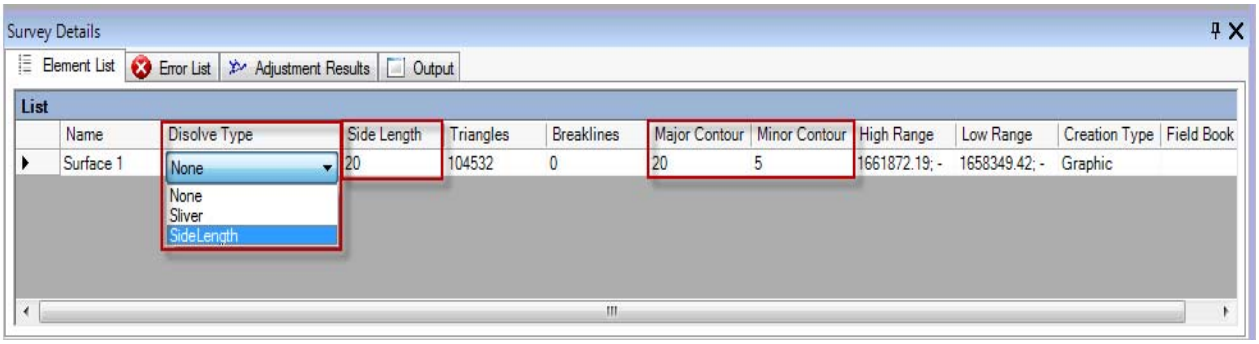
1. Focus on the DA Data Tree: **Surface 1**
2. Enable the check mark for Triangles.

   The triangles for the Surface will now be displayed as transient graphics.

3. We can reset the **Side Length** and **Dissolve** options to "clean up" the outside triangles of the dataset.
4. Focus on the "Survey Details" panel.
5. Select the **Surface 1** item in the panel.
6. Reset the **Side Length** attribute to **120** <Enter>
7. Reset the **Dissolve Option** attribute to **Side Length** <Enter>

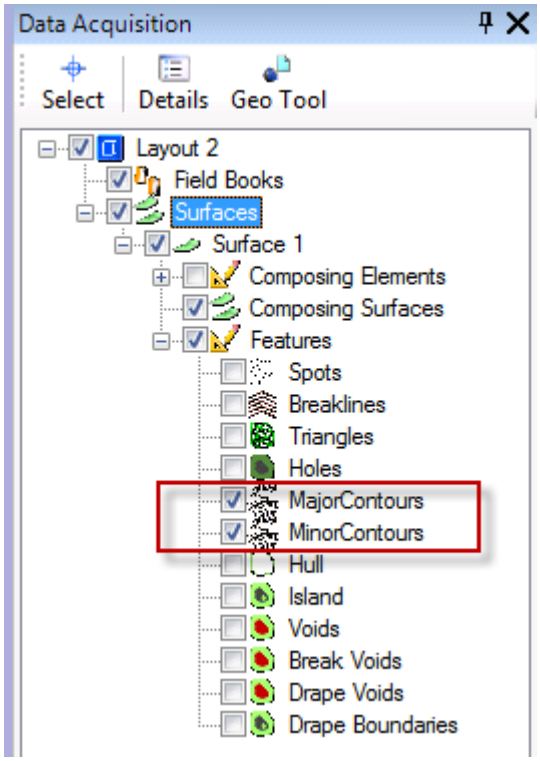
   The Surface triangulation should now appear significantly different around the outer edges.

8. Reset the **Minor Contour** attribute to **2** <Enter>
9. Reset the **Major Contour** attribute to **10** <Enter>



Return focus to the Surface 1 feature enablers on the data tree.

10. Enable **Major Contours** and **Minor Contours** features.



EXERCISE: EXPORT SURFACE 1 TO GEOPAK TIN

This exercise will guide you through the steps to export a DA Surface to a native Bentley Civil Application DTM. For this workshop, we will export to a GEOPAK TIN.

1. Focus on the DA Data Tree: **Surface 1**
2. Select **Surface 1**.
3. Right Click>Export to>GEOPAK TIN
4. Navigate the Save As dialog to the folder ***C:/2009 RBC/GW1/DATA*** and key in the file name **Surface1.tin**.
5. Select **Save**.

This will create a GEOPAK TIN named Surface1.tin.

6. Close **Data Acquisition** data tree.

Lesson Name: Create Finished Surface DTM using Corridor Modeling tools

LESSON OBJECTIVE:

Using the ***Corridor Modeling*** toolset, build a design surface digital terrain model for future analysis exercises

Corridor Modeling

The Corridor Modeling tools with GEOPAK are designed to interactively create Highway and Roadway designs using a template based system that provides instantaneous visual feedback during the design process.

We will create a proposed highway project and generate a DTM of the finished surface – and then merge that finished surface into the existing surface we created using the DA tools.

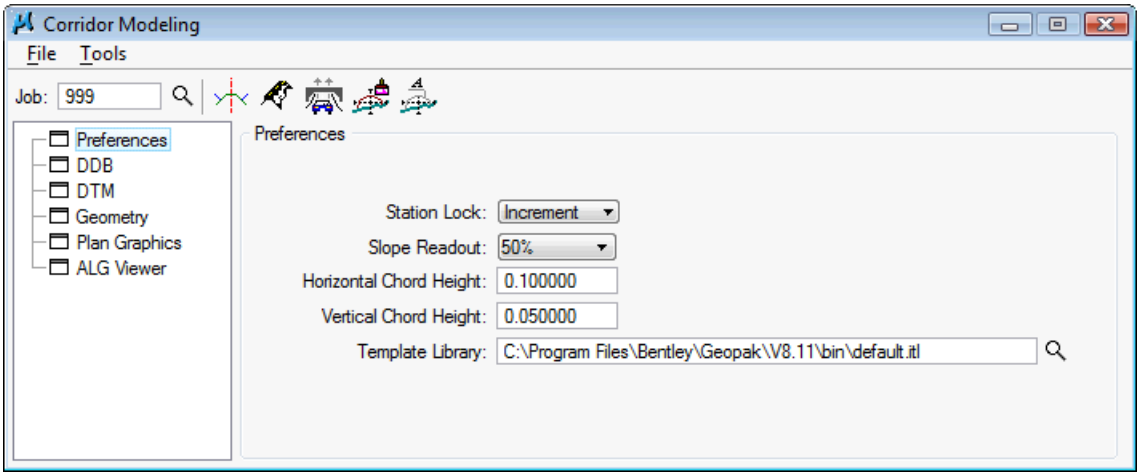
That composite surface will them be used as we explore the DTM>Analysis tools.

EXERCISE: CREATE HIGHWAY CORRIDOR DATA IN CORRIDOR MODELER

This exercise will guide you through the steps to create Highway design data and a design DTM from the Corridor Modeling tools.

As this workshop is not designed to teach Corridor modeler, a number of data files have been pre-populated to expedite the process.

1. Select Applications>GEOPAK>Road>Corridor Modeling



2. File>Load>MainRoad.rdp.
3. Select GPK file: job999.gpk

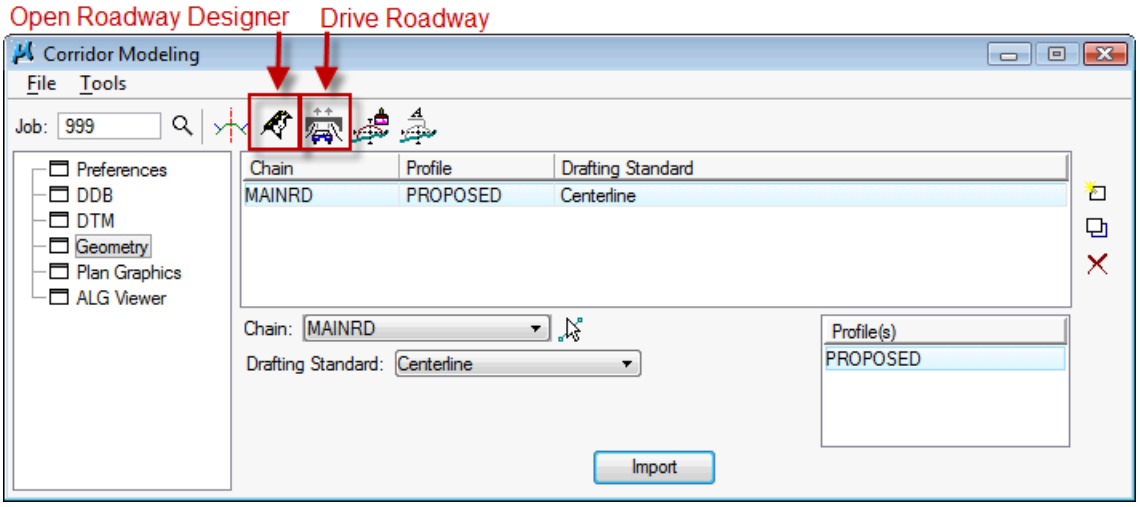
4. Select **DDB** item. *The active DDB file should be default_styles.ddb*.
5. Select **Import**.

   If a message appears that says file is already imported, cancel out of this operation and move to next step.

6. Select **DTM** item. *The dialog should already include the file C:\2009 RBC\GW1\DATA\NoVoids.tin*
7. Select **Import**.

   If a message appears that says file is already imported, cancel out of this operation and move to next step.

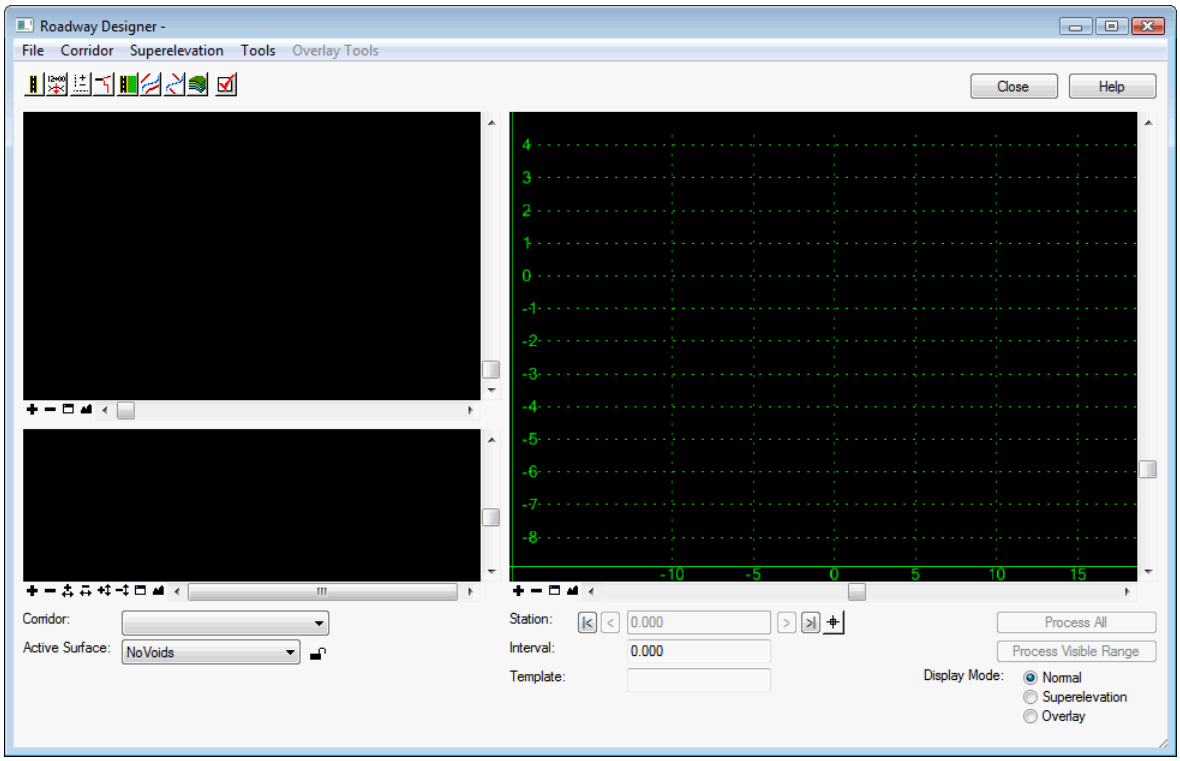
8. Select **Geometry** item. The dialog should already have one row populated with data (shown below).



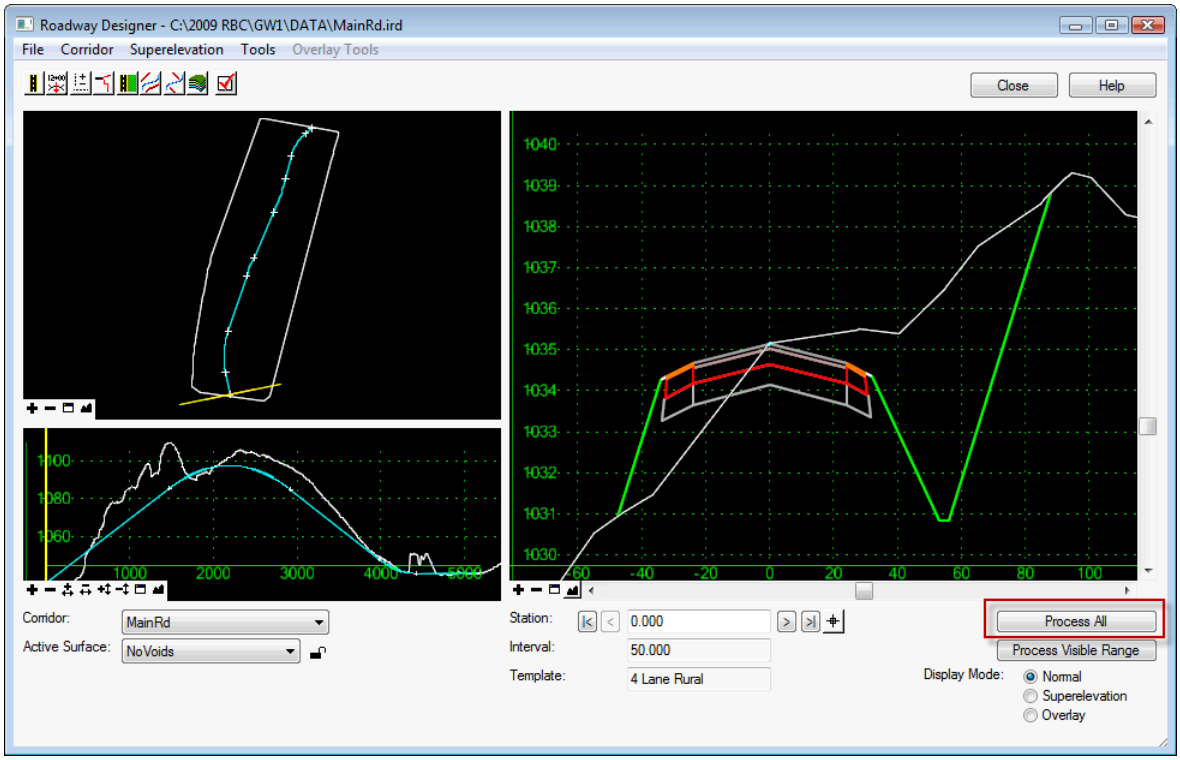
9. Select the row and select **Import**.

   This completes the steps required to import GEOPAK data into Corridor Modeling.

10. Select **Open Roadway Designer**.



11. **File>Open>MainRd.ird**
12. Set **Corridor** =**MainRd**
13. Set **Active Surface** = **NoVoids**
14. Select **Fit** button in each view of the Roadway Designer application dialog.

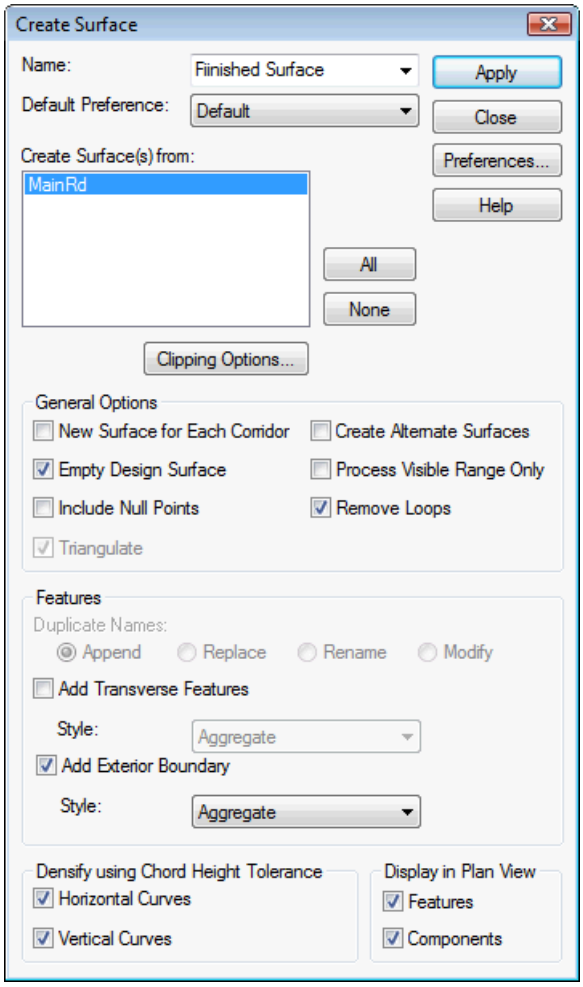


15. Select **Process All**.

    The Roadway Designer will calculate and process the template drops at 50 foot intervals for the complete length of the corridor.

16. Close the **Results** pop up dialog.

17. **Corridor>Create Surface**



18. Populate the dialog as shown above.
19. Select **Apply**.

    Both an InRoads DTM and a GEOPAK TIN file will be created following this step.

20. Close the **Results** pop up dialog.
21. Close the **Create Surface** dialog.
22. Close the **Roadway Designer** application dialog.

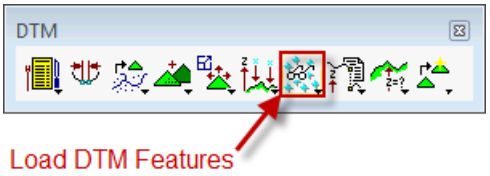
EXERCISE: CREATE "DRIVE THROUGH" OF YOUR ROADWAY DESIGN

This exercise will guide you through the steps to create a "drive through" of your roadway design.

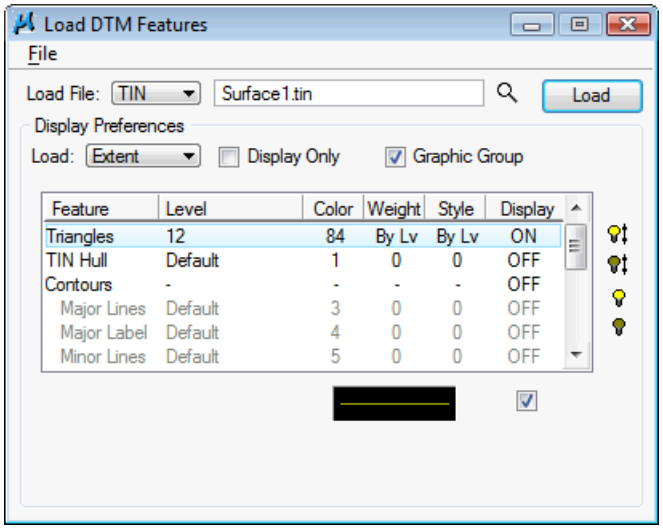
There has been some view settings enabled with View 5 of the DGN. We shall generate the drive through from that view.

Hint Please stop and listen to your Instructor before proceeding with this exercise!

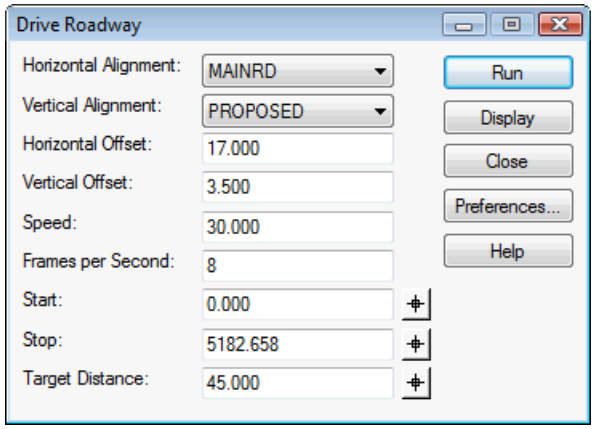
1. Applications>GEOPAK>SITE>DTM Tools.
2. Load DTM Features – Triangles.



3. Populate the dialog as shown below. Select Load.



4. Open View 5.
5. ***IMPORTANT***: DP in View 5 to ensure it is the "Active" view.
6. Select **Drive Roadway** button from Corridor Modeling dialog.
7. Populate the dialog as shown below.

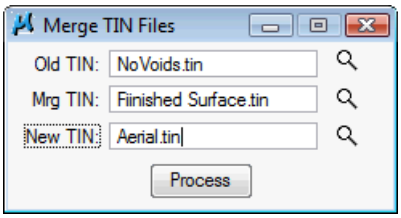


8. Select **Run**.

EXERCISE: CREATE OVERALL DTM (EXISTING + DESIGN SURFACES)

This exercise will guide you through the steps merge the Roadway surface (Finished Surface.tin) and the existing surface (NoVoids.tin) into a single surface.

1. DTM>Build Merge TINs.



2. Populate the dialog as shown above:
   a) The “Old TIN” is the existing surface
   b) The “Mrg TIN” is the roadway surface
   c) The “New TIN” is the TIN that will be created as a result of the merge process.
3. Select Process.

Lesson Name: GEOPAK DTM Tools

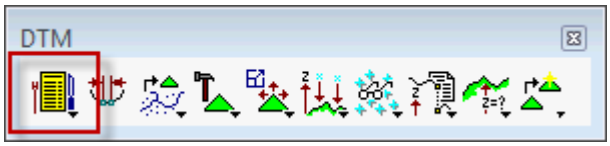
LESSON OBJECTIVE:

Initially, we shall locate the GEOPAK DTM tools and review the available toolset

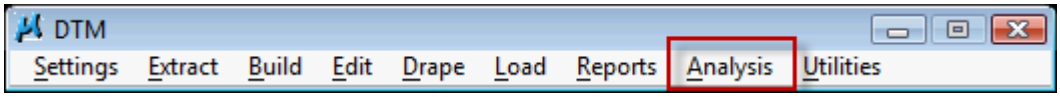
EXERCISE: DTM MENU – REVIEW TOOLSET

This exercise will guide you through the steps to access and open the GEOPAK DTM tools and we will review what capabilities are available.

1. Open the DTM toolbox. (*Applications>GEOPAK>Road>DTM Tools*)



2. Open the DTM menu bar.



We shall now review the available menu items and the tools available from the menu items

3. Extract: Tools to create/append data to "DAT" files. The DAT file is a method for gathering accumulating data to be built into a DTM.
4. Build: Tools to build TIN and Lattice files. The TIN is built from a DAT file or from an existing TIN (merge/clip options). The Lattice files can only be built from an existing TIN.
5. Edit: Tools to edit/modify a DAT or TIN file. Tools include filtering points for proximity or overlapping (and elevation mismatched) breaklines within DAT files or the dynamic editing of elements with a TIN file.
6. Drape: Tools to create 3 dimensional graphical elements by referencing 2D elements to a DTM surface.
7. Load: Draw or display the elements from with the different GEOPAK DTM files (DAT, TIN, Lattice).
8. Reports: Simple reports to provide feedback regarding data within the DAT/TIN or Lattice files.
9. **Analysis:** *The focus of this session*. A series of tools to analyze the DTM surface for design purposes. These tools are specifically designed to review an existing surface and allow the Designer to become familiar with the site before commencing their design project.
10. Utilities: Tools to convert the DTM files to different formats and systems including exporting the DTM data to machine control formats.

Lesson Name: Editing Triangles

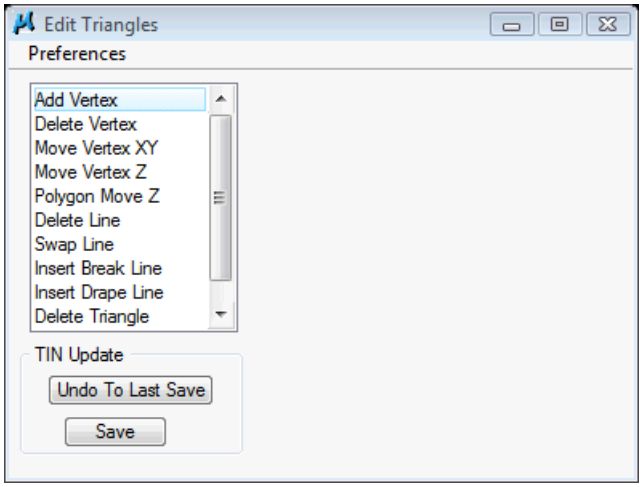
LESSON OBJECTIVE:

A myriad of tools to interactively edit TIN models are located in the TIN Edit Tools dialog. The triangulated model can be dynamically edited in terms of adding, deleting or moving spot elevations. Break lines can be added, draped or deleted. As editing is initiated, resultant triangles, contours, flow arrows, and voids are optionally displayed "on the fly."

The objectives of this lesson are:

1) Become familiar with the editing options that are available within the GEOPAK TIN Editing tool.
2) Know when to utilize the available tools and when not to.
3) Use a sample of the tools and become comfortable with their operation.

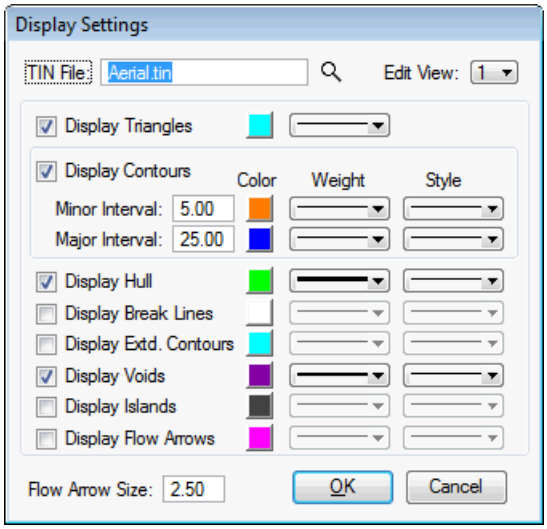
The list box on the left side of the dialog contains the editing options. As each tool is selected, the right side of the dialog dynamically changes to reflect the current tool. All these editing features dynamically show the changes as they occur. In addition, the changes are not written permanently to the triangulated model until the user selects the Save button. This allows the User the option of saving their modifications (Save) OR rejecting the modifications (Undo To Last Save).



EXERCISE: EDITING TRIANGLES – SETTINGS FOR TOOL

This exercise will guide you through the steps to get started.

1. Select DTM Menu>Edit>Triangles



2. Populate the Display Settings dialog as shown. Color settings shown are not mandatory – set colors that will be easily distinguished from the original data.

The Edit Triangles dialog cannot be accessed until the Display Settings dialog is closed.

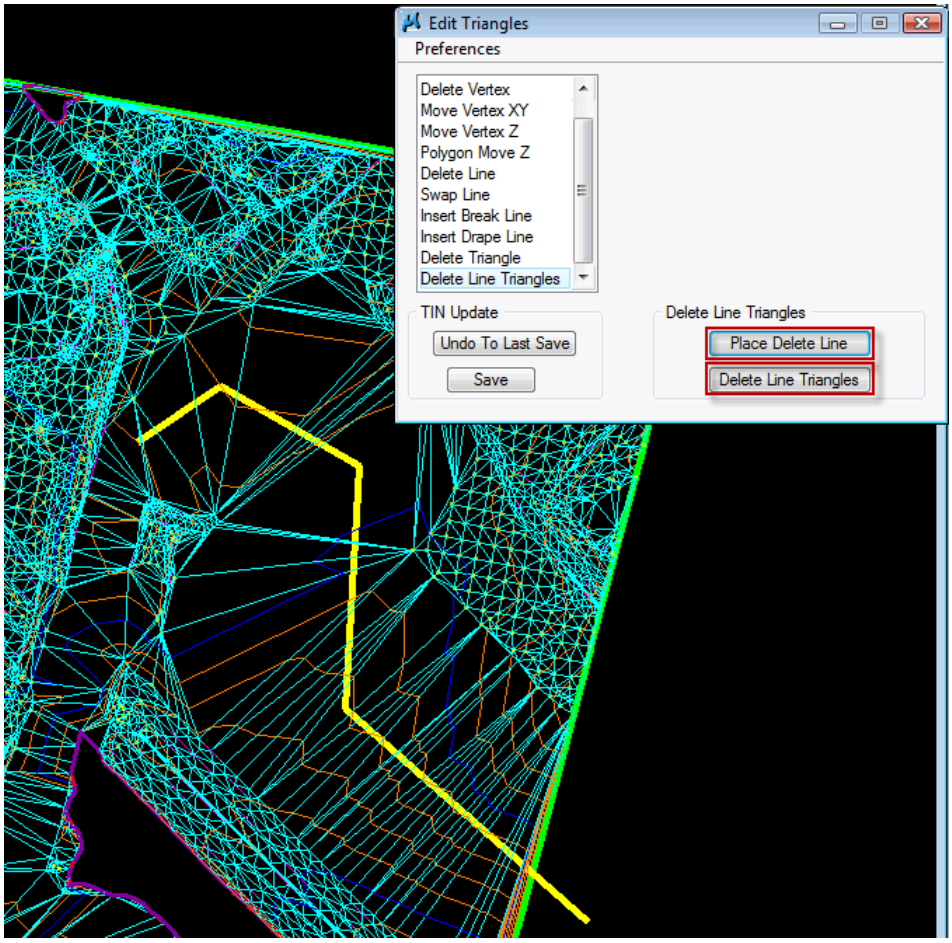
Tin File:	*aerial.tin*
Edit View:	1
Display Triangles	Enable
Display Contours	Enable
Minor Interval	5
Major Interval	20
Display Hull	Enable
Display Voids	Enable

3. Select OK.

EXERCISE: EDITING TRIANGLES – DELETE LINE TRIANGLES

This exercise will guide you through the steps to select triangles by line for removal.

1. Scroll to the bottom of the editing options.
2. Select Delete Line Triangles.
3. Select Place Delete Line and place a line in the plan view that crosses the triangles you wish to delete. *An example is shown below*.



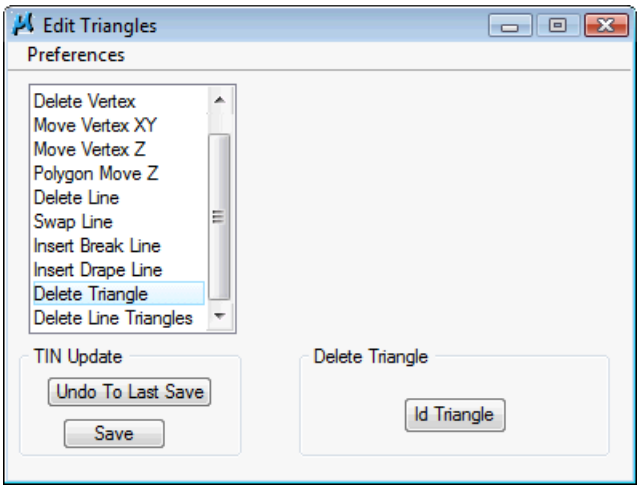
4. Select Delete Line Triangles to remove the crossing triangles.

EXERCISE: EDITING TRIANGLES – DELETE TRIANGLES

This exercise will guide you through the steps to delete individual triangles.

This tool is typically used to delete "sliver" or "edge" triangles. The typical workflow is to select triangles, starting outside the edge of the TIN and working your way in. If you select an internal triangle and delete it, you will create a "void".

1. Select Delete Triangle.

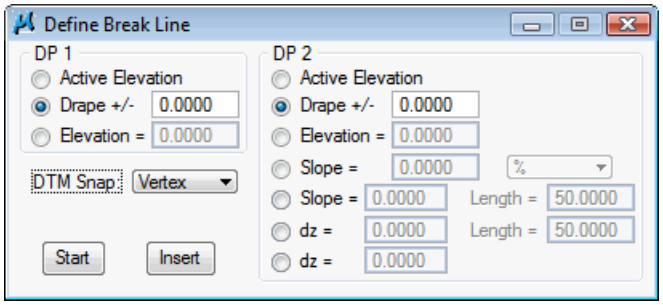


2. Select Id Triangle.
3. Starting just outside the triangle you wish to delete and DP with your mouse. The triangle inside your current location will be deleted.
4. Continue deleting until the triangulation outer edge is as expected (*or the Instructor says stop*).

EXERCISE: EDITING TRIANGLES – INSERT BREAKLINE

This exercise will guide you through the steps to insert additional breaklines into your DTM.

1. Select **Insert Breaklines**.
2. Two options are provided.
   a. **Place:** the User places the proposed breaklines interactively
   b. **Select:** The User selects existing graphical features and those are inserted as breaklines.
3. Select **Place**. A second dialog will appear. This dialog allows the user to set constraints and snap options for how the breaklines will be inserted.



4. Set the DTM Snap to Vertex.
5. Set DP1 and DP2 to the Drape option.

   There are many options for the placement of DP1 and DP2. Most are self explanatory. Any options that are unclear should be discussed in the class.

6. Move to an open area of the triangulation and begin placing breaklines across existing triangles.
7. Select **Insert** to apply the breaklines.

   This will add the breaklines. The dataset will re-triangulate and redisplay immediately. The elevations at each end of these new breaklines will be the same as the existing triangle vertices that the lines commenced and ended at. There will be a straight grade between the vertices.

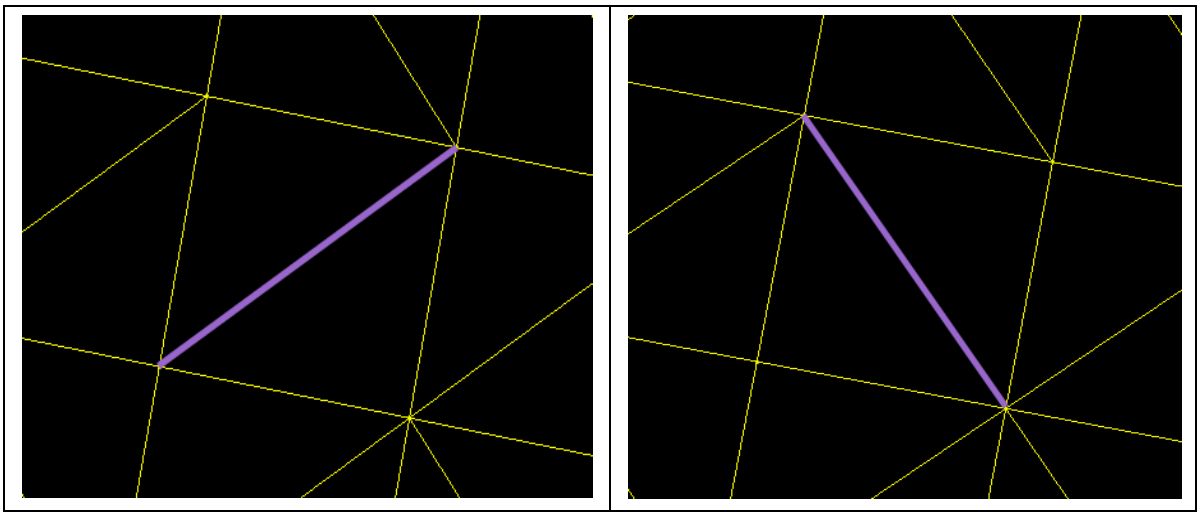
8. Close the **Define Break Line** dialog.

EXERCISE: EDITING TRIANGLES – DELETE LINE AND SWAP LINE

This exercise will guide you through the steps to Delete or Swap triangle edges.

As both of these tools operate similarly, we'll look at these two tools in this single exercise.

1. Select **Swap Lines**.
2. Select **Id Lines**.
3. Move into the display and select a triangle edge that is shared between two triangles.



4. The tool will rearrange the triangle edge as shown above.
5. Select **Delete Lines**.
6. Select **Id Lines**.
7. Move into the display and select a triangle edge that is shared between two triangles.
8. The tool will delete the selected triangle edge.

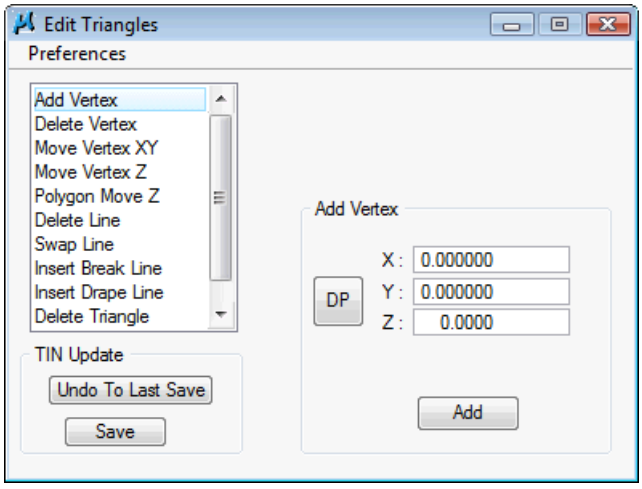
The Delete Lines tool will create a void within your DTM surface.

EXERCISE: EDITING TRIANGLES – ADD VERTEX AND DELETE VERTEX

This exercise will guide you through the steps to Add or Delete a triangle vertex.

As both of these tools operate similarly, we'll look at these two tools in this single exercise.

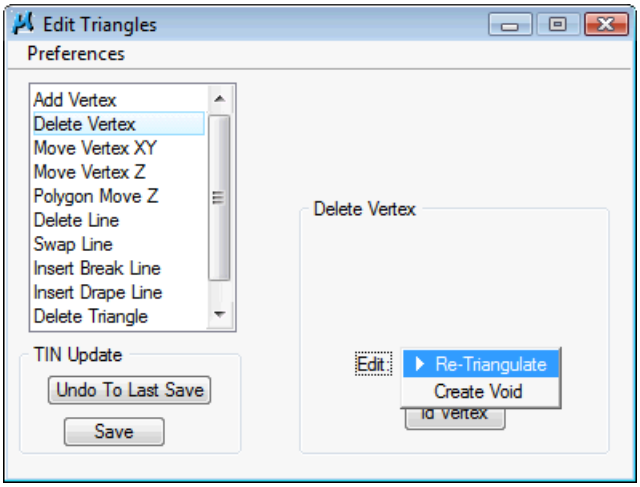
1. Select **Add Vertex**.



2. Select **DP**.
3. Move into the display area. Note that triangles are automatically added as you move the cursor around the plan.
4. DP to locate the new point. The X, Y & Z values are populated in the dialog. The User can edit these values in the dialog.
5. Select Add. The point is written to the DTM surface.

Add more vertices – edit the elevation before adding the point to the data. Add a point inside a void. What is the outcome??

6. Select **Delete Vertex**.



The Delete Vertex>Edit options allow the User to re-triangulate the surface or to create a void.

7. Set **Edit** option to **Re-Triangulate**.
8. Select **Id Vertex**.
9. Move into the display area.
10. DP to select a triangle vertex. The vertex and all attached/effected triangles will highlight.
11. DP to accept the delete.
12. The modified triangulation will redraw.
13. ***Continue…***
14. Set **Edit** option to **Create Void**.
15. Select **Id Vertex**.
16. Move into the display area.
17. DP to select a triangle vertex. The vertex and all attached/effected triangles will highlight.
18. DP to accept the delete.
19. The modified triangulation will redraw.

This will end our editing session. There are more editing tools available and these can be discussed and attempted within the class as time permits.

We will now move on and examine and use the Analysis and Visibility tools

Lesson Name: DTM Analysis tools

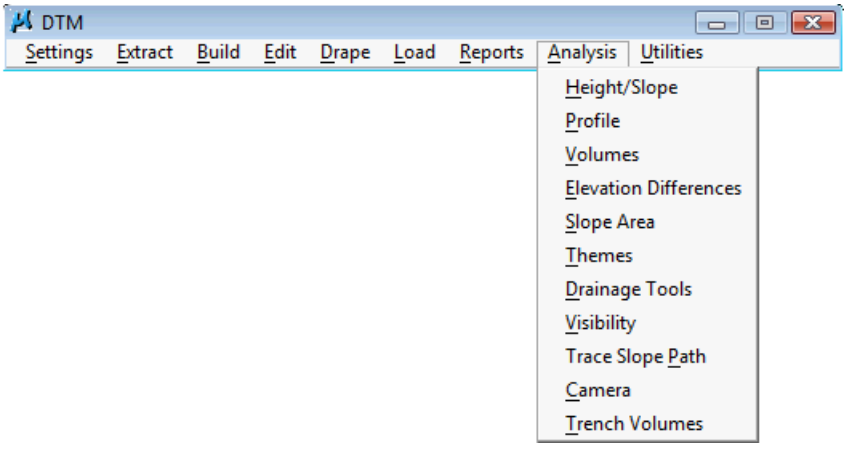
LESSON OBJECTIVE:

Review available Analysis tools. Become familiar with the tools; their purpose and the value to the designer.

EXERCISE: DTM ANALYSIS TOOLS

This exercise will guide you through the steps to evaluate the value of and use the available DTM Analysis tools.

1) Review available DTM>Analysis tools.



DTM>Analysis menu

DTM>Analysis toolbox

2) Available tools:
   a) Height/Slope
   b) Profile
   c) Volumes
   d) Elevation Differences
   e) Slope Area
   f) Themes
   g) Drainage Tools
   h) Visibility
   i) Trace Slope Tools
   j) Camera
   k) Trench Volumes

We shall now discuss and use each of these analysis tools.

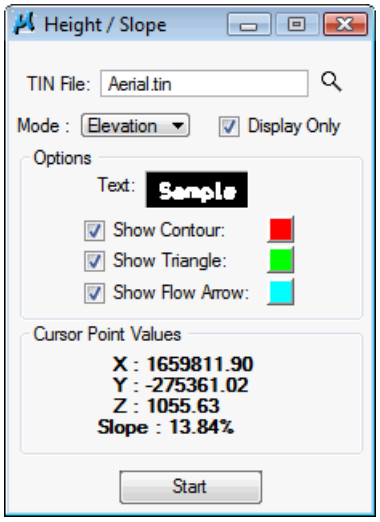
• Height	Determine Elevation and Slope at locations within the TIN model.
• Profile	Extract Profile/section at any location in the TIN model.
• Volumes	Compute volumes between two TIN models or TIN to Plane.
• Elevation Difference	Generate grids, or contours of elevation differences.
• Slope Area	Displays the horizontal area and actual slope area of a specified shape.
• Themes	Analyze TIN file in terms of elevation, slope, or aspect ranges.
• Drainage Tools	Analyze and evaluate TIN model from a drainage perspective.
• Visibility	Determine visibility of triangles from a given point on the model.
• Trace Slope Path	Traces a path along a TIN file from a user defined origin.
• DTM Camera	A wide variety of tools and options to view Digital Terrain models within a MicroStation 3D file.
• Trench Volumes	Computes the trench and bedding volumes for pipes in a drainage and / or water sewer project. *The User requires Water/Sewer and/or Drainage project data to use this tool.*

EXERCISE: HEIGHT/SLOPE TOOL

This exercise will guide you through the steps to get started using the Analysis>Height/Slope tool.

The Analysis>Height/Slope tool will provide the user with instantaneous visual feedback regarding a selected surface for the elevation and slope direction for any location on the Surface. Also, at any selected point, the contour for that elevation will be shown across the entire surface – providing the User

1. Select the **Height** tool. *(DTM Tool Frame: Analysis > Height)*.



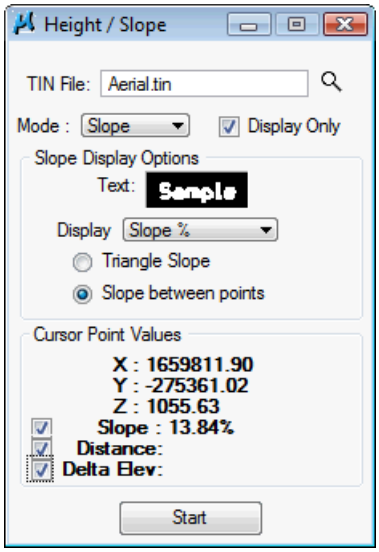
TIN File	*C:/2009 RBC/GW1/DATA/Aerial.tin*
Show Contour	Enable, Red
Show Triangle:	Enable, Green
Show Flow Arrow:	Enable, Blue

2. Click **Start.**
3. You can now move the mouse cursor into the area of your DTM. As you move around, the Height/Slope tool dynamically displays the elevation, the direction of slope and the current elevation contour in the symbology color set in the dialog.

   The text attributes for the elevation are set within the Text sample graphic. Double click the black text rectangle to reset the text attributes.

4. A **Data Point (DP)** will provide a snap shot WYSIWYG. All activated options will be drawn to the CAD file at the location of the DP.
5. Reset when finished (*right mouse button*).

6. In the Height/Slope dialog, change the Mode option to Slope.



In Slope Mode, the tool is designed to provide the User with slope value feedback. The slope values can be toggled between Triangle Slope and Slope between points.

7. Set the Slope Display Options to **Slope %** and activate Slope between points.
8. Enable the **Slope**, **Distance** and **Delta Elev** options.
9. Click **Start**.
10. Data point in two locations to review the slope between them.
11. Close the **Height/Slope** dialog.

Please Note: The *Display Only* toggle provides the User with the option to write the analysis data to the CAD file or simply display the analysis data. Enabling the option will display the data. Disabling the option will write the data to the CAD file.

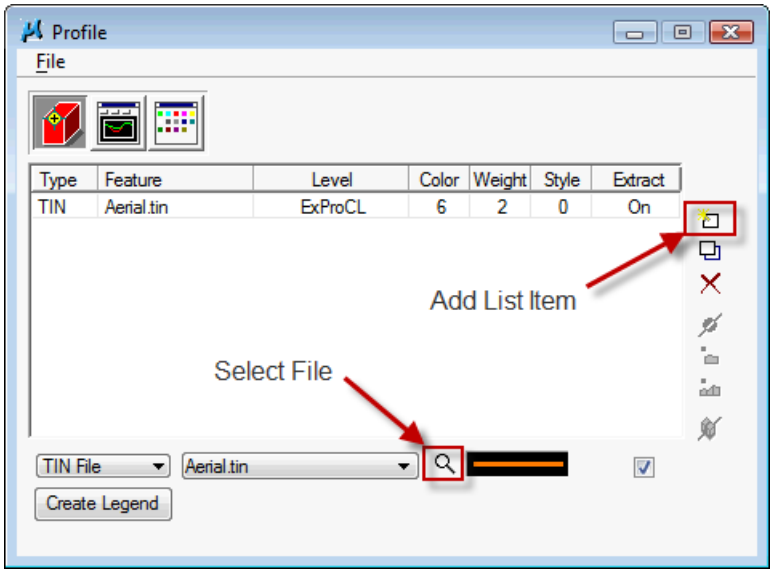
EXERCISE: PROFILE TOOL

The Profile tool allows the user to select one or more TIN files (and/or Models and Objects when invoked within Site Modeler) and create “quick” profiles of that surface (or those surfaces) at any location desired.

The User has the option of setting profile scales and grids, selecting an existing graphical element to create the profile along or striking a new location along which the profile will be cut.

The profiles can be “quick viewed” inside the available viewing panel OR they can be drawn into the CAD file.

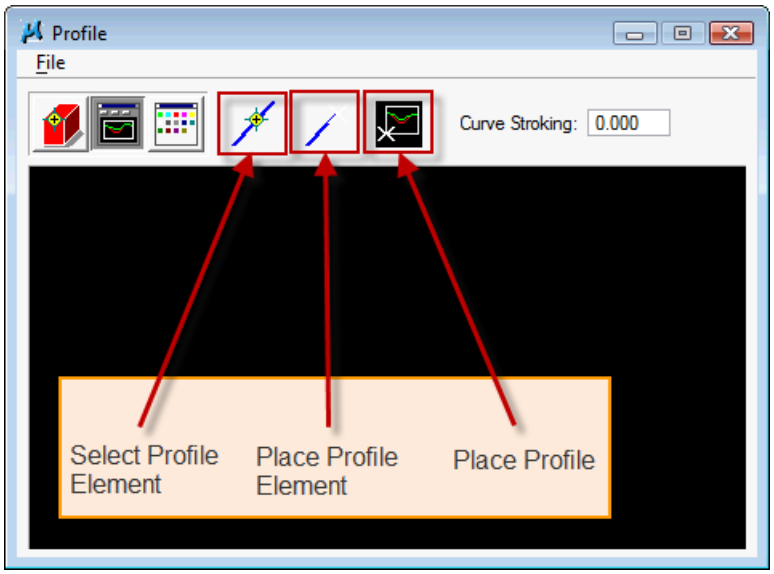
1. Select the Profile tool. (DTM tool frame: Analysis > Profile).



2. Select ***C:/2009 RBC/GW1/DATA/*Aerial.tin** using Select File.
3. Set the profile symbology by double clicking the sample line graphic.

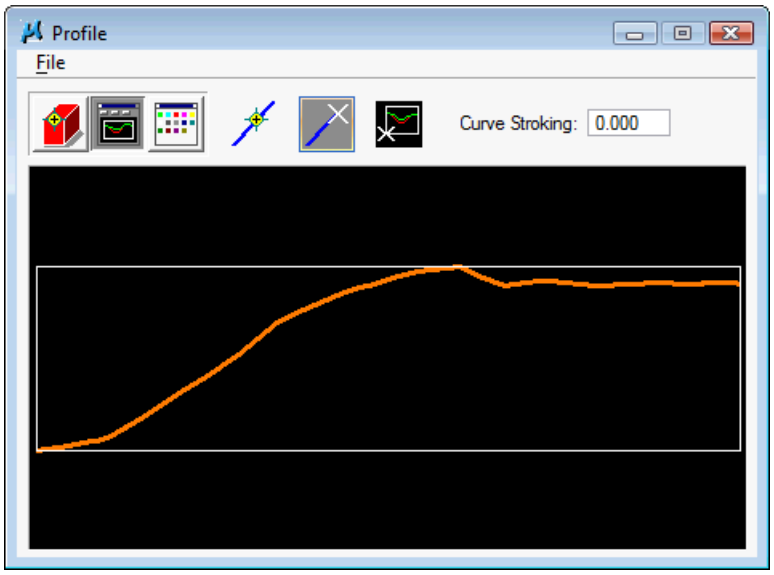
Hint This will activate the Set Feature dialog.

4. Select **OK** to close **Set Feature** dialog.
5. Select **Add List Item** icon (top icon, right side of list).
6. Select **Create Profile** button.



7. Click **Place Profile Element** and data point (twice) to define the beginning and endpoints of the desired profile.

Hint The extracted profile is displayed in the dialog.

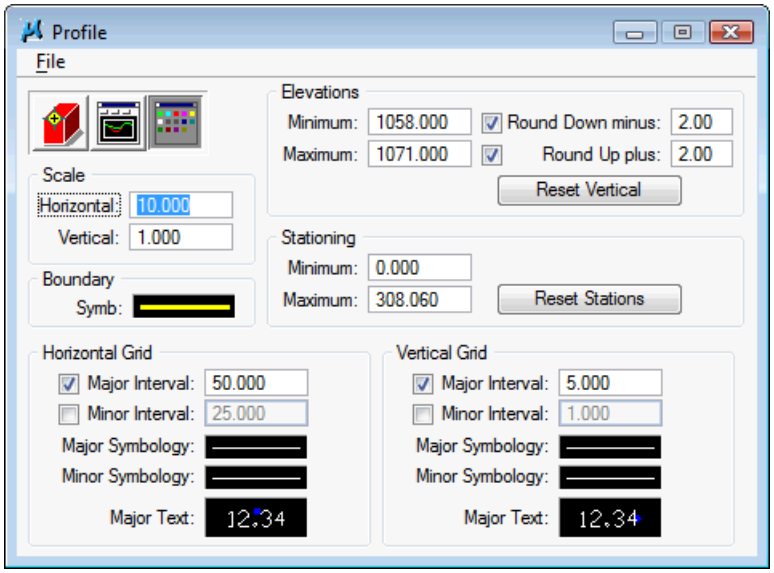


8. Right click the mouse button to reset.

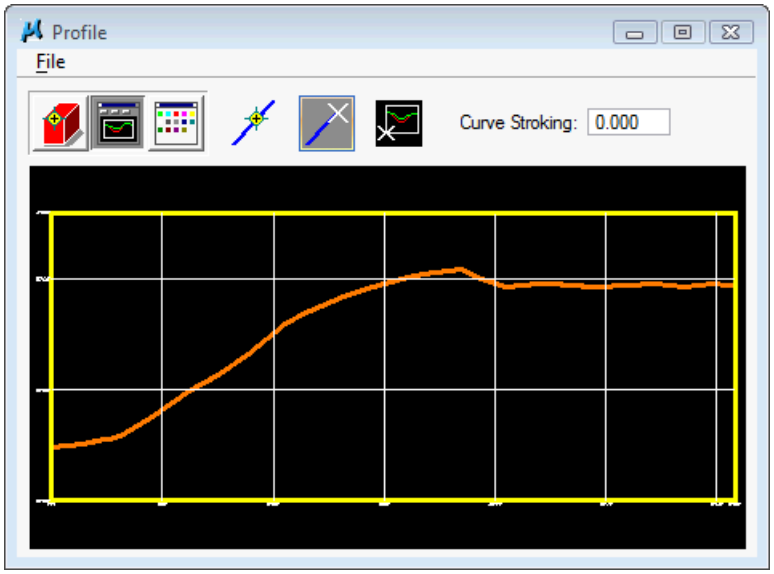
Hint To extract another profile, select the Place Profile Element button again and data point in MicroStation View 1.

9. Select the **Profile Preferences** button.

10. Populate the dialog as shown below.
11. The **Elevations** and **Stationing** values are automatically read directly from your TIN file. These can be modified by the User to provide "space" around the profile graphic itself, if desired. The **Elevation>Rounding** options will assist.



12. Switch back to the Profile Tab to see the grid.



13. (*Optional*) Select Place Profile and data point in the desired location in MicroStation View 1.
14. The profile, as seen in the preview window, will now be drawn into the DGN.

    This is a static profile and does not automatically update if the surface should change.

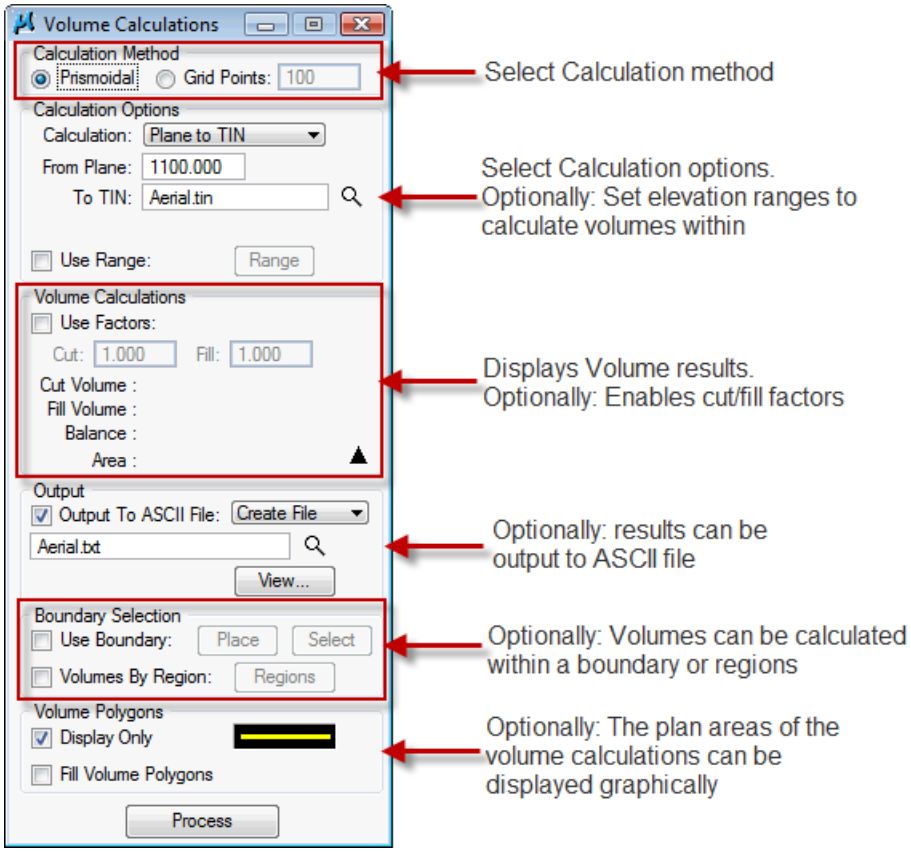
15. Close the **Profile** dialog.

EXERCISE: VOLUMES CALCULATIONS TOOL

The Volumes tool provides the user with either **Prismoidal** or **Grid** based DTM volumes between a single surface and a plane or between two surfaces.

Other options available on the tool dialog include the ability to calculate volumes within different elevation ranges (useful when calculating retention pond requirements), within a prescribed boundary, within multiple regions, to factor in different cut/fill bulking and shrinkage factors and to output the results to an ASCII file.

1. Select the **Volumes Calculations** tool. (DTM tool frame: Analysis > Volumes).



2. Set **Calculation Method** to **Prismoidal**.
3. Set **Calculation Options** to "**Plane to Tin**".
4. Set **From Plane** value to **1100**
5. Set **To TIN** as ***C:/2009 RBC/GW1/DATA/Aerial.tin***
6. Select **Process**

Other options will be discussed and implemented in the class. Having a single existing surface TIN file makes some of the options and calculations redundant.

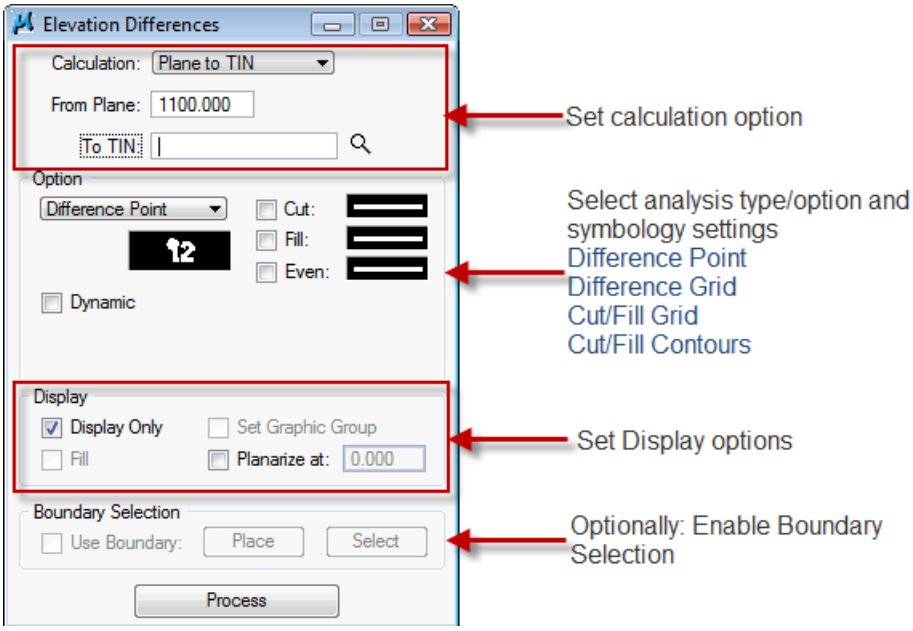
EXERCISE: ELEVATION DIFFERENCES TOOL

The Elevation Differences tool provides the user with elevation differences between surfaces. The Surfaces can be a TIN (and/or Object or Model in Site Modeler) or a Plane. The combination and order of the surfaces/planes to be analyzed can be manipulated by the User.

Available analysis options are:

1) Difference Point
2) Difference Grid
3) Cut/Fill Grid
4) Cut/Fill Contours

1. Select the **Elevation Differences** tool. (DTM tool frame: Analysis > Elevation Differences).



2. Set **Calculation** to **Plane to TIN**.
3. Set **From Plan** to **1100**
4. Set **To TIN** to ***C:/2009 RBC/GW1/DATA/Aerial.tin***
5. Set **Option** to **Difference Point**.
6. Enable **Cut/Fill/Even** and set symbology for each.
7. Enable **Display>Display Only** (graphical result data will not be committed to CAD file).

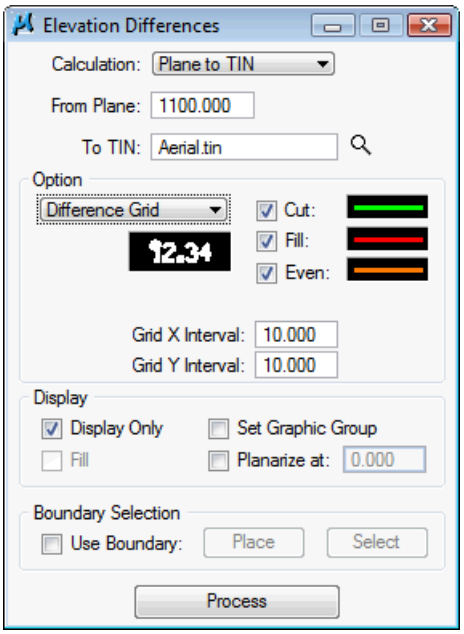
8. Select **Process**. Move the cursor into the graphics and DP.

At each DP point, the difference in elevation between the Plane value and the TIN will be calculates and displayed. Continue to DP. You will see different symbology as the values move from negative to positive (cut to fill). The Analysis>Height tool can be optionally enabled and used to verify the results you see.

9. Return focus to the dialog.
10. Enable **Dynamic** and select **Process**.

The tool will now return real time results as you move the cursor over the data.

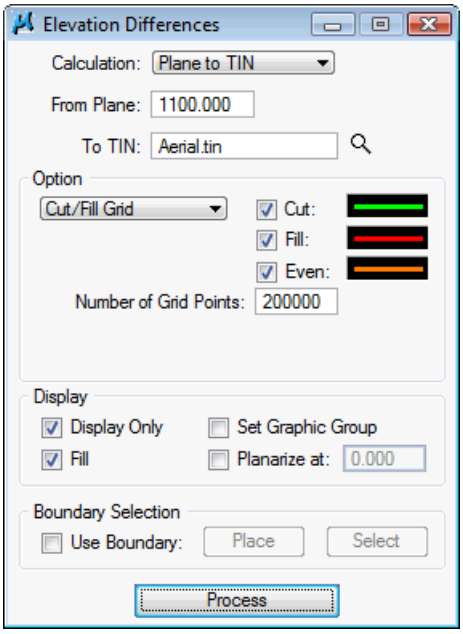
11. Set **Option** to **Difference Grid**.



12. Set the **Grid Intervals** to **10**.
13. Set text height/width to 1.00 (double click in text sample graphic to enable the Set Feature dialog).
14. Select **Process**.

At an X/Y grid of 10/10, the elevation differences will be calculated and displayed in the graphics. The “cut” values will be displayed in green. The “fill” values will be displayed in red. The “even” values will be displayed in brown (these are at elevation 1100 – same as the plane). These values could be written to the CAD file permanently as part of a construction document set when an existing and proposed surface is used.

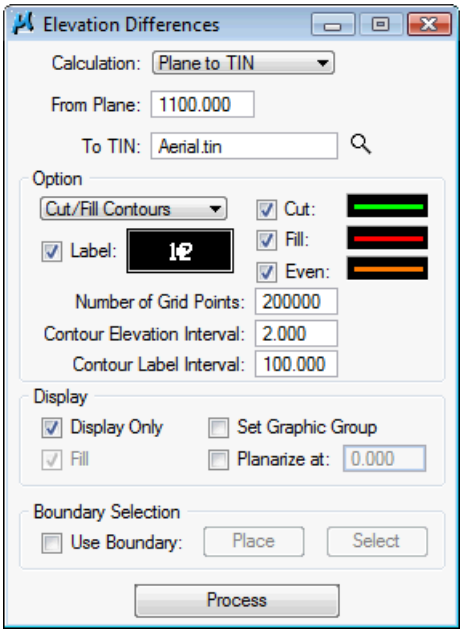
15. Set **Option** to **Cut/Fill Grid.**



16. Set **Number of GRID Points** to **200,000**.
17. Enable **Display>Fill**
18. Enable **View Attributes>Fill.** (*MS menu>Settings>View Attributes*)
19. Select **Process.**

Grid points will be created across the TIN area and elevation differences will be calculated. The grid will then be colored based on selected symbology settings for cut/fill/even. With the Display>Fill option enabled and the View Attributes>Fill enabled, the areas of cut/fill will be filled.

20. Set **Option** to **Cut/Fill Contours.**



21. Set **Contour Elevation Interval** to **2.0**
22. Set **Contour Label Interval** to **100.0**
23. Enable the **Label**. Set the label height/width to 5.0. Set Label decimals to 0.
24. Select **Process**.

Isopac contours will now be displayed in the CAD file. These contours show the elevation difference between the Plane (elevation 1100) and the TIN surface. Again, a useful inclusion is a construction documents set to show where the cut/fill is across a site AND the depths.

25. Close the **Elevations Differences** dialog.

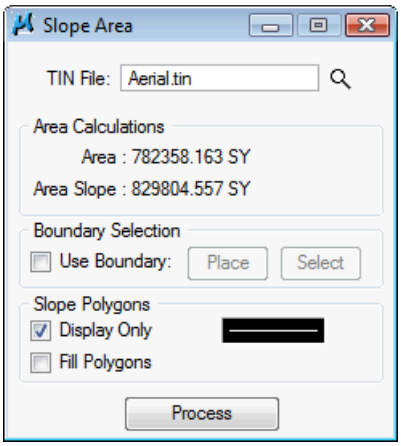
EXERCISE: SLOPE AREA TOOL

The Slope Are tool provides the user with a TIN surface area for any defined plan area. The tool will intersect the plan area with the Surface and calculate the actual triangle surface areas within that plan area.

The steeper the terrain, the larger the difference between slope and plan areas will be. Conversely, the flatter the terrain, the less the difference between slope and plan area will be.

One example usage for this tool is area of grass required for replanting or stabilization.

1. Select the **Slope Are** tool. (DTM tool frame: Analysis > Slope Area).



2. Select the file ***C:/2009 RBC/GW1/DATA/Aerial.tin***
3. Select **Process**.

The Plan Area (Area) and Slope Area of the entire surface will be calculated and displayed.

Hint Other options allow the User to select or place a boundary for calculation within that designated area.

4. Close the **Slope Area** dialog.

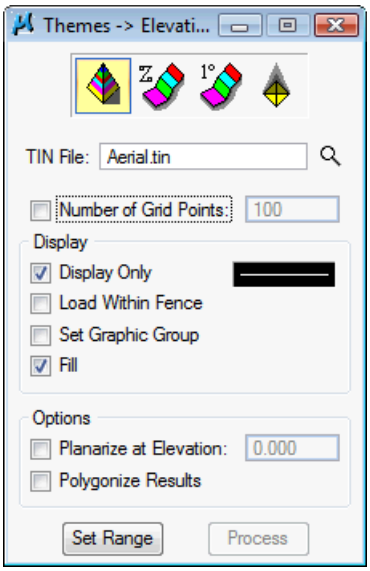
EXERCISE: THEMES TOOL

Various theme options are available when using the Themes Tool:

AVAILABLE ANALYSIS OPTIONS ARE:

1) Elevation Range
2) Slope Range Percent
3) Slope Range Degree
4) Slope Aspect

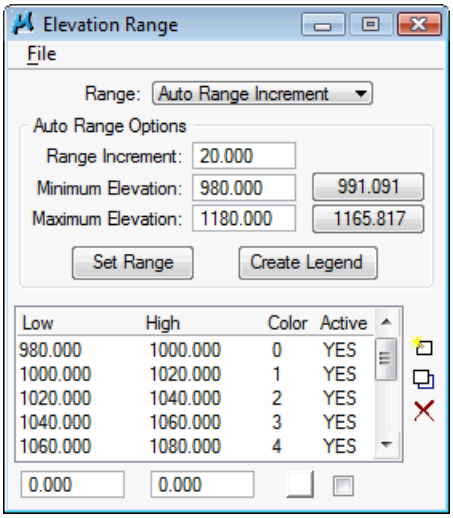
1. Select the **Themes** tool. *(DTM Tool Frame: Analysis>Themes)*



2. Select **Elevation Range**.
3. Set the following items on the dialog.

TIN File:	*C:/2009 RBC/GW1/DATA/Aerial.tin*
Display Only:	Enabled
Fill:	Enabled

4. Select Set Range. *(Bottom left of dialog)*



5. Set the Auto Range Options as follows:

Range Increment:	20
Minimum Elevation:	980
Maximum Elevation:	1180

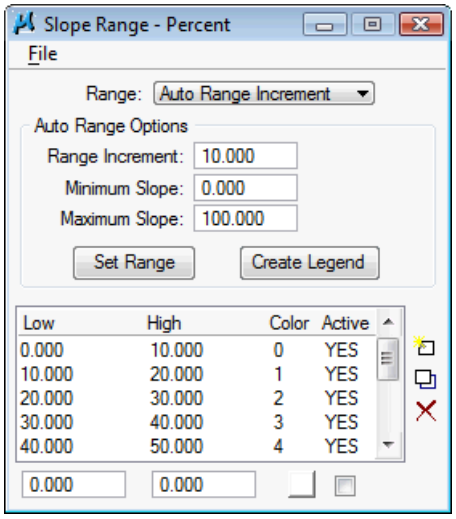
6. Select **Set Range** to populate the table in the bottom portion of the dialog.
7. Close the **Elevation Range** dialog.
8. Return focus to the **Themes** dialog.
9. Select **Process**.

Hint The resulting colored triangles (displayed in wireframe or filled/shaded depending on current view options) are based solely on the triangles. This will provide and accurate result (based on the data) but may be a little "jagged" for presentation purposes. Let's try another dialog option to improve the result.

10. Enable Number of Grid Points and set the value to 1,000,000.
11. Select Process.

This will take a few seconds to calculate and display a result, but the result will be significantly more "presentable" that typically you will see with the triangle only based calculation.

12. Select **Slope Range Percent**.
13. Disable **Number of Grid Points**.
14. Select **Set Range**



Range Increment:	10
Minimum Slope:	0
Maximum Slope:	100

15. Select **Set Range** to populate the lower portion of the dialog.
16. Close the **Slope Range – Percent** dialog.
17. Select **Process**.

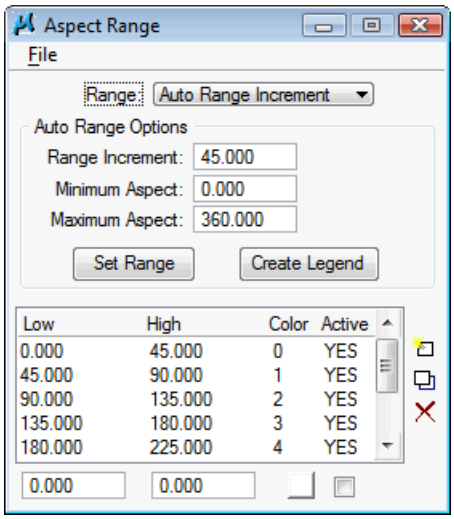
Hint As the slope range calculation is based solely on the triangle slopes, there is nothing to be gained from enabling the grid points option. The results will be better and faster with that option disabled.

18. Select **Aspect**.

As the Slope Range – Percent and Slope Range – Degree are very similar in functionality, we shall move on to the Aspect tool.

The Aspect tool (like the Slope Range tools) are very much triangle surface analysis tools. Disable the Number of Grid Points option.

19. Select **Set Range**



Range Increment:	45
Minimum Aspect:	0
Maximum Aspect:	360

20. Select **Set Range** to populate the lower portion of the dialog.
21. Close the **Aspect Range** dialog.
22. Return focus to the Themes dialog.
23. Select **Process**.

Hint There are dialog options to create polygons of the resulting data and to create those polygons at a specific elevation (flatten them).

The different aspects (the direction that the individual triangle faces point towards) will be colored based on the ranges set.

24. Close the **Themes** dialog.

EXERCISE: DRAINAGE TOOLS

The Analysis>Drainage tools are designed to provide feedback to a Designer related to typical drainage type questions that a Civil designer may face.

Where does the water go?

Are there existing ponds? What volume do those ponds hold?

If I outlet water here – where does it go? How does water get to this location?

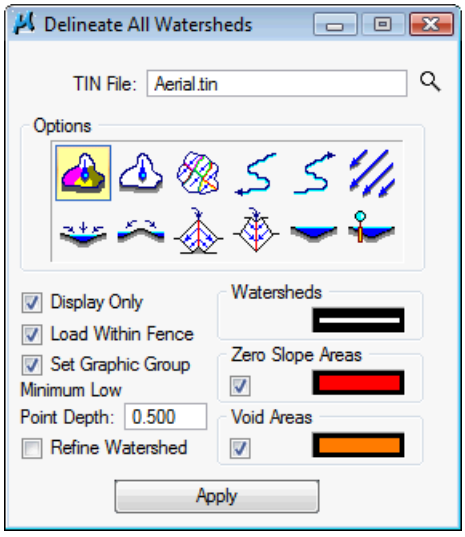
What are the existing catchment areas?

Where are my low points? Where are the high points?

THESE TYPES OF ANALYSIS CAN BE UNDERTAKEN WITH THE DRAINAGE ANALYSIS TOOLS PROVIDED BY GEOPAK.

USING THE DRAINAGE TOOLS – DELINEATE ALL WATERSHEDS

1. Select the **Drainage Tools**. *(DTM Tool Frame: Analysis>Drainage Tools)*
2. Select **Delineate All Watersheds**.
   The Delineate All Watersheds tool displays the watershed boundaries that exist within a DTM. Shapes may be created for each watershed contained in the TIN.
3. Set the dialog options as follows:



Display Only:	Enabled
Load Within Fence	Enabled
Set Graphic Group	Enabled
Minimum Low Point Depth:	0.500
Refine Watershed:	Disabled

Note The Refine Watershed option, when activated, processes the entire TIN evaluating ridges, sumps, and low points and determines more precise flow boundaries within the triangles.

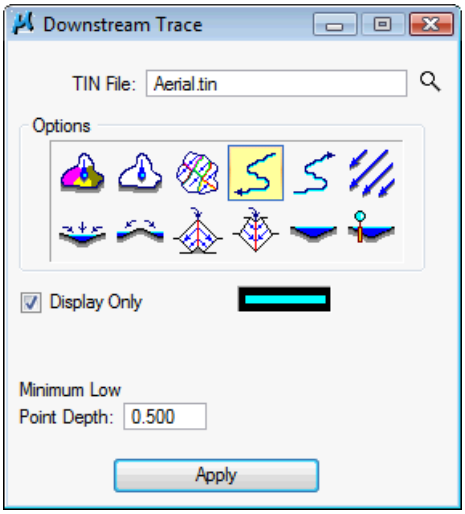
4. Select **Apply**.

The catchment areas, based on the TIN surface, will be displayed in the CAD file. Using the Min Low Point Depth option will have removed a number of superfluous areas, but not all. The DTM analysis should be regarded as a "first pass" that will assist in the final delineation of watershed areas… these results should be reviewed and interpreted by a drainage engineer.

USING THE DRAINAGE TOOLS – DOWNSTREAM TRACE

1. Continuing in the Drainage tools dialog, select **Downstream Trace**.

2. Set the dialog options as follows:

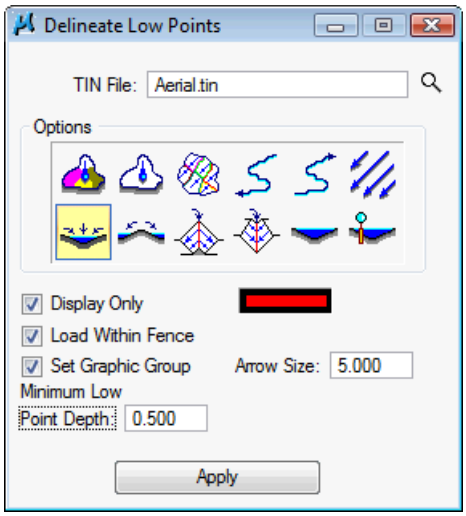


3. Click Apply

4. Data point somewhere in View window 1 on the surface.
5. Continue to data point in various locations around the surface.

USING THE DRAINAGE TOOLS – DELINEATE LOW POINTS

1. Continuing in the Drainage tools dialog, select Delineate Low Points.



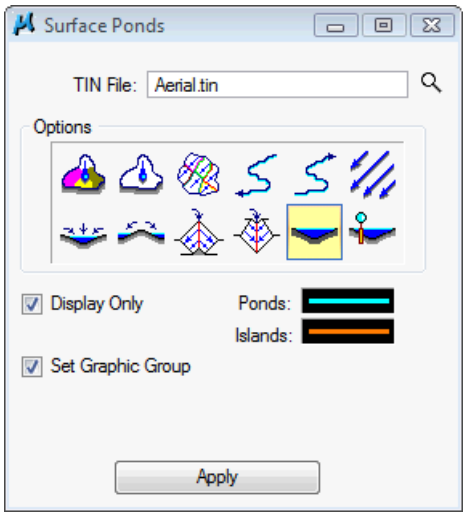
2. Populate the dialog as shown.
3. Select Apply.

The tool will analyze the TIN and indicate (with red arrows) the locations of the low points. With the Point Depth value populated, any low point that is found to be less than 0.50 deep will be deemed as an undulation and will be ignored.

USING THE DRAINAGE TOOLS – SURFACE PONDS & POND ANALYSIS

1. Continuing in the Drainage tools dialog, select **Surface Ponds**.

2. Populate the dialog as shown.

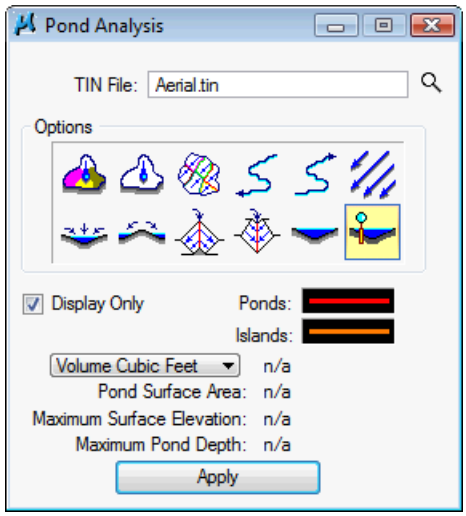


3. Select **Apply**.

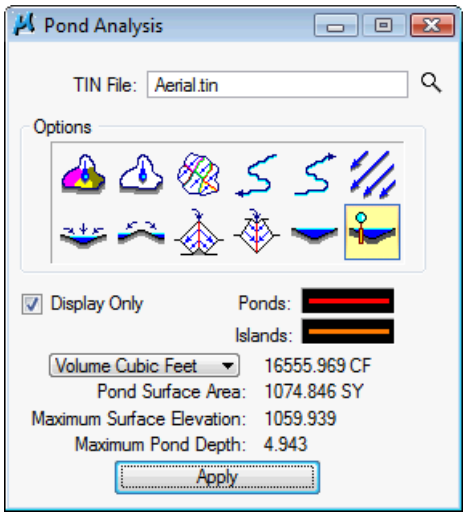
The Surface Ponds tool delineates the area(s) of ponded water within the specified Aerial.tin file.

Hint Take note of a location where a large pond has been found. We will now analyze that specific pond.

4. Select **Pond Analysis**.



5. Populate the dialog as shown.
6. Select **Apply**.
7. Data point near where the large a pond had been identified.



The **Pond Analysis** tool traces a point downstream to a low point and fills it giving the volume, surface area, maximum depth, and maximum elevation. In addition, the pond delineation is graphically displayed

8. Close the **Drainage Tools** dialog.

EXERCISE: VISIBILITY TOOLS

The Analysis>Visibility tools are designed to provide feedback to a Designer related to line of sight and what is visible/invisible from a specific location.

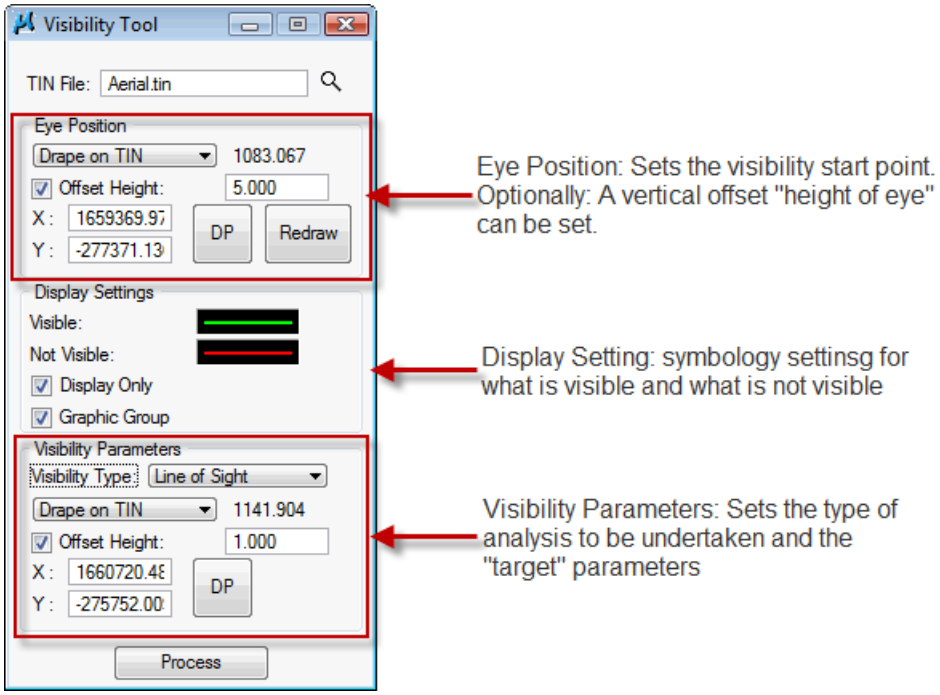
Based on a user-defined point of origin, it visually displays lines of sight, which triangles can and cannot be seen, or what is visible between two specified points.

This analysis toolset would typically be used for intersection line of sight review (when a 3D dataset has been produced) or for studies of Site designs where taking advantage of or hiding a view is of value to the Client.

Example: Being able to see the shore or hiding an old factory from a new residential development…

Available visibility analysis options are:

1) Line of Sight
2) Surface Points
3) Surface Lines
4) Surface Regions



VISIBILITY TOOLS – LINE OF SIGHT

1. Select the **Visibility** tool. *(DTM Tool Frame: Analysis>Visibility)*
2. Set the **TIN file** to ***C:/2009 RBC/GW1/DATA/Aerial.tin***
3. **Eye Position** group:
    4. Select **Drape on TIN** option.
    5. Select **DP** and data point in the DTM area. *Do not DP in a void*…
    6. Enable **Offset Height** and set the value to **5.0**
7. Display Settings group:
8. Populate the dialog as shown.
9. **Visibility Parameters** group:
    10. Set **Visibility type** to **Line of Sight.**
    11. Select **Drape on TIN** option.
    12. Enable/Disable **Offset height** option (*your decision* ☺)
13. Select **DP** and data point within the data set… *chose a location away from your **Eye Position** location*.
14. Select **Process**.

There will be a line drawn between the Eye Position location and the Visibility Parameters location. The line will be "visible" or "not visible" or a combination of the two.

VISIBILITY TOOLS – SURFACE POINTS

In this tool, GEOPAK displays each triangle vertex in the model as visible or not visible. As the **Eye Position** is defined at the top of the dialog, no additional user requirements are needed.

1. Select the **Visibility** Parameter type to Surface Points.
2. Select Process.

The TIN vertices will be color coded depending on visibility status (visible or not visible).

3. Move your **Eye Position** and **Process** again to review a different result.

VISIBILITY TOOLS – SURFACE LINES

In this tool, GEOPAK displays each triangle edge in the model as visible or not visible. As the **Eye Position** is defined at the top of the dialog, no additional user requirements are needed.

1. Select the **Visibility Parameter** type to **Surface Lines**.
2. Select **Process**

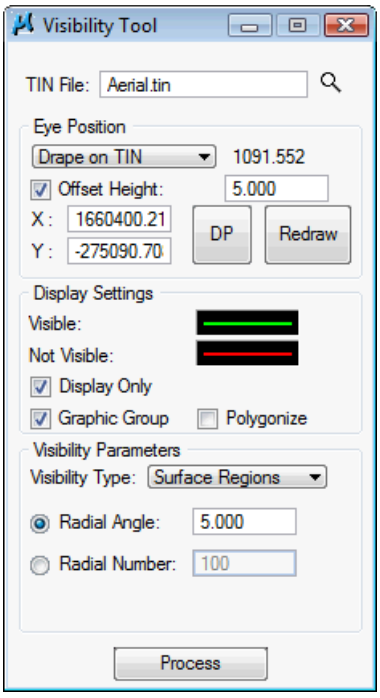
The TIN edges will be color coded depending on visibility status (visible or not visible).

3. Move your **Eye Position** and **Process** again to review a different result.

VISIBILITY TOOLS – SURFACE REGIONS

This option displays radials emanating from the original eye position with two options. The initial radial always begins going Due East (horizontally to the right from the Eye Position). Radials are determined by moving in a counterclockwise direction. When the **Radial Angle** is activated, the angle is specified. The angle between each radial is the specified degrees. Therefore, GEOPAK determines the number of wedges drawn. When **Radial Number** is the selected option, the input number of radials is calculated and displayed within the 360 degree range.

1. Select the **Visibility Parameter** type to **Surface Regions**.



2. Populate the dialog with a **Radial Angle** value of 5.0

3. Select **Process**

Radial lines will be drawn from the Eye Position at 5 degree intervals to the extent of the TIN surface. These radials will color coded based on what is "visible" or "not visible" or a combination of the two from the Eye Position to the edge of the TIN surface.

4. Move your **Eye Position** and **Process** again to review a different result.
5. Close the **Visibility Tool** dialog.

EXERCISE: TRACE SLOPE PATH

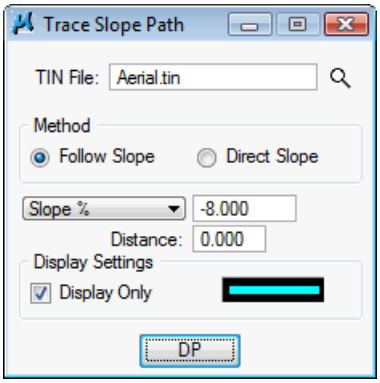
This exercise will guide you through the steps to use the Trace Slope path tool.

The tool will find a path up or down a DTM surface at a specific grade. The User can designate a slope segment length or, if the length is set to zero (0), the tool will find the longest path possible at the desired slope.

There are some caveats with this tool. For example; It is not possible to find a 10% path slope across a surface which has only a 5% surface slope.

Reasonable input values must be applied and, to ensure that reasonable values are used, this tool should be used in conjunction with the Height/Slope tool.

1. Select the **Trace Slope Path** tool. *(DTM Tool Frame: Analysis>Trace Slope Path)*.
2. Set the **TIN file** to ***C:/2009 RBC/GW1/DATA/Aerial.tin.***
3. Zoom to a specific area of data.
4. Open the **Height/Slope** tool and ascertain the surface slope in the area of focus.
5. Populate the dialog similarly to what you see below ensuring that the Trace Slope value is LESS that the surface slope in the area of focus.



6. Select **DP** and data point into the DGN within the area of focus.

   The tool will trace a slope across the surface triangles at the requested slope value for as long a path as is possible.

7. Modify the dialog settings and view the alternate results.

   Hint The slope value is sensitive to "sign" (-/+).

8. Discuss options with your instructor.