


# Digital Terrain Model

## 3.1 Introduction

<b>Objectives</b>	Learn how to display and analyze DTMs for use in roadway design.
<b>Project Manager</b>	Existing Ground
<b>Tools</b>	
<b>Menu Bar Application</b>	GEOPAK Road > DTM Tools

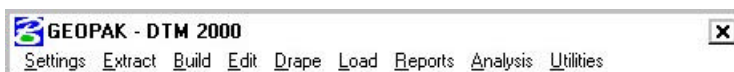
A **Digital Terrain Model (DTM)** represents the topography of a project in the form of a triangulated network. The DTM can be drawn in a 2D or 3D file, and then rotated to see the existing surface of the project area.

Digital Terrain Models can be generated from various sources including MicroStation Elements, survey data, photogrammetry data, **GEOPAK** cross-sections, and geometry data.


**Triangulation** is a mathematical process applied to ground points and vertices along longitudinal features to create planar surfaces. The result of triangulation is the creation of triangles connecting these points. These triangles are included in the GEOPAK TIN file from which existing ground profiles and existing ground cross sections can be generated.

## 3.2 Accessing

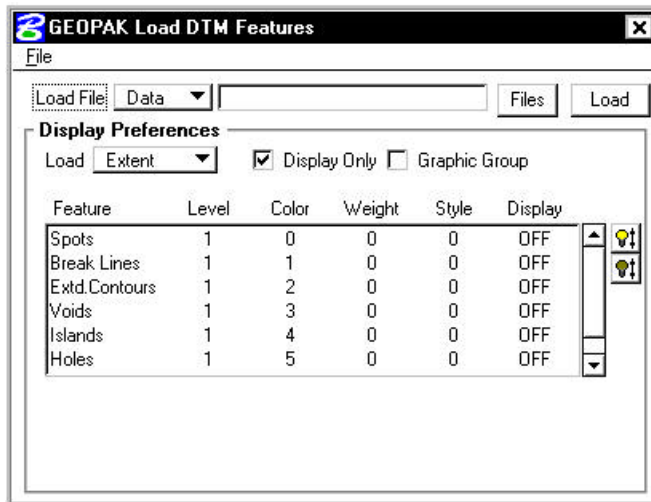
Clicking the **Existing Ground** button from the Road Project: Road1.prj dialog box within Project Manager invokes the tool frame shown to the right. All of the DTM tools can be accessed from the tool frame or from the DTM menu that can be accessed from the top/left icon on the tool frame.



### 3.3 Load DTM Features

Tool	
Menu Bar	Load > DTM Feature

Load is the process by which we can visualize the DTM data, TIN model, lattice model, and contours. By selecting the Load DTM Feature icon, the following dialog box appears.



The user can choose to load the DTM data (.dat), the TIN file (TIN), or the Lattice file (.lat). Each of these files can be loaded for the model extents, within a fence, or selected view.

Activating the **Display Only** toggle enables the user to view the elements without writing them to the MicroStation file (temporary display). Conversely, deactivating the toggle writes the DTM features to the MicroStation design file at the defined symbology. These elements can be placed as a graphic group when **Display Only** is deactivated.

Feature	Level	Color	Weight	Style	Display
Triangles	1	4	2	0	ON
Tin Hull	2	4	2	0	ON
Contours	-	-	-	-	ON
Major Lines	9	5	2	3	ON
Major Label	17	5	4	0	ON
Minor Lines	10	7	2	0	ON

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Activates the display of all Features.



Turns off the Display of all Features.




Turns on only the selected Feature. This can also be accomplished by activating the toggle (below the list box) or double-clicking on an item that is turned off within the list box.



Will turn off only the selected item. This can also be accomplished by activating the toggle (below the list box) or double-clicking on an item that is turned on within the list box.

### 3.4 Analysis Tools

Tools	
Menu Bar	<p> <b>Analysis &gt; Height</b>  <b>Analysis &gt; Profile</b>  <b>Analysis &gt; Volumes</b>  <b>Analysis &gt; Elevation Differences</b>  <b>Analysis &gt; Slope Area</b>  <b>Analysis &gt; Themes</b>  <b>Analysis &gt; Drainage Tools</b>  <b>Analysis &gt; Visibility</b>  <b>Analysis &gt; Trace Slope Path</b> </p>

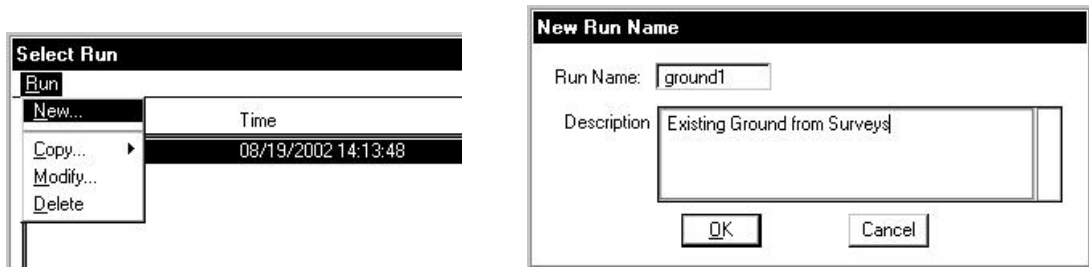
The **Analysis** tools allow the user to visually analyze the digital terrain model utilizing numerous tools as a profile analysis, thematic analysis, drainage flow patterns, and visual portions on the model from any given location.

<b>Height</b>	To determine the height and other associated data dynamically based on user-defined data points within the model.
<b>Profile</b>	View a profile based on a user defined MicroStation element.
<b>Volumes</b>	To compute the volume between two TIN models, the volume between a TIN model and a plane, or the cut and fill totals between two TIN models while applying a shrinkage/swell factors.
<b>Elevation Differences</b>	Will display the elevation difference, or the amount of cut and fill between two TIN models, or a TIN model and a plane of constant elevation.
<b>Slope Area</b>	The Slope Area tool displays the horizontal area and actual slope area (area following the terrain of the Model).
<b>Themes</b>	Displays the digital terrain model based on different user definable themes such as elevation ranges, slope percentage, slope degree, or aspect.
<b>Drainage</b>	Displays and analyzes drainage patterns within a TIN model. Tools include delineating watersheds, drawing flow arrows, determining upstream and downstream traces, finding high and low points, and ridge and sump lines.
<b>Visibility</b>	Based on a user-defined point of origin, GEOPAK visually displays which triangles can and cannot be seen, or what is visible between two points.
<b>Trace Slope Path</b>	Traces a path along a TIN file using a user specified slope and method.

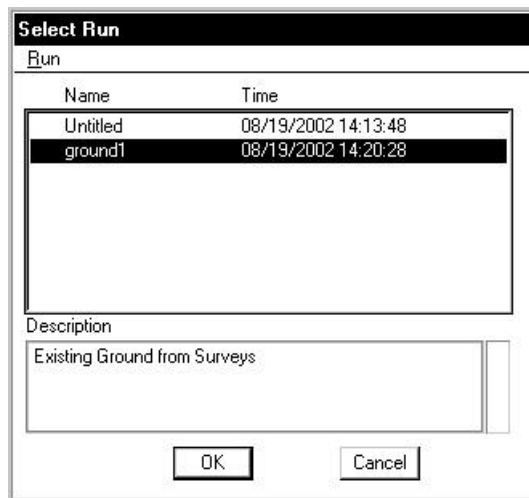
# Lab 3: Digital Terrain Modeling

## 3.1 Accessing DTM Tool via Project Manager

- Step 1.** Execute **C:\data\geo\VDOT\road1\LAB3.EXE**.
- Step 2.** Open the MicroStation file **c:\data\geo\VDOT\road1\d17682dtm.dgn**.  
Access **Project Manager**. It should automatically access the Road workflow dialog box since we “remembered” the options in Exercise 2.
- Step 3.** Select the **Existing Ground** tool from the **Project Manager Road** dialog box.
- Step 4.** Create a new run **ground1**.



- Step 5.** After creating the run, select the run by highlighting the name of the run in the dialog list box and click **OK**.



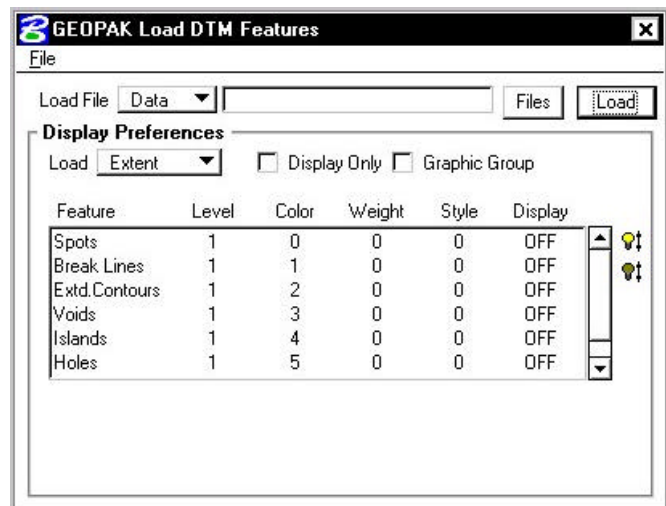
This invokes the DTM Tool Frame.



### 3.4 Load DTM Features



- Step 1.** Select the **Load DTM Features** icon from the tool frame to invoke the following dialog box.
- Step 2.** Change the **Load File** option to **TIN**.
- Step 3.** Select the TIN file **'SURVEY.TIN'** by clicking the **Files** button.
- Step 4.** Enable the toggles for **Graphic Group** but leave the **Display Only** disabled.



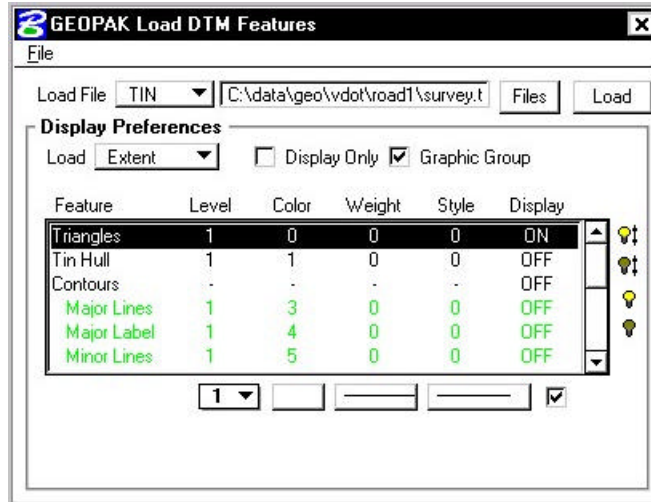
- Step 5.** Select the **Triangles** Feature by highlighting in the list box. Notice that initially the display is set to OFF. You can control the display of an item three ways:

**Use the “lightbulb” icons to the right of the dialog box**

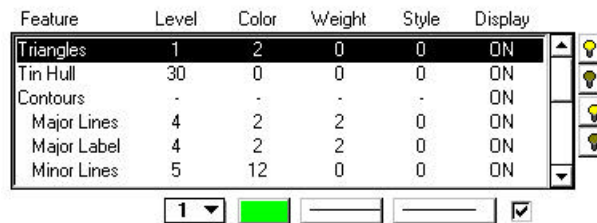
**Double-click on an item**

**Use the “display” toggle in the lower right corner of the dialog box**

Set the Triangles display to ON. At this point your dialog box should resemble the following:



**Step 6.** Set the display symbology for the Triangles as indicated below:



**Step 7.** Select the **Tin Hull** (the boundary of the surface model) feature. Activate the Display of the feature and set the symbology as follows; Level = 30, Color = 0, Weight = 0, Style = 0.

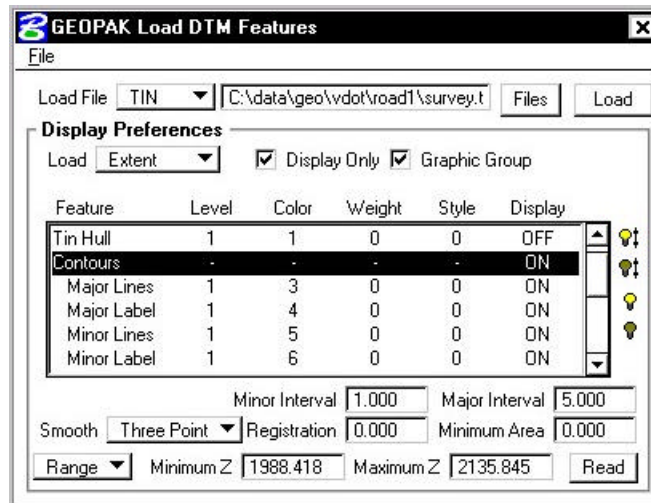
**Step 8.** Click **Load** and review the results. When complete, toggle OFF the triangles and tin hull.

**Step 9.** Select the **Contours** feature. Activate the **Display** Feature.

Verify that **On** is set in the Display field.

**Step 10.** Complete the bottom of the dialog box as indicated below. To complete the Minimum and Maximum Z, Click the **Read** button, which will review the active TIN file and determine these values.

Enable the **Display Only** toggle since we only want to “preview” our contours but not actually write them to the design file.



**Step 11.** Activate the Display of the Contour **Lines** and **Labels** and set the symbology as indicated below:

	Level	Color	Weight	Style	Font	TH / TW	Distance
<b>Major Lines</b>	10	4	3	0			
<b>Major Labels</b>	10	5	3	0	0	TH=3, TW=3	200
<b>Minor Lines</b>	9	1	1	0			



The contour symbology standards should be the same as Survey's and are documented in CAICE\_2000.doc.

**Step 12.** Click the **Load** button to initiate the process.

**Step 13.** Close the Load DTM Features dialog box and Save Settings.

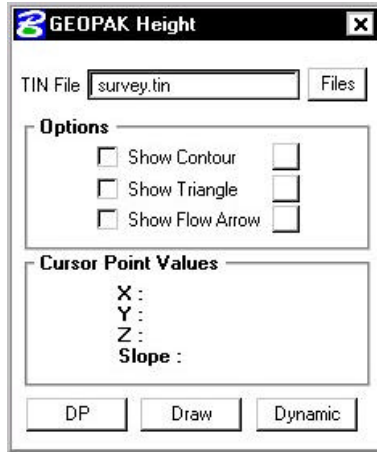
## 3.5 Analysis Tools

We will review several analysis tools in the following exercises. These include the height, themes and profiles tools.

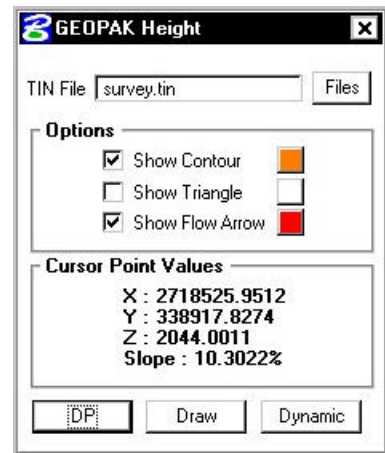
### 3.5.1 Height Tool



**Step 1.** Select the **Height** icon from the tool frame to invoke the following dialog box.



- Step 2.** Activate the **Show Contour** and **Show Flow Arrow** toggles. The color may be altered to your choice of colors from the active color table on the Height dialog box. The weight of the contour line and arrow are controlled by the active Microstation settings.
- Step 3.** Click the **Dynamic** button and scan the surface model with the cursor to display the values for xyz and the slope on the model at the cursor point.
- Step 4.** The **DP** option can be utilized to review this information at a specific location and the **Draw** option will label the elevation at the selected data point.
- Step 5.** Close the Height dialog box.



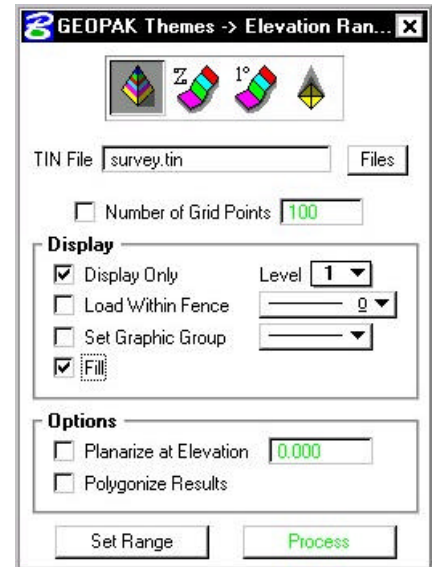
### 3.5.2 Themes Tool



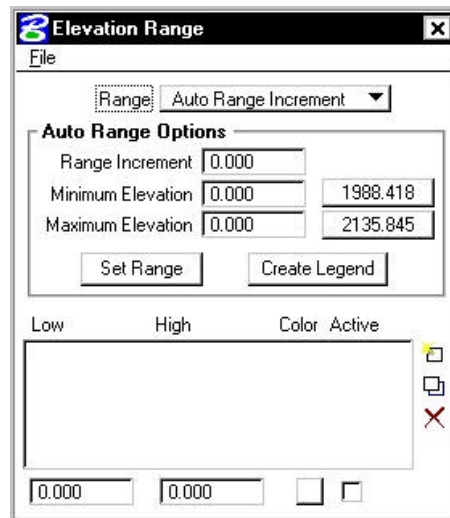
- Step 1.** Select the **Themes** icon from the Analysis tool box to invoke the dialog box depicted below.



- Step 2.** Ensure that all graphic elements are Fit in View 1.
- Step 3.** We will determine the Elevation Range first for the **TIN File** 'SURVEY.TIN'. (This is the first icon on the dialog box).
- Step 4.** Activate the **Display Only** toggle and the **Fill** toggle.

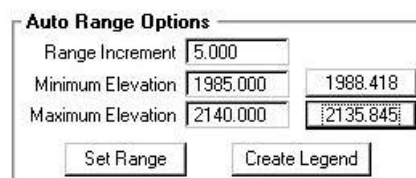


- Step 5.** Next, click the **Set Range** button to access the following dialog box.



As shown on the right of the **Minimum** and **Maximum** Elevation Fields, the values for the active TIN elevations are listed. By clicking these buttons individually, the elevation fields will automatically be populated.

- Step 6.** Set the Range option to **Auto Range Increment**.
- Step 7.** Set the Auto Range Options as shown below:



**Step 8.** Click the **Set Range** button to populate the list box on the bottom portion of the dialog box.

Selection of any list of elevations will populate the fields at the bottom.

Low	High	Color	Active
1985.000	1990.000	0	YES
1990.000	1995.000	1	YES
1995.000	2000.000	2	YES
2000.000	2005.000	3	YES
2005.000	2010.000	4	YES

Utilizing the buttons on the right side of the list box will permit additional ranges to be included in the list, modifications to be made to elevation ranges (or the color display of this range), or deleting a particular elevation range.

**Step 9.** Close the Elevation Range dialog box (select the X in the upper right hand corner of the dialog box).

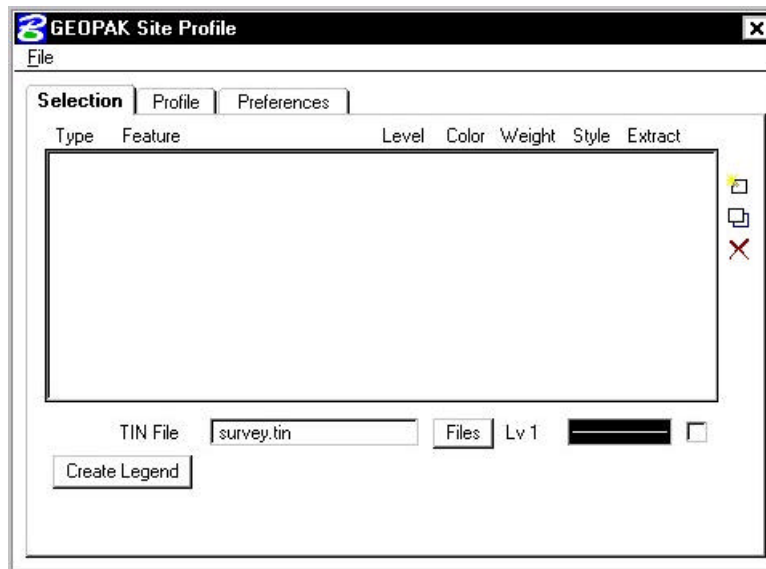
**Step 10.** Click the **Process** button to initiate the display of the Elevation Ranges for the surface model.

**Step 11.** Close the Themes dialog box and Save Settings.

### 3.5.3 Profile Tool



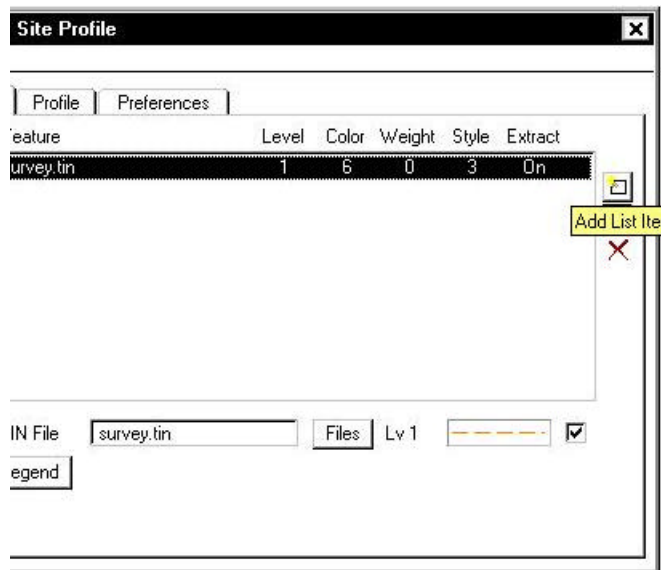
**Step 1.** Select the Profile icon from the Analysis tool box to invoke the following dialog box.



**Step 2.** Use the **Selection** tab to identify your surface model (TIN File) which you will generate a profile from, and the symbology for your profile.

**Step 3.** Select the Tin File “**SURVEY.TIN**” by using the **Files** button.

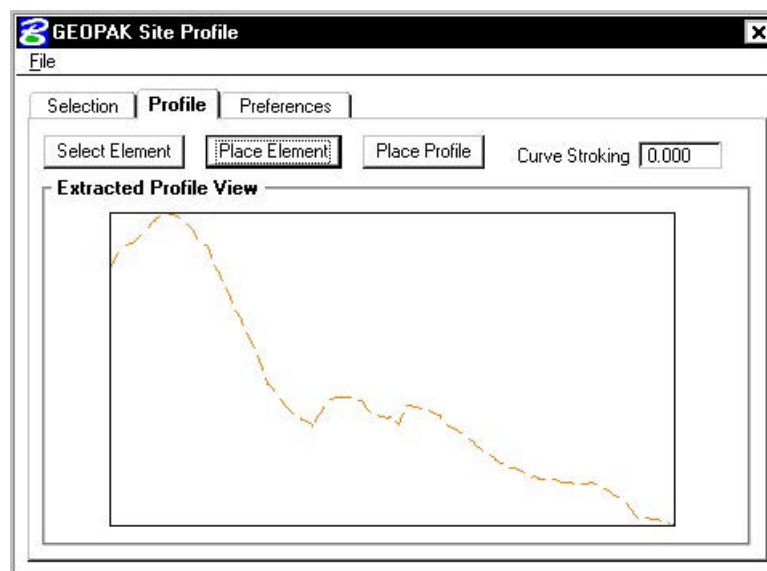
**Step 4.** Double-click on the symbology box (field to the right of the **Files** push button) to set the symbology representing the ground surface profile. You may choose any symbology you wish. Once the symbology has been set, click **OK**.



**Step 5.** Click the **Add** icon (top icon next to the list box) to add the feature to the collection box.

**Step 6.** Select the **Profile** Tab.

**Step 7.** Click the **Place Element** button to cut your actual profile at any desired area by just placing two data points (i.e. a line) or a series of data points (i.e. a line-string) across your surface model at any location.



**Step 8.** You can use the **Preferences** tab to set up a grid for your profile if desired.

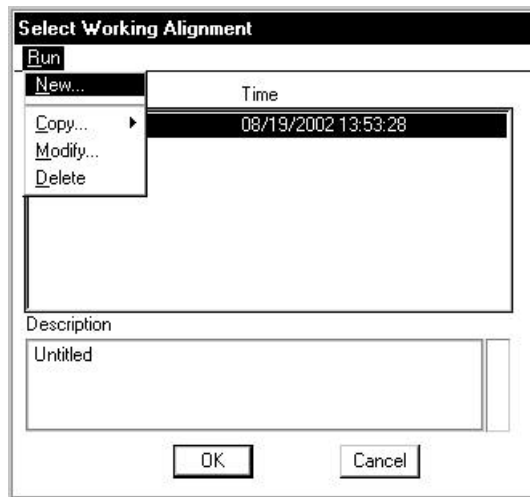
**Step 9.** Close the Profile dialog box and remove the DTM Tools tool frame.

### 3.6 Working Alignment

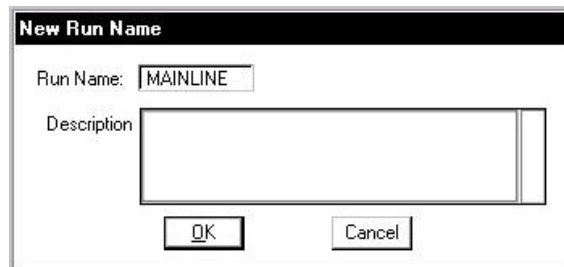
Before leaving this exercise, let's go ahead and begin to set the stage for further design via the Project Manager by defining the **Working Alignment**. You will usually create a **Working Alignment** for each alignment on your project, but because of time constraints we'll only do it for alignment MAINLINE on our sample project.

To do this, we'll need to use the **Select** and **Define** buttons on the Project Manager Workflow dialog box. The Project Manager workflow dialog box should still be active (we 'sank' it earlier in the lab). Access the dialog box by selecting **Window > Road Project: 17682.prj** from the MicroStation menu bar.

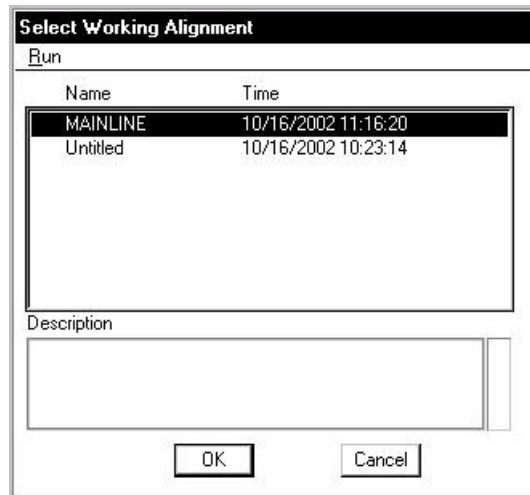
- Step 1.** Click the **Select** button to create a new Working Alignment. This will be very similar to creating a run as we did earlier in this exercise. The Working Alignment is the active chain that we are designing for.



- Step 2.** Create a new Working Alignment called **MAINLINE** as shown below and click **OK**.

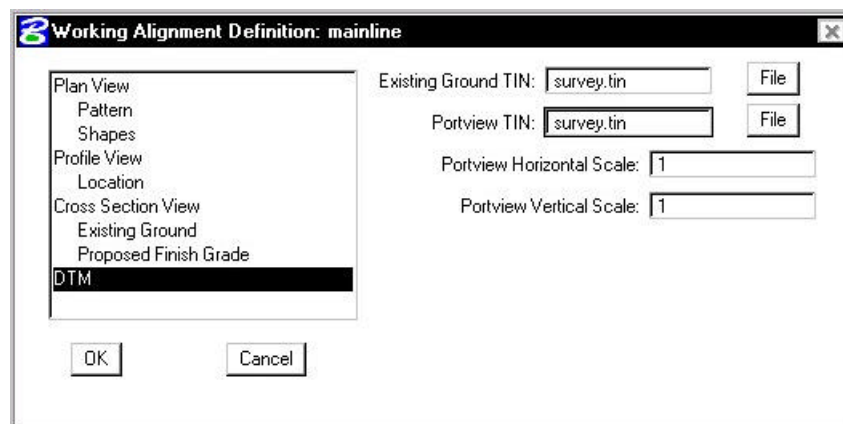


- Step 3.** After creating the run, select the run by highlighting it in the dialog box and clicking **OK**.



**Step 4.** You will now return to the main Workflow dialog box. Click the **Define** button to access the Working Alignment Definition dialog box.

**Step 5.** Select the DTM item in the list box and complete the DTM definitions as shown below:



**Step 6.** Click **OK** to exit the Working Alignment Definition dialog box.

**Step 7.** **Exit** MicroStation.