



# Coordinate Geometry

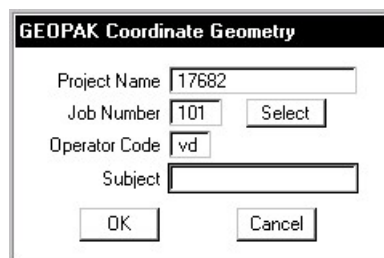
## 4.1 Introduction

<b>Objectives</b>	Learn to set up and access the coordinate geometry database file. Become proficient in using GEOPAK Coordinate Geometry.
<b>Project Manager</b>	Coordinate Geometry
<b>Tool</b> 	
<b>Menu Bar Application</b>	GEOPAK Road > Geometry > Coordinate Geometry

The Coordinate Geometry database file (\*.GPK file) is comprised of stored geometric elements such as points, lines, curves, spirals, chains, parcels and profiles. When COGO calculations are completed, the results are stored in the binary database file, which is then utilized throughout the design process with many other applications.

## 4.2 Accessing COGO

When Coordinate Geometry is started, the Start-Up Dialog box appears.



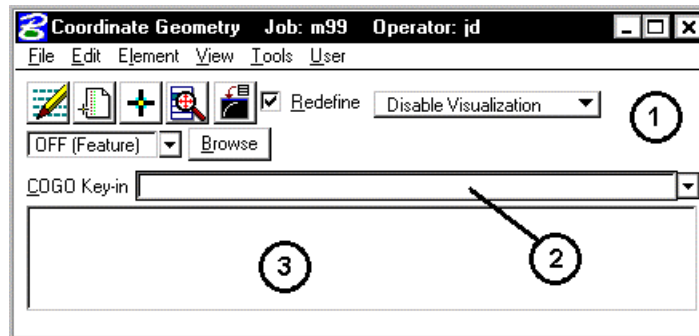
The fields in the Start-Up dialog box are detailed below.

- Project Name** Name displayed on reports. This is an optional entry, with a maximum of 60 alphanumeric characters. If Project Manager is active, this field is populated automatically.
- Job Number** Identifies coordinate geometry database file and is a required field. The job number is a maximum of three alphanumeric characters. If Project Manager is active, this field populated automatically. This field is required.
- Operator Code** Unique 2-character code which enables multiple users access to database file. The user's initials are suggested. Note this field is not required for single user access, but highly recommended. If Project Manager is active, this field is populated automatically.
- Subject** Description of coordinate geometry work (could relate to the project) with a maximum of 48 alphanumeric characters.

This field is optional.

After the dialog box is populated, and the **OK** button is clicked, the main coordinate geometry dialog box is invoked.

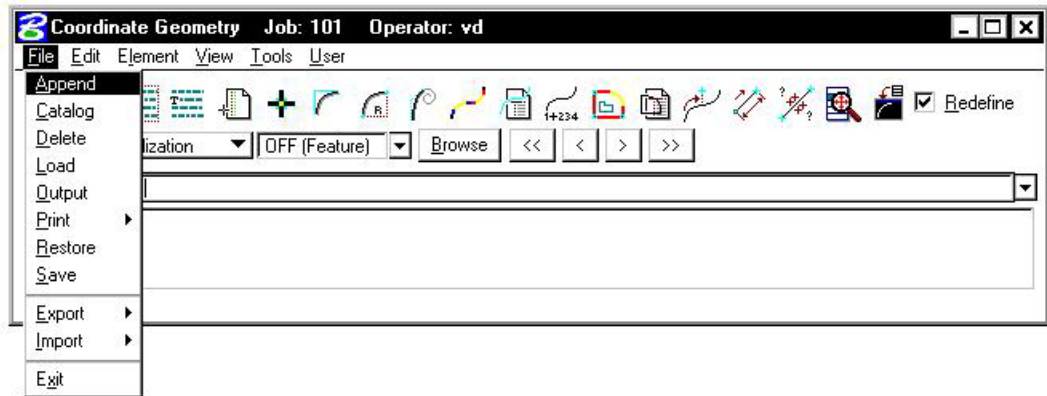
### 4.3 Coordinate Geometry



The coordinate geometry dialog box is made up of three separate display areas:

- **Tool Bar (1)** consisting of drop down options and icons. The display of specific icons is customizable.
- **COGO Key-in (2)** this field enables manual entry of COGO commands. The drop down button allows for a history of commands to be reviewed.
- **Output Display Window (3)** shows the results generated by the commands.

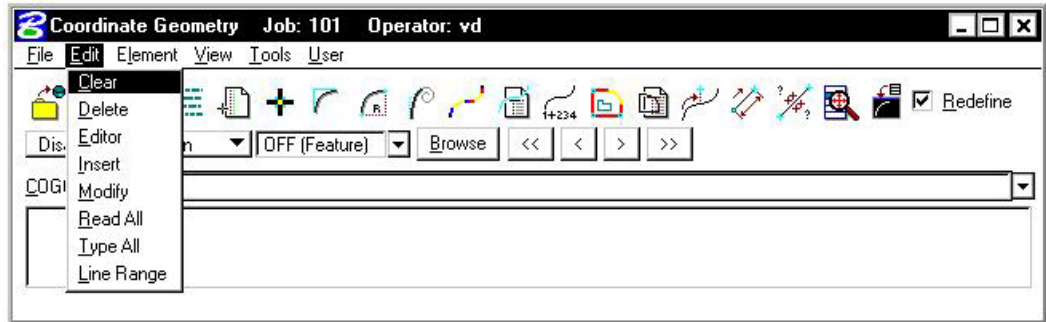
### 4.3.1 File Commands



The File commands (as displayed in the exploded view above) are detailed in the table below.

<b>Append</b>	This command is for <i>input files</i> only. A new input file is created by copying the contents of an existing input file to the end of the current input file. The Save command must be used in order to store this new file.
<b>Catalog</b>	When selected, a menu appears listing all saved input files (under the current operator code) in the project directory. This is for reference only no action is taken.
<b>Delete</b>	When selected, a menu appears listing all saved input files. <i>Highlight</i> a file, then click the <b>OK</b> button to remove this file from your project directory. Although the file is deleted, the elements stored as a result of processing the commands are not deleted.
<b>Load</b>	When selected, a menu appears listing all saved input files. <i>Highlight</i> a file, then click the <b>OK</b> button. The input lines from the highlighted file are now displayed in the display window for viewing, editing, or processing.
<b>Output</b>	Writes an ASCII file of the current display for reviewing and / or printing. (Fname999.ooc, where 999 is the current job number and oc is the operator code).
<b>Print</b>	Sends your output/input file to the printer.
<b>Restore</b>	Loads an ASCII file of GEOPAK commands into the display window. Note no processing occurs. The file must be named j999ooc.inp, where 999 is the current job number and oc is the operator code.
<b>Save</b>	Saves the current audit trail to a file. (Fname999.ioc, where 999 is the current job number and oc is the operator code.).
<b>Export</b>	Exports GEOPAK points, chains and profiles into formats for use in various data collectors.
<b>Import</b>	Imports horizontal and vertical alignments and points from RDS and SDMS format into the GEOPAK .gpk file.
<b>Exit</b>	Closes the COGO dialog box and ends the coordinate geometry session. A prompt to save the session appears. <b>Yes</b> saves the audit trail, <b>No</b> exits without saving, <b>Cancel</b> returns to the COGO session. Whether you pick <b>Yes</b> or <b>No</b> everything you did is still saved in the .gpk file.

### 4.3.2 Edit Commands



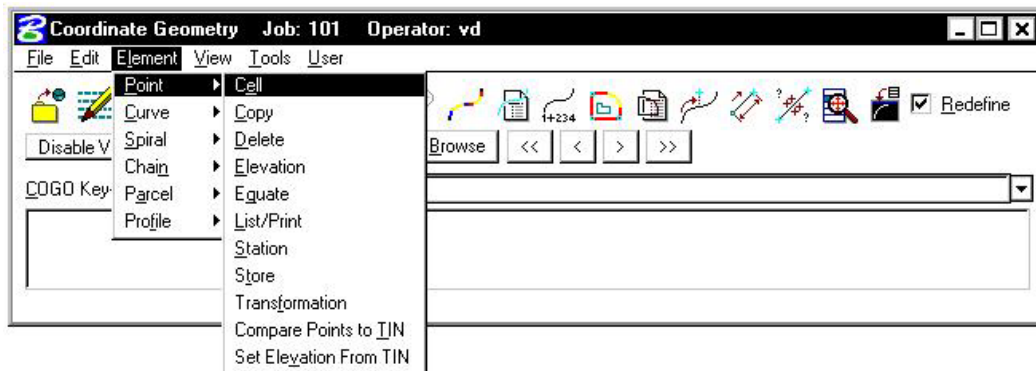
The Edit commands (as displayed in the exploded view above) are detailed in the table below.

<b>Clear</b>	Empties the memory of the current audit trail without saving and initializes the line numbers to begin a new sequence of commands. <b>Note this does not clear the display window.</b>
<b>Delete</b>	Deletes input commands in the input buffer by line number (or range of line numbers) and re-sequences the line numbers for the remaining commands.
<b>Editor</b>	Opens the GEOPAK COGO Command Editor, which enables the user to edit the current input file.
<b>Insert</b>	Adds a command line to the current input buffer <i>before</i> a specified line number; subsequent command lines shift down and line numbering is automatically re-sequenced.
<b>Modify</b>	Changes a fragment in a command line. The modified command line is not processed until a Read command is performed.
<b>Read All</b>	Processes the specified lines in the audit trail. This may be done for the entire file (All) or by specifying a range of line numbers (Line Range).
<b>Type All</b>	Displays the content of the audit trail, (All) or a portion of the audit trail by specifying a range of line numbers (Line Range).
<b>Line Range</b>	Allows you to specify a beginning line number and ending line number. This range of lines can then be either “read” into COGO or just typed/listed in the display window.

### 4.3.3 Element Commands

The mainstay of GEOPAK Coordinate Geometry are the various element commands. Tools are supported for storing, stationing, adding additional data, deleting, etc. GEOPAK supports a wide variety of elements: points, curves, spirals, chains or alignments, parcels, and profiles. Each element is detailed below.

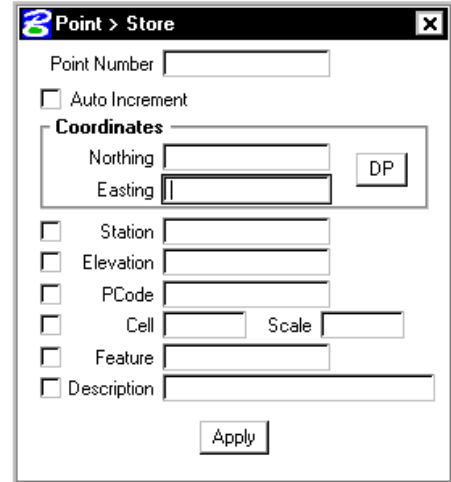
#### 4.3.3.1 Element > Point



One of the most utilized sets of COGO tools are the point commands, as detailed in the table below.

<b>Cell</b>	Assigns a cell name to a previously stored point. This point and associated cell can then be plotted later through D&C Manager.
<b>Copy</b>	Copies points or a point range to a new point number or range within the same GEOPAK database file
<b>Delete</b>	Deletes a point number (or range of numbers) from the database file.
<b>Elevation</b>	Assigns an elevation to a previously stored point
<b>Equate</b>	Stores a new point with the same values as a previously stored point
<b>List/Print</b>	Input a range of point numbers. <b>List</b> displays the point numbers (but no associated data) currently stored in the .gpk file within the specified range. <b>Print</b> displays point number, x, y, z coordinates, station value and other stored information in the display output window for the requested points.
<b>Station</b>	Adds a station to a previously stored point.

**Store** Stores a point by key-in coordinates or by selecting a location graphically. A station, elevation, point code, cell, feature, or description can be optionally stored with the point.

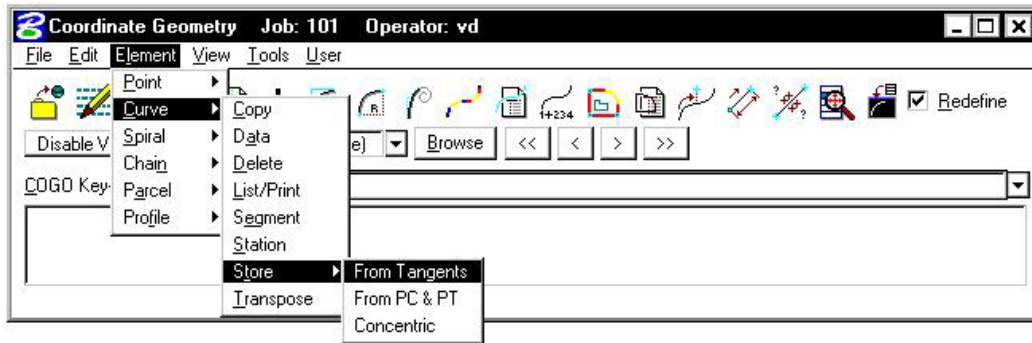


**Transformation** Performs coordinate transformations based on user-defined control pairings

**Compare Points to TIN** Utilizing a set of COGO points (with elevations) compares the COGO elevation to the TIN elevation and completes statistical analysis for "goodness of fit."

**Set Elevation from TIN** Utilizing this command, GEOPAK adds or updates an elevation to a previously defined point, based on a TIN model.

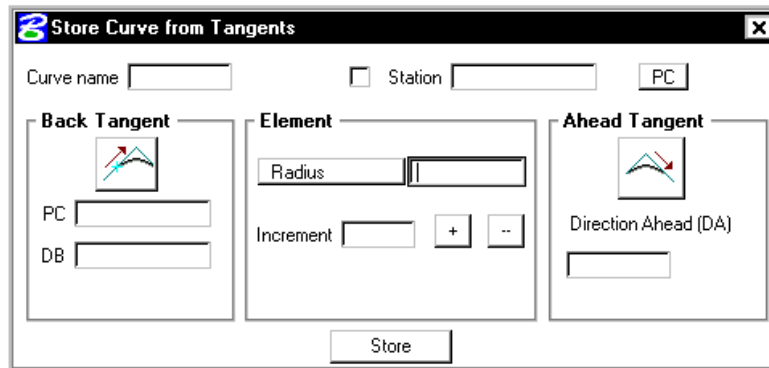
### 4.3.3.2 Element > Curve



The Curve commands (as displayed above) are detailed in the table below.

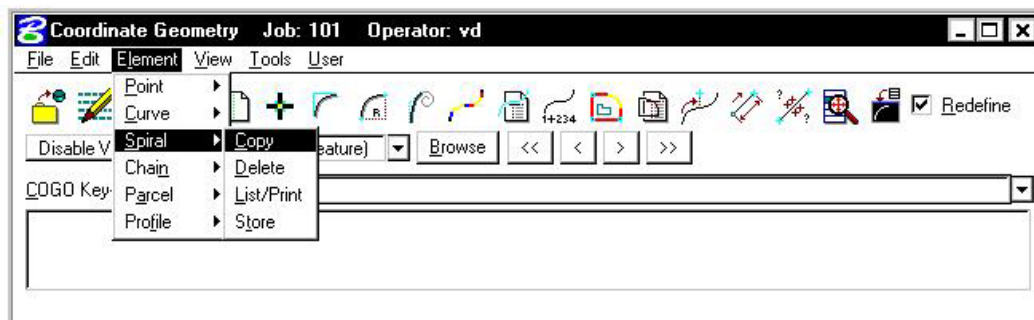
<b>Copy</b>	Copies a specified curve to another curve name.
<b>Data</b>	Calculates the geometric parameters of a curve, displaying values for Delta, Degree, Tangent, Length and Radius.
<b>Delete</b>	Deletes selected curve from the database file.
<b>List/Print</b>	List displays only the curve names currently stored in the .gpk file. Print displays the curve data of the selected curve.
<b>Segment</b>	Defines new curves by dividing a stored curve into segments.
<b>Station</b>	By identifying a curve and a control point on the curve (PC, PI, or PT), a station value may be assigned.

**Store** Provides various options for defining and storing lines and curves such as Store Curve from Tangents as shown below.



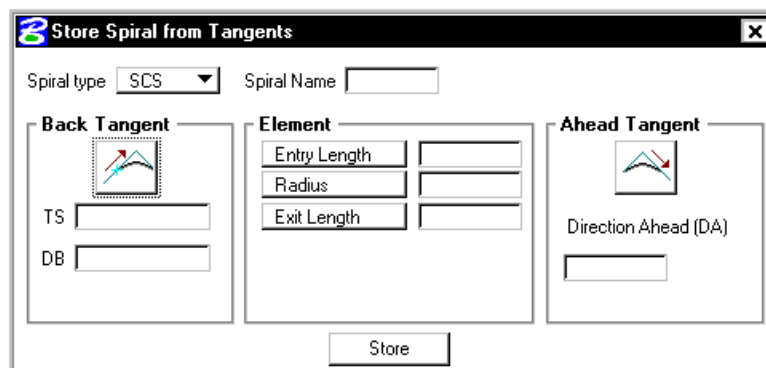
**Transpose** Reverses a previously stored curves direction.

### 4.3.3.3 Element > Spiral

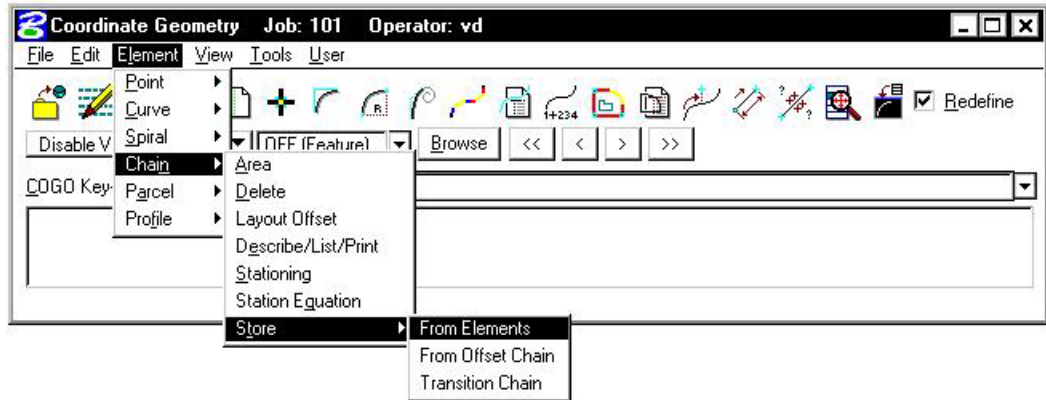


The Spiral commands (as displayed in the exploded view above) are detailed in the table below.

- Copy** Copies a specified spiral to another spiral name.
- Delete** Deletes the selected spiral from the database file.
- List/Print** Displays all spiral data for the selected curve. List displays only the spiral names currently stored in the .gpk file. Print displays the spiral data of the selected spiral.
- Store** Provides various options for defining and storing spirals.



### 4.3.3.4 Element > Chain

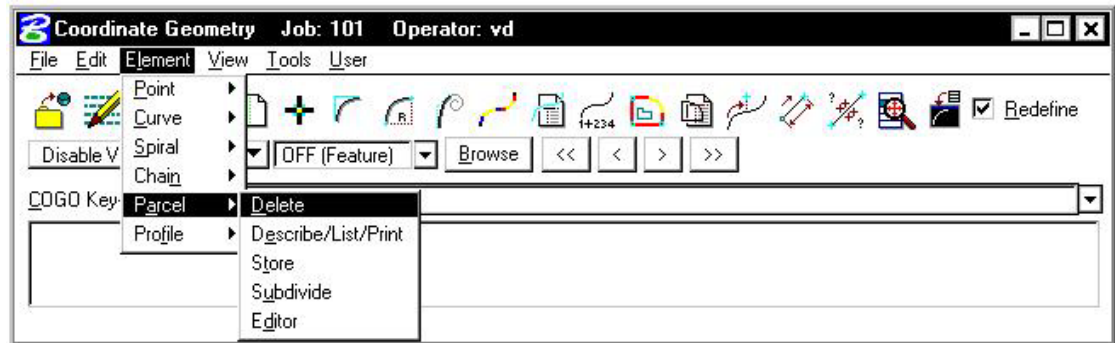


The Chain (GEOPAK alignment) commands (as displayed in the exploded view above) are detailed in the table below.

<b>Area</b>	Calculates the area of a closed chain
<b>Delete</b>	Deletes selected chains from <b>.gpk</b> database file.
<b>Layout Offset</b>	Project points onto a chain or compute offset distance and direction between two chains at each control point or at user defined intervals of a specified station range.
<b>Describe / List / Print</b>	Displays chain information. <b>Print</b> displays the name of each chain element. <b>Describe</b> displays the alignment data of each element in the selected chain.
<b>Stationing</b>	Provides a method for stationing or re-stationing a chain.
<b>Station Equation</b>	Provides a method for applying a station equation to a chain.
<b>Store</b>	Provides three options for storing a chain in the database file, <b>From Elements</b> , <b>From Offset Chain</b> and <b>Transition Chain</b> . (Chain name can be between 1-9 alphanumeric characters)



### 4.3.3.5 Element > Parcel



The Parcel commands (as displayed in the exploded view above) are detailed in the table below.

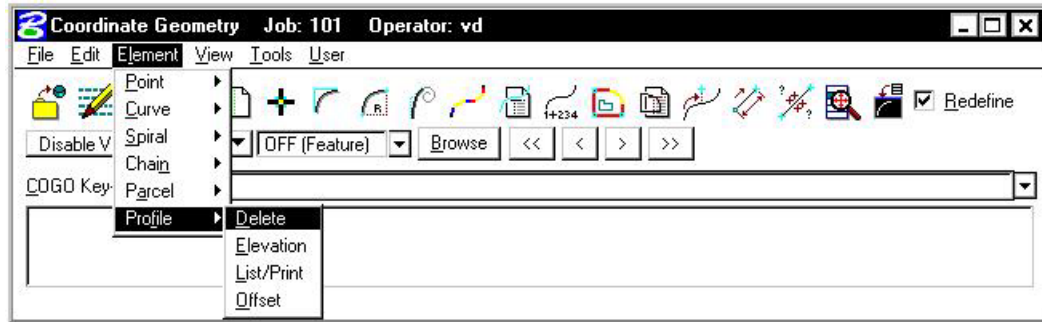
<b>Delete</b>	Deletes selected parcels from the database file.
<b>Describe / List / Print</b>	Displays parcel information. Describe displays the elements of composition, the area of tract stored, taken and remaining and a point, bearing, distance description of the specified tract. Print displays the elements of composition, the area of tract stored, taken and remaining.
<b>Store</b>	Stores a parcel by adding points, curves and spirals.
<b>Subdivide</b>	Divides a parcel into individual lots.
<b>Editor</b>	Edits a parcel.

### 4.3.3.6 Parcel Commands (Manual Entry)

Several parcel commands are supported only by manual entry and have no associated dialog boxes.

<b>Store Taken</b>	Store the portion of a parcel taken by entering point and curve names in either a clockwise or counterclockwise direction.
<b>Store Easement</b>	Store easements by entering point and curve names in either a clockwise or counterclockwise direction.
<b>Own Parcel</b>	Stores the names of the owners associated with previously stored parcels.
<b>Make Legal</b>	Creates a metes and bounds description and writes it to a user named text file. See also <i>Legal Description Editor</i> for the ability to create detailed and customizable legal descriptions.

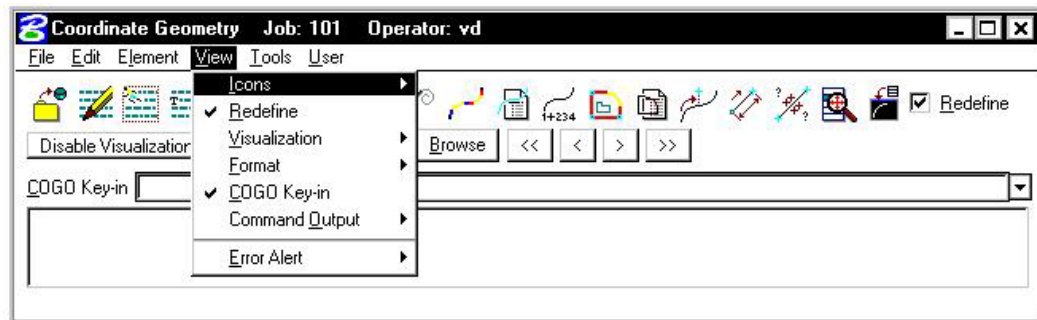
### 4.3.3.7 Element > Profile



The Profile commands (as displayed in the exploded view above) are detailed in the table below. **Note additional commands are supported as keyin only commands.**

- Delete** Deletes selected profiles from the database file.
- Elevation** Provides three options for reporting elevations along a selected profile, **Station**, **Even Station**, **Incremental Stations**.
- List/Print** Displays profile information. **Print** displays the data of the selected profile from the database file.
- Offset** Stores a new profile within a specified Station Range at a defined vertical offset from the original profile.

### 4.3.4 View Commands



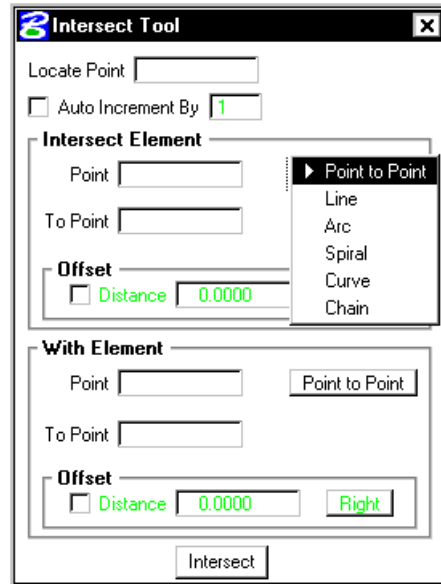
The View commands (as displayed in the exploded view above) are detailed in the table below.

- Icons** Enables the user to customize which icons appear in the tool bar.
- Redefine** Displays the **Redefine** box on the tool bar.
- Visualization** Displays the visualization items on the tool bar.
- Format** Displays the format items (i.e. number of decimals, station format, etc.) on the tool bar.
- COGO Key-in** Displays the COGO Key-in box for entering commands in the dialog box.
- Command Output** Displays the Command Output Window in the dialog box, and controls options for the Command Output Window. The Command output window can also be saved to a text file in lieu of using the File > Output command.
- Error Alert** Enables the user to activate a *beep* and/or restore a minimized COGO dialog box when an error occurs.

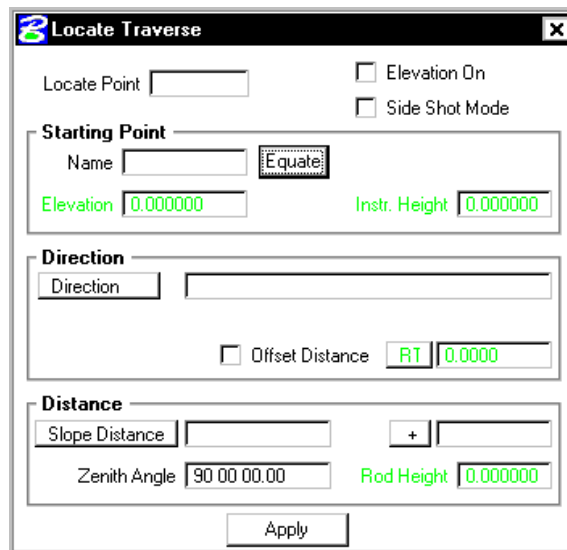
### 4.3.5 Tools Commands

The Tools commands are detailed in the table below.

**Intersect** Stores a point at the intersection of any two COGO elements.



**Locate** Stores a point or series of points not by specifying coordinates, but based on a previously stored point using several methods. To locate a point by distance and bearing, use the **Tools > Locate > Traverse** as depicted in the dialog box below.



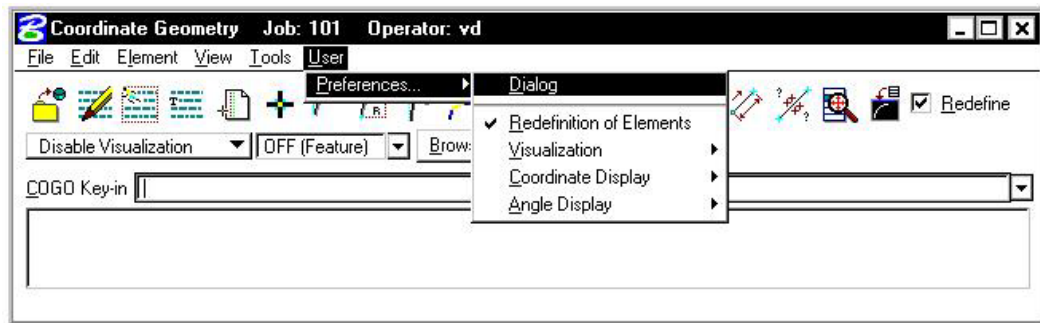
**Superelevation** Calculates the superelevation transitions for a given chain and design speed by the Classic Methods delivered prior to GEOPAK 2000.

**Inverse** Calculates the distance and direction between points.

**Navigator** Invokes the COGO Navigator. See Section 4.4.

<b>Best Fit</b>	Calculates a best-fit chain through a set of points.
<b>Translation and Rotation</b>	Moves, rotates, and scales a data set.
<b>Map Check</b>	Edits a parcel.
<b>Roadway Intersections</b>	Calculates data for the intersection of two COGO elements, usually chains.
<b>Cul-de-sacs</b>	Calculates data for a cul-de-sac.
<b>Redraw Visualized Elements</b>	Re-syncs the visualized COGO elements in the MicroStation file with the coordinate geometry data.
<b>Clear Visualized Elements (Temporary)</b>	Removes all temporary visualized elements from the view.
<b>Clear Visualized Elements (All)</b>	Clears all temporary and permanent visualized elements from the Microstation file.


### 4.3.6 User Preferences



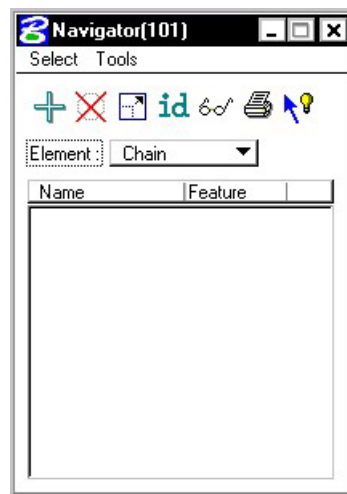
The User Preferences (as displayed in the exploded view above) are detailed in the table below.

<b>Dialog</b>	Allows access to COGO Preferences dialog box.
<b>Redefinition of Elements</b>	Toggles the Redefine option on/off. If Redefine is on, COGO data can be redefined/overwritten.
<b>Visualization</b>	Enables the elements to be displayed in the MicroStation file permanently, temporarily, or not at all.
<b>Coordinate Display</b>	Toggles between displaying NE or XY coordinates.
<b>Angle Display</b>	Toggles between displaying Bearing or Azimuth.

## 4.4 COGO Navigator

<b>Feature / Function</b>	View, edit and display COGO elements.
<b>Tools</b>	
<b>COGO Menu Bar</b>	Tools > Navigator

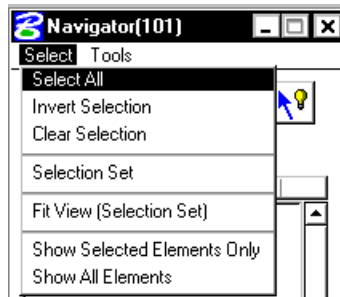
The **COGO Navigator** is a tool utilized to easily view and edit COGO data. Store, delete, edit, print elements, plus visualization and selection set commands are easily accessible via the Navigator. The **Navigator** can be accessed by the pull down menu **COGO > Tools > Navigator** or by the **Navigator** icon. The following dialog box opens.



From the **Navigator**, points, curves, spirals, chains, survey chains, parcels, and profiles (all COGO elements contained in the coordinate geometry database file; \*.gpk) can be added, deleted, modified, identified, visualized, printed, or selected.

### 4.4.1 Navigator > Select Tools

A variety of selection tools can be invoked via the Select pulldown, as depicted in the exploded view below.

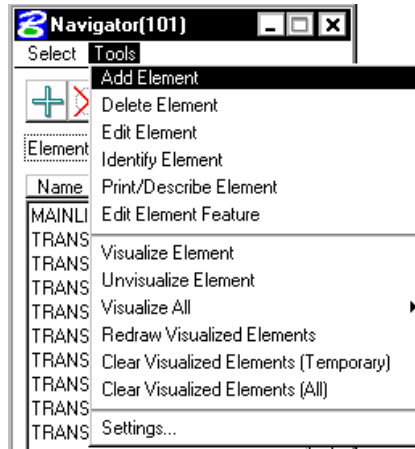


The Select tools are detailed in the table below.

<b>Select All</b>	Selects all data items of a certain type. (i.e. all points)
<b>Invert Selection</b>	Selects all items not previously selected, and unselects all items previously selected.
<b>Clear Selection</b>	Unselects all items.
<b>Selection Set</b>	Allows the user to create a selection set that meets particular criteria. Same as using the <b>Selection Set</b> icon
<b>Fit View (Selection Set)</b>	Fits the selected items to the active MicroStation window.
<b>Show Selected Elements Only</b>	Only the items in the selection set are displayed in the MicroStation window.
<b>Show All Elements</b>	All items in database file are displayed in the MicroStation window.

## 4.4.2 Navigator > Tools

A variety of tools can be invoked via the Tools pulldown, as depicted in the exploded view below. Many can also be invoked via the shortcut icons displayed at the top of the Navigator.



### Add Element



Enables the selected type of element to be stored. When selected, the appropriate Store Element dialog box is invoked.

### Delete Element



Deletes the highlighted element.

### Edit Element



Invokes the appropriate Store Element dialog box, populated with the associated data of the selected element for editing.

### Identify Element



When clicked and a COGO element is graphically selected, the element is highlighted in the display field. If the selected element is not the displayed element type (i.e., curve or point), the element type is also changed.

### Print/Describe Element



Displays the selected element's data.

### Edit Element Feature

Changes the feature code of the element.

### Visualize Element



Displays the selected elements according to their feature code or default symbology.

### Unvisualize Element

Removes display of selected elements.

### Visualize All

Displays all of the elements of a certain type, or all elements.

### Redraw Visualized Elements

Re-syncs the coordinate geometry data with the data displayed in the MicroStation file.

### Clear Visualized Elements (Temporary)

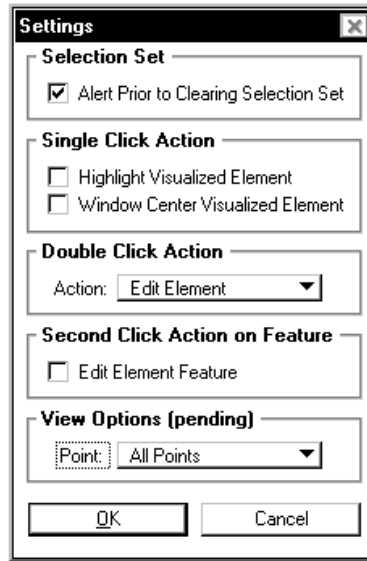
Clears only temporary visualized elements from the view.

### Clear Visualized Elements (All)

Clears all visualized elements from the MicroStation file.

**Settings**

Enables the user to define certain actions and behaviors of the Navigator.





# LAB 4: Coordinate Geometry

## 4.1 Accessing COGO

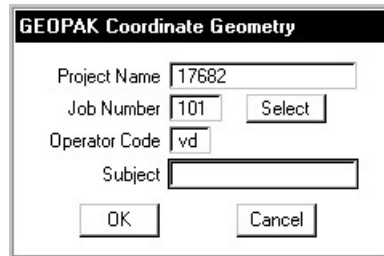
**Step 1.** Execute **C:\data\geo\VDOT\road1\LAB4.EXE**.

**Step 2.** Open the MicroStation file **c:\data\geo\VDOT\road1\17682des.dgn**.

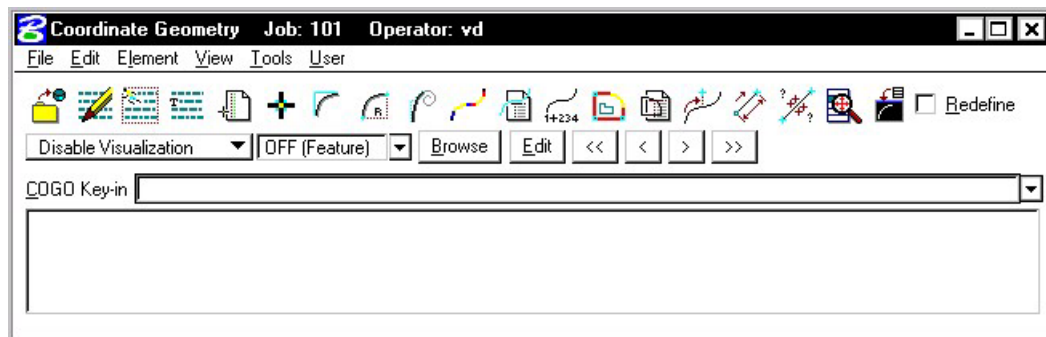
Access **Project Manager**. It should automatically access the Road workflow dialog box since we “remembered” the options in Exercise 2.

**Step 3.** Select the **Coordinate Geometry** icon from the **Road Project: 17682.prj** workflow dialog box.

The following COGO startup dialog box opens. Notice that the Project, Job Number and Operator Code fields are populated automatically. This information is taken from the project information that we defined when creating the project in Exercise one.



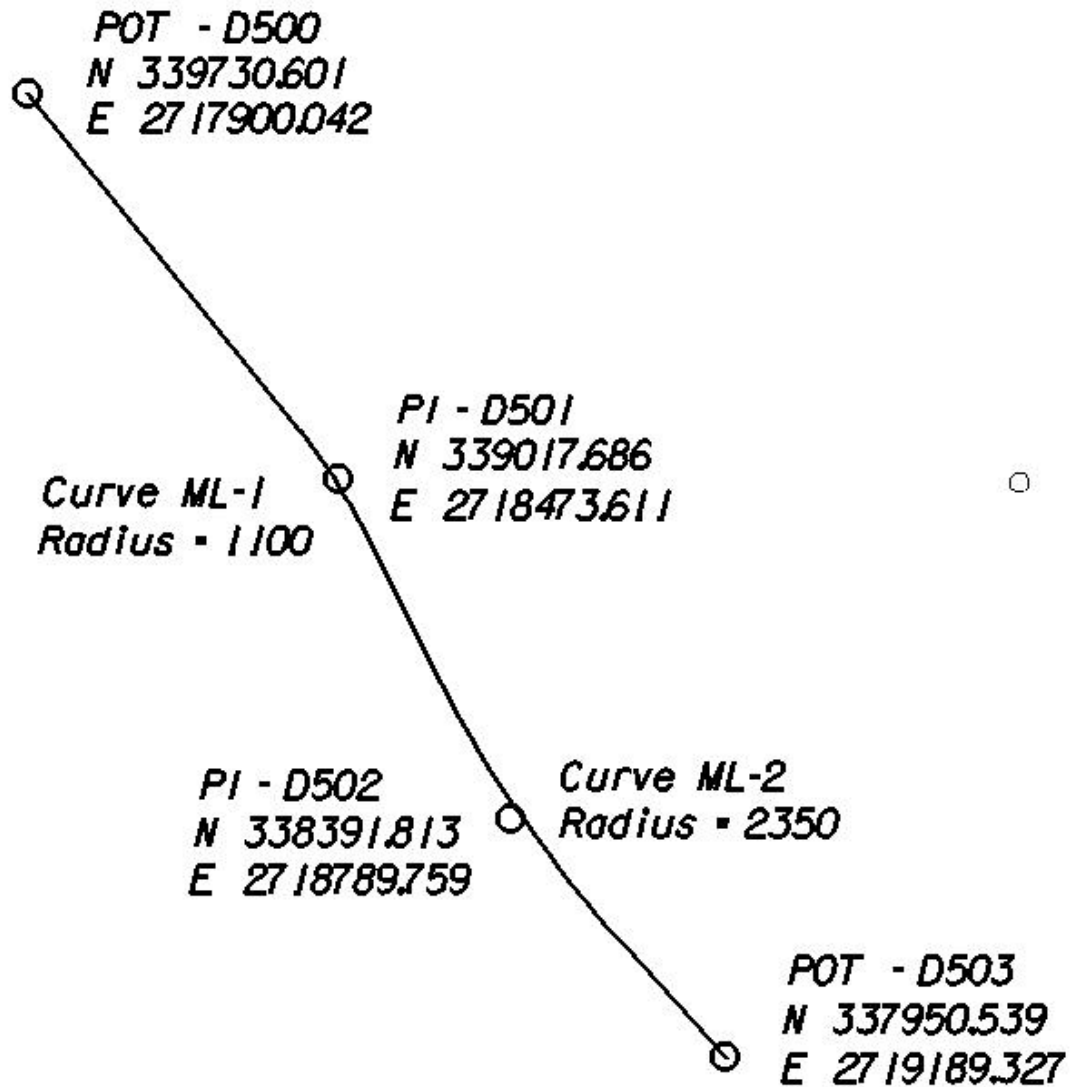
**Step 4.** Click **OK** to access the coordinate geometry dialog box shown below.



This dialog box is completely re-sizable, so you can position it where you're most comfortable.

## 4.2 Store Geometry

Our course project has 4 alignments. We'll store two of them using Coordinate Geometry. The first alignment will be called **MAINLINE** and is shown below:

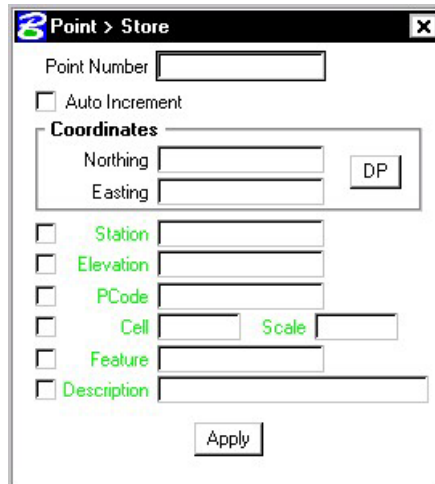


### 4.2.1 Store Points

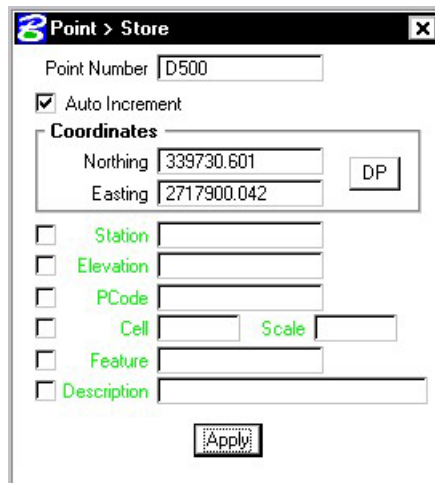
- Step 1.** Select the visualization option **Permanent Visualization** on the main COGO dialog box.
- Step 2.** Access the Store Point dialog box by pressing the **Store Point** icon



or using the **Element > Point > Store** pulldown.



**Step 3.** To store point D500, manually enter the point number and coordinates as indicated in the dialog box below. Activate the **Auto Increment** toggle which will automatically increment the point number by 1 for subsequent Store Point commands.



**Step 4.** Press the **Apply** button to store the point into the COGO database.

**Step 5.** Continue storing points **D501-D503** by utilizing the coordinates shown on the alignment diagram. When complete, exit the Store Point dialog box by pressing the “X” in the upper right hand corner.



Note that the following point naming conventions should be followed:

- Design – All points should begin with **D** (e.g. D501, D502, etc.).
- Hydraulic – All points should begin with **H** (e.g. H501, H502, etc.)
- Survey – All points should begin with **S** (e.g. S501, S502, etc.)
- Traffic – All points should begin with **T** (e.g. T501, T502, etc.)
- Right of Way – All points should begin with **R** (e.g. R501, R502, etc.)
- Environmental – All points should begin with **E** (e.g. E501, E502, etc.)
- Utilities - All points should begin with **U** (e.g. U501, U502, etc.)

## 4.2.2 Store Curves

**Step 1.** Access the **Store Curve from Tangents** dialog box by pressing the Store Curve from Tangents icon



or select Elements > Curve > Store > From Tangents from the COGO menu bar.

**Step 2.** To store **Curve ML-1**, complete the dialog box as shown below and press **Store**.



NOTE: Pressing the “picture” buttons allows you to select from multiple methods of defining the Back and Ahead Tangents

**Step 3.** To store **Curve ML-2**, complete the dialog box as shown below and press **Store**.



NOTE: Visualized points may be selected to complete any field that requires defined points or directions.

**Step 4.** Dismiss the Store Curve from Tangents dialog box by pressing the “X” in the upper right hand corner.

### 4.2.3 Store Chain

**Step 1.** Invoke the **Store Chain** dialog box by pressing the Store Chain icon



or select **Element > Chain > Store > From Elements** from the COGO menu bar.

**Step 2.** Fill in the dialog box as shown below.



**NOTE:** You can enter the elements manually or select the visualized elements graphically in order to fill in the dialog box.

**Step 3.** Press **Apply** and dismiss the Store Chain dialog box. The chain **MAINLINE** should be visualized in the design file.

### 4.2.4 Describe Chain

From the COGO dialog window, let's preview the geometry of the chain we just stored.

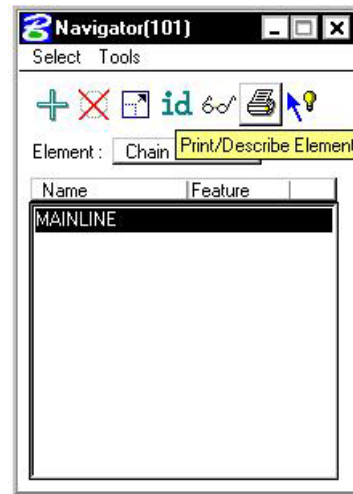
**Step 1.** Select the COGO **Navigator** icon



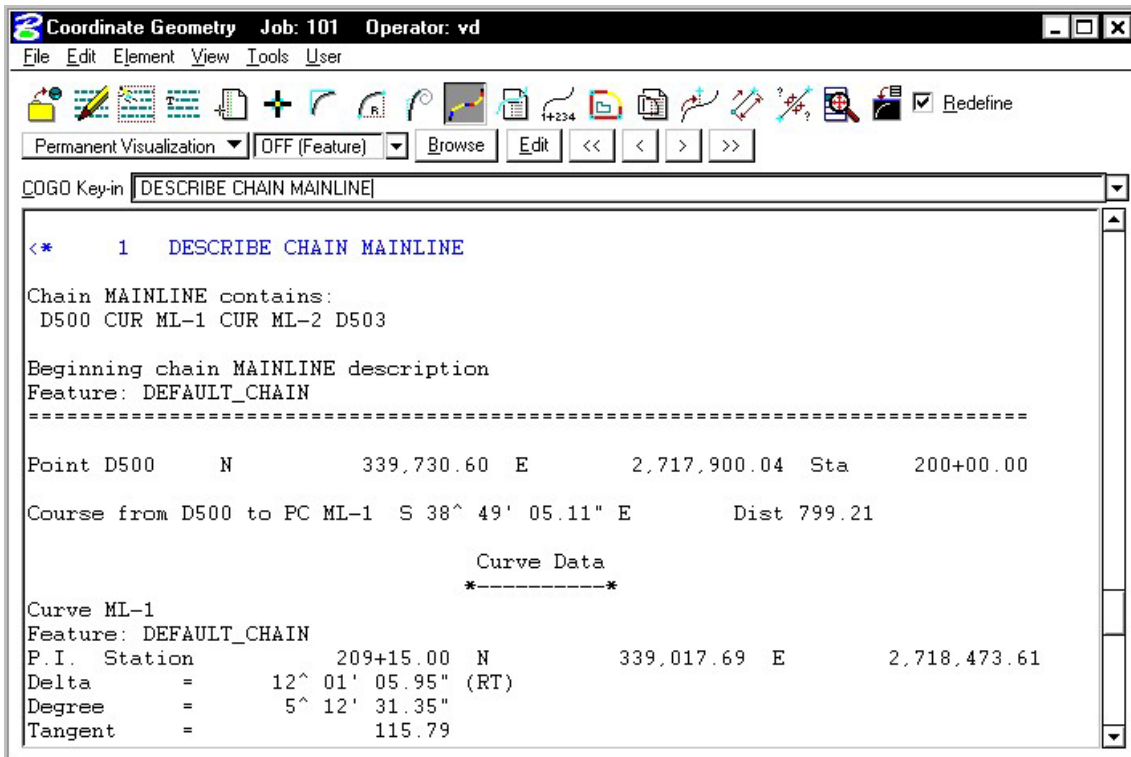
or use the **Tools > Navigator** option on the COGO menu bar to access the COGO Navigator dialog box.

**Step 2.** Set the element option to **Chain** and highlight the chain **MAINLINE**.

**Step 3.** Press the "printer" icon.



**Step 4.** The chain geometry output will be displayed in the main COGO window.



- Step 5.** To save an input trail of your commands, select **File > Save** from the COGO menu bar. Fill out the dialog box as shown below and press **OK**. The saved file will be called 'ML101.ivd'.

The 'Save' dialog box has a title bar 'Save'. It contains two input fields: 'Save As' with the text 'ML' and 'Subject' with the text 'Chain MAINLINE'. Below these is a section labeled 'Files' containing a table with two columns: 'Name' and 'Subject'. The table is empty. At the bottom of the dialog are two buttons: 'OK' and 'Cancel'.

- Step 6.** To save an output file with the actual results of the computations, select **File > Output** from the COGO menu bar. The saved file will be called 'ML101.ovd'.

The 'Output' dialog box has a title bar 'Output'. It contains one input field: 'Output File' with the text 'ML'. Below this is a section labeled 'Files' containing a table with two columns: 'Name' and 'Subject'. The table is empty. At the bottom of the dialog are two buttons: 'OK' and 'Cancel'.

- Step 7.** From the Edit pulldown, select **Edit > Clear** to 'clear' out all the commands that we just previously typed in.

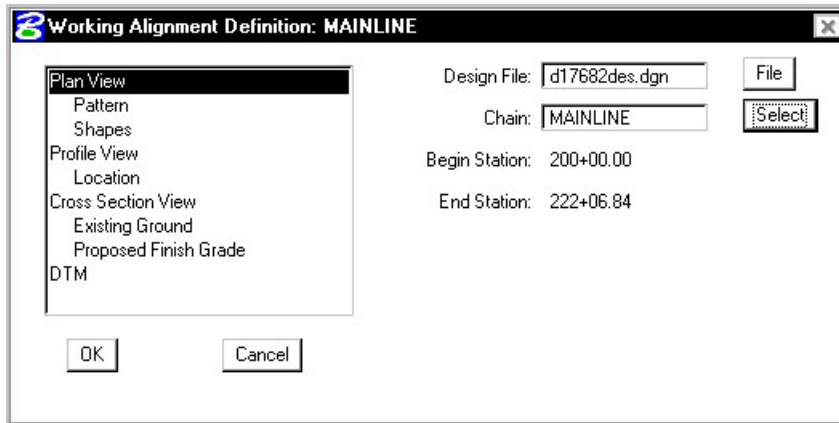


This will not remove the stored data from COGO.

### 4.3 Working Alignment

Now that we have our alignment, we have another piece of information for the Working Alignment definition.

- Step 1.** Access the Project Manager Road workflow dialog box.
- Step 2.** Click the **Define** button to access the Working Alignment Definition dialog box.
- Step 3.** Highlight the **Plan View** option and use the **File** and **Select** buttons to populate the Design File and Chain fields as shown:

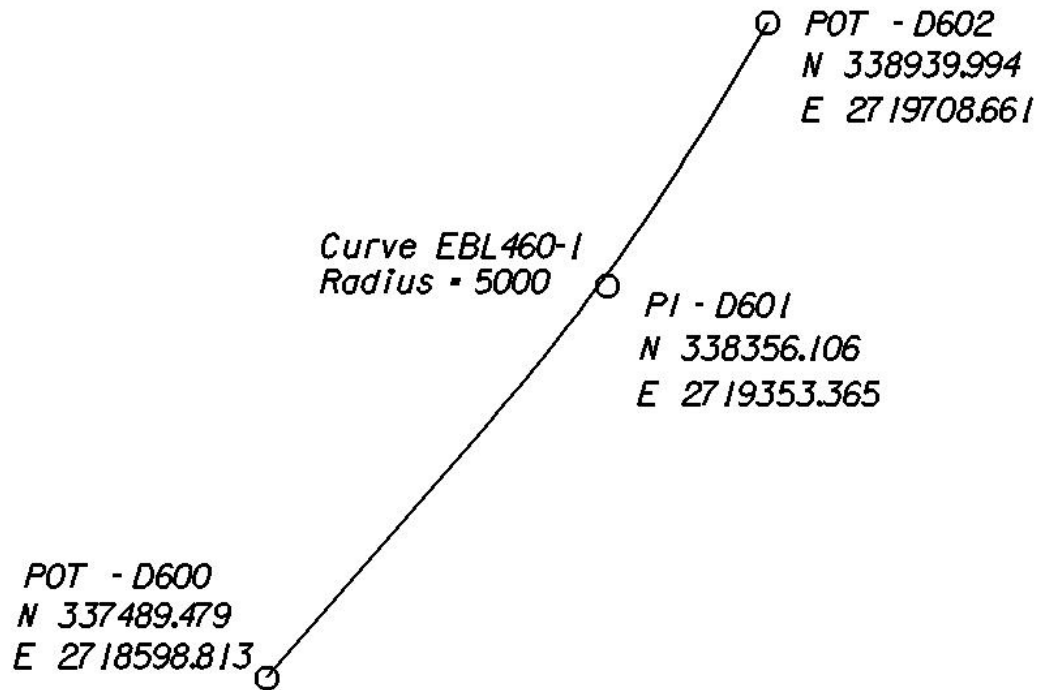


- Step 4.** Click **OK**.



## 4.4 Store Another Alignment

Using the same general steps we learned in storing the previous alignment, use the diagram below to store another chain 'EBL460'. The beginning station of the chain will be **107+00**.



Save an input trail of your commands.

**Exit** COGO.

**Exit** MicroStation.