

Overview

03/24/06

The guide discusses procedures for calculating final earthwork quantities using GEOPAK. This is abbreviated guidance. Only some of the more common techniques for calculating earthwork are discussed in this manual. For a more comprehensive discussion of using GEOPAK and calculating earthwork see the GEOPAK help files within the application.

This guide does not discuss survey techniques and practices need for calculating earthwork.

This guide discusses two methods of calculating earthwork;

1. Average End Area Method from Cross Sections
2. Surface to Surface Volumes from Digital Terrain Models

Some of the procedures needed to calculate earthwork are the same for both methods and some are different. The following outline highlights the procedures are applicable to each method.

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Most of the procedures discussed in this guidance are listed chronologically. When using this guidance you need to reference the above outline to know which procedures are applicable to your calculations.

Determine Method of Calculating Earthwork

03/24/06

If you are calculating earthwork quantities for a roadway, you should use the “Average End Area Method from Cross Sections”. Plan Quantities (as-designed) have been already calculated. If so you will want to compare the as-designed quantities with the as-built quantities.

If you are calculating earthwork quantities for a borrow, waste or stockpile site you probably should use the “Surface to Surface Volumes from Digital Terrain Models” method. This method is more applicable to small and less linear sites.

There are some exceptions to the above recommendations. Occasionally, the “Surface to Surface Volumes from Digital Terrain Models” calculation method has been used for complex sections of roadways like at an interchange. However advanced DTM modeling skills are required (GEOPAK Site) to use “Surface to Surface Volumes From Digital Terrain Models” when materials removed such as pavement removal and materials add such as new pavement intersect in space. Interim DTM’s with these surfaces removed need to be created. This advanced modeling is not covered in this guide. Surface to Surface Volume comparisons don’t allow for haul distance comparison. If average haul needs to be recalculated, cross sections need to be used.

Sometimes the “Average End Area Method from Cross Sections” method is used for borrow, waste or stockpile sites because the information was gathered by field book notes (without electronic data gathering tools). The “Average End Area Method from Cross Sections” is also used when a site needs to be formally document by cross sections.

Occasionally both methods of calculating earthwork are used for comparison.

Setting Up or Identifying the Working Directory

11/20/08

Electronic files used for final earthwork calculations should be stored on the NDDOT Central Office CADD Server (r: drive). Final earthwork quantity information should typically be stored in the “as-built” directory of the project folder. See the NDDOT CADD Standards Manual section 2.1.

You may want to initially store project files in a working directory on the c: or g: drive. After you are satisfied with the results of your earthwork you must move this information to the correct project file on the r: drive so it can be stored with the rest of the projects final records.

Preparing Files

11/12/08

Earthwork by Cross Sections for Roadways

If you are calculating earthwork by cross sections and comparing it to as-designed calculations you will probably start out with the following files.

1. GEOPAK database file (*.gpk) from design
2. Cross-Section Drawing (xsec_*.dgn) from design - Copy the design cross section drawing into your working directory (as-built directory).
3. A final ground data file from survey
4. Selected CADD resource file (generic input files) from
S:\STANDARD\XM\GEOPAK\Criteria\As-built_Earthwork.

Note, “DTM.dgn” and “Shape.dgn” are optional files that could be copied but recreating these drawings is recommended.

Earthwork by Cross Sections for Borrow, Waste or Stockpile Sites

If you are calculating earthwork by cross-sections for a borrow, waste or stockpile site (starting from scratch), you will probably start out with the following files

1. Existing ground data from a survey
2. Final ground data from a survey
3. Selected CADD resource file (generic input files) from
S:\STANDARD\XM\GEOPAK\Criteria\As-built_Earthwork.

Note, the drawings “DTM.dgn”, “xsec*.dgn”, “Align.dgn” and a new GEOPAK database file (*.gpk) will need to be created for these calculations. If you are calculating earthwork for a borrow, waste or stockpile site you probably are not referencing any previously defined alignments and it will simpler to create a new “.gpk” file.

Earthwork from Surfaces

If you are calculating earthwork directly from surfaces for a borrow, waste or stockpile site (starting from scratch), you will probably start out with the following files

1. Existing ground data from a survey
2. Final ground data from a survey

Note, the drawing “DTM.dgn” and a new GEOPAK database file (*.gpk) will need to be created for these calculations.

The survey data is usually in stored in files with a .txt, .csv, .asc or .dat extension. This data will be used to create surfaces and or cross-sections that GEOPAK will use for earthwork calculations.

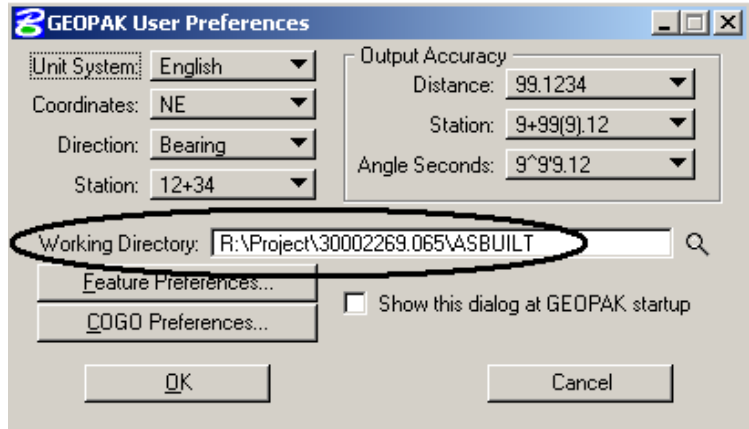
The most common surface model that the NDDOT uses is a “triangulated irregular network” of points. This surface is stored in a file with a “.tin” extension. This surface is sometime referred to as a “digital terrain model” (DTM). You will need these files to calculate earthwork. The only time you will not need at least one *.tin file is when both of the following conditions occur; you use the “Average End Area Method from Cross Sections” and final cross section data is taken at the exact same stations as the existing ground data was surveyed.

GEOPAK User Preferences

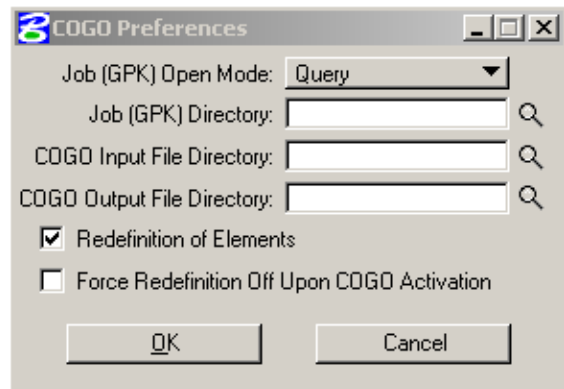
11/12/08

Certain user preferences need to be set up when you use GEOPAK. The “User Preferences” dialog can be accessed from the “Applications>Road>User Preferences” pull down menu. You need to set these directories so that GEOPAK stores information in the correct location. If you do not check these preference settings you could save data over somebody else’s. These preferences should be checked every time you use GEOPAK.

Set the working directory path in this command box. Use the asbuilt or directory discussed in the “Working Directory” section of this guide. Once you have set the working directory you may need to set the COGO Preference. Select the COGO Preferences button. This should open the COGO Preferences dialog box.



Most of these setting are left empty. If the fields for “Job (GPK) Directory”, “COGO Input File Directory”, and “COGO Output File Directory”, are empty, these settings will default to the “Working Directory” as previously setup. Occasionally you may want to set the Job (GPK) Directory if your “Working Directory” doesn’t contain the GPK file that you are working with (example: your “Working Directory” is [\\Asbuilt](#) and the GPK file is in the [\\Design](#) directory). Once this is complete or settings have been confirmed (usually as shown) push the OK button to close the two dialog boxes.



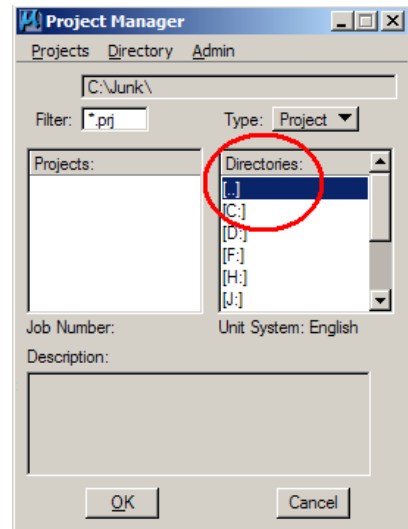
GEOPAK has a tool named “Project Manager” that helps manage settings for a project. Project Manager overwrites several GEOPAK user preferences. In earlier versions of GEOPAK, the NDDOT promoted this tool as an optional tool. Today this tool is strongly recommended. See the next section.

Some settings such as “Global Working Directory” are only available in Project Manager. You may have to activate “Project Manager” to edit this setting.

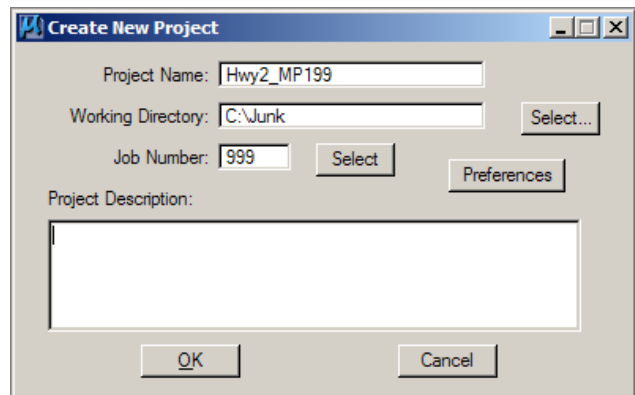
Project Manager Setup for GEOPAK Road

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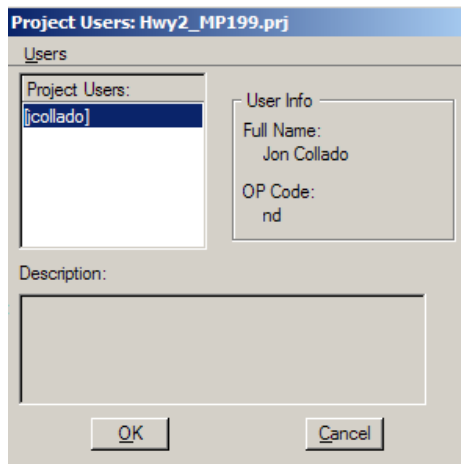
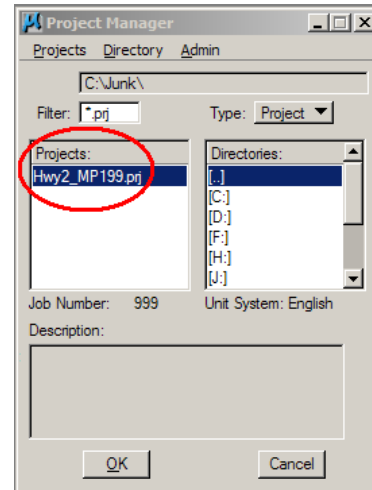
1. Project manager can be activated from the main pull down menu, “Applications>Road>Project Manager”, or the GEOPAK Road tool box.
2. The Project Manager dialog box for project selection or setup should open. Select the directory where you want to save the “*.prj” file. The prj file is a “project” file that is used to point to other project manager resources. This file is typically stored in your project working directory. Use the “Directories:” panel to select the working directory. Note, the path shown as “[..]” selects a parent directory of the presently selected directory (moves out one directory). The selected directory will show near the top of the dialog box. In this picture it is shown as “C:\Junk\”.



3. After the location for the “*.prj” (project) file has been selected. Create the project file by selecting “Projects>New” from the Project Manager dialog box for projects. A “Create New Project” dialog box will open. Type an applicable “Project Name:” (example, Hwy2_MP199). Usually there is only one prj file per working directory so the naming convention isn’t extremely important. Select the working directory and a Job Number for the GPK file. If you select a Job Number for a GPK file that doesn’t exist, a new GPK file will be created. The Project Description is optional.

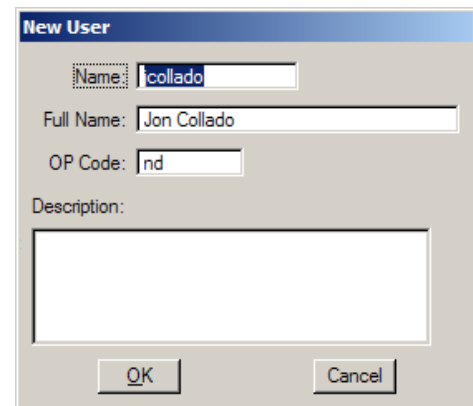


4. Select the “OK” button after filling the information for the “Create New Project” dialog box. The Project Name should now show up in the Project Manager dialog box for projects. Select the “OK” button to select the newly created project. A “Project Users:” dialog box should open.

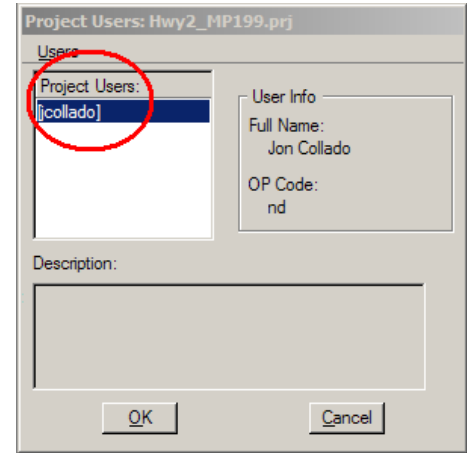


5. Project manager can keep track and segregate the work of several different users if the separate users are setup. Select “Users>New” from the Project Users dialog box.

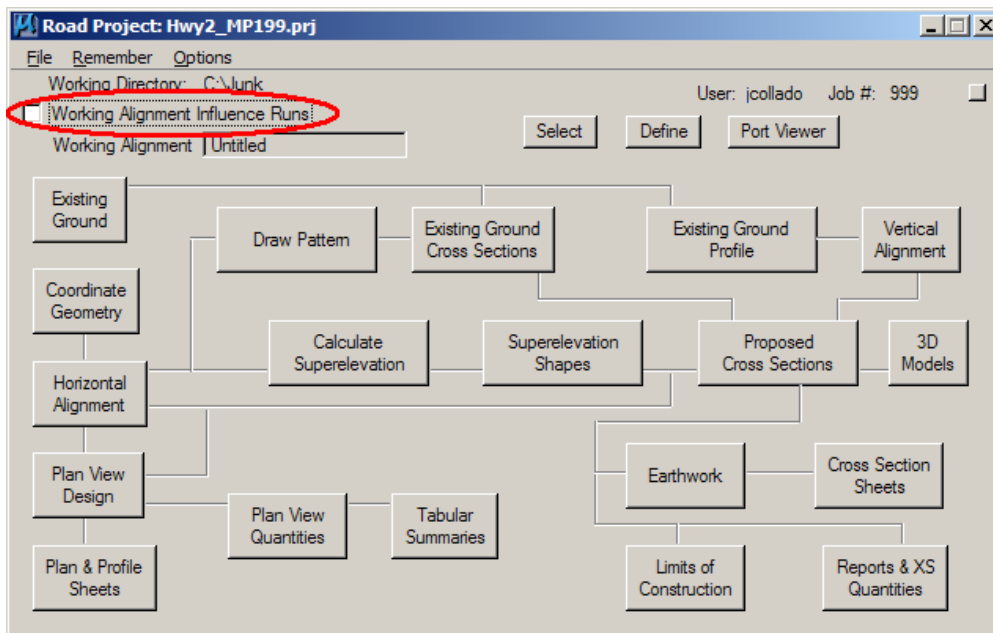
6. Fill out the information for the New User. The Name should be your NDDOT email name (example, “jcollado”). The CADD Standards Promote using your email name because this name should be unique within the NDDOT. Example, there could be more than one person named “Jon” working on the same project. **Users sharing the same name at the same time within one project manager may cause problems such as crashing and corruption of project manager files.** The “Full Name” field should just be your full name (example, “Jon Collado”). The OP code: should be “nd”. This is an Operator Code. It is used in some files named by GEOAPAK. The description is optional. Select the “OK” button after the user information has been set up. You will be prompted to password protect your files. Select No.



7. Within the Project User dialog box, select the user. The user should be highlighted in the Project Users panel. Select the “OK” button and the “Road Project” dialog box will open.



8. This is the “Road Project” dialog box. It is very robust and this manual will discuss only a few of its features. This dialog box may be used when drawing cross section elements and calculating earthwork as discussed latter in this manual.



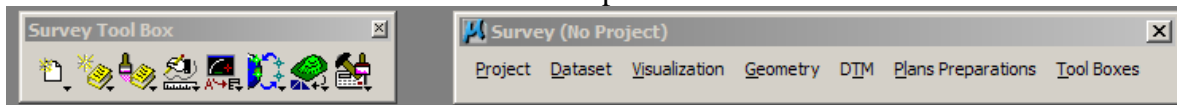
9. The “Working Alignment Influence Runs” is a setting that is not used in this manual. You may not always have one fixed working alignment definition for one alignment. For simplicity, toggle this option off.

Survey Project Preferences

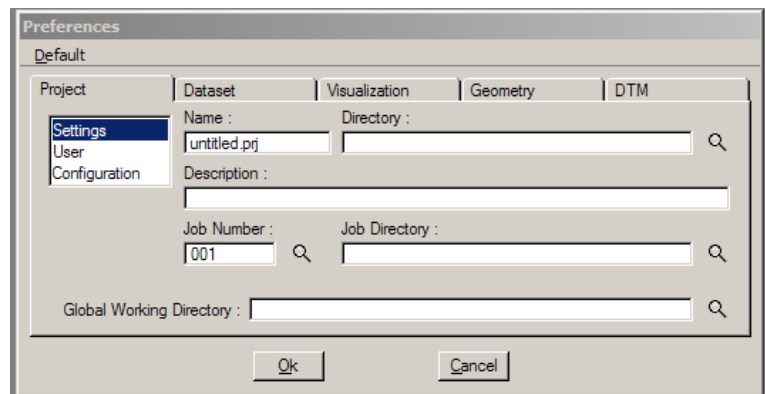
12/31/08

GEOPAK Survey uses a “*.prj” project file similar to Project Manager. Using GEOPAK Survey and Project Manager for Road at the same time is not recommended.

1. GEOPAK Survey can be activated by selecting “Applications>Survey” from the main pull down menu. The “Survey Tool Box” and a separate survey menu bar should open. Most of the same tools can be access from either the tool box or the menu bar. This manual will use the menu bar for the most part.

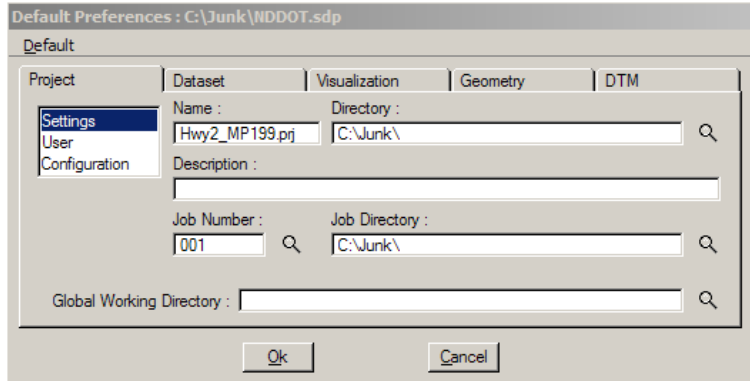


2. Several preferences need to be setup. From the Survey menu bar select “Project>Preferences”. The Preferences dialog box should open.



3. Many of these preferences can be imported by selecting “Default>Open”. Pick the file “S:\STANDARD\XM\GEOPAK\Survey\NDDOT.sdp”. Notice the name of the dialog box changes from “Preferences” to “Default Preferences”.
4. Several “default” preferences will be load such as; Dataset>Linking Codes, Visualization>Settings, and Visualization>Cross Sections. However you will need to edit several Project preferences.
5. Select the “Project” tab in the preferences dialog box. On the left side of the dialog box there is a selection panel. Select “Settings”.

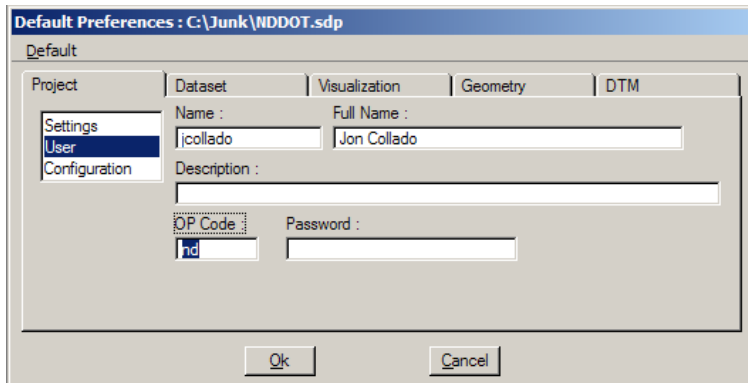
- Rename the project “Name” from untitled.prj to something more applicable (example, Hwy2_MP199.prj). Usually there is only one prj file per working directory so the naming convention isn’t extremely important. Select the Directory and Job Directory. These directories should typically be set to the project working directory.



Setting the global Working Directory is not recommended because it can’t be adjusted outside of GEOPAK Survey. Set the Job Number for the GPK file. If you select a Job Number for a GPK file that doesn’t exist, a new GPK file will be created. The Project Description is optional.

- On the left side of the “Default Preferences” dialog box, select “User” in the selection panel.

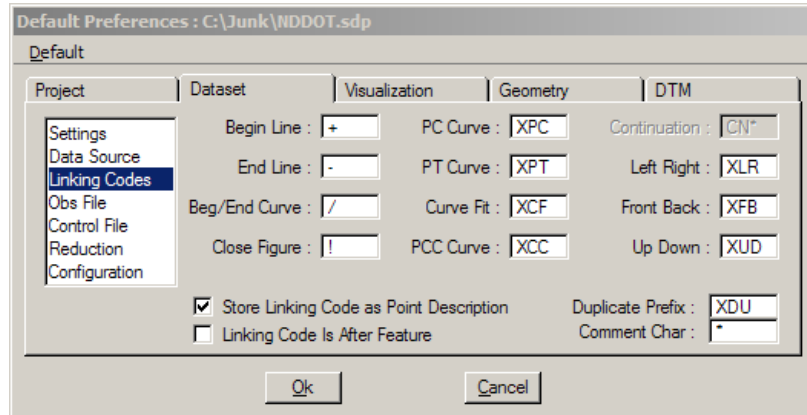
- Fill out the information for User. The Name should be your NDDOT email name (example, “jcollado”). The CADD Standards Promote using your email name because this name should be unique within the NDDOT. Example, there could be more than one person named “Jon” working on the same project.



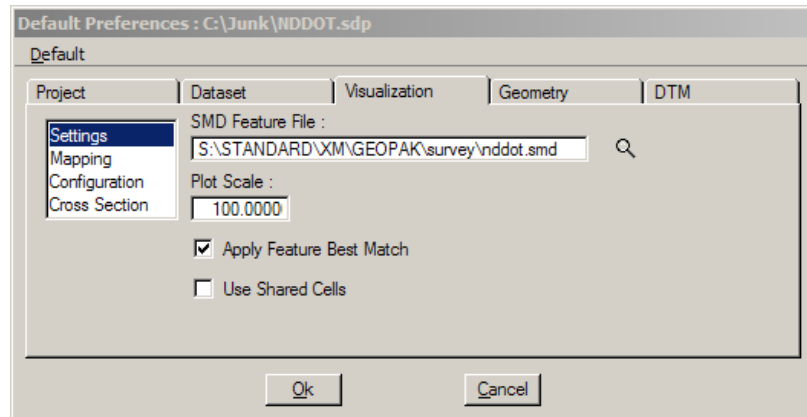
Users sharing the same name at the same time within one project may cause problems such as crashing and corruption of project manager files. The “Full Name” field should just be your full name (example, “Jon Collado”). The OP code: should be “nd”. This is an Operator Code. It is used in some files named by GEOAPAK. The description is optional. Don’t use the password field. Select the “OK” button after the user information has been set up.

- The following settings (Dataset>Linking Codes, Visualization>Settings, and Visualization>Cross Sections) should have been imported from the NDDOT.sdp file. They will be reviewed for informational purposes.

12. The Linking Codes can be set under the “Dataset” tab within the “Linking Codes” panel extension. The Linking Codes are also discussed in the NDDOT CADD Standards, Section 4.6.



13. Under the “Visualization>Settings” the standard nndot.smb should be selected and the “Apply Feature Best Match” should be activated. The “Apply Feature Best Match” option allows slight variations of a point code names (example; BRK1, BRK2 and BRK3 will all be considered as break lines “BRK”).



14. Under the “Visualization>Cross Section” the standard symbology for cross sections is setup for existing ground.
15. The Default Preferences must be resaved after the editing. If you don’t save them, they will be lost. Default Preferences are not the same as active Preferences. Default Preferences are stored in a *.spd file. Active Preferences are temporarily stored in a rsc file. Select “Default>Save As” from the Default Preferences dialog box to save the project default settings. Using the same names for the *.prj and the *.spd files is recommend for intuitive file navigation.
16. Select the “OK” button after the preferences have been set up. The “Project Preferences” dialog box will close.

Creating a Digital Terrain Model (DTM)

11/13/08

Digital Terrain Models are often used for drawing cross sections and earthwork. Usually DTM's are needed for both existing and as-built ground surfaces. DTM's are often stored in files with a ".tin" extension.

Sometimes projects may not require field personnel to create a DTM. Here are some instances when you may not need to create a DTM

1. Someone else has created a DTM for you. DTM's of existing ground for roadway alignments are often created by Surveys and Photogrammetry in the Design Division. If you are working on roadway earthwork you may be able to use the DTM that Design created. However, Design seldom creates as-built DTM's. So Field personnel may be required to make as-built DTM.
2. If field data was taken at regular intervals – transversely at specific stations, a DTM may not be required. Cross Sections can be created directly from data files that contain station, northing, easting and elevation information or cross sections can be created directly from data files that contain station, offset and elevation information. However, the stationing for the existing cross sections must match the stationing for the as-built cross sections. If additional cross sections are needed, additional field data will need to be collected. Choosing to collect data at regular intervals in order to directly create cross sections (skip creating a DTM) does not usually save time. Using xyz data collected transversely across a roadway instead of at irregular intervals in order to create a DTM is discouraged because the cross sections obtained from these DTM's are often misinterpreted.

If you don't need to make a DTM you can skip the following step. The following procedures discuss how to create a DTM. Both GEOPAK Road and GEOPAK Survey can be used to create a DTM. There are variations of both of DTM creations methods. Both of these methods extract survey data from a text file.

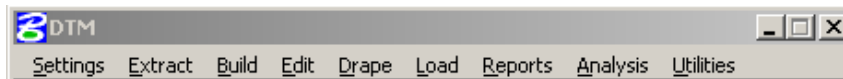
Two methods are presented here. However, using GEOPAK Survey to visualize the data before creating a DTM is strongly recommended. Visualizing the data early on in the process may point out surveying shortcomings. The GEOPAK Road method can use break lines, but it requires more work to correct problems. Sometimes these problems are easier to correct by graphical methods and you'll end up extracting graphics anyway.

Creating a DTM using GEOPAK Road

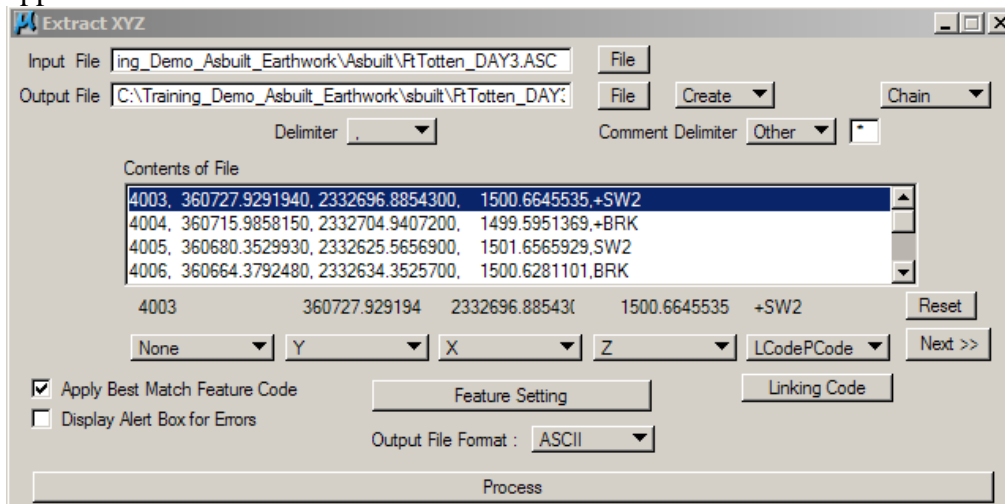
1. Create and or Open the drawing DTM.dgn. For this simplified DTM use the standard seed file “S:\STANDARD\XM\seed\NDDOTseed.dgn”.
2. Select “Applications> ROAD>DTM Tools” from the main pull down menu. The following tool box will appear.



3. From the DTM tool box, select the “DTM Menu” tool (it is the icon that looks like a data collector). The menu bar shown below should appear.



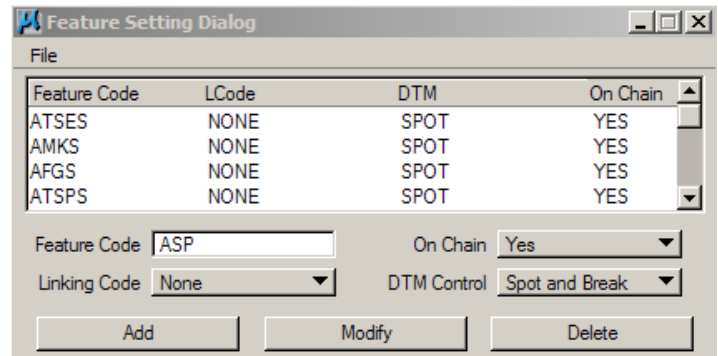
4. Select “Extract>XYZ” form the DTM menu bar. The following dialog box will appear.



5. The input File is the file from your total station survey equipment. It should have a point number, Northing, Easting, and Elevation. The data may also contain Link Codes, Point Codes and Comments.
6. The output file is the file that GEOPAK will create. This file usually has a “dat” extension. In proceeding steps the “dat” file will be used to make a “tin” or DTM file. In review, the survey ASCII “asc” file is used to create a GEOPAK output data “dat” file which will then be used to create a DTM “tin” file. Your file name should be something that you can recognize from the name. It is a good practice to use the same name with different extensions for the creation of one surface (example: pile4final.asc, pile4final.dat, pile4final.tin). You can use the File buttons to set these and it should be stored in the working directory.

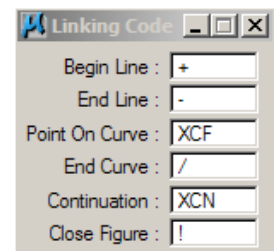
- Once you have set the “Input File” and “Output File” the contents of the input file should be similar to the one shown in step 4. GEOPAK is particular in that the Delimiter and the Comment Delimiter can not be the same. So you may need to edit the file you got from your total station so, for example there is only a “comma” that separates the Northing, Easting and Elevation and a “*” that separates your comments. Once you have selected your input file and delimiters, select the first line of the input file as shown in the “Contents of File” panel. The data contained on that line should appear above the buttons that say “None”. Next select each button that has something above it and set it to the feature that best identifies it.

- Link and point codes can also be setup. Select the “Feature Setting” button. The “Feature Settings Dialog” box should open. From this dialog box, select “File>Open”. The settings for this dialog have been saved to a file named “Limited_DTM_Features.adf”. This file can be copied from S:\STANDARD\XM\GEOPAK\Survey. This file should be reviewed to see if all your pcodes are included. If they are not included you will need to add them.



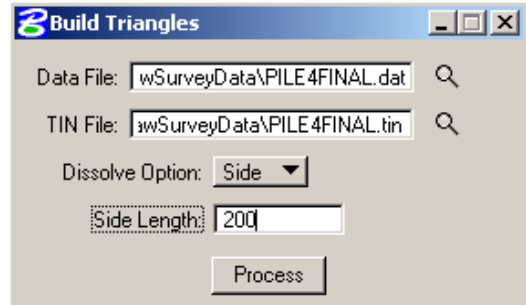
- In the “Extract XYZ” dialog box, make sure “Apply Best Match Feature Code” toggle is on. This is import because we number features to be identified and addressed similar to unnumbered features (example, BRK, BRK1, and BRK2 will be treated the same way)

- From the “Extract XYZ” dialog box, select the “Linking Code” button. Fill out the codes as shown.
- From the “Extract XYZ” dialog box, choose the “Process” button.



- If you haven’t assigned PCodes, you may receive an alert if you are not using the point code. Say OK to the alert, the PCode is not mandatory. GEOPAK will create the “dat” file. You can use Windows Explorer to confirm its creation. After the “dat” file has been created the “Extract XYZ” dialog box can be closed.

13. The next step is to build the triangles. This is done by choosing “Build>Triangles” from the DTM menu bar. The following box will appear.

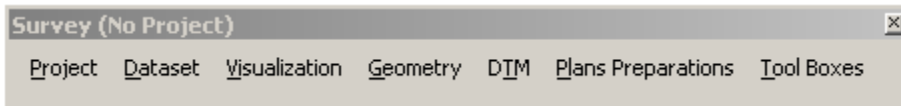


14. The Data File in this box is the name of the file that you just created in the previous steps. The TIN file name should again be a file name that you can recognize from its name. The Dissolve Option will help eliminate any unwanted triangles. Your triangles generally do not have very long sides but this depends on how close of shots the surveyor took. My suggestion is to set the Dissolve Option to “Side” and input a side length of 200. Once you have done this you want to choose the “Process” button.
15. At this point you should have a “tin” file –have created at DTM. These steps will need to be repeated if you have multiple surfaces (example: existing ground and as-built ground).

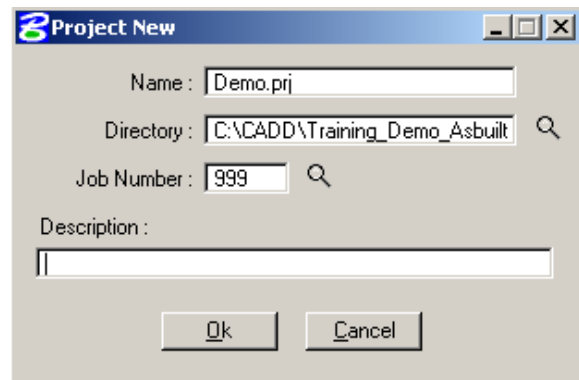
Creating a DTM using GEOPAK Survey

This section discusses how to extract survey information from a text file into a drawing and then extract the drawing information into a DTM. The advantage with this method is that the break lines can be visually reviewed before the DTM is created. The intermediate step of extracting the survey data into a drawing will allow for visually checking the data for crossing break lines and Boundaries.

1. Create and or Open the drawing DTM.dgn. For this DTM creation method the 3D seed file “S:\STANDARD\XM\seed\3D_NDDOTseed.dgn” will be required. If you are modeling both existing (preconstruction) and as-built (new) conditions, using two different drawings (DTM_exst.dgn and DTM_asbuilt.dgn) is recommended. This will simplify the process by helping to prevent existing elements from getting into the as-built DTM and prevent as-built materials from getting into the existing DTM.
2. Import survey levels. The easiest way to do this is by opening a survey stg (select “NDDOT>Select Settings>Photo>Topog” from the main pull down menu. Then close the select settings dialog box that just opened.
3. Select “Applications>SURVEY>Survey”. A “Survey” menu bar and toolbox should appear. Most of the tools from the menu bar and the tool box are the same. This section will discuss GEOPAK Survey in terms of the menu bar.

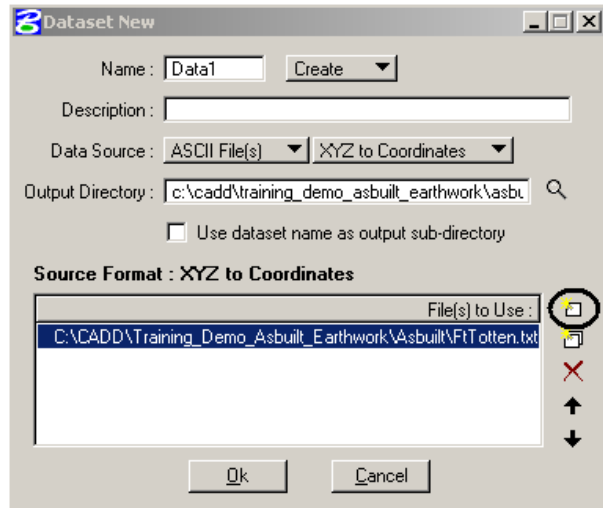


4. From the Survey menu bar select “Project>New”. If you had previously created a Survey Project for a NDDOT project, you would select open. You can add multiple cross section data sets to your previously stored project (example: cross sections for different borrow pits). The box to the right should appear. Fill in the Project Name, with a name that refers to the area you are working with. Set the Working directory to the same directory that you created earlier, use the select button. If you set up the Survey Project Preferences most of this information will already be populated.

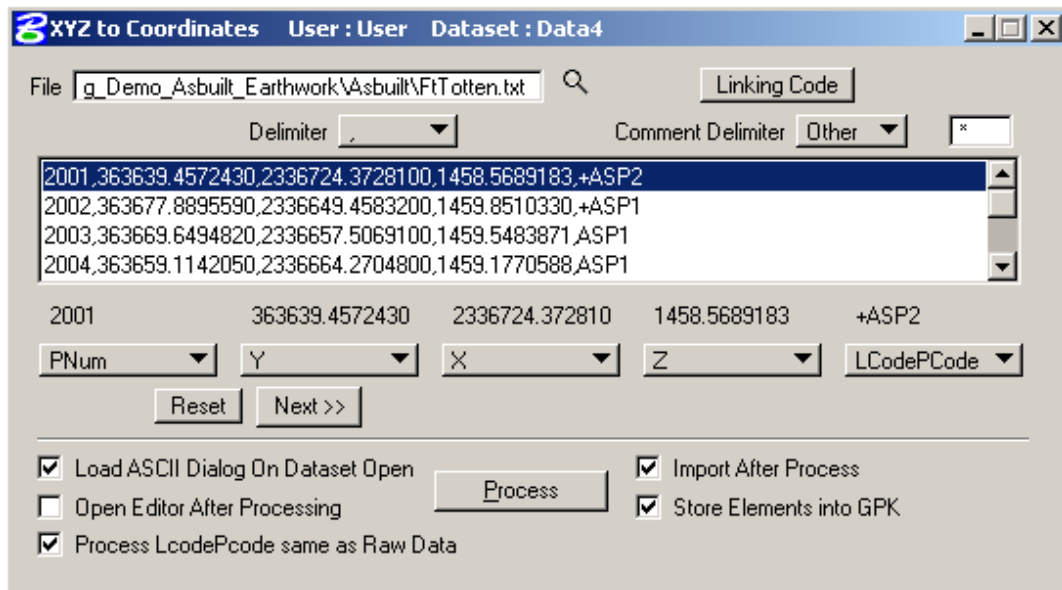


5. You could use the gpk file –job number that is used for alignments but you must be certain that point names are not reused. Often it is easier and safer to create a new gpk file just for the dtm extraction. The Job Number 999 often reference to a temporary DTM file. The project description area is optional. Then click OK. The “Project New” dialog box should close.
6. Confirm that the “Project Preferences” were setup correctly. See the section title “Survey Project Preferences”.

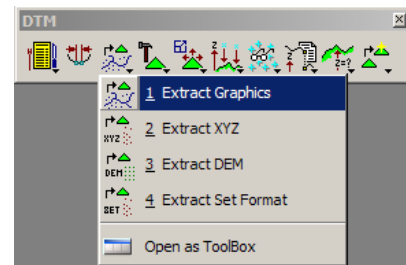
7. From the Survey menu bar select “Dataset>New”. The box to the right should appear. Give the data set a name (example: Data1). The Description is optional. Set the “Data Source” to “ASCII File(s)” and process to “XYZ to Coordinates”. Set the “Output Directory” to your Working Directory (As-built folder). Then select the “Dataset Add Source File to List” button. Then pick the ASCII file that contains your survey coordinate data. The panel on the bottom of the “Dataset New” dialog box should show the file you just selected. Next select the “OK” Button.



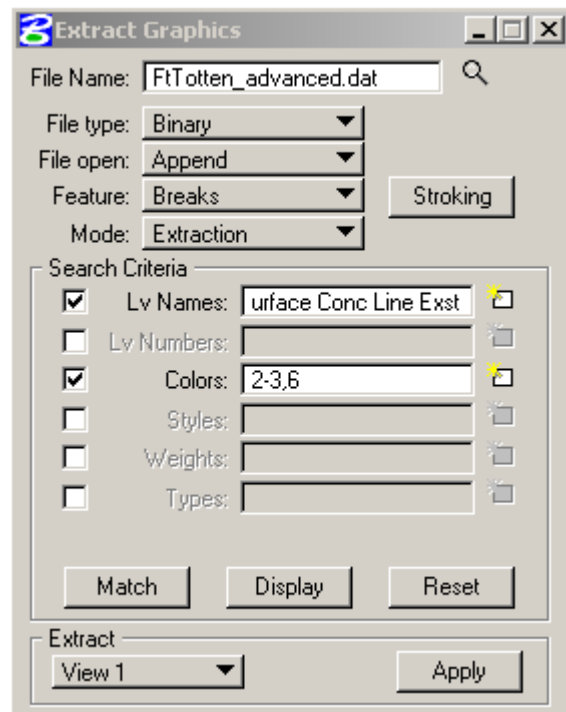
8. Another dialog box (XYZ to Coordinates) should appear. The Contents of your ASCII file should appear in the middle panel. Set the appropriate “Delimiter” usually “Space” or “,”. Then select the first line of data. It should become highlighted.



9. What you should see happen is that the text of the line you chose appears above the button that says none. Your next step is to click on each of the “none” buttons and choose the appropriate description for the text that is above the button. It should look like the box above. You will need to keep hitting the next bar until you have a description under each field of text.
10. Activate the options “Import After Process” and “Store Elements into GPK”. Then select the “Process” button. The survey data will be drawn into your 3D drawing.
11. After the data is drawn by GEOPAK Survey it should be examined. Make sure there are no crossing break lines. Also check the side or front views for drawing – survey elements that don’t appear to be on the ground surface (example, check for elements that have a negative or zero elevation - all element should appear as if they are on a surface with realist elevations). The “XYZ to Coordinates” dialog can be closed after the drawing has been inspected and corrected. Problems with surveys and surveying techniques are not discussed in this manual.
12. Select “DTM>DTM Tools” from the survey menu bar. From the DTM Tools select Extract Graphics.



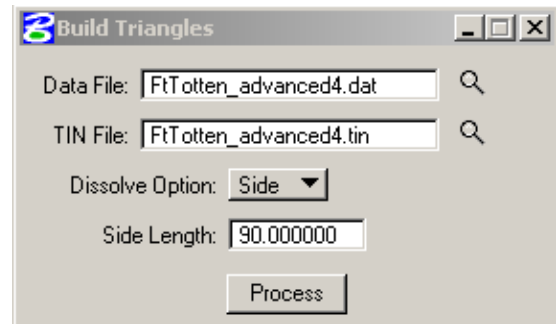
13. The dialog box to the right should appear. This dialog box – tool is used to create a “dat” file from the drawing graphics. Provide a file name for the dat file. This data file is usually created in two parts. One part extracts the break lines and the other part extracts the points. In the first part of the extraction the “File Open” option must be set to “Create” and during the second part of the extraction the “File Open” option must be set to “Append”.



14. The “File Type” can be “Binary” or “Ascii”. “Binary” is smaller and faster but it can not be reviewed directly. An “Ascii” file can be reviewed with any text editor. The “File open” option needs to be set to “Create” to extract the first group of features. In these directions the first group of features will be “Spots”.

15. Set the “Search Criteria” for spots. This criteria should exclude symbology for break lines. The “Match”, “Display”, and “Reset” buttons can be used to help select the search criteria.
16. After the search criteria is selected, select the “Extract” option. If a view is used such as “View 1” be sure to adjust the view so you can see the spots that you need to extract. If you are zoomed in and only see some of the points, then only those points will be extracted.
17. Select the “Apply” button and the Spots – Points will be imported into the dat file.
18. Switch the “File open” option to “Append” and set the “Feature” option to “Breaks” (break lines). Reset the Search Criteria and select symbology that matches the break lines.
19. After the search criteria is selected, select the “Apply” button and the break lines will be imported into the dat file.
20. “Boundaries”, “Voids” and other features can also be imported in to the dat file using this tool. Close the “Extract Graphics” dialog box after the dat file has been created.

21. Select “DTM>Build DTM>From Dat File” from the Survey menu bar. The “Build Triangles” dialog box should open.



22. Select the dat file created previously and provide a name for tin file that is about to be created. It is a good habit to use similar names for the raw survey ascii file, the dat file and the tin file.

23. Set the “Dissolve Option” to “Side” and set the “Side Length” to the maximum length of the side of a desired exterior tin triangle. This setting may have to be set by trial and error. If the value is too big, deceptive exterior triangles will be created. If the value is too small, the tin surface coverage may be gapped. See the section of this “Reviewing and Displaying a DTM”

24. Select the “Process” button to create the tin. See the next section of this manual “Reviewing and Displaying a DTM”.

Reviewing and Displaying a DTM

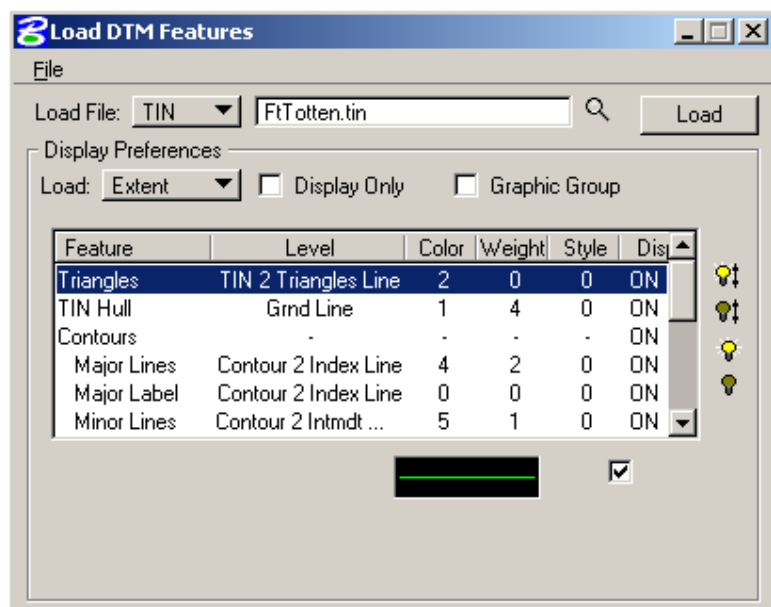
12/26/08

Once you have created existing ground and as-built ground DTM's, you should compare the models by having GEOPAK draw them. A drawing of the DTM's will also be required if you need to store an alignment through the center of the model.

There are several parts of a DTM that can be displayed. The steps listed here will display the TIN Hull (boundary), Triangles and Contours. This drawing can be used to check the coverage. The models should overlap and adequately tie to one another. The points should be dense enough to represent the surface. The Contours from the existing ground and the as-built ground should merge near the tie points.

1. This process assumes that the DTM menu bar is loaded and you are in the DTM drawing. If this is not so, see steps 1-3 from "Creating a Digital Terrain Model Using GEOPAK Road".

2. Select "LOAD>DTM Features" from the DTM menu bar. The box to the right will appear. Set the "Load File" button to "TIN", and then go search for the tin files for your project. GEOPAK can only draw features for one tin – surface at a time so these steps will have to be repeated for each surface. Set the "Load:" option to "Extent". Turn off the "Display Only" option. If the "Display Only"

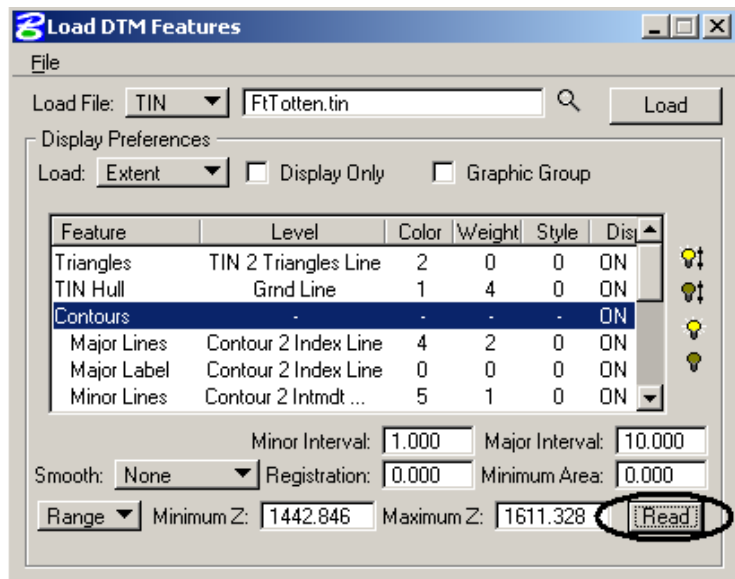


option is turned on the elements displayed will only be temporary. They will not be saved with the drawing. Next under the Feature items make sure the Display is on for only the Triangles, Tin Hull and Contours. To do this, you can double click on the line that says Triangles. Do the same for the TIN Hull and Contour lines. The light bulb icons to the right can also be used turn on and off the display of a feature.

- Unique symbology for the different elements, especially for the levels, can simplify your review of the “tin”. Levels can be turned off when they aren’t being reviewed.

Feature	Existing Ground (Preconstruction)				As-built			
	Level	Color	Weight	Style	Level	Color	Weight	Style
Triangles	TIN 1 Triangles Lines	1	0	0	TIN 2 Triangles Lines	2	0	0
TIN Hull	Tin Hull Line 1	1	2	0	Tin Hull Line 2	2	2	0
Major Lines (Contours)	Contour 1 Index Line	2	2	0	Contour 2 Index Line	4	2	0
Minor Lines (Contours)	Contour 1 Intmdt Line	3	1	0	Contour 2 Intmdt Line	5	1	0
Major Label (Contours)	Contour 1 Index Line	2	0	0	Contour 2 Index Line	4	0	0

- The settings for “Contours” such as intervals and labels may need to be adjusted for your specific project. The elevation “Range” for the contours needs to be set or “Read”.



- Once the symbology is set choose the “Load” button. You should see triangles, boundary lines (Tin Hull) and contours on your MicroStation screen. If you don’t see your DTM use the “Fit View” tool in MicroStation.

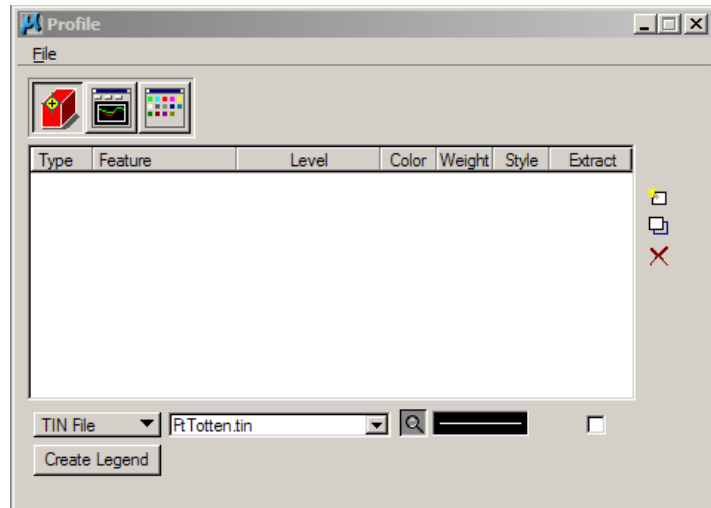
- Repeat the proceeding steps for the other DTM if needed. Separate drawings are recommended for each DTM. Presently there isn’t unique symbology for all features used in a survey such as break lines and spot shoots.
- Once both DTM’s are drawn you will probably need to used “Level Display” to turn on and off levels to clearly compare tin models.

Review DTM by Analysis of Profiles

11/13/08

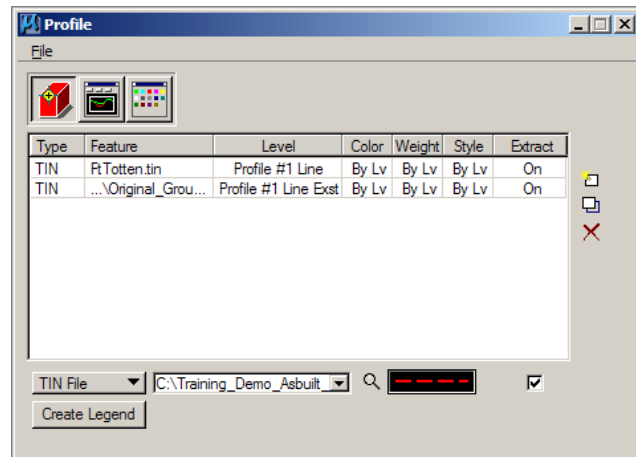
This tool can be used to cut profiles- cross sections from one or more DTM's. This tool can cut several profiles very quickly without storing a formal alignment. Sometimes it is easier to study a profile rather than an entire surface.

1. This process assumes that the DTM menu bar is loaded and you are in the DTM drawing. If this is not so, see steps 1-3 from "Creating a Digital Terrain Model Using GEOPAK Road".
2. Select "Analysis>Profile" from the DTM menu bar. The box to the right will appear. There are three icon at the top of the dialog box that show different parts of the Profile tool;
 - a. Object selection,
 - b. Create Profile
 - c. Profile Preferences

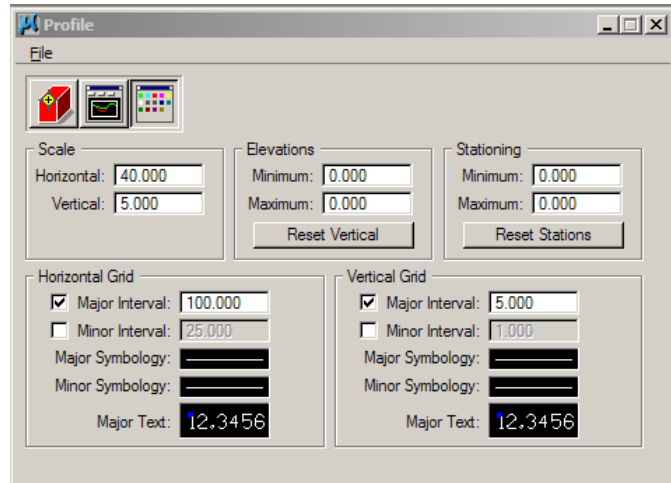


3. Pick the Object Selection icon, select the "TIN file" for the profile. Just to the right of the "TIN File" field is a symbology button to set the symbology for the profile (example: Level ="Profile #1 Line Exst", color=ByLevel, style=ByLevel, Weight=ByLevel).

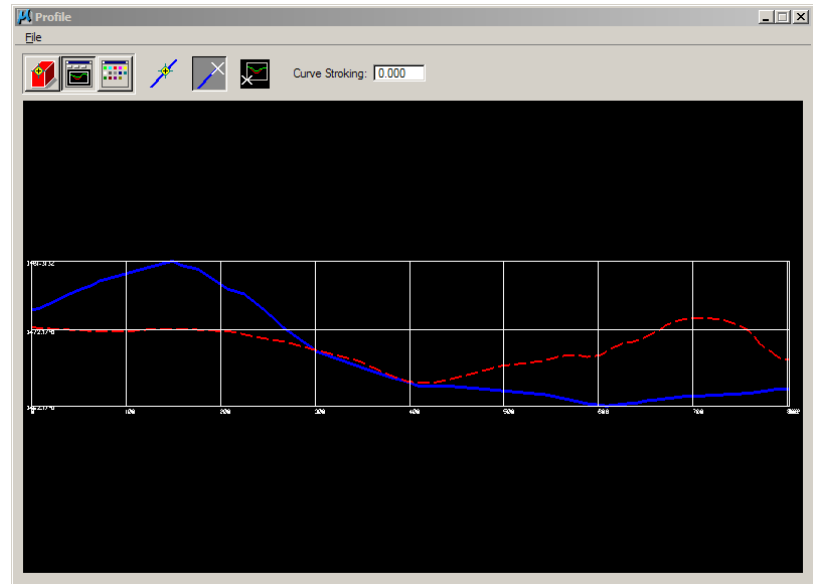
4. After the TIN File has been selected and the symbology set, add the profile to the selection by using the "Add List Item" button on the right side of the dialog box. Note multiple profiles can be cut at one time by adding multiple surfaces to the selection as in step 3 above.



5. Select the “Profile Preference” icon. Set the scale for the profile and grid preferences.



6. Select the “Create Profile” icon. There are two methods to cut a profile. The “Select Element” to identify a previously drawn element such as a line or line string to cut the profile from, or use the “Place Element” button to temporarily draw a line or line string to cut the profile from.



7. After the horizontal alignment for the profile has been selected, the “Extracted Profile View” should have been created. Select the “Place Profile” button place the profile in the drawing. The profile will be attached to the cursor and it can be placed anywhere in the drawing with a right mouse click.

Review DTM by 3D Rendering

10/17/06

(To be added)

Goggle Earth Import

11/20/06

(To be added)

Advance DTM Creation and Editing

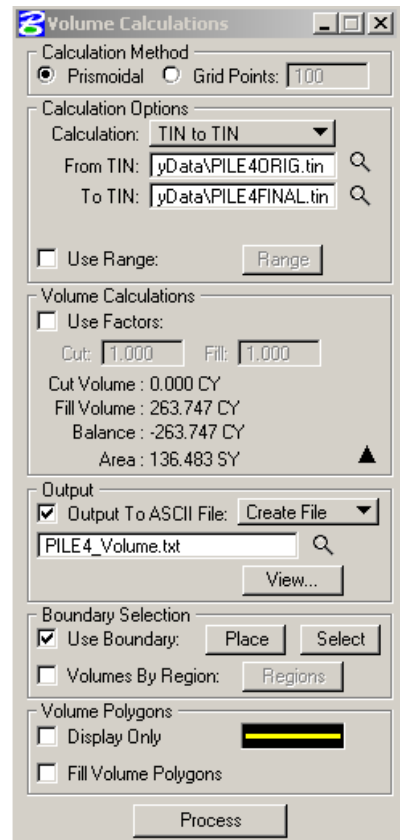
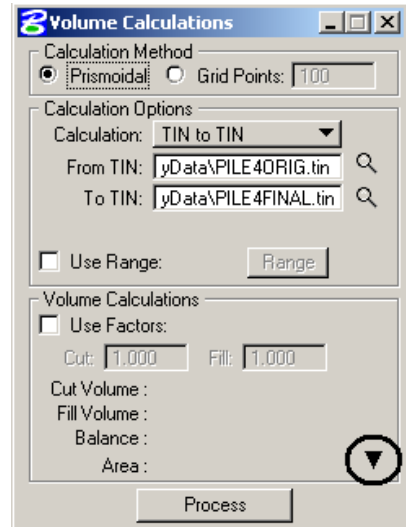
03/24/06

(Interim tins - pavement and base removals)

Earthwork Quantities by Using Surface to Surface Volumes from Digital Terrain Models

03/24/06

1. This process assumes that you have existing and as-built DTM's and that the DTM menu bar is loaded. If it is not, see steps 1-3 from "Creating a Digital Terrain Model".
2. Choose the "Analysis>Volumes" from the DTM Menu bar. The following box will appear.
3. The Prismoidal method should be selected. The Calculation option button should be set to "TIN to TIN". The "From TIN" should be your existing tin file name and the "To TIN" should be your final tin file name.
4. Make sure that your "Volume Calculations" dialog box is expanded to show all the options. There is an arrow-triangle in the lower right area of the dialog box to see the expanded options.
5. Draw a polygon around the area you want to compare volumes. The polygon should be contained within both of your DTM's. It is important to draw and save your boundary polygon incase you need to reproduce GEOPAK's Exact Calculation.
6. In the expanded area of the "Volume Calculations" dialog box select the option to "Output to ASCII File". The ASCII File name should have the same path of your project file and you should give it a file name that you can recognize from the name. Select the Option "Use Boundary" and select the boundary you drew in step 5.
7. Select the "Process" button. You should see Volume Calculations for, Cut Volume, File Volume, Balance, and Area. Remember the volumes may or may not include aggregate and pavement. This is dependent on when the survey was done. The volume data is stored in the "Output To ASCII File". This file can be reviewed with the GEOPAK "Text Editor" or with the NOTEPAD application.



Storing a Horizontal Alignment (Chain)

11/20/08

If you are calculating earthwork from cross sections and a horizontal alignment has not previously been stored, you will need to store an alignment. This situation typically occurs when you are making cross sections for a borrow, waste or stockpile site.

If you are calculating earthwork for a roadway and comparing as-designed quantities with as-built quantities a horizontal alignment should already be stored in an existing GPK file.

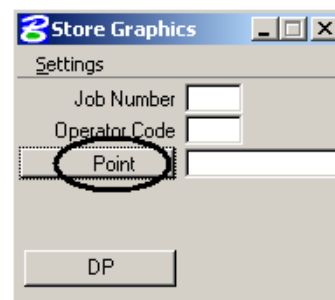
If you are calculating earthwork directly from surfaces you do not need an alignment.

This section assumes that only a very simple alignment is needed for a borrow, waste, or stockpile site. This simple alignment will consist of only a line with a start and end point. This alignment must extend beyond the affected site (longer than the earthwork area). This alignment should run close to the center of the site.

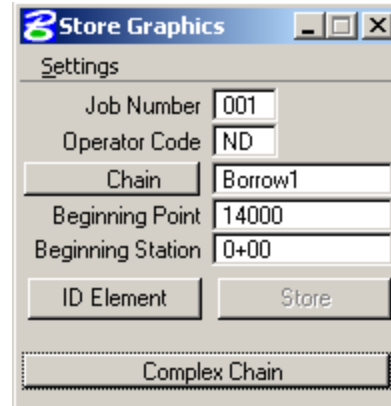
Some sites require more complex alignments. Complex alignments are not discussed in this manual. Complex alignments can cause areas of concern such as intersecting cross sections and centroid adjustments.

This section discusses how to store an alignment in GEOPAK using the “Store Graphics” tools.

1. Create and open the Align_*.dgn. Make sure you use the standard seed files.
2. Reference in the DTM_*.dgn. This reference file should have the TIN hulls (survey surface boundary drawn in it.
3. Draw a straight line through the site. The line should be longer than the earthwork site - start and end beyond the areas of earthwork. This line will become the GEOPAK alignment. Make sure to draw the line with the first point representing the beginning of the stationing and the second point representing the end of the stationing.
4. Open the “Store Graphic” dialog box by selecting “Applications>ROAD>Geometry>Store Graphics”. You might have to change the element option from “Point” to “Chain” within the Store Graphics dialog box.



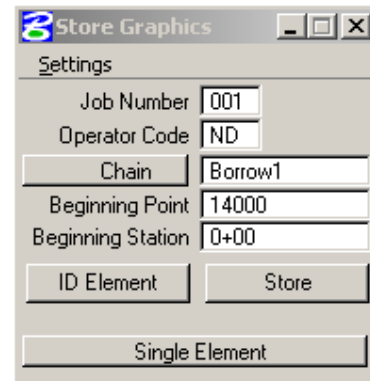
- Fill out the dialog box. The dialog box to the right shows some typical values. The Job Number is the number of the main GEOPAK database. Don't worry if it doesn't exist yet. GEOPAK will prompt you for it's creation in a following step. The "Operator Code" should be "ND" this will help standardize files created by GEOPAK. Chain names should descriptive like "Borrow1", "Waste1" or "Pile1". Point numbers used by the District for As-builts should be between 14000-14999. These point numbers have been standardized incase design elements need to be merged into the as-built GPK.



The beginning point should be a point that has not been stored in GEOPAK. If you have other information in this GPK file you need to see what points are available. If you would happen to use a point number that is already used one of two things could happen. If your COGO redefine key is active it will erase the point that is already stored or if the redefine key is not active it will not store the new point.

- Change the button on the bottom of the dialog box from "Complex Chain" to "Single Element". Note that the "Store" button is disabled at this time. Select "ID Element" Button. Then select and accept the element you drew in step 3 (double click on it).

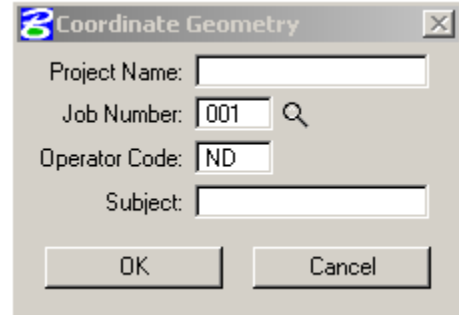
- After you have accepted the element – line, the "Store" button should become enabled. Select the store button to save the alignment into the main GPK data base.



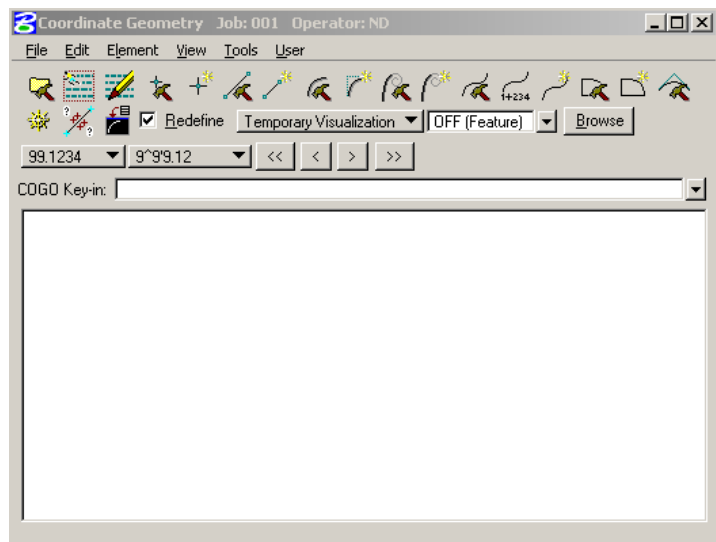
- An ALERT box may appear if the GPK file – "Job Number" doesn't exist. Click the "Yes" button if you wish to create the database.
- You will also be prompted for an "Input File Name". Use the default name provided (j001oND.inp). This file will contain the GEOPAK COGO commands used to create the alignment. This file is only needed if you want to recreate your alignment in GEOPAK. This file will probably not be used again unless something goes wrong with your GPK or drawing file (job001.gpk or Align_*.dgn).

10. At this point the alignment should be stored in GEOPAK. The following steps are not required to store an alignment. However it is good to review your work and confirm that the alignment is in GEOPAK. Open COGO by selecting “Applications>ROAD>Geometry>Coordinate Geometry” from the main pull down menu.

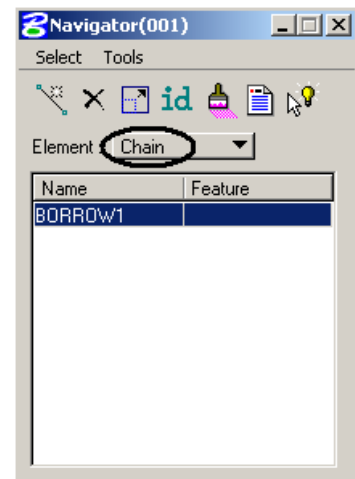
11. A “Coordinate Geometry” box should open. Confirm or fill in the “Job Number” and “Operator Code” fields. The “Project Name” and “Subject” fields are optional fields used for GEOPAK Reports. Then select the “OK” button.



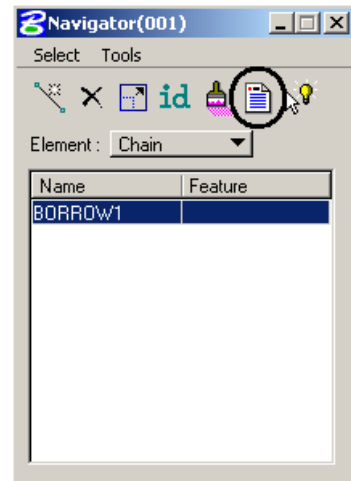
12. The main “Coordinate Geometry” box should open. From this dialog box, select “Tools>Navigator” for the pull down menu.



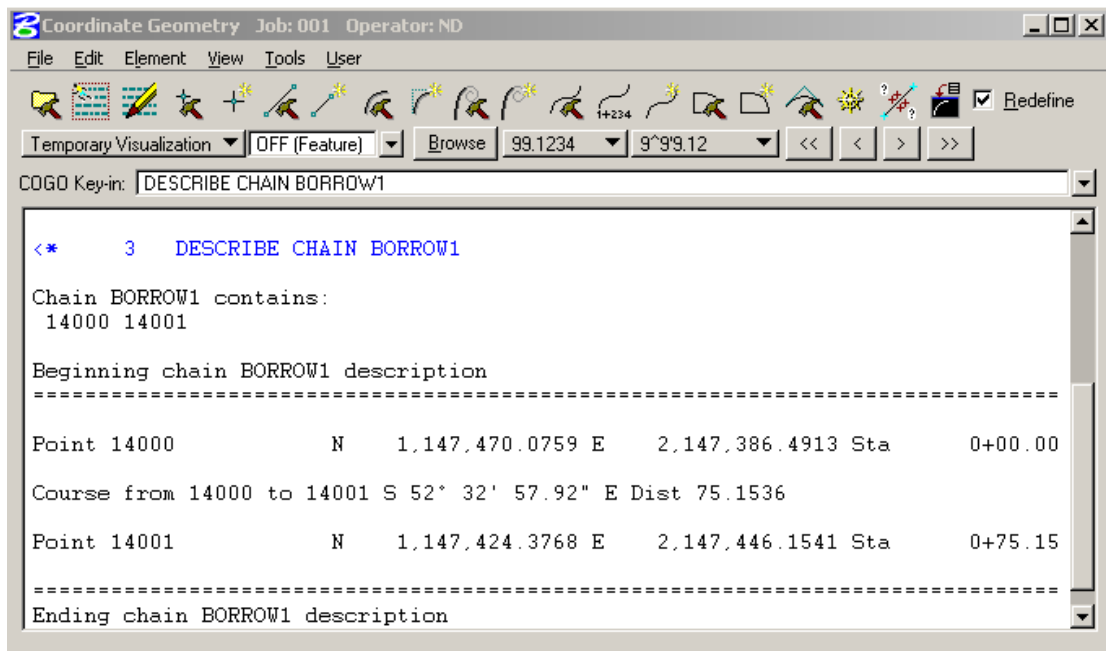
13. The “Navigator” dialog box should open. This tool lets you review the elements that are in your gpk file. Change the “Element” type to “Chain”. The alignment name stored previously should appear in the bottom panel of the dialog box.



14. Select the alignment name. Then select the “Print/Describe Element” icon.

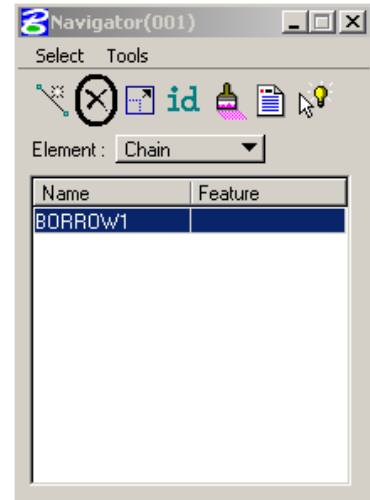


15. The main “Coordinate Geometry” box should display coordinate geometry information about the alignment.



16. After you have reviewed this information, close the “Coordinate Geometry” dialog box. An “Alert” dialog box will open, asking you if you want to save the session. If you are just reviewing the GPK you can exit without saving the session.
17. If something is wrong with the alignment stored in GEOPAK, you will have to repeat previous steps. If you are going to correct elements previously stored in GEOPAK, make sure your redefine button is on in COGO. Redefinition of Elements can also be turned on from the “Coordinate Geometry” dialog box by selecting “User>Preferences>Redefinition of Elements”.

18. If you want to delete elements out of the GEOPAK database, you can use the COGO “Navigator” and the “Delete Element” button (similar to step 14).



Drawing Cross Sections

10/17/06

There are several different methods to draw cross sections. These methods are dependent on how the field data was collected. The following methods will be discussed in this guide.

1. Cross Sections by Station Offset Elevation File (*.soe)
2. Cross Sections by XYZ and Station File (*.xyz or *.cor). The points surveyed in this file are usually collected at “regular” intervals. Groups of points are collected transversally across the road. This file should not be confused with XYZ files used to create a representative DTM in which points are collected at irregular intervals.
3. Cross Sections by Raw Field Data (Station, Offset, Height of Instrument and Raw Rod Readings). This method is used when electronic data collection tools are not available. Data was collected by a field book. This method is sometimes used with “90-1” surveys. Creating cross sections by this method can be cumbersome because someone has to key-in all the field data into a text file.
4. Cross Sections from Surfaces (DTM).

Cross Sections by Station Offset Elevation File

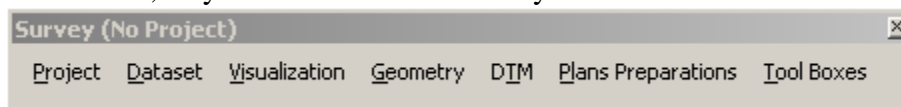
Electronic data collection tools are usually used with this method. Survey field data is stored in a simple text file with a format similar to the following:

```
XS station (-)offset elevation (-)offset elevation offset elevation offset elevation  
XS station (-)offset elevation (-)offset elevation offset elevation offset elevation
```

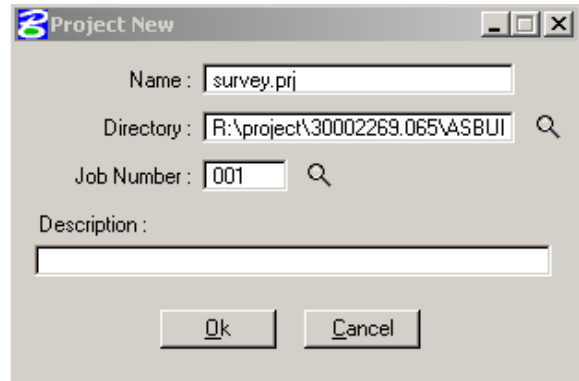
One line can't contain more than 6 offsets and elevations. If more data for one section is needed, create another line with the same station.

This section discusses how to draw cross sections from station offset elevation field data using GEOPAK Survey.

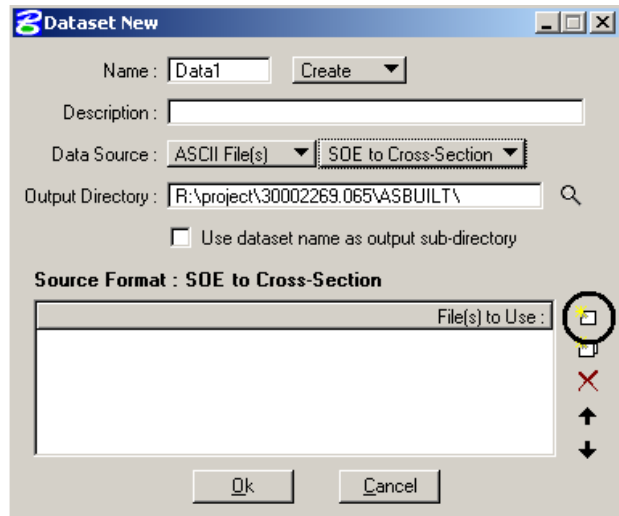
1. Open your cross section drawing. See the “Working Files” section of this guide. This drawing is probably a new – empty drawing that you had to create.
2. Select “Applications>SURVEY>Survey”. A “Survey” menu bar and toolbox should appear. Most of the tools from the menu bar and the tool box are the same. This section will discuss GEOPAK Survey in terms of the menu bar, so you could close the Survey tool box.



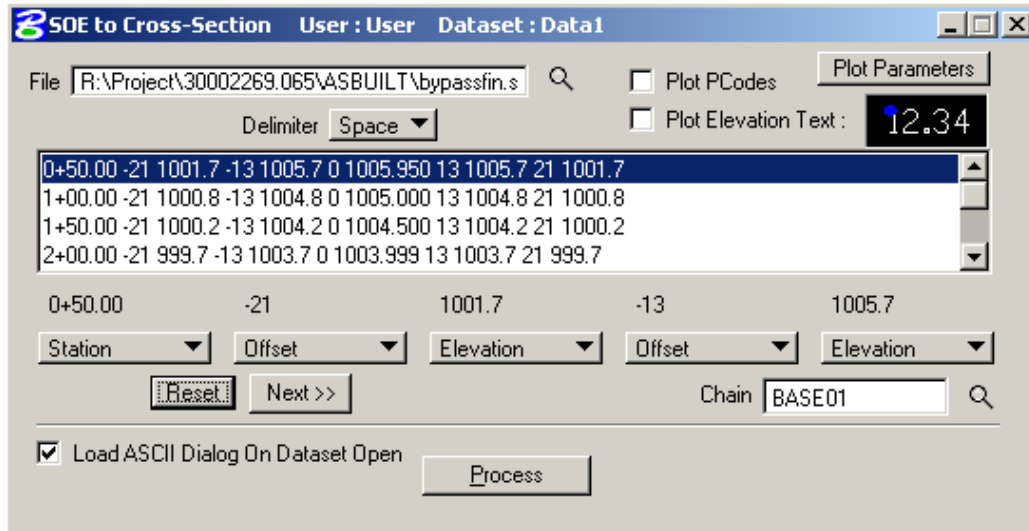
- From the Survey menu bar select “Project>New”. If you had previously created a Survey Project for a NDDOT project, you would select open. You can add multiple cross section data sets to your previously stored project (example: cross sections for different borrow pits). The box to the right should appear. Fill in the Project Name, with a name that refers to the area you are working with. Set the Working directory to the same directory that you created earlier, use the select button. The Job Number is the same Job number used when we initially went into COGO, which is 001, use the select button. You may want to fill out the project description area but it is optional. Then click OK. The “Project New” dialog box should close.



- From the Survey menu bar select “Dataset>New”. The box to the right should appear. Give the data set a name (example: Data1). The Description is optional. Set the “Data Source” to “ASCII File(s)” and process to “SOE to Cross-Sections”. Set the “Output Directory” to your Working Directory (As-built folder). Then select the “Dataset Add Source File to List” button. Then pick the ASCII file that contains your station offset elevation survey data. The panel on the bottom of the “Dataset New” dialog box should show the file you just selected. Next select the “OK” Button.

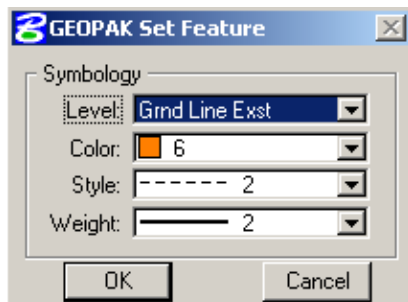
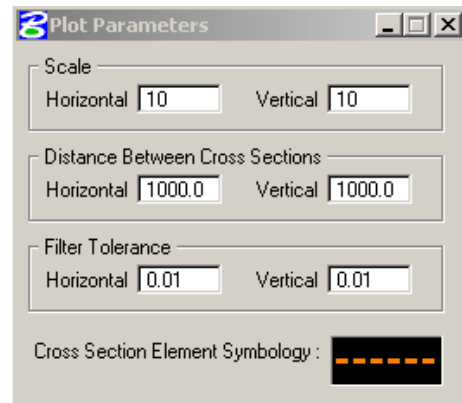


- Another dialog box (SOE to Cross-Section) should appear. The contents of your ascii file should appear in the middle pannel. Set the appropriate “Delimiter” usually “Space” or “,”. Then select the first line of data. It should become highlighted.

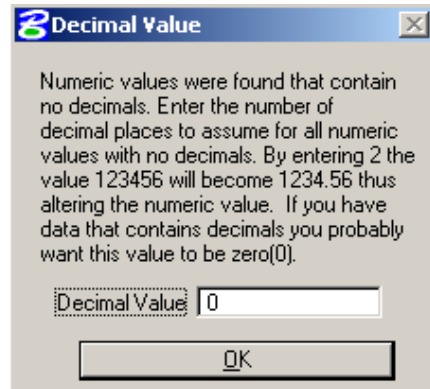


- What you should see happen is that the text of the line you chose appears above the button that says none. Your next step is to click on each of the “none” buttons and choose the appropriate description for the text that is above the button. It should look like the box above. You will need to keep hitting the next bar until you have a description under each set of text.
- Select the chain for the cross sections. This alignment must have been previously stored into GEOPAK.

- Select the “Plot Parameter” button in the upper left corner of the “SOE to Cross-Section” dialog box. Another dialog box (Plot Parameters) should appear. The typical parameters are as show to the right. Don’t forget to set the “Cross Section Element Symbology:” button. The “Cross Section Element Symbology” should be according to the NDDOT CADD Standards.



9. After the “SOE to Cross-Cross Section” dialog box has been filled out, select the “Process” button.
10. An “Alert” dialog boxes may appear. This to confirm that you will be drawing Cross-Sections in the drawing is presently open. This should be your Cross-Section drawing. Select OK.
11. A “Decimal Value” dialog box may also appear if data with no decimals were encountered. Read the dialog box and enter an appropriate value (typically “0”). Then select OK.
12. Finally, GEOPAK should draw the cross-sections. See the section “Viewing Cross Sections” in this guide if you need help reviewing cross sections.



Cross Sections by XYZ and Station File

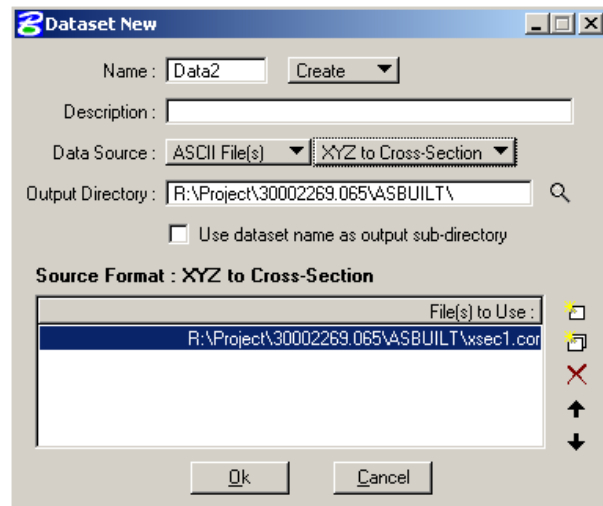
Electronic data collection tools are usually used with this method. Survey field data is stored in a simple text file with a format similar to the following:

```
N 1144153.45462497 E 2140039.09114346 ELEV 1153.30000000 STA 0+00.00
N 1144165.44575907 E 2140039.55234093 ELEV 1153.40000000 STA 0+00.00
```

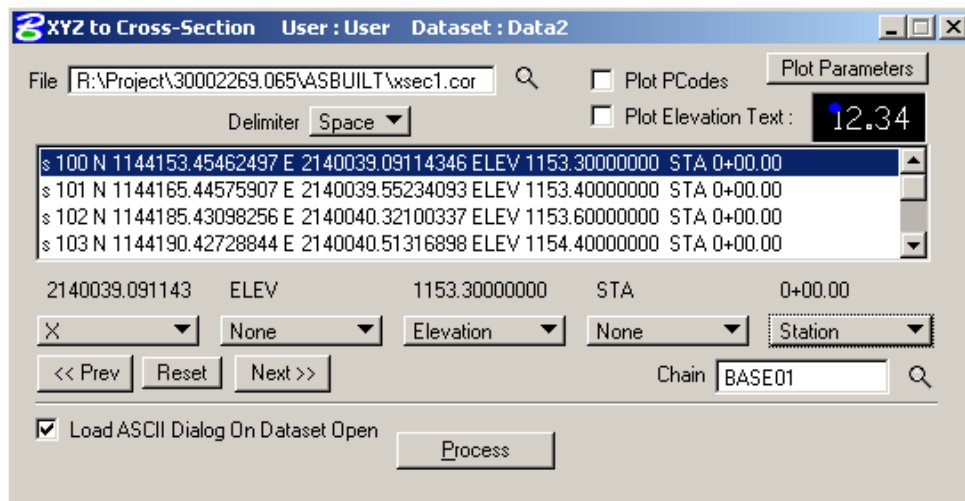
Several different formats are acceptable. The data (northing, easting, elevation and station) must exist in one file and it must be delimited. If there are text strings that are not directly used such as the abbreviation “STA” (not the value itself), set this string to “None”.

The process of Cross Sections by a XYZ and Station file is similar to Cross Sections by SOE method discussed previously. Sets 4 and 6 are a little different.

In step 4, the process should be set to “XYZ to Cross-Section” instead of “SOE to Cross-Sections”.



In step 6, you will have to setup the fields for “Northing, Easting, Elevation, and Station” instead of “Station, Offset, and Elevation”.



Cross Sections by Raw Field Data

This process is similar to the previous process “Cross Sections by XYZ and Station File”. However, additional steps are needed to process the raw data. This section will discuss how to use COGO to convert raw field book information into a “XYZ and Station File”. Then the steps in the “Cross Sections by XYZ and Station File” section can be used to draw cross sections.

Electronic data collection tools are usually not used with this method. This information is collected with a field book and the data will have to be keyed in an ASCII text file with the following format:

```
GROUND chain-name ### OUT xs.xyz
HI elevation
GL station rod-reading distance rod-reading distance rod-reading distance
GL station rod-reading distance rod-reading distance rod-reading distance
END GROUND
END
```

Example:

```
GRO BASE01 14100 OUT XSEC1.COR
HI 1163.10
GL 00+00.00 RT 009.8 133 009.7 121 009.5 101 008.7 96 012.1 88
GL 00+00.00 RT 013.4 86 011.5 83 007.9 76 005.8 61 004.3 41
GL 00+00.00 RT 003.7 33 003.4 14 003.8 0
GL 02+00.00 RT 009.9 133 009.9 123 010.0 103 010.1 84 012.3 77
GL 02+00.00 RT 012.7 72 012.3 65 011.0 61 008.8 54 007.0 43
GL 02+00.00 RT 005.4 33 004.8 25 004.2 13 003.9 0
GL 04+00.00 RT 009.9 133 010.1 116 010.1 103 010.4 77 012.8 72
GL 04+00.00 RT 013.0 68 012.5 62 009.9 55 006.0 42 004.9 33
GL 04+00.00 RT 004.7 23 003.8 9 003.6 0
GL 06+00.00 RT 009.7 133 010.3 103 010.7 84 013.2 78 013.4 73
GL 06+00.00 RT 012.3 68 010.6 61 007.1 52 005.9 45 005.2 33
GL 06+00.00 RT 004.8 23 003.3 15 003.6 8 003.7 0
HI 1163.79
GL 08+00.00 RT 007.8 133 007.2 121 007.6 105 010.0 95 011.1 87
GL 08+00.00 RT 011.9 83 014.2 77 014.2 73 013.1 66 011.6 62
GL 08+00.00 RT 010.9 59 007.7 49 006.0 40 005.8 33 005.3 23
GL 08+00.00 RT 004.8 13 004.3 6 004.3 0
GL 10+00.00 RT 006.5 133 006.4 107 006.9 90 010.2 79 013.2 70
GL 10+00.00 RT 014.1 64 013.2 59 011.8 54 010.3 50 007.8 41
GL 10+00.00 RT 005.8 33 004.6 18 004.0 12 004.4 6 004.5 0
END GRO
END
```

In the example file:

“GROUND” or “GRO”	Is the command to begin a ground based calculation
“BASE01”	Is the chain name (alignment) that resides in the GPK file in the working directory
“14100”	Is the beginning point number for the points that COGO will produce from this run. It is important to start these numbers with a value greater than the numbers used to define the alignment (BASE01) otherwise they could be overwritten!
“OUT”	Tells the COGO run to send data to an output file
“XSEC1.COR”	Is the name of the output file produced. You can change the “XSEC1” part to anything you want
“HI 1163.10”	Describes the height of instrument used in the field book cross sections
“GL”	Is the command for COGO’s Ground Line calculations
“END GRO”	Ends the ground calculation

The stationing is typed following the “GL” command and then the rod reading and distance from centerline are added. Subsequent shots are described with rod reading and offset until the station data is completed. The program does not require + or - signs before entries, as long as the centerline shot is entered with a “0”. If data is included for just one side, the entry should be preceded by a “RT” or “LT” suffix.

Note: Be sure not to have more than 52 characters per line. Do not split the rod reading and the offset data between lines of data.

The data contained in the field book should be entered into an ASCII text file. The file should be named ***001.IND, where 001 relates to the GPK file in your working directory (example: JOB001.GPK)

Once the data has been created, a MicroStation session is initiated in a directory containing the project’s GPK file. A COGO session is activated and the above “***.IND” file is “Loaded” into COGO and “Read”. When the file is “read” GEOPAK creates an ***.COR points file. You should be able to open Windows Explorer and see the new file in your working directory.

At this point we have created X, Y, Z and station coordinates from our input data. To create cross sections from this data see the section “Cross Sections by XYZ and Station File”.

Cross Sections from Surfaces (DTM)

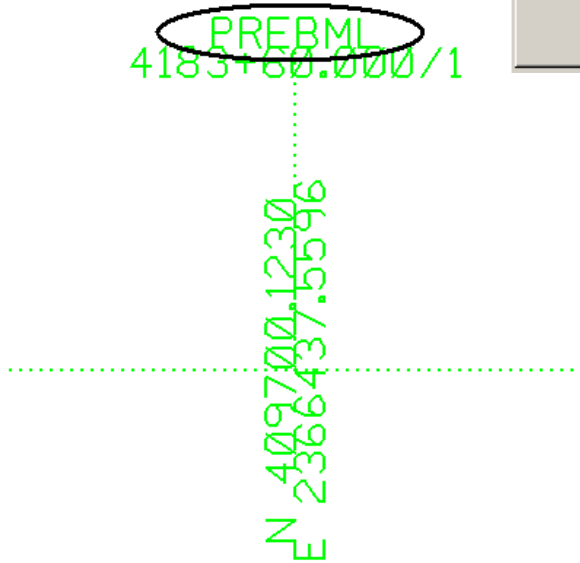
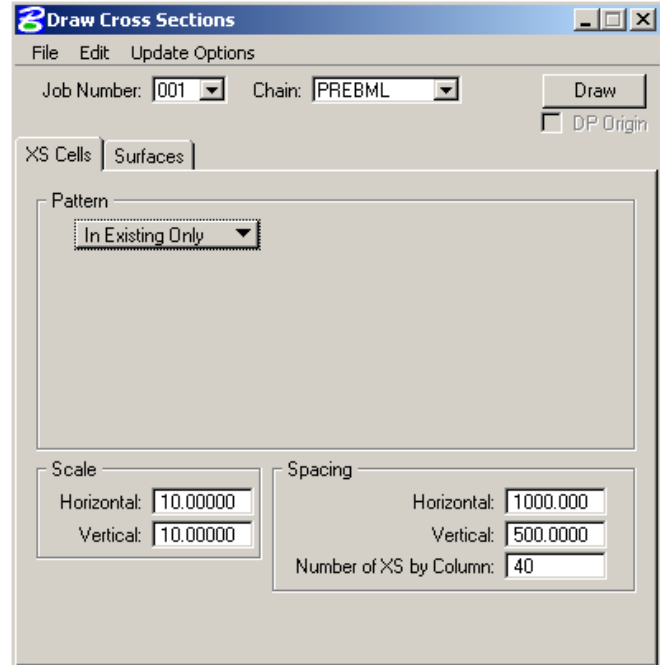
This process requires existing and as-built surfaces. This process is often used to compare as-designed quantities to as-built quantities. If so, a designer has probably already created existing and proposed cross sections and you will draw as-built ground elements over the top of the existing ground.

If this process is used for a borrow, waste or stockpile site you can have GEOPAK draw both surfaces at the same time.

Drawing As-built Cross-Sections for As-built to As-designed Comparison

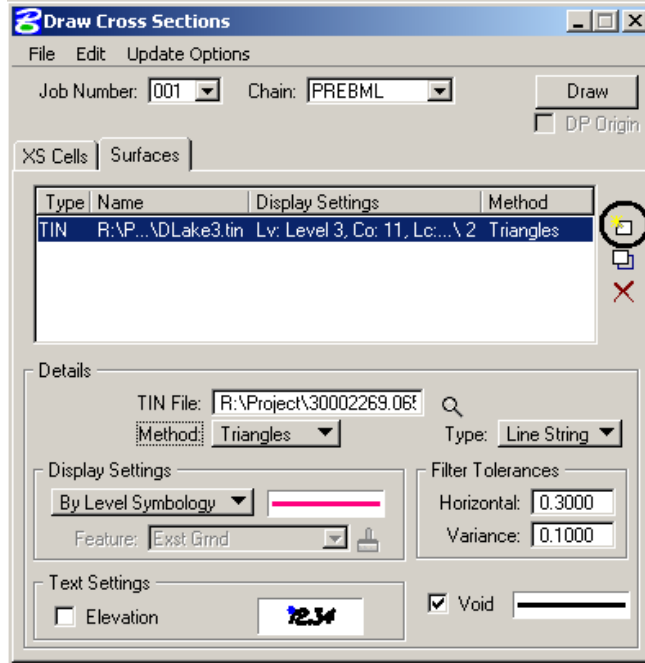
1. Find the working cross section drawing and the GPK file used by the designer for proposed cross-sections. There may be several xsec_*.dgn and GPK files. You may need to review “AAREADME” files in the design directory and or call the designer to find the required files.
2. Determine the location of the As-built surface model - *.tin file. This is a file that field personnel typically have to create and is stored in the As-built folder. If you need to create this file, see the section “Creating a DTM”.
3. Copy the working cross sections from Design into the As-built folder. Then open the copied drawing in MicroStation. Delete everything except existing (preconstruction) ground, void ground lines and the green cross section reference cells. You could redraw both existing (preconstruction) ground and as-built ground from the tin files. However the same green cross section reference cells should be used. Most likely you will want to compare the as-designed cross sections with the as-built cross sections by referencing the as-designed cross sections into the as-builts. If you use the same green cross section reference cells the reference files should be coincidental.
4. If you haven’t copied the GPK file into your working directory (As-built folder), make sure to set your “COGO Preferences: Job (GPK) Directory” to the design folder. See the “GEOPAK User Preferences” section of this guide.

5. Select “Application>ROAD>Cross Sections>Draw Cross Sections from Surfaces” from the main pull down menu. The “Draw Cross Sections” dialog box should open.
6. Select the appropriate Job Number and Chain for the Cross Sections. Use the cross section baseline chain. The Cross Section baseline-chain may be different than the roadway alignment-chain. Review the green cross section cell to determine the baseline chain. See the picture below.



7. There should be two tabs in this dialog box; “XS Cells” and “Surfaces”. You should be on the “XS Cells” tab. Near the middle of the “Draw Cross Sections” dialog box there is a “Pattern” panel. Pattern lines indicate where cross sections should be obtained. Set the pattern toggle to “In Existing Only”. This setting will obtain cross sections at only the locations that the designer used.

8. Next set the tab to “Surfaces”. Near the bottom of the dialog box there should be a panel for surface “Details”. Select the as-built TIN File. Set the “Method” to “Triangles”. Set the “Type” to “Line Strings”. The Display Settings for the As-built ground should be according to the CADD Standards for Ground Lines:
 - Level = “Grnd Line”
 - Color = 1
 - Style = 0
 - Weight = 3
 Void lines should be on the same level as as-built ground but the color should be white “0”. After setting these details, select the “Add Surface” button. This button is on the right sided of the dialog box. The surface information should appear in the middle panel.



9. Select the “Draw” button in the upper right hand corner of the “Draw Cross Sections” dialog box. GEOPAK should draw the as-built surface.

Drawing Cross-Sections for a Borrow, Waste or Stockpile Site

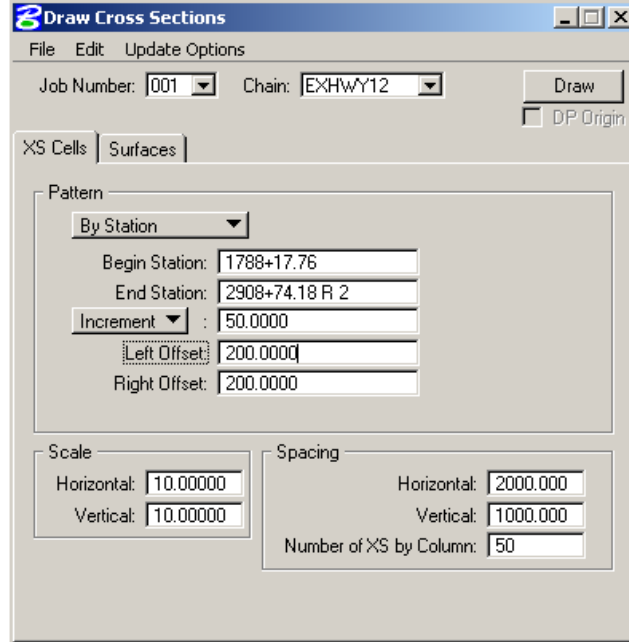
This process is similar to “Drawing Cross Sections for As-built to As-designed Comparisons”. The main differences are you start your cross section drawing from scratch and you draw two surfaces at once instead of one.

1. Create and or open the cross section in the as-built folder.
2. Determine the location of the existing and as-built surface models - *.tin files. These files are typically created by field personnel and are stored in the As-built folder. If you need to create these files, see the section “Creating a DTM”.

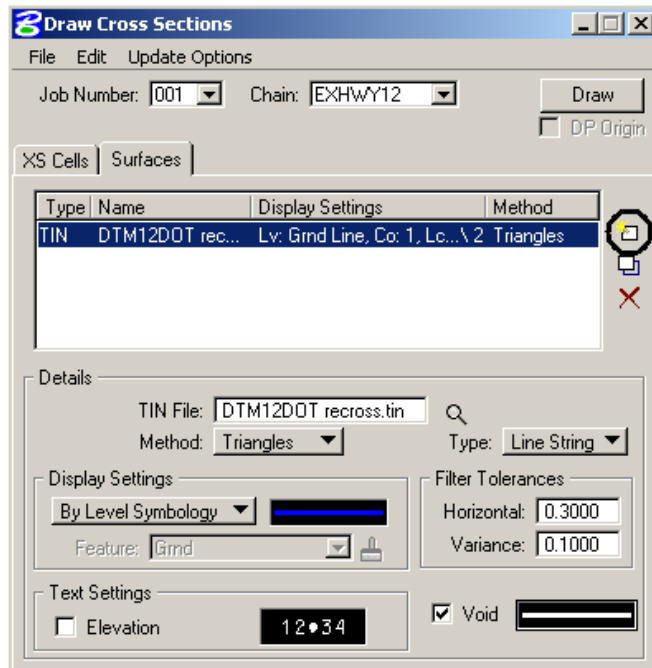
3. Select “Application>ROAD> Cross Sections>Draw Cross Sections from Surfaces” from the main pull down menu. The “Draw Cross Sections” dialog box should open.

4. Select the appropriate Job Number and Chain for the Cross Sections.

5. There should be two tabs in this dialog box; “XS Cells” and “Surfaces”. You should be on the “XS Cells” tab. Near the middle of the “Draw Cross Sections” dialog box there is a “Pattern” panel. Pattern lines indicate where cross sections should be obtained. Set the pattern toggle to “By Station”. Complete the data for the pattern of the cross sections. The increment sets how often a cross section will be cut from a surface. The Left and Right Offsets must be long enough to extend past the earthwork area. It is better to have these offset longer than what is need rather than to short. A horizontal and vertical scale of 10 is common. This scale will give you about 140’ when printed on traditional sheets. The spacing of the cross sections sets how far apart the cross sections are drawn. Set this spacing so that you have a least 500 feet between elements from different cross sections. If you draw your cross sections are too close, GEOPAK may not be able to distinguish which drawing elements belong with which cross section.



6. Next set the tab to “Surfaces”. Near the bottom of the dialog box there should be a panel for surface “Details”. Select the as-built TIN File. Set the “Method” to “Triangles”. Set the “Type” to “Line Strings”. The Display Settings for the As-built ground should be according to the CADD Standards for Ground Lines:
 Level = “Grnd Line”
 Color = 1
 Style = 0
 Weight = 2

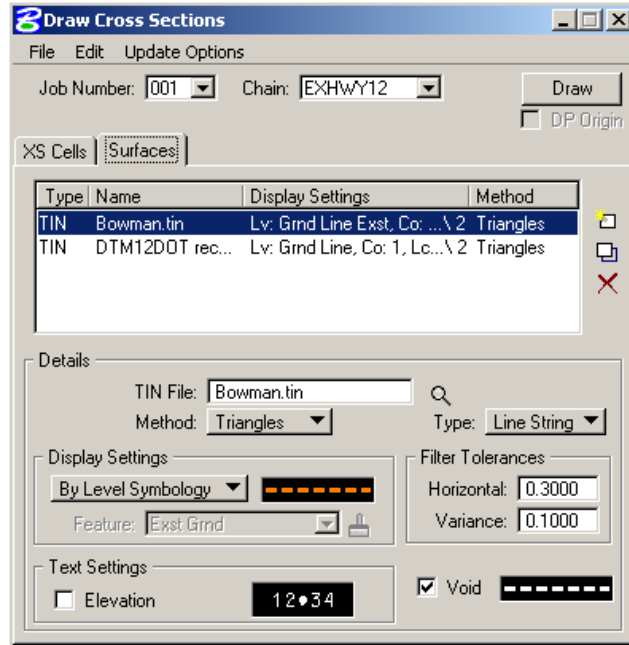


Void lines should be on the same level as as-built ground but the color should be white “0”. After setting these details, select the “Add Surface” button. This button is on the right sided of the dialog box. The surface information should appear in the middle panel.

7. Repeat the previous step for the existing ground surface. Be sure to the Display Settings for the existing (preconstruction) ground according to the CADD Standards for Existing Ground Lines:

Level = “Grnd Line Exst”
 Color = 6
 Color = 0 (void lines)
 Style = 2
 Weight = 2

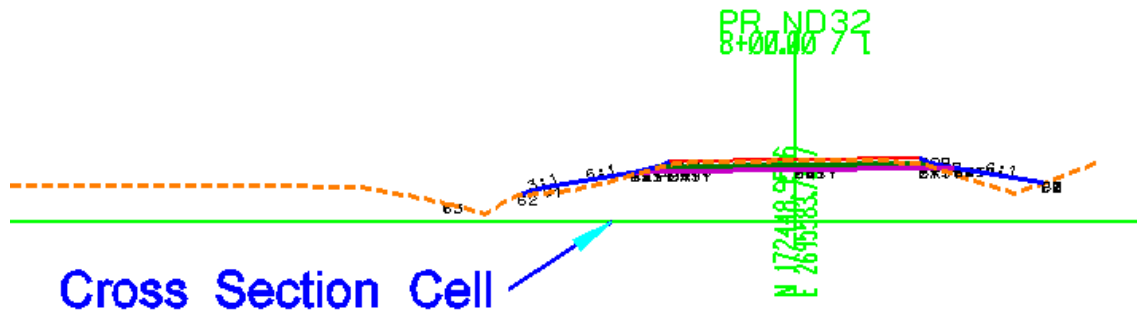
8. Now, you should have to surfaces listed in the middle panel. Select the “Draw” button in the upper right hand corner of the “Draw Cross Sections” dialog box. GEOPAK should draw the as-built surface.



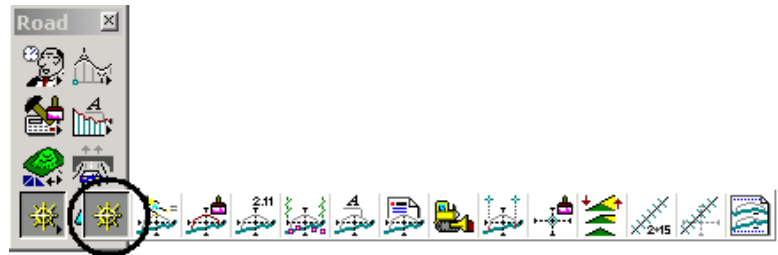
Viewing Cross Sections

03/24/06

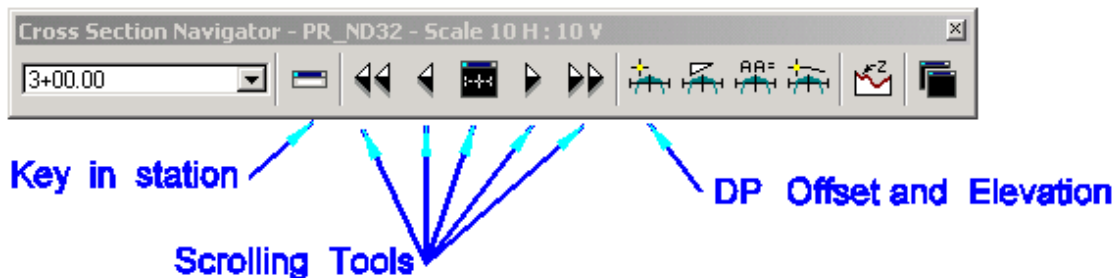
You will need to review your cross sections several times as you prepare your earthwork calculations. “Cross Section Navigator” is one of the tools you will use to review your data. “Cross Section Navigator” uses a working Cross Section drawing. A Working Cross Section file is a drawing with a series of cross sections with cross section cells. A cross section cell is typically green and on level 63. The cross section cells are location references. The working drawing does not typically have grid lines and the name of the file usually starts off with the letters “xs”.



You may be able to zoom in and out to find the cross section you want to review. However the “Cross Section Navigator” tool is much more efficient. Select the “Cross Section Navigator” tool by selecting “Applications>GEOPAK>Cross Sections>Navigator” or by selecting the icon from the GEOPAK Road tool box.



The Cross Section Navigator dialog box should open. Use the station pull down field on the left of this dialog box to navigate to that station.



The following is an overview of some basic navigator tools.

Keyin Station

Key in the desired station and click Enter (on keyboard). The XS Navigator moves to the specified station or the closest station if the typed value is not at a section.

Scrolling Tools

The scrolling buttons enable the user to quickly scan both forwards and backwards within the cross section range. The single arrows move forward (>) or backward (<) one section each time the button is pressed. The double arrows move to the first section (<<) or last section (>>), however, they maintain the same relative positioning and window size. The reset navigator (center button on the dialog) returns the user to the first section and the entire section is placed on the screen. Therefore, the relative window is not maintained.

DP Station Offset

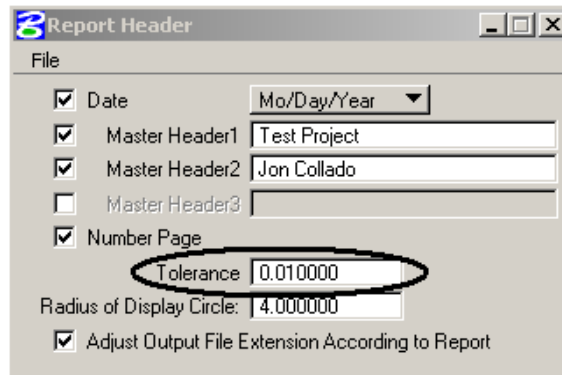
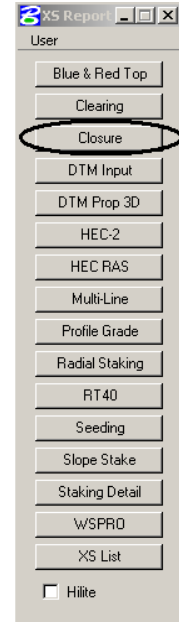
In this dialog, the Elevation and Offset can be typed in or can be dynamically ascertained by clicking Get Cursor XS Position, which expands the dialog. Click the button, then place a data point on the cross section. The information is displayed in the Elevation and Offset fields. The information can be utilized in any MicroStation or GEOPAK command which requires a data point, by clicking the left button when a data point is required.

Processing Cross Sections for Closure Errors

03/24/06

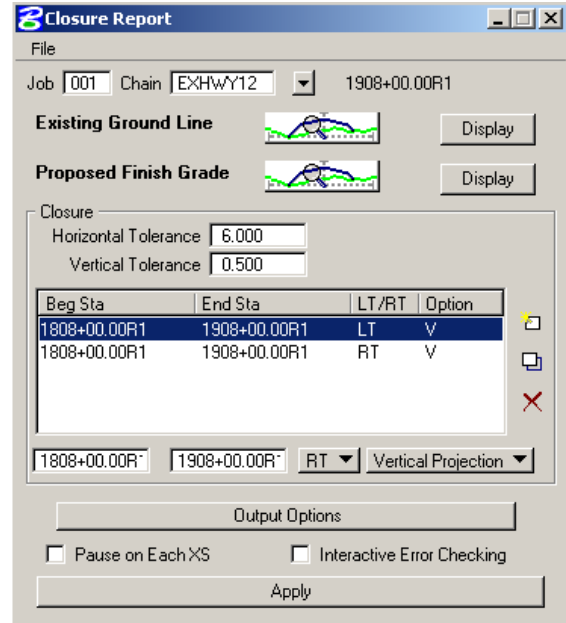
At this step you should have a Horizontal Alignment (chain), Existing Ground Cross-Sections and Final Ground Cross-Sections. If you have these items complete you are now ready to check to see if your cross-sections can tie within the tolerances that is acceptable to the NDDOT. This step is also need to correct acceptable tie closure errors.

1. Select “Applications>ROAD>Cross Sections>Reports” from the main pull down menu. A “XS Report” dialog box should open with several different report buttons.
2. From the “XS Report” dialog box, select “User>Preferences”. The dialog box shown below should appear. Make sure to set the tolerance. Typically it is set at “0.01”. This should be less than what will be used for your earth work tolerance (typically “0.05”). The other fields for the Report Header are optional.



3. The “Report Header” dialog box can be closed. The tolerance setting is not directly part of the “Report Header” settings and doesn’t need to be saved. The optional header settings can be saved for other reports by selecting “File>Save”. The header settings can be retrieved by selecting “File>Open”.

4. Select the “Closure” button from the “XS Report” dialog box. The dialog box shown to the right should appear. Select the Job number and the chain used for the cross sections.



5. Use the “Existing Ground” search symbology button (magnifying glass looking at cross sections) to set the symbology for Existing Ground:

- Level = “Grnd Line Exst”
- Color = 6
- Color = 0 (void lines)
- Style = 2
- Weight = 2

Set the symbology for the as-built ground (Proposed Finish Grade):

- Level = “Grnd Line”
- Color = 1
- Style = 0
- Weight = 2

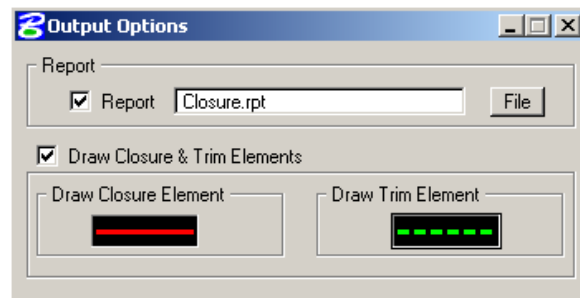
6. In the Closure part the “Horizontal Tolerance” is 6.00 and “Vertical Tolerance” is 0.50. The next step is to set the type of tie constraints that you want. In the bottom portion, set the beginning station and end station of your cross-sections. Set the next button to LT and the button following to Vertical Projection. There are three small buttons on the right side of the dialog box: “Add”, “Modify”, and “Delete”. Click on the “Add” button. Next change the LT bar to RT and click on the Add button.

7. Select the “Output Option” button. The “Output Option” dialog box should open. Check the “Report” box and provide a name for your report. The file name should be Closure.rpt. Check the “Draw Closure & Trim Elements” box. Set the “Draw Closure Element” to

- Level = “Closure Line”
- Color = 3
- Weight = 2
- Style = 0

Set the “Draw Trim Element” to

- Level = “Closure Line”
- Color = 2
- Weight = 2
- Style = 2

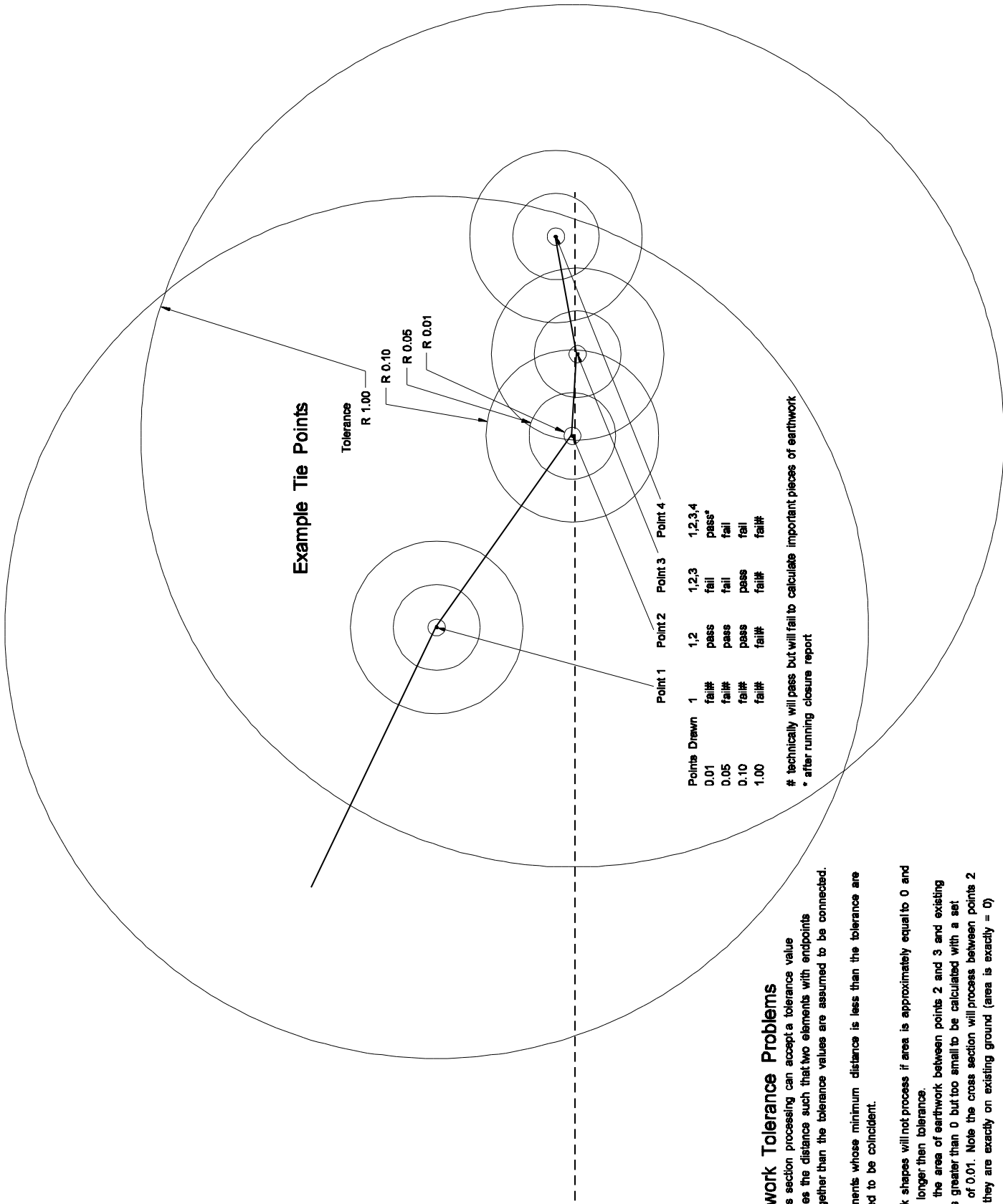


8. After filling out the “Output Options” dialog box, it can be closed. Select the “Apply” button from the “Closure Report” dialog box. GEOPAK will compare the existing ground to the final ground and determine where they do not tie. GEOPAK will tie the two grounds together with the closure constraints defined. It is also making a closure.rpt file that will indicate which cross-sections have closed within acceptable tolerances and which ones need to be corrected.
9. Once GEOPAK has finished processing the cross sections, open the text file closure.rpt that GEOPAK just created. The report file may look similar to the one below.

STATION	LEFT CLOSURE		RIGHT CLOSURE	
	VERT	HORIZ	VERT	HORIZ
0+00.00R1	0.264	0.000	*1.181	0.000
0+20.00R1	* 1.003	0.000	0.741	0.000
0+30.00R1	0.393	0.000	* 1.873	0.000

10. The numbers with the asterisk indicate a cross-section that did not tie with the tolerance that was specified. These cross-sections are ones you will need to review and adjust. Once you have tied all the cross-sections within the allowable tolerances you are ready to run the earthwork part of GEOPAK.
11. The GEOPAK Closure tool will help tie existing and as-built ground surfaces together. However earthwork uses a tolerance to process areas and some sections may not directly process. You may get errors saying some sections don’t tie. This problem might not be a problem with the closure tool. It could be a problem with tolerances.

Some projects will have cross sections that require different tolerances to process. You can only use one tolerance while processing the cross sections. You may need to try different tolerances. Pick the tolerance that processes the most cross sections. You may be required to manually correct (edit the drawing) on sections that don’t process. These corrections are usually very small and should have a negligible impact on the earthwork calculations. These corrections are sometimes required when you have multiple points that could be tie points. The following drawing elaborates on the problem with tolerances.



Example Tie Points

Points Drawn	1	1,2	1,2,3	1,2,3,4
0.01	fail#	pass	fail	pass*
0.05	fail#	pass	fail	fail
0.10	fail#	pass	pass	fail
1.00	fail#	fail#	fail#	fail#

technically will pass but will fail to calculate important pieces of earthwork
 * after running closure report

Earthwork Tolerance Problems

- Any cross section processing can accept a tolerance value that defines the distance such that two elements with endpoints closer together than the tolerance values are assumed to be connected.
- Two elements whose minimum distance is less than the tolerance are considered to be coincident.
- Earthwork shapes will not process if area is approximately equal to 0 and length is longer than tolerance.
- Example, the area of earthwork between points 2 and 3 and existing ground is greater than 0 but too small to be calculated with a set tolerance of 0.01. Note the cross section will process between points 2 and 3 if they are exactly on existing ground (area is exactly = 0)

Widening XS Cells (Draw XS Cell)

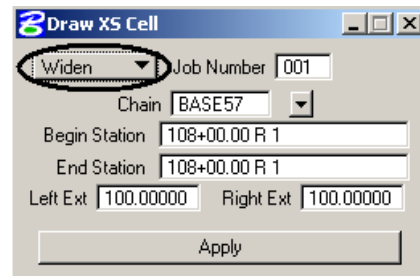
10/26/06

Sometimes widening existing XS cells is more productive than redrawing them. This is often the case when the sections have been manually-individually modified (adjusted with MicroStation tools vs. GEOPAK and Criteria). The widening tools can also be used without compromising references to “As-designed” drawings (the As-designed and As-built cross sections will coincidentally overlap).

1. The “Draw XS Cell” tool can be used to widen cross sections. This tool can be found from the main pull down “Applications>ROAD>Cross Sections>Draw Cross Section Cells” or from the Cross Sections tools tray as shown.



2. The “Draw XS Cell” dialog box should open. Set the upper left option to “Widen”.
3. Set the job number for the XS alignment. Set the Chain for the cross sections. Select the beginning and ending stations for the cross sections that need to be widened. Set the left and right extension length. Then select Apply. GEOPAK should widen the specified sections.

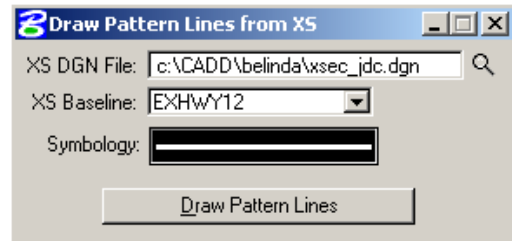


Draw Pattern Lines from XS

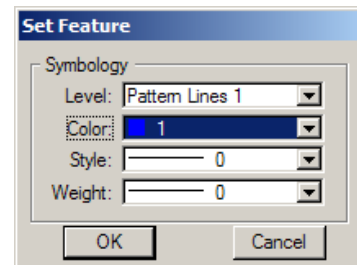
12/31/08

Sometimes a plan view drawing of where the cross sections are located needs to be created or recreated. This typically occurs when pavement and base layers need to be drawn into the cross sections and the sections are not at even intervals and or widths. See “Drawing Pavement and Base Into Cross Sections” for when this is needed.

1. Create and or open your shape drawing (shape.dgn).
2. Select “Applications>ROAD>Cross Sections>Draw Patterns from Cross Sections” from the main pull down menu. The following dialog box should appear.



3. Set your “XS DGN File”, “XS Baseline”, and Symbology. The symbology is set as shown.
4. After your settings have been selected, select the “Draw Pattern Lines” button. GEOPAK should draw pattern lines into your drawing that follow your alignment and match the widths and intervals of your cross sections.



Drawing Pavement, Base and Topsoil into Cross Sections

10/17/06

Pavement and bases need to be drawn into most roadway cross sections in order to calculate the correct earthwork quantities. Both existing-preconstruction and as-built layers (pavement, base and sometimes topsoil) may have to be drawn into the cross sections. These materials need to be drawn so that they can be excluded from the excavation and fill calculations for soil suitable-grading.

Sometimes materials can be accounted for outside of the GEOPAK Calculations and they don't need to be drawn. Here are some examples:





1. If existing topsoil = as-designed topsoil (plan quantity) = as-built topsoil, then it is often assumed that actual "common excavation" = GEOPAK calculated "common excavation" – plan quantity topsoil.
2. If existing pavement and or base removed is all in a fill area (as-built suitable grading material is above), then the entire pavement or base removal quantity can be **added** to the GEOPAK calculations for the actual common excavation quantity. See example case 1.
3. Similarly if all the existing pavement and or base removed is completely in a cut area (as-built surface is below removed pavement and base), then the entire pavement or base removal quantity can be **subtracted** from the GEOPAK calculations for the actual common excavation quantity. See example case 2.
4. If as-built pavement and or base added is all in a fill area (existing fill-soil-suitable grading material is below the added materials), then the entire pavement or base added quantity can be **subtracted** from the GEOPAK calculations for the actual common excavation quantity. See example case 1.
5. Similarly if all the as-built pavement and or base added is completely in a cut area and below existing pavement and base to be removed, then the entire pavement or base removal quantity can be **added** to the GEOPAK calculations for the actual common excavation quantity. See example case 2.

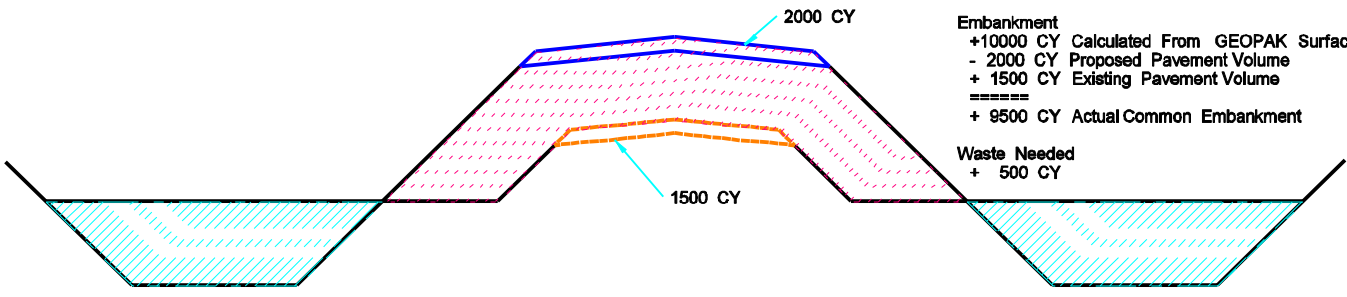
Sometimes materials can't be accounted for outside of the GEOPAK Calculations and need to be drawn. Here are some examples:

6. If the existing pavement and or base are in both fill and cut areas or removed and added surfaces overlap, then the layers need to be drawn in order to determine correct quantities. See example case 3.

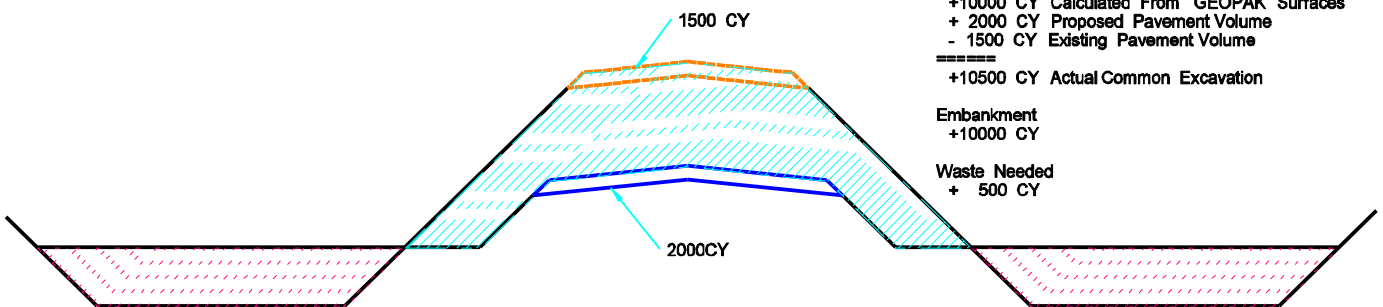
7. If the as-built pavement and or base are in both fill and cut areas or remove and added surfaces overlap, then the layers need to be drawn in order to determine correct quantities. See example case 3.
8. The existing materials removed and the as-built materials added also need to be drawn in the cross sections if a correct mass diagram and or average haul calculations are required.

The examples shown on the following page demonstrate the above concepts. In these examples the original GEOPAK calculations did not account for the existing and as-built materials (pavement and base that was added or removed). All of the situations have the same common excavation quantity calculated by GEOPAK, same proposed pavement volume and same existing pavement volume. However these volumes need to be interpreted differently. All three cases have a different actual common excavation quantity.

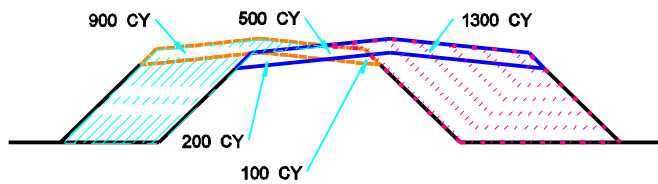
Given:
 Common Excavation Calculated by GEOPAK = 10,000 CY
 Shaded Area 
 Common Embankment Calculated by GEOPAK = 10,000 CY
 Shaded Area 
 Proposed Pavement = 2,000 CY
 Blue 
 Existing Pavement = 1,500 CY
 Orange 



Case 1
 Excavation
 +10000 CY
 Embankment
 +10000 CY Calculated From GEOPAK Surfaces
 - 2000 CY Proposed Pavement Volume
 + 1500 CY Existing Pavement Volume
 =====
 + 9500 CY Actual Common Embankment
 Waste Needed
 + 500 CY



Case 2
 Excavation
 +10000 CY Calculated From GEOPAK Surfaces
 + 2000 CY Proposed Pavement Volume
 - 1500 CY Existing Pavement Volume
 =====
 +10500 CY Actual Common Excavation
 Embankment
 +10000 CY
 Waste Needed
 + 500 CY



Case 3
 Excavation
 +10000 CY Calculated From GEOPAK
 - 900 CY Existing Pavement Volume
 + 200 CY Proposed Pavement Volume
 =====
 + 9300 CY Actual Common Excavation
 Embankment
 +10000 CY Calculated From GEOPAK
 - 1300 CY Proposed Pavement Volume
 + 100 CY Existing Pavement Volume
 =====
 + 8800 CY Actual Common Embankment
 Waste Needed
 + 500 CY

If you need to draw materials into your cross sections, GEOPAK Criteria can be used to expedite the process. GEOPAK Criteria is a set of instructions that tell MicroStation how to draw.

Drawing Cross Section Layers without Project Manager

1. Copy all the files in the directory S:\STANDARD\XM\GEOPAK\Criteria\As-built_Earthwork to your working directory. Do not copy the directory folder itself. The files need to be placed directly into your working directory. Note, you might not need all the files.
2. Edit the input file `exst_material.inp` with the GEOPAK “Text Editor” or Notepad. The lines that you need to edit in your input file are:

“`xs dgn =`” Set to the directory and `dgn` file that has your cross-sections

“Pattern by Station” or “Pattern `dgn`”

Set all the pattern setting used to create the cross sections. ; job number, baseline, horiz scale, vert scale. “Pattern by Station” will use the additional variables; begin station, end station, even, lt, and rt. “Pattern `dgn`” will use the additional variables; type, lfname, and co (color). Either “Pattern by Station” or “Pattern `dgn`” settings will be used but not both settings. These settings need to match the settings used to create the surfaces. These setting will be different if “Pattern `dgn`” is used. The following are examples.

Pattern by station

```
pattern set
  job number = 001
  baseline = EXHWY12
  horiz scale = 10
  vert scale = 10
  beg station = 1808+00
  end station = 1908+00
  even = 200.00
  lt = 300.00
  rt = 300.00
```

Pattern dgn = c:\CADD\belinda\shape.dgn

pattern set

job number = 001

baseline = EXHWY12

horiz scale = 10

vert scale = 10

type = line, line_string

lvname = Pattern lines 1

co = 1

“shape cluster baseline” Set to the horizontal alignment used for cross sections

“shape cluster profile” Set to the vertical alignment used for cross sections

“shape cluster pgl chain” Set to the horizontal alignment used for cross sections

“Write XS Into Dgn” Set to the directory and dgn file that has your cross-sections

3. Once you have made these changes, save the file.
4. Edit the criteria file “variables_Preconstruction.x”. This file has re-definable variables near the end of the file that control the width and thickness of the layers drawn. The standards manual has picture of what criteria will draw (Appendix J-Material_Layers_From_Surface). The standards manual also lists what these variables represent (Appendix J-Variables). Only the materials removed or mined and blend need to be drawn. If existing base is dealt with as common excavation, it doesn't need to be drawn. If you don't want to draw a layer, set the “depth” to 0. The following is a list of variables that should be redefined.

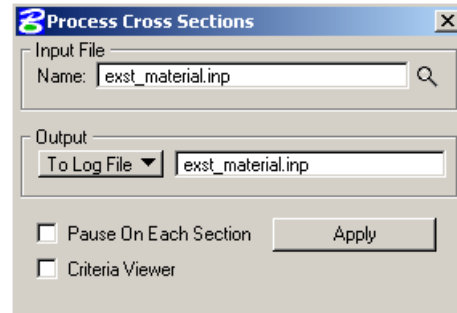
<u>_d_draw_asbuilt</u>	-	Set to 1 to draw asbuilt surfaces. Set to 0 to draw existing – preconstruction surfaces.
<u>_d_exst_aggr_depth1</u>	-	depth of exst aggr at center of road
<u>_d_exst_aggr_depth2</u>	-	depth of exst aggr at outside edge of mine and bend shoulder
<u>_d_exst_aggr_slough_width</u>	-	horizontal width from top to bottom of slough
<u>_d_exst_aggr_width</u>	-	width of exst aggr (mine and blend) from centerline
<u>_d_exst_asph_depth1</u>	-	depth of exst asph at center of road
<u>_d_exst_asph_depth2</u>	-	depth of exst asph at outside edge of mine and bend shoulder
<u>_d_exst_asph_slough_width</u>	-	horizontal width for top to bottom of slough
<u>_d_exst_asph_width</u>	-	width of exst asph (mine and blend) from centerline
<u>_d_exst_conc_depth1</u>	-	depth of exst conc at center of road
<u>_d_exst_conc_depth2</u>	-	depth of exst conc at outside edge of shoulder
<u>_d_exst_conc_width</u>	-	width of exst asph from centerline
<u>_d_exst_ts_depth</u>	-	depth of exst topsoil
<u>_d_exst_ts_start</u>	-	distance from centerline to useable exst topsoil
<u>_d_exst_ts_transition_width</u>	-	horizontal width from 0 to full depth

- Excavation limits indicate where topsoil is stripped and where earthwork is calculated. The as-built survey should indicate where the tie point is located with a break line. This information should be in the drawing DTM_*.dgn and on level name "Tie Point Line Exst". If this line is found the criteria will draw the excavation limits at the tie point. If it is not found, the criteria sets the excavation limits at a fixed distance or 1' outside the as-built ground as determined by the variable "_d_exc_Lim_d1". A line in the criteria "standard.x" may need to be modified.

"define_dgn "Exc_Lim_From_Dgn" dgn=DTM.dgn lvName=Tie Point Line Exst co=6"

The file "DTM.dgn" may need to be edited with the exact name of the drawing with the "Tie Point Line Exst" break line.

- Open the as-built cross sections and select "Applications>Road>Cross Sections>Process Cross Sections". The box to the right should appear. Fill out the box as shown. Once you have the box filled out you want to choose the Apply box.

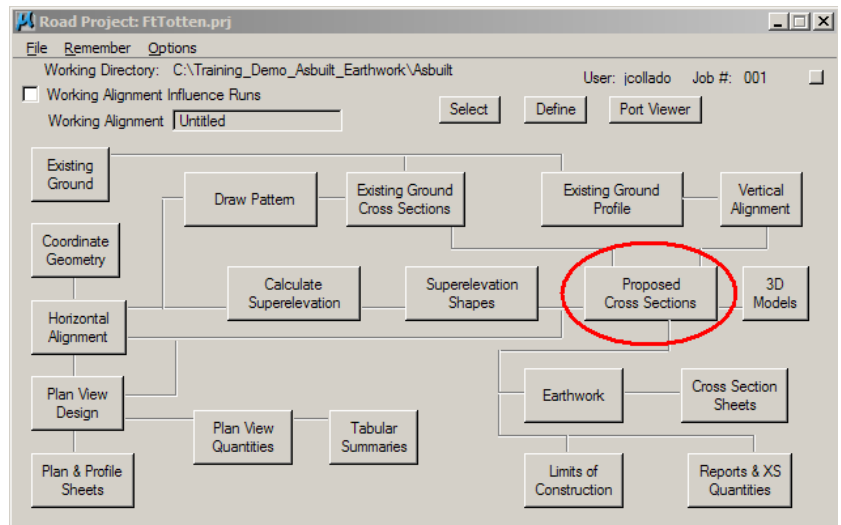


- GEOPAK will draw the material layers into the cross sections. GEOPAK will also create a text file exst_material.log. If problems drawing the layers are encountered, reviewing the log file may help you find the problem.
- Steps 2-6 will have to be repeated for the as-built material layers. However this time use the input file "final_material.inp" and write the log file final_material.log. Use the file "variables_asbuilt.x" to define the cross section variables.

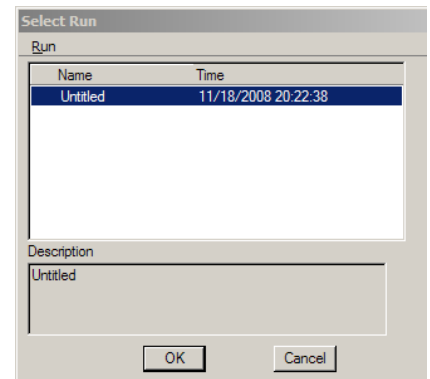
Drawing Cross Section Layers using Project Manager

11/20/08

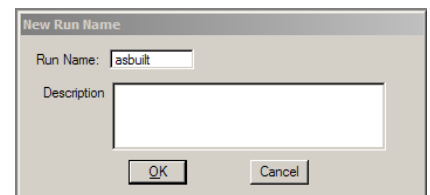
1. Select the Project Manger file, and user for your project. If the general settings for project manager have not been set up, see the section named “Project Manager for GEOPAK Road”.
2. Select the “Proposed Cross Sections” button.



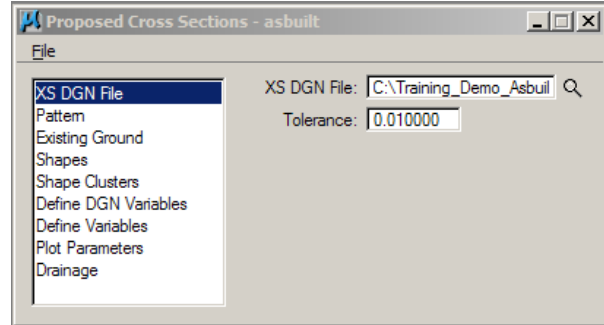
3. A “Select Run” dialog box should appear. Within this dialog box, select “Run>New”.



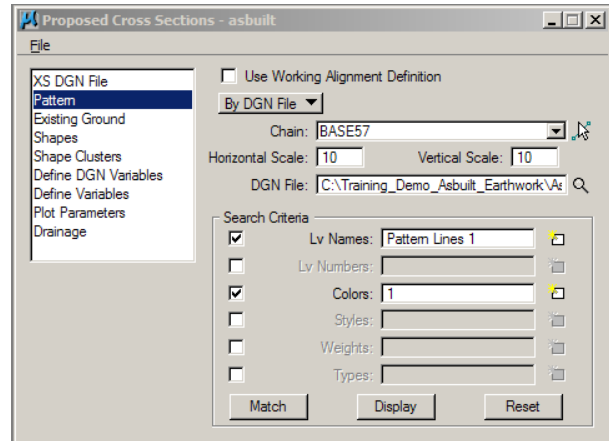
4. Provide a name for the run. The naming convention for the run is not very important. It only has to be memorable. The description is optional. Select the OK button on the New Run Name dialog box. The name of the newly created run should appear in the “Select Run” dialog box. Double click on the name of the newly created run.



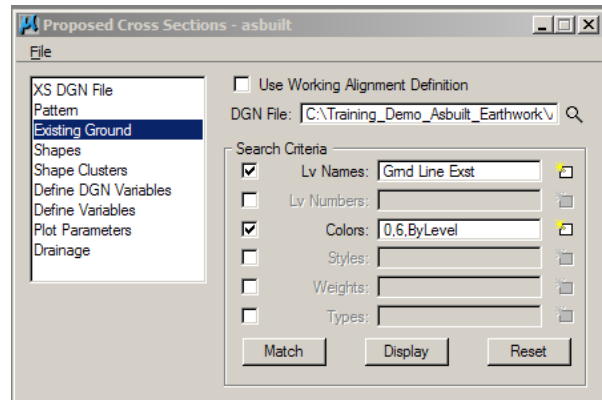
- The proposed Cross Sections dialog box should appear. On the left side of this dialog box is a panel with categories of settings that need to be completed. Click on the first category “XS DGN File”. Use the icon that looks like a magnifying glass to select the working cross section drawing. Change the “Tolerance” for drawing elements to 0.01.



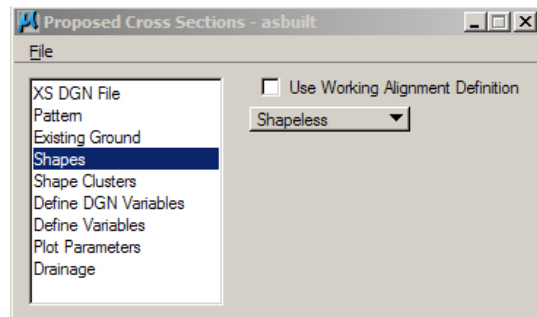
- Select the “Pattern” category. Several of the categories have an option called “Use Working Alignment Definition”. This manual will not use this option. The NDDOT usually uses pattern lines that are drawn “By DGN File”. This option is a toggle button option. Complete the information for the pattern lines. You may have to open your pattern line drawing (see section “Drawing Pattern Lines from XS”). The Horizontal Scale and Vertical Scale should both be 10. The “Search Criteria” tells GEOPAK how to look for the pattern lines. Usually “Lv Names” and “Colors” is enough information segregate different sets of pattern lines.



- Select the “Existing Ground” category. Provide the drawing name and Search Criteria for the lines and line strings that make up the existing ground in the working cross section drawing. Don’t forget to include the ground void line symbology if used. Ground void lines are often used through areas that disrupt a DTM such as a body of water or building. These lines are needed to keep the existing ground model continuous. Parts of GEOPAK (criteria) may not work correctly if the ground is not continuous.

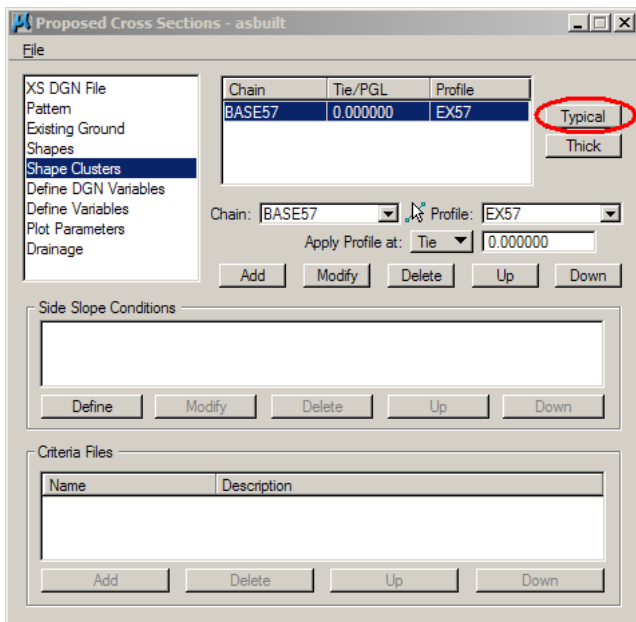
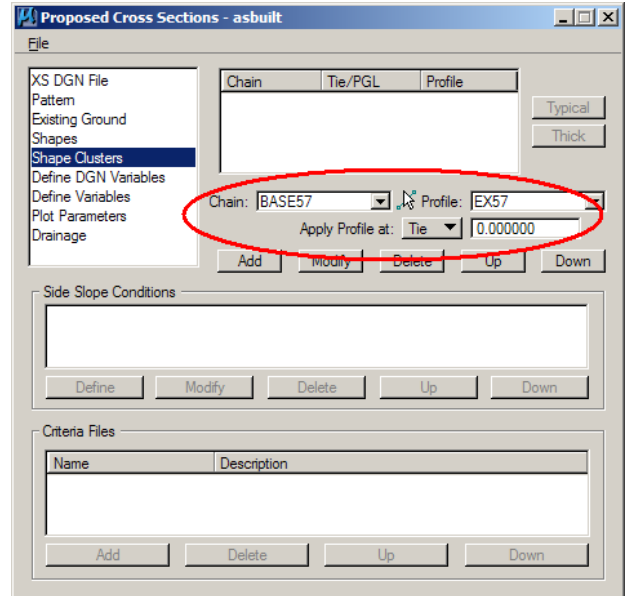


- Select the “Shapes” category. This category refers to supper elevation shapes. As-built cross sections seldom reference back to supper elevation shapes. Change the button toggle to “Shapeless”.



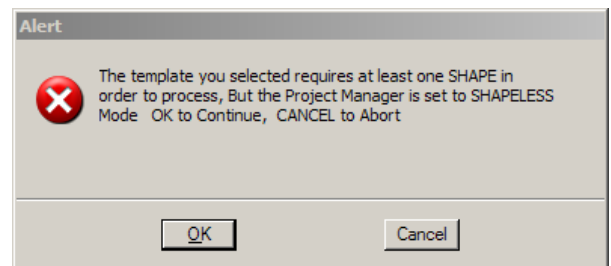
9. Select the “Shape Cluster” category. This category will be used even if shapes are not used. This category is used to tell GEOPAK what to draw. Special separate files or subroutines named “Criteria” files contain drawing instructions for GEOPAK. Use this dialog to tell GEOPAK how to apply the criteria – instructions to your proposed cross sections. This manual will use an addition tool to help simply this process.

10. First select the chain, profile and tie that apply to your as-built cross sections. The “Tie” value is usually 0. The tie value is used to apply the chain alignment at an offset. After these fields have been filled out, select the “Add” button near the middle of the dialog box.

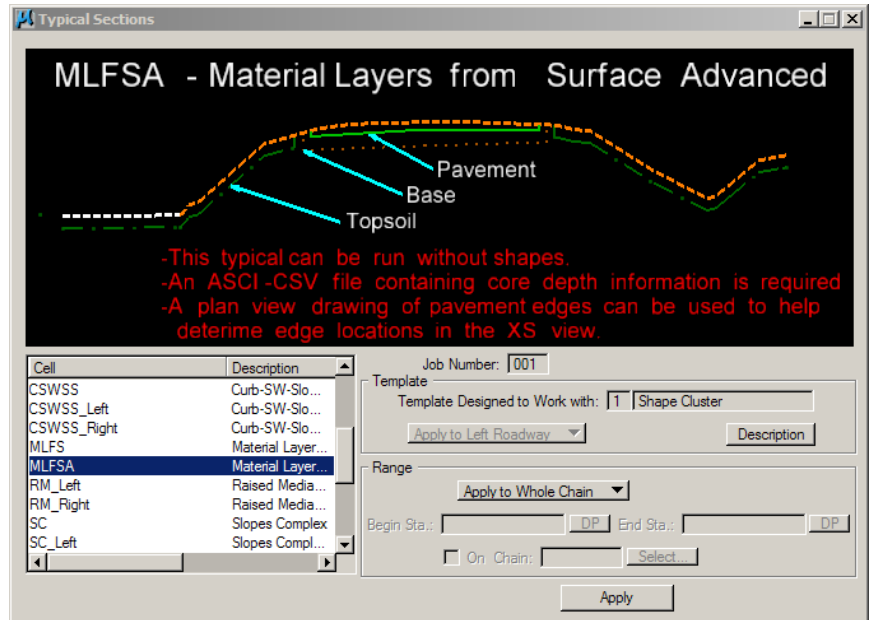


11. The field information will be added as an entry in the top panel. Select this entry and the “Typical” button will be enabled. Select this button to launch the supplemental typical section generator tool.

12. As the “Typical Sections” generator tool opens, you will receive an Alert about running in “SHAPELESS” mode. Select “OK” to continue. We will be selecting a typical that doesn’t use shapes. This typical will be applied to the cross sections.

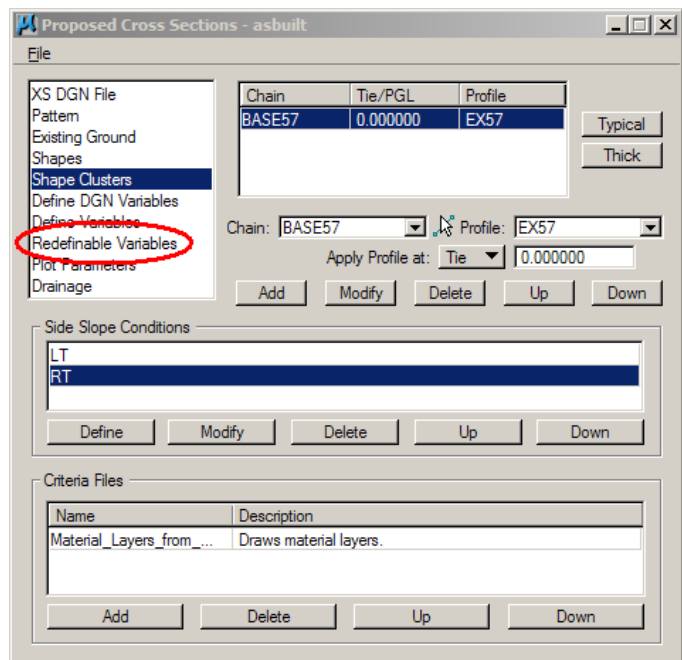


13. In the lower left area of the “Typical Sections” dialog box, there is a panel that can be used to select different types of typical. Select the “Cell” (typical) named “MLFSA” (Material Layers from Surface Advanced).

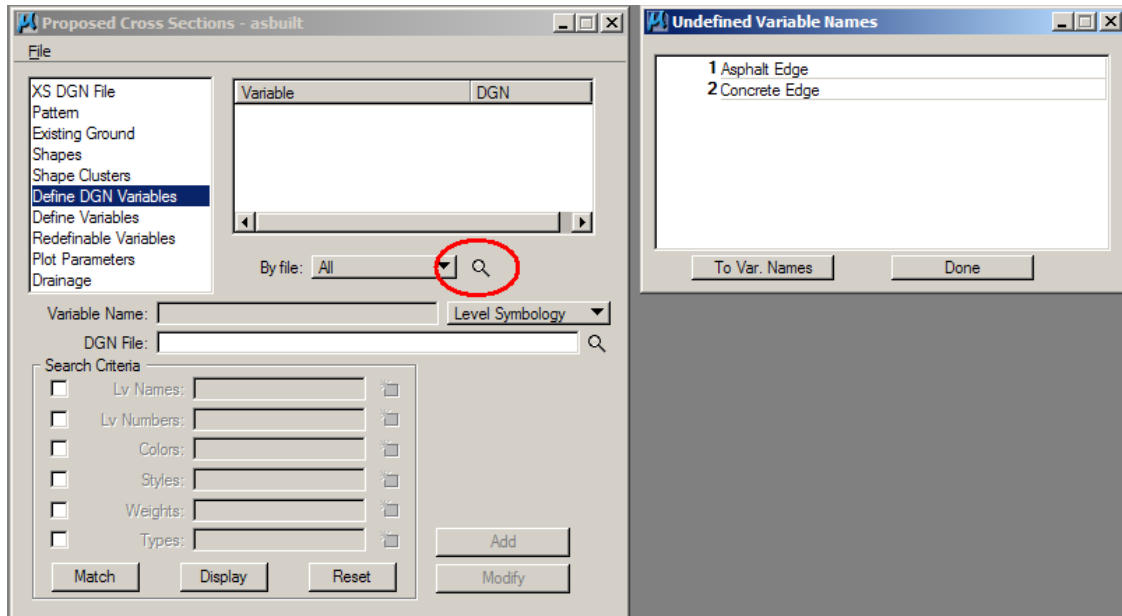


14. This one typical can be modified to address many different types of as-built surfaces. The criteria (subroutines) can account for many different project variations. Different typicals can also be applied to the same roadway a different stations. This manual will not elaborate on this situation. In the lower right area of the dialog box is a “Range” panel with toggle button for applying the typical to the whole chain. Use the “Apply to Whole Chain” default and select the “Apply” button at the bottom of the dialog box.

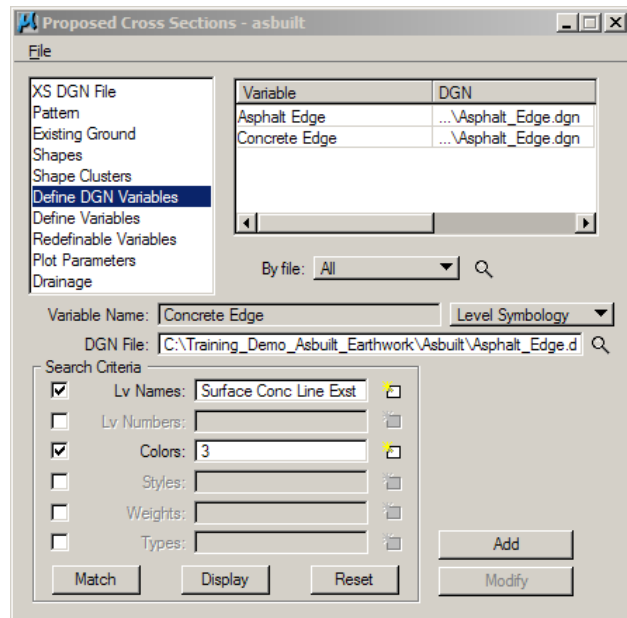
15. The “Typical Sections” dialog box will have closed and several changes to the “Proposed Cross Sections > Shape Clusters” will have been made such as adding “side slope conditions” and “Criteria” files. An extra category named “Redefinable Variables” will also have been added. If you examine the contents of your working directory, should also note that 3 criteria files have been added; standard_symbology.x, material_layers_from_surface_advanced.x, and exposed_redefinable_variable_english.x



- In the “Proposed Cross Sections” dialog box, select the “Define DGN Variables” category. Toward the middle of the dialog box is a variable selector tool. Select this tool and a list of drawing features will appear. You need to tell Geopak how to find these elements because it will use the information to draw the cross section in the right location. This information needs to be defined even if you don’t plan on using it (example, “concrete edge” needs to be defined even though there is no concrete on the project. “concrete edge” also needs to be defined if the location is described by redefinable variables).

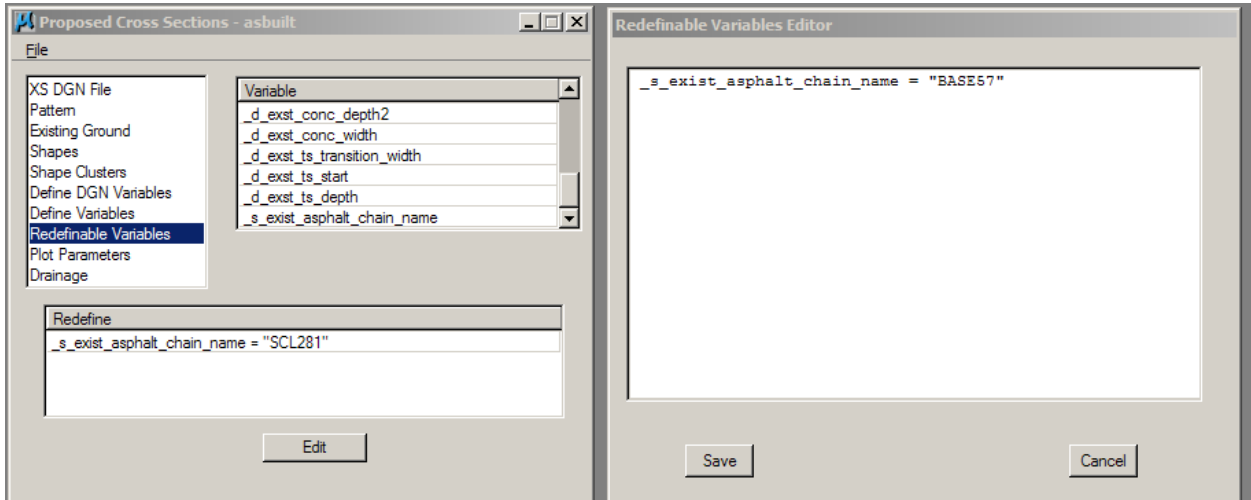


- Double click on the variable name then define where this feature can be found in project drawing. After you have defined one feature make sure to use the “Add” button. Each variable needs to be defined and added one at a time. When the variables have been defined, they should appear in the top panel.

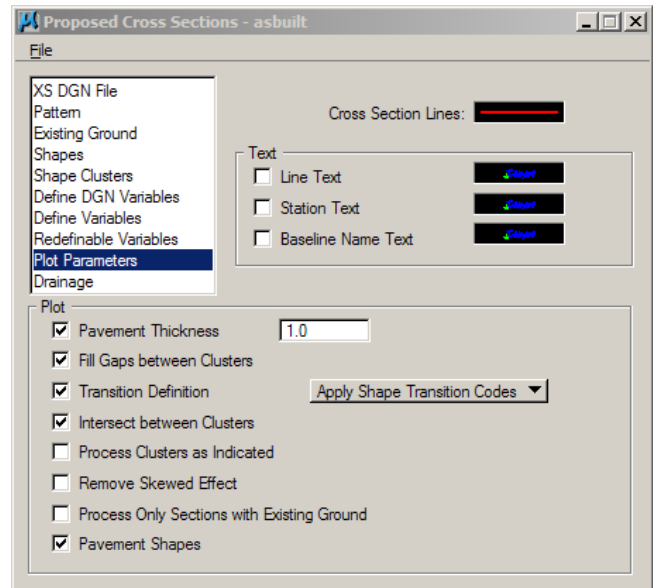


- The next category is “Define Variables”. This category is seldom edited because most of the regular (fixed) variables have been defined in the CADD Standards (standard_symbology.x).

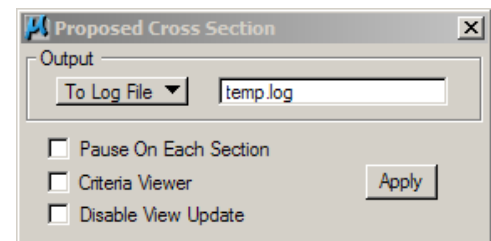
19. Select the “Redefinable Variables” category. There will be a list of redefinable variables in the top right panel. Each variable will have a default value. These values can be changed by double clicking on the variable name. Project manager will remember these values without change the criteria files. **You do not need to change the variable values in the criteria files with exposed redefinable variables.** Explanation of what the variables define is built into the criteria files and discussed in the CADD Standards.



20. Select the “Plot Parameters” category. The default values are fine for this as-built example.
21. The “Drainage” Category is seldom used at the NDDOT.
22. After information for the “Proposed Cross Section” dialog box and its many categories has been completed. Select “File>Save Setting” from this dialog box. **This step is extremely important because if you don’t do it you could lose your work.**



23. After the settings have been saved, select “File>Run” from the “Proposed Cross Sections” dialog box. Another dialog box will open with several processing options. Switch the Output toggle from “To Screen” to “To Log File”. The name temp.log is fine. This is a name for a text file that GEOPAK will create. It is often is used in trouble shooting problems. Select the “Apply” button to have GEOPAK draw the cross section features.



Earthwork from Cross Sections

10/26/06

To run earthwork in GEOPAK you need to create an earthwork input file. This input file is a set of instructions for GEOPAK to calculate earthwork quantities. GEOPAK Project Manager can be used to create this file or the file can be edited with a text editor.

Editing and Running Earthwork without Project Manager

1. Copy the file S:\STANDARD\XM\GEOPAK\Criteria\As-built_Earthwork \Earth.inp and paste into your working directory. You may have already have done this if you drew pavement materials into your cross sections (Drawing Pavement and Base into Cross Sections).
2. Edit the file with the GEOPAK “Text Editor” or Notepad. The lines that you need to edit in your earth.inp file are:

“xs dgn =” Set to the directory and dgn file that has your cross-sections

“fill mult factor =” Set to the shrinkage factor for suitable grading materials.
Example, fill material with 25% shrinkage should have a “fill mult factor” of 1.25. Materials not used for common excavation should remain at a factor of 1.00.

“Proposed Undercut” These paragraphs are used to account for materials that are brought on to the project so that GEOPAK can correctly calculate common excavation and fill. If you are working with a simple borrow, waste or stockpile site, these paragraphs can be deleted.

If the proposed material is base including material from mining and blending, then the “soil type” should match the “Existing Suitable Material” for blended material. Do not use the same “soil type” for existing materials and proposed materials unless the material is going to be reused.

“Existing Suitable Material” These paragraphs are used to account for materials that might stay in place. Base material on a project may be able to remain in place for a mine and blend project. These paragraphs can be deleted if you are calculating earthwork for a simple borrow, waste or stockpile site. Note “Existing Suitable Material” will still be removed if the proposed material “soil type” doesn’t match. Do not process existing base if it is to be addressed as common excavation.

“Existing Unsuitable Material” These paragraphs are used to account for materials that must be moved or removed. This material should not be accounted for in the mass ordinate. Example if existing topsoil and as-built topsoil overlap in certain areas, the term “Unsuitable” would make GEOPAK excavate the material even though it would be replaced again. The term “Suitable” would allow for the same topsoil to remain in place.

“Skip Areas” Revise these lines for areas where earthwork should not be calculated such as over bridges. Additional lines will need to be added if additional skip areas are required. This paragraph can be deleted if there are no skip areas.

“Volume Adjustment” Revise these line for borrow and waste sites. “Volume Adjustments” are also used for approach, interchanges and intersections. Add or Delete these paragraphs as needed.

“Process Earthwork for Baseline =” Set the chain name and job number for your cross sections.

“beg sta” Beginning station of your chain

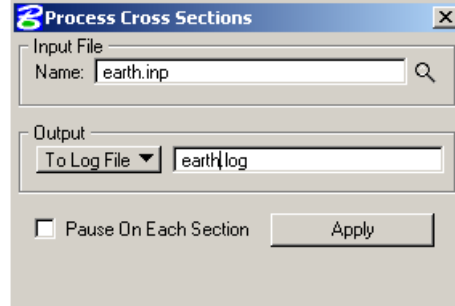
“end sta” End station of your chain

3. Sometimes corrections for excavation and embankment need to be accounted for outside of the cross sections. Examples of these corrections include borrow and waste sites. They also include earthwork from adjoining or intersecting roadways. Variations of the following paragraph may need to be added. Multiple corrections can be made at different locations by adding multiple paragraphs. These paragraphs should be included in the input file right before the “Write Earthwork Shapes” statement.

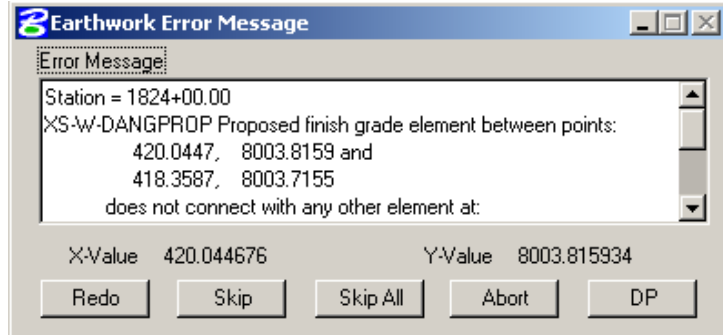
```
volume adjustment /* Borrow from Wetland */  
station = 98+00  
soil type = suitable_grading  
common excavation volume = 125354
```

4. Once you have made these changes you can save the file.

- Now go back to MicroStation and choose “Applications>Road>Cross Sections>Process Cross Sections”. The box to the right should appear. Fill out the box as shown. You may want to adjust the earth.log file name if you will have multiple earth work runs (different cross sections drawings). Once you have the box filled out you want to choose the Apply box.



- GEOPAK will now run through each cross section and calculate the fill and cut. If GEOPAK can not tie the two grounds together you will get an “Earthwork Error Message”. You can interactively correct some cross sections as GEOPAK

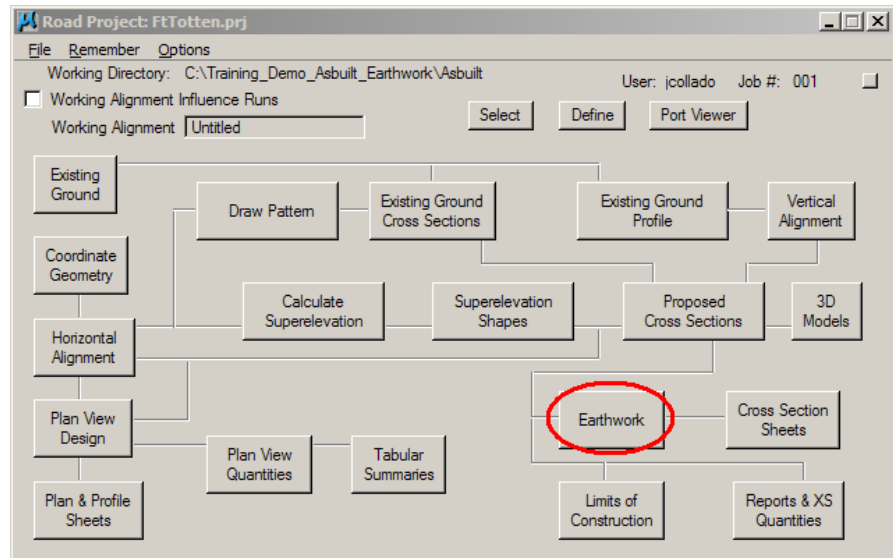


calculates earthwork. If the “DP” button is enabled, it can be used to help find the to the problem area. “DP” stands for Data Point. A MicroStation tool such as “Place Line” or “Zoom In” can be used in conjunction with the GEOPAK “DP” button to find this problem area. Example if the above error message appears, you could select the MicroStation “Place Line” tool then select the “DP” button from the “Earthwork Error Message” dialog box. MicroStation will start to draw a line from the coordinates of the problem area. The place line command could then be canceled and then you could correct that specific cross section. After the cross section has been corrected the “Redo” button can be selected and GEOPAK will try to reprocess the cross section. If you choose to “Skip” a cross section, earthwork for that section will not be calculated, at some time you will need to tie the two grounds together. This process is just a trial and error situation. The log file that is produced will have all of your calculation and can be printed out.

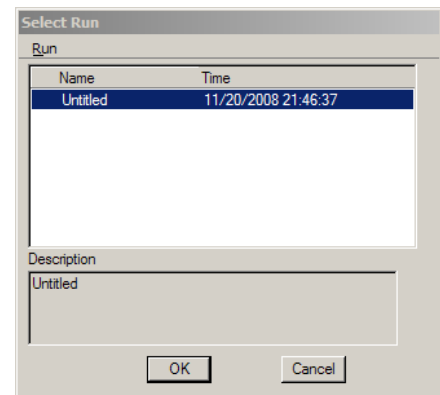
Running Earthwork with Project Manager

11/20/08

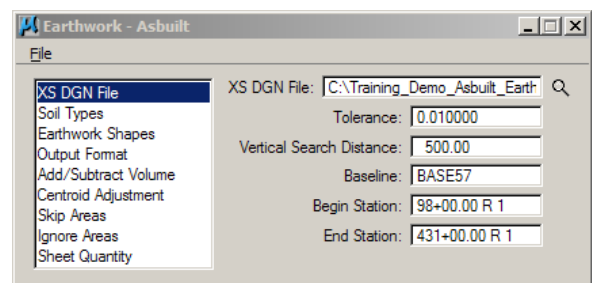
1. Select the Project Manager file, and user for your project. If the general settings for project manager have not been set up, see the section named “Project Manager for GEOPAK Road”.
2. Select the “Earthwork” button.



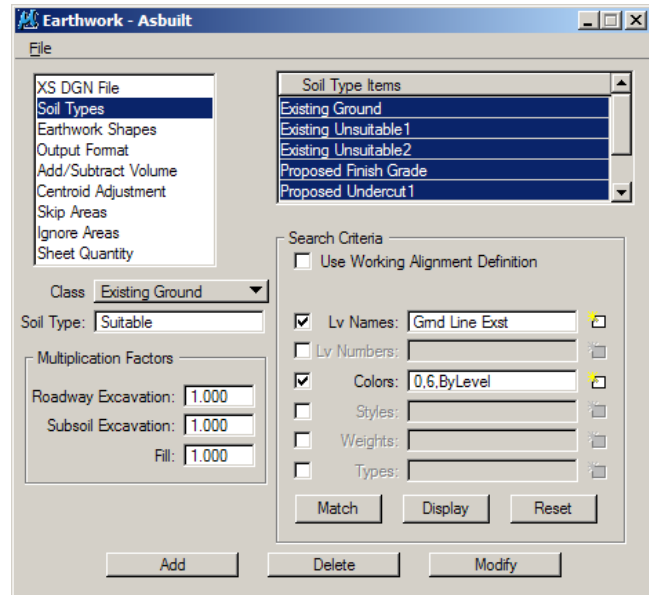
3. A “Select Run” dialog box should appear. Within this dialog box, select “Run>New”.
4. Provide a name for the run. The naming convention for the run is not very important. It only has to be memorable. The description is optional. Select the OK button on the New Run Name dialog box. The name of the newly created run should appear in the “Select Run” dialog box. Double click on the name of the newly created run.



5. The Earthwork dialog box will open. On the left side of this dialog box is a panel with categories of settings that need to be completed. Click on the first category “XS DGN File”. Use the icon that looks like a magnifying glass to select the working cross section drawing. The “Baseline”, “Begin Station” and “End Station” fields should automatically fill in when the working XS drawing is selected.



- Select the “Soil Types” category. This dialog is used to tell GEOPAK how drawing elements represent different soil types. There are 6 different classes of earthwork elements; Existing Ground, Existing Suitable, Existing Unsuitable, Proposed Finished Grade, Proposed Undercut and Excavation limits.



Existing Ground must always be defined. The “Soil Type” name should be the same name used in for the Proposed Finished Grade. Soil types with the exact name are the same materials even if it comes from a different earthwork class (example, the soil type named “suitable_soil” that is excavated from the “Existing Ground” classification can be used as fill for soil named “suitable_soil” in the “Proposed Finished” classification).

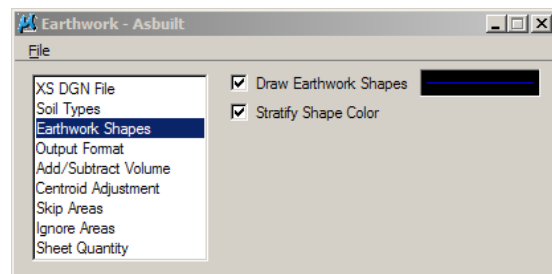
“Proposed Finished Grade” must always be defined. This is the As-built surface including closure lines. Don’t forget to adjust the “Multiplication Factors” for “Fill” (example, project that have 20% additional soil for shrinkage, should be entered as 1.2).

“Existing Unsuitable” class is often used for topsoil stripping. If the “Existing Unsuitable” classification is not used for topsoil stripping, GEOPAK will assume it acceptable to build – embank directly on top of the topsoil. “Excavation Limits” must be used in conjunction with “Existing Unsuitable” features. Existing Unsuitable is also used for pavement and base removals.

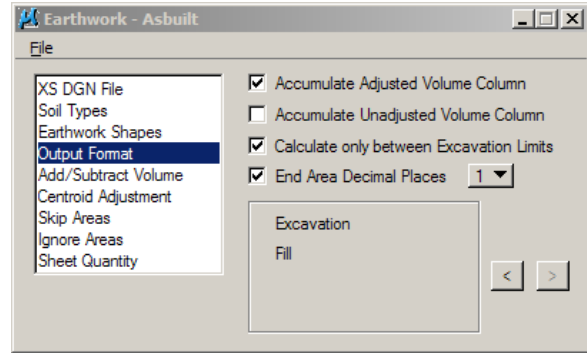
“Existing Suitable” class is used for full depth reclamation projects. The existing pavement and base can remain in place.

Proposed undercuts are for proposed (as-built) materials such as topsoil, base and pavement.

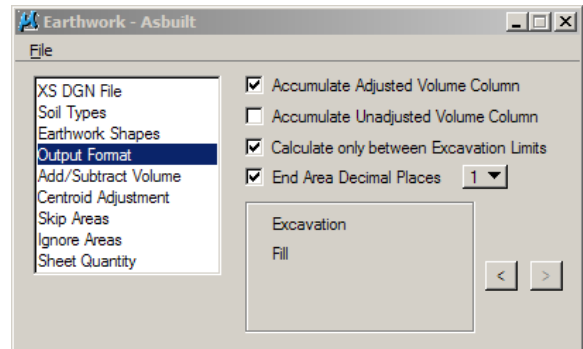
- Select the “Earthwork Shapes” category. Turn on the options for “Draw Earthwork Shapes” and “Stratify Shape Color”. Set the symbology for the earthwork shapes. The level should be changed to “Earthwork Shapes 1”.



8. Select the category “Output Format”. Turn on the options as shown. In the lower right area of the dialog box are arrows (< and >). Click and re-click on the “>” arrow until the display format shows only, Excavation and Fill.



9. The “Add/Subtract Volume” category is used to make earthwork corrections within the earth log (earthwork report). Corrections within the earth log are important for creating a Mass Diagram. Typical corrections include borrow sites and extra material needed for intersections and approaches. Materials for centerline pipe may also need to be accounted. These corrections should be thought of in terms of the roadway project; material from a borrow pit is additional excavation, material needed for approaches is fill.



10. The category “Centroid Adjustment” is seldom used by the NDDOT because most of our control alignments are close to or within the actual earthwork, and the stationing measurements are close enough. The “Centroid Adjustment” is important when the actual distance between stations is different than the distance calculated from stationing alone (example, the distance between station 1+00 and 2+00 is 100 feet if measured at centerline, but it would be longer if it was measured on the outside of a curved alignment).
11. The category “Skip Areas” is used to omit areas of earthwork. The category “Ignore Areas” calculates volume through the station range but none of the data within that station range is used in the end area calculations. Skip Areas are often used for bridges. Ignore Areas are sometimes used for unique cross sections that don’t represent earthwork correctly.
12. The category “Sheet Quantity” is seldom used by the NDDOT. This category can be used to create a special custom ASCII report. This report is different than the earth log file. It can be imported into Excel and or used to print individual cut and fill quantities on the cross section sheets.

Reviewing Earthwork Calculations

11/20/08

After running earthwork (Earthwork form Cross Sections) you should have a report (earth.log) and GEOPAK should have drawn earthwork shapes into your cross section drawing. These earthwork shapes should be on level "Earthwork Shapes 1". GEOPAK assigns (in ascending numerical order) each material type two colors, one for cut and one for fill. Even color numbers are assigned to excavation and odd numbers are assigned to fill. Below is an example of color assignments based on a specific earthwork setup (run-input file). Your color numbers may vary based on your setup.

<u>Soil Type</u>	<u>Process</u>	<u>Color</u>
suitable_grading	cut	0
suitable_grading	fill	1
base	cut	2 (will only occur if salvaging base)
base	fill	3
asphalt	cut	4 (doesn't occur, requires processing after salvaging)
asphalt	fill	5
base_removed	cut	6
base_removed	fill	7 (doesn't occur, would use the term "base" instead)
asphalt_removed	cut	8
asphalt_removed	fill	9 (doesn't occur, requires processing after salvaging)

If you reprocess earthwork, these shapes should be deleted before reprocessing.

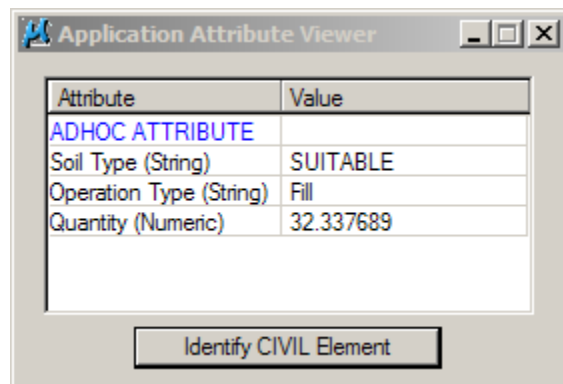
These earthwork shapes should be reviewed in order to confirm that earthwork was correctly processed. Typically a small percentage of the cross sections are examined with MicroStation measurement commands. Every single shape in the selected cross section is measured with the MicroStation "Measure Area" tool or the supplemental "Measure Area" tools. These areas are then added according how the earthwork was intended to be process. These calculations are then compared to the GEOPAK calculations as compared in the earth.log.

Application Attribute Viewer

11/20/08

The Application Attribute Viewer is GEOPAK tool that can be used to help review earthwork shapes. GEOPAK attaches additional information to drawing elements such as earthwork shapes. This information is attached as Adhoc Attributes.

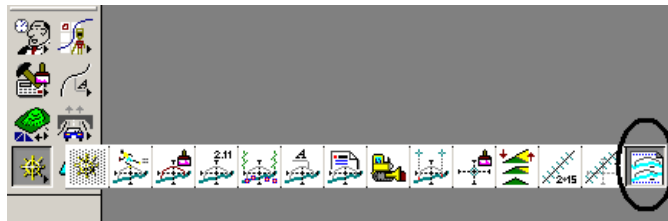
1. Select “Applications>Road>Element Attributes” from the main pull down menu. The Application Attribute Viewer dialog box should open.
2. Select the “identify CIVIL Element” button. Then click on an earthwork shape. Information about the shape such as end area will appear.



Creating Cross Section Layout Sheets

03/24/06

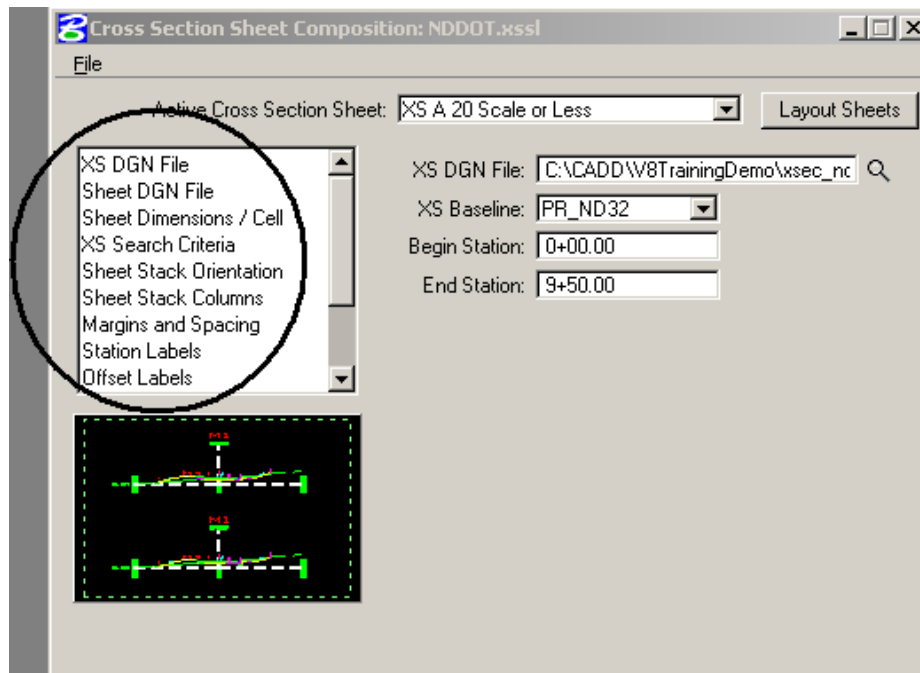
1. Create a new drawing for the cross section layout sheets. The NDDOT Standard seed file should be used (NDDOTseed.dgn). The layout drawing should be named according to the CADD standards (lxsec*.dgn). GEOPAK will reference in the working cross section drawing (xsec*.dgn).
2. Copy the file S:\STANDARD\XM\GEOPAK\Criteria\As-built_Earthwork\NDDOT.xssl and pasted into your working directory. You may have already have done this if you copied resource files into working directory during previous earthwork procedures.
3. Open your working cross section drawing (xsec*.dgn).
4. Open the “Cross Section Sheet Composition” dialog box. It can be found in the pull down menu “Applications>ROAD>Cross Sections>Cross Section Sheet Composition”, project manager or the standard tool tray as shown.



5. From the cross section sheet composition dialog box, attach the XM standard library by selecting “File>Sheet Library>Attach” and pick the file “NDDOT.xssl” that you copied into your working directory.
6. Most of the cross section sheet settings should be set up for the typical project. However if you plan on changing several of the default settings, you will probably want to save these revised setting. The following are some examples why you may want edit the default settings.
 - a. Exaggerated vertical scale
 - b. Different level search criteria
 - c. Different “Baseline X Offset”
 - d. Different cross section spacing
 - e. Different earthwork table setup

Most of the settings have been set up for the typical project. The settings that don't typically need to be edited are not reviewed here. The follow is a review of the setting that you will have to setup within the “Cross Section Sheet Composition” dialog box.

7. First, select your “Active Cross Section Sheet”. The most common “Active Cross Section Sheet” setting is “XS A 20 Scale or Less”. The “Active Cross Section Sheet” setting contains groups of related standard default settings.
8. Within the “Cross Section Sheet Composition” dialog box you can pick the group of settings that you want to review or edit from the left panel. Select the group of settings for “XS DGN File” and adjust the settings for your working cross sections drawing (xsec*.dgn).



9. From the group of settings dealing with “Sheet DGN File”, set the “Sheet DGN” to your cross section layout drawing (lxsec*.dgn). Note the layout file needs to exist before laying out the sheets. Also note, the bottom two options; “Detach Existing Sheets Before Processing” and “Attachment: All Sheets in Active Model”. Multiple drawing models are used on large sets of cross sections in order to improve management of numerous of reference files. If you don’t know why and when to use models, don’t use them. Use the Attachment “All Sheets in Active Model” option.
10. This guide doesn’t explain the “Label Earthwork Quantities” options. This is an optional labeling tool that needed to be setup before processing earthwork. From the group of settings dealing with “Earthwork Quantity Labels”, turn of the “Label Earthwork Quantities” options.
11. Layout the cross section sheets by selecting “Layout Sheets” and review the drawing (lxsec*.dgn). Be sure to review the attached reference files. Future changes to reference cross sections will automatically show up in the sheet layout drawing.