Machine Control Grading Projects

Originally Issued: 05-23-07

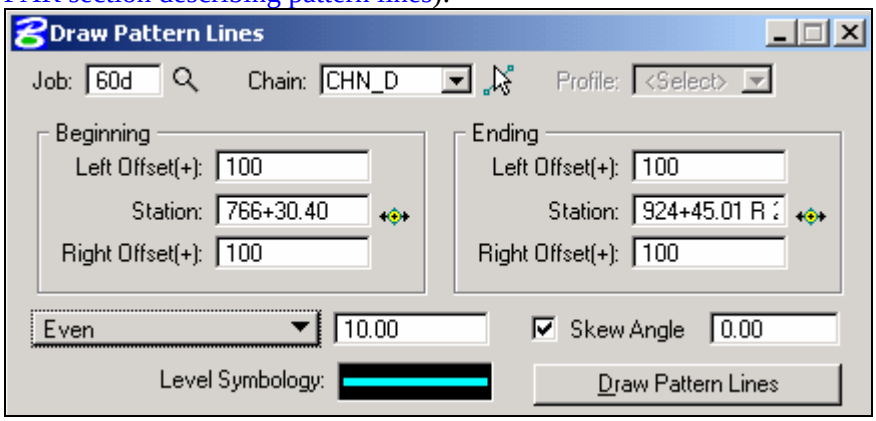
To facilitate the development of the data files needed for machine control grading, the following protocol needs to be followed when developing cross sections for mainline, side roads, ramps, loops, and on-site detours for a project.

Cross Sections Pattern Line Placement

1. Normal Cross Section Spacing:
   A 10’ spacing between cross section pattern lines is required for projects that will be built with machine control techniques. There needs to be a cross section made at the exact beginning and end of the project. The cross section on 10’ intervals shall be at even +10 stations.

   Note: The 10’ spacing will not be used for calculating earthwork quantities and soils layer lines will only be placed at currently established cross section intervals.

   Use the GEOPAK “Draw Pattern Lines” tool, shown below, which is accessed through “Cross Section” and then “Draw Patterns by Station Range” to accomplish this task (Future PAR section describing pattern lines):

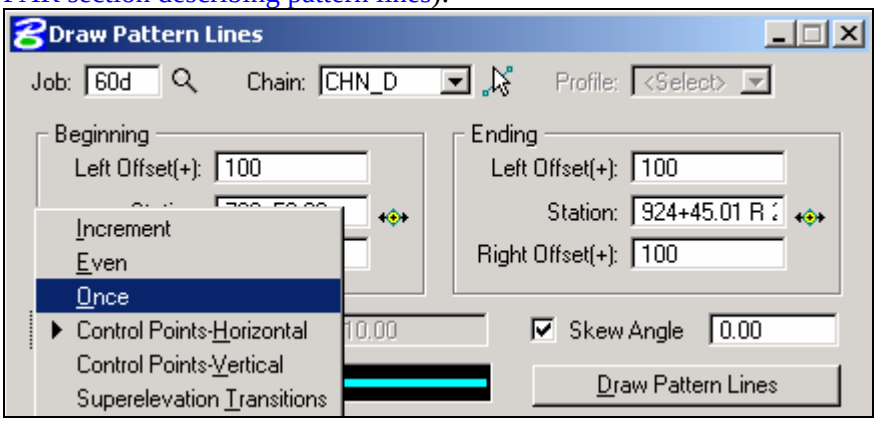


2. Additional Cross Section Locations:
   In addition to the 10’ spaced cross sections, the following locations require a cross section due unique changes in the proposed design:

   - Changes in Typical Sections
   - Beginning and End of Transitions
   - Ditch Grades
     An effort should be made to place ditch grade points on +10 stations to avoid the need for additional section.

- Foreslope Transitions
- Backslope Transitions
- Horizontal Curve Geometry Points:
  a. Curves Without Spirals: PC and PT
  ftp://165.206.203.34/design/dmanual/02a-01.pdf
  b. Curves With Spirals: TS, SC, CS, and ST
  ftp://165.206.203.34/design/dmanual/02c-01.pdf
  c. PI Points With No Curves.
- Vertical Curve Geometry Points:
  a. VPC and VPT
  ftp://165.206.203.34/design/dmanual/02b-01.pdf
  b. Maximum or Minimum Points (if not VPC or VPT)
- Super Elevation Points (A, B, C, and D)
  See Typicals 2114A, 2114B, 2114C, and 5303
  Ramps: See Typicals 2114D and 2115
- Guardrail Berms Transition Points
  See Standard Road Plans
  RL-14A ftp://165.206.203.34/design/stdrdpln/english/erl14a-01.pdf
  RL-14B ftp://165.206.203.34/design/stdrdpln/english/erl14b.pdf
- Median Shaping for Cable Barrier
  See Standard Road Plan RL-12 ftp://165.206.203.34/design/stdrdpln/english/erl12.pdf

Use the GEOPAK "Draw Pattern Lines" tool, shown below, which is accessed through "Cross Section" and then "Draw Patterns by Station Range" to accomplish this task (Future PAR section describing pattern lines):



Gapped Areas

The following areas will not require special cross sections since they will not included in the models for machine control grading.

1. Intersection Returns
   Note: Both the mainline and side road should still be included in the model surface.
2. Bridge Berms
   See Standard Road Plan RL-17 ftp://165.206.203.34/design/stdrdpln/english/erl17.pdf
3. Side Pier Berms
   See Standard Road Plan RL-15 ftp://165.206.203.34/design/stdrdpln/english/erl15.pdf

4. Wing Dikes
   See Standard Road Plan RL-3 ftp://165.206.203.34/design/stdrdpln/english/erl03.pdf
5. Let Down Berms, Ditch Blocks & Dikes
   See Standard Road Plan RL-4 ftp://165.206.203.34/design/stdrdpln/english/erl04.pdf

6. Entrances and Safety Dikes
   See Standard Road Plan RL-7 ftp://165.206.203.34/design/stdrdpln/english/erl07.pdf
7. Median Crossovers

Note: An overview layout of the project should be developed which shows the areas which are not included in the surface model. The following is an example of this type of layout:

Shortcut to 51MCLayout.pdf.lnk

Grouping Cross Section Cells

NOTE: Currently, the 10' cross section spacing will not have soil layer lines drawn for them, nor will they be sheeted for the final plan set. However, in the future, it is planned that a method will be developed for soil layer lines to be drawn using subsurface TIN files. Also, it is planned that the DOT will move away from printing cross sections to paper. If these new methods come to pass, then the process of grouping cross sections as described below will no longer be necessary.

Because the 10' cross section spacing will not be used for drawing soil layer lines, calculating earthwork quantities, or printing cross section sheets to include in the plan set, the ability must exist to choose which cross sections will be used for any given process. There are three steps that allow for this to happen:

3. Set Cross Section Pattern Lines to be Unique:

   There are generally four different sets of cross sections that will need to be cut:
   - A. Regular interval cross sections for earthwork quantities (100' rural or 50' urban)
   - B. Single cross sections for unique changes in the proposed design
   - C. Single cross sections for culverts and drainage areas
   - D. Regular interval cross sections for machine control grading (10')

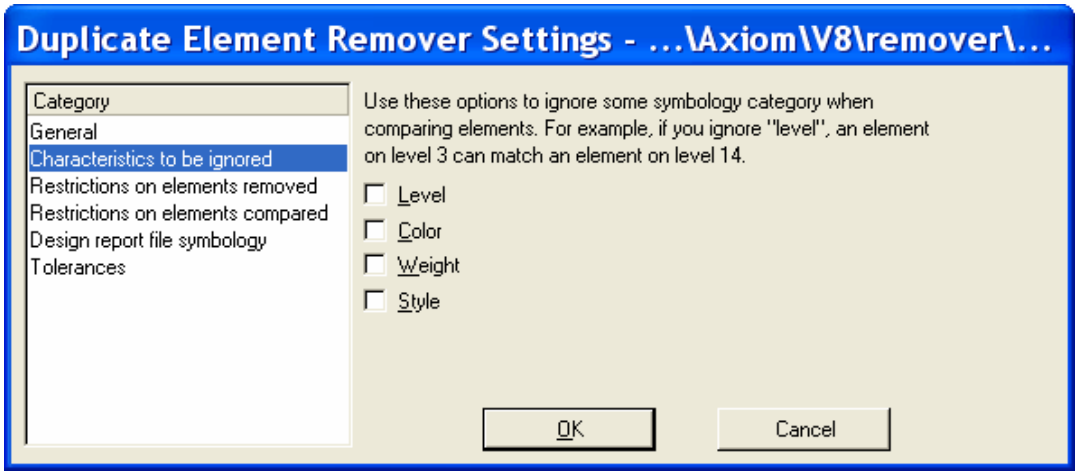
   For each of these sets of cross sections, a different symbology must be used when drawing the pattern lines. This symbology difference can be accomplished by placing the pattern lines on a different level, different color, different line style, etc.

   This will generally not present a problem except for the case where the two sets of regular interval cross sections overlap one another (which will happen every 100' rural or every 50' urban). In this instance, the user needs an easy way to eliminate the duplicate pattern line that will be placed. One method is to use Axiom's Duplicate Element Remover.

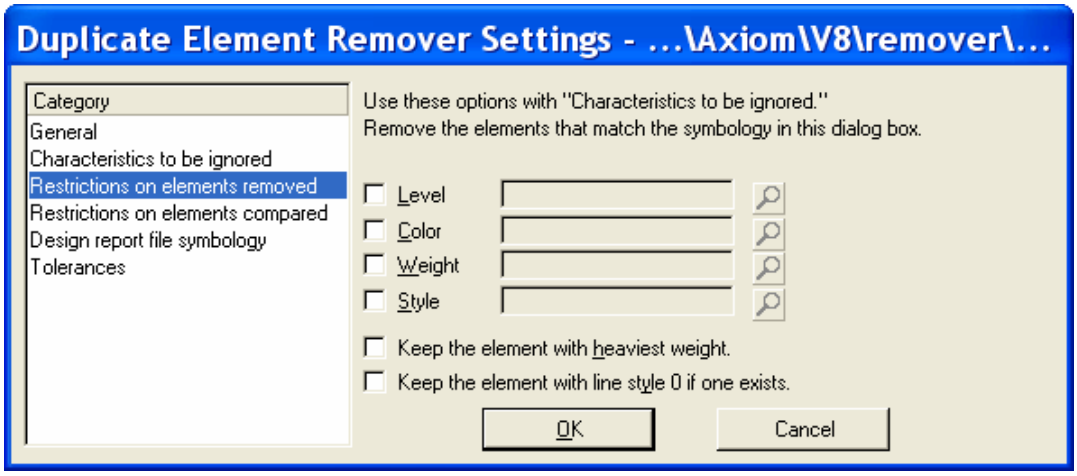
   Once the tool is started and the target file is chosen, the user must tell the tool how to find and delete the duplicate elements. This is done by going into the 'Change Settings' dialog.

The ‘Change Settings’ dialog has several screens, but the ones of most interest are the three that follow below, which all work together to accomplish the removal of the extra pattern lines.

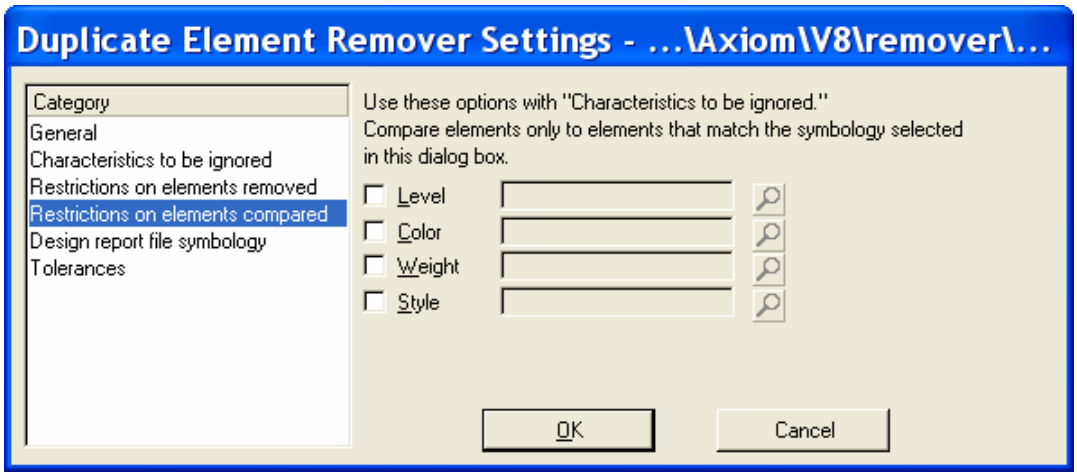
The first screen is labeled ‘Characteristics to be ignored’. Even though the duplicate pattern lines are the same length and occupy the same location, they have some part of their symbology that is unique, so that they can be used at different times. By choosing one of the check boxes on this screen, the user can tell the tool to ignore this difference in symbology.



The next screen is labeled ‘Restrictions on elements removed’. The same checkboxes are chosen as on the first screen, and the purpose of this screen is to make the distinction on which of the duplicate elements is to be removed.



The final screen is labeled ‘Restrictions on elements compared’ Similar to the last screen, the same checkboxes are chosen as on the first screen, only the purpose of this screen is to decide which of the duplicate elements will be kept (not deleted).



4. Cut Existing Ground Cross Sections in Different Sets

   Because the pattern lines for the various sets of cross sections are unique, they can be cut at different times. And when the sets of cross sections are cut separately, they will be drawn to different parts of the working cross section file. This is important for the next step. Once the user has cut all of their cross sections, they should make note of where each set of cross sections has been drawn by placing a large MicroStation shape around each set, with text that labels the type of set that is represented.

5. Using the MicroStation ‘Group’ Command

   Because the different sets of cross sections have been drawn to different locations in the working cross section file, it is possible to use the MicroStation ‘Group’ command to isolate a particular cross section set (in this case, the regular interval cross sections for machine control grading that were cut every 10’). This is accomplished by using the Element Selection tool in MicroStation to select all of the cross sections in a set. Once the entire set of cross sections has been selected, the user will choose Edit | Group from the MicroStation menu bar.

What this does is wrap a blank cell header around all of the selected elements. Because of this cell header, Geopak now cannot 'see' the cross section cells within the group. As a result, these cross sections effectively disappear as far as Geopak is concerned. They cannot be seen by the Cross Section Navigator, they cannot be used for earthwork calculations, and they cannot be sheeted.

So the procedure will be to 'Group' the machine control cross sections right before earthwork or sheeting is run, and then afterward, they will be put back to normal by doing an element selection on the group and choosing Edit | Ungroup from the MicroStation menu bar.

Generation of 2D Cross Sections

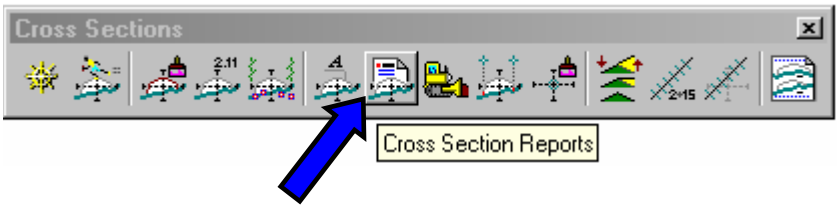
Future PAR section describing generation of 2D cross sections.

Generation of 3D Surfaces

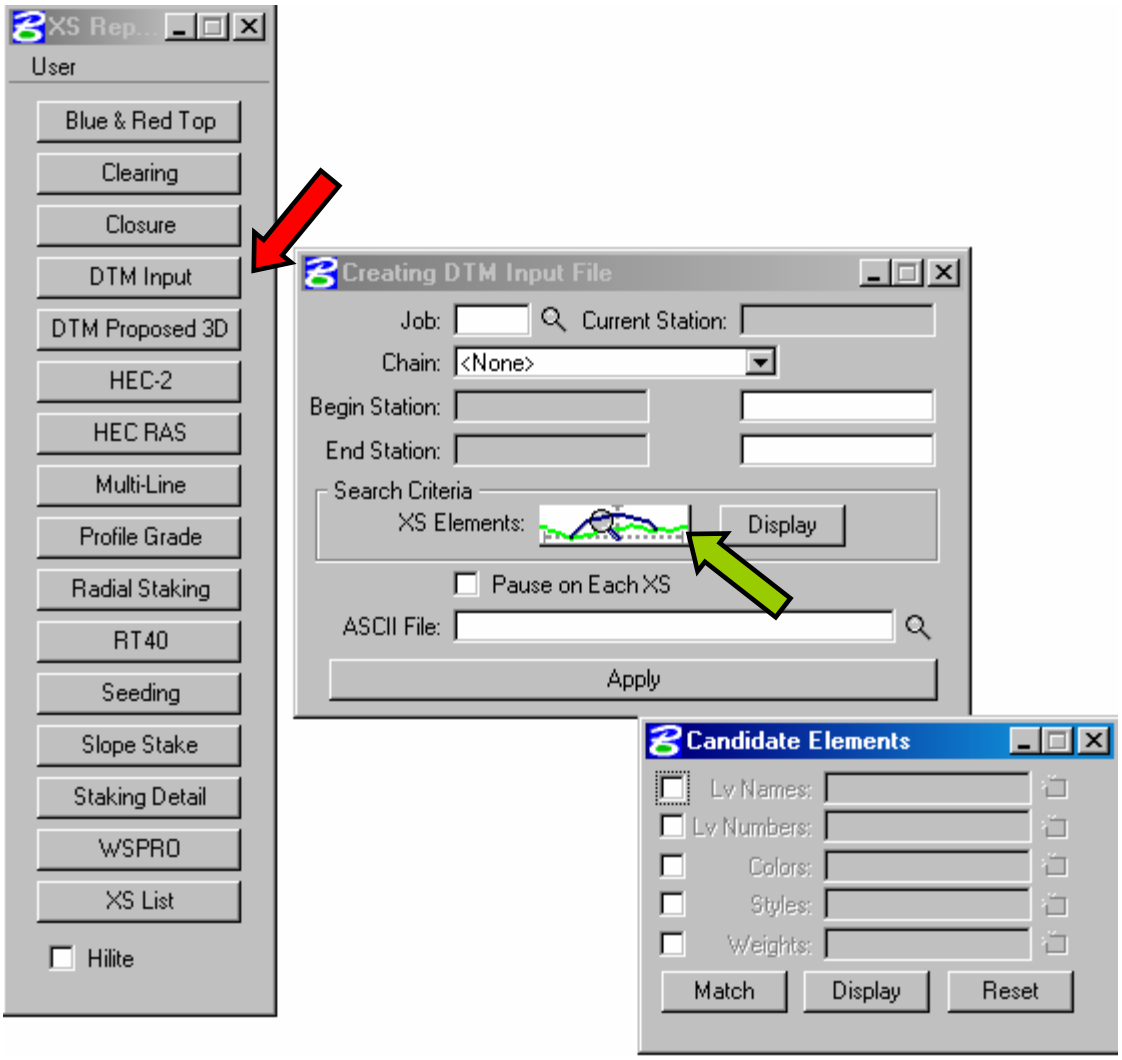
Once the cross sections are complete the following steps are to be completed to develop the surface files in the Triangular Irregular Network (TIN) format. data files that will be provided to the grading contractor for application in the machine control grading process. There are multiple ways to accomplish this task, 2 processes are discussed below.

Process 1

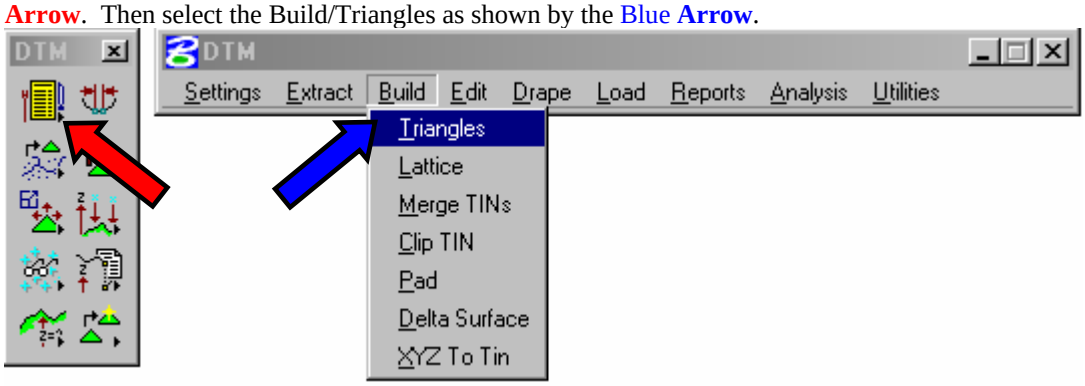
Start GEOPAK, Get the Cross Section Reports icon in the Cross Sections icon bar, as shown by the **Blue arrow**.



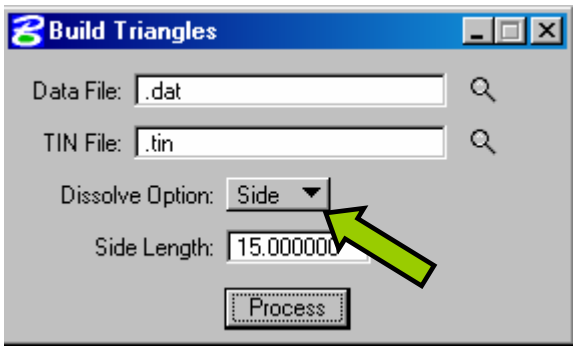
Select the DTM Input report as shown by the **Red arrow**. Then select the job, chain, station range and by the **Green arrow** select the cross section line work you want as a DTM. Then name and create the .dat file.



After the .dat file has been created open the GEOPAK DTM icon bar and select the DTM as shown by the Red **Arrow**. Then select the Build/Triangles as shown by the Blue **Arrow**.



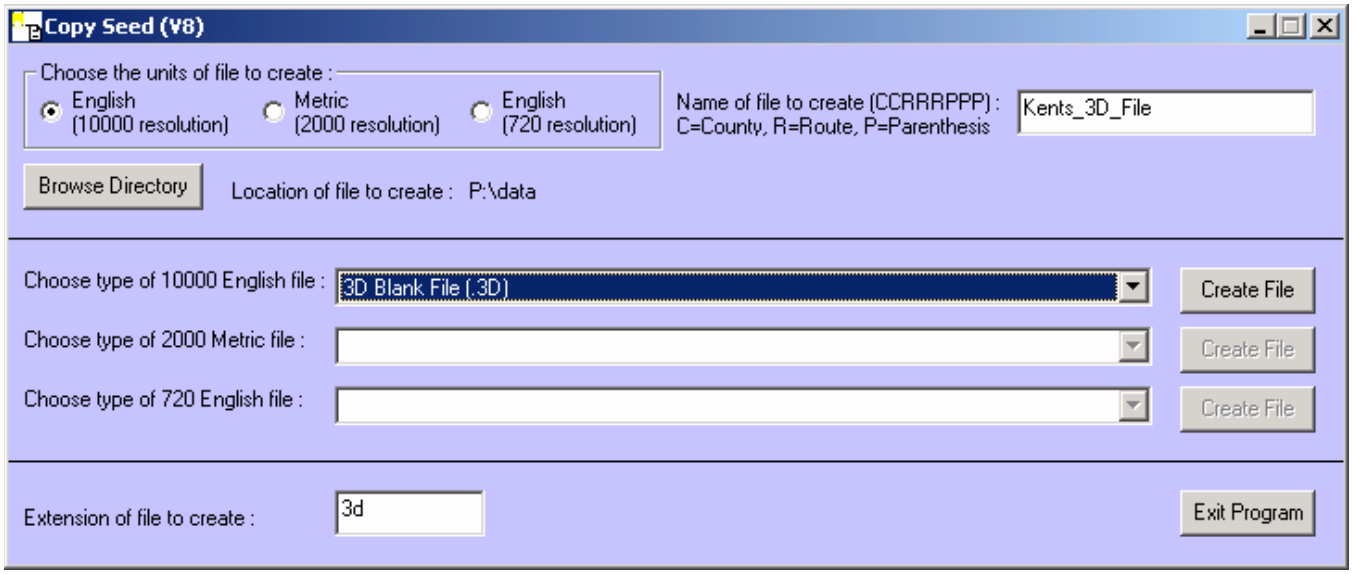
Then select your created .dat file, name your .tin file, set the Dissolve Option as shown by the Green **Arrow**, and set the side length as the 15 ft (5 ft farther than the maximum cross section spacing).



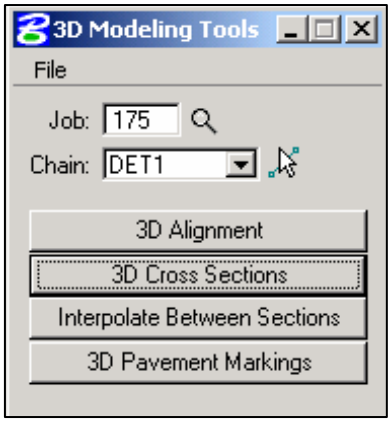
Process 2

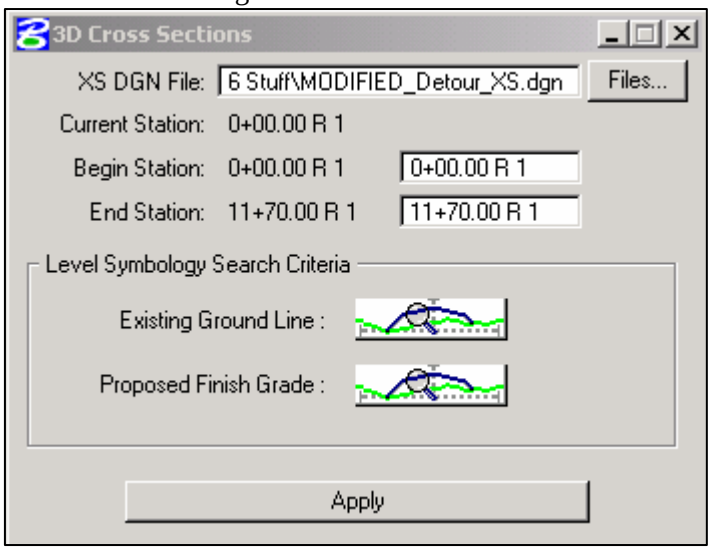
3D Cross Sections

1. Copy from the seed files a 3D design file for use in the development of the 3D cross sections. (Future PAR section describing the Copy Seed application.)

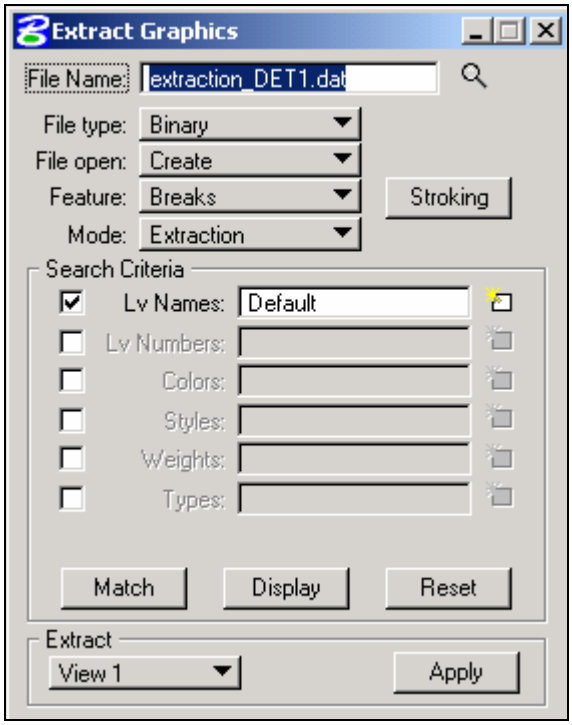


2. Generate 3D cross sections for all of the proposed improvements.
   Use the GEOPAK "3D Modeling" tool which is accessed through "3D Tools" and then "3D Cross Sections" to accomplish this task (Future PAR section describing 3D cross sections.). The tool palettes are shown here:

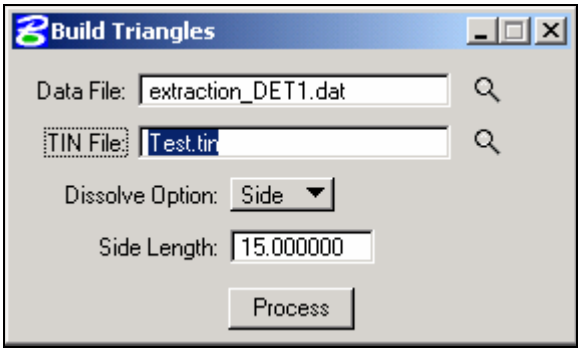




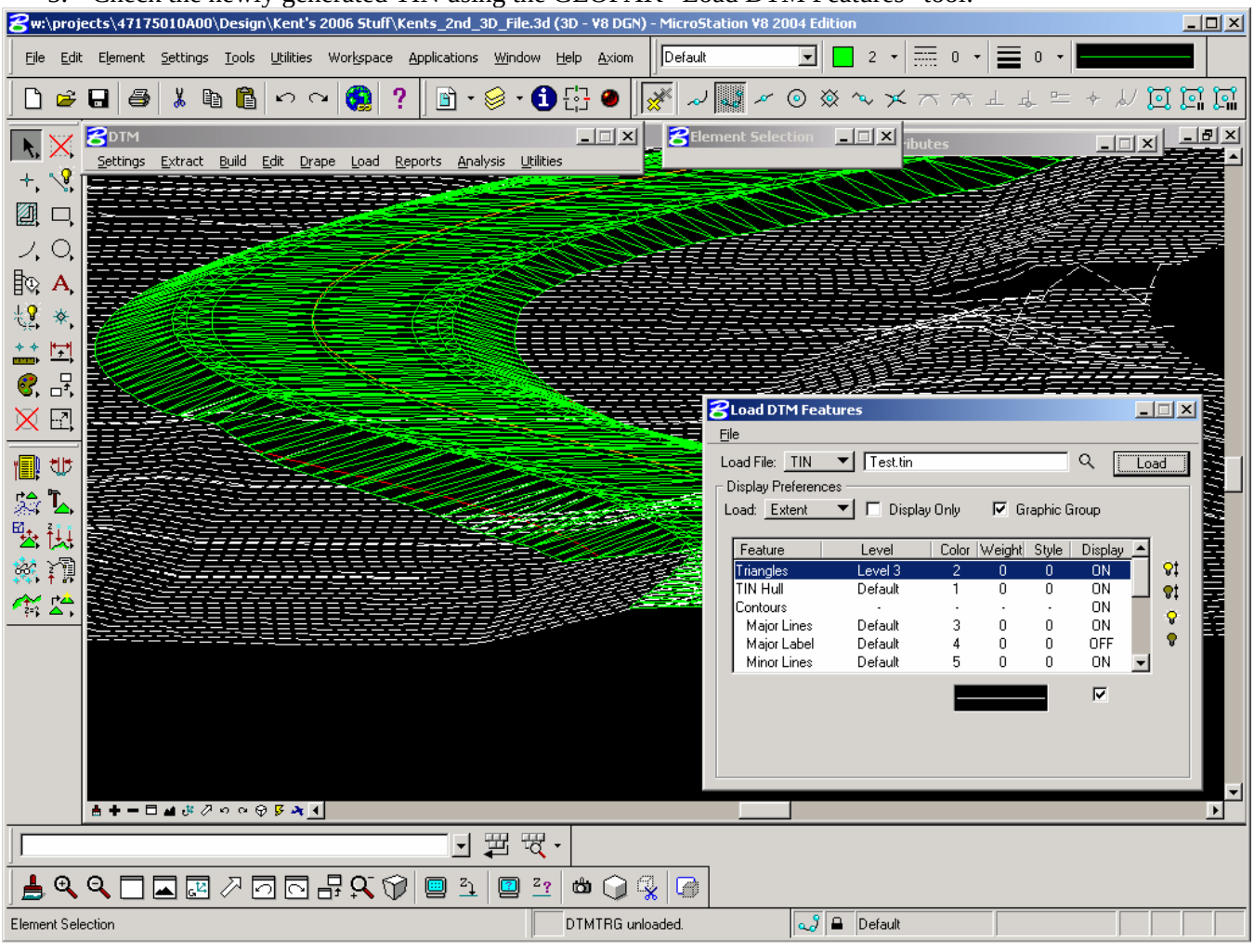
3. Use the GEOPAK "DTM" tools set to "Extract Graphics" into a ".dat" file. This tool palette is:



4. Use the GEOPAK "DTM" tools set to "Build Triangles" as shown in the following palette:



5. Check the newly generated TIN using the GEOPAK "Load DTM Features" tool:



6. Merge TINS as needed to develop the needed composite TIN file. This may be a composite TIN by stage of construction or composites for grading and paving projects.

Additional Surfaces

Surfaces should also be developed for the following situations:

1. Borrows (By Soils Design using GEOPAK Site)
2. Under Cuts
3. Over Burden
4. Special Channels
5. Recreational Trails

Comments

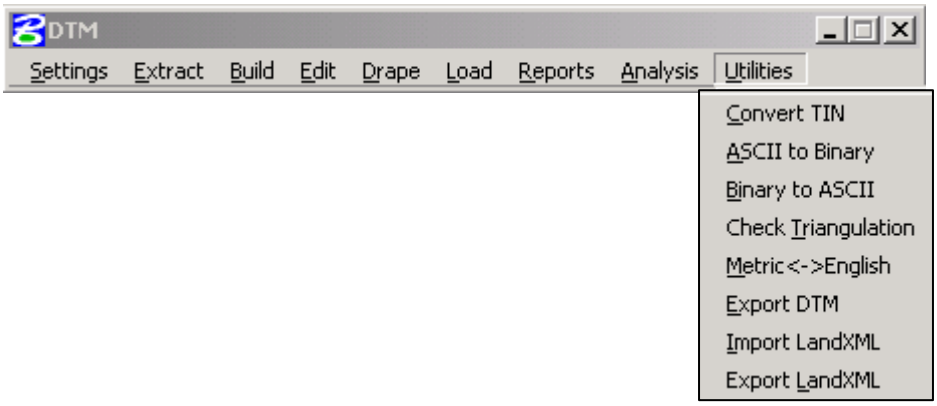
Roadway Pipes and Boxes do not require special sections for modeling.
Final Surface with Topsoil vs. Class 10 Surface
Select Treatment – Top or Bottom

Output Surfaces

Once the TIN files have been completed, then the following steps are to be process should be followed to generate the that will be provided to the grading contractor for application in the machine control grading process.

File Formats

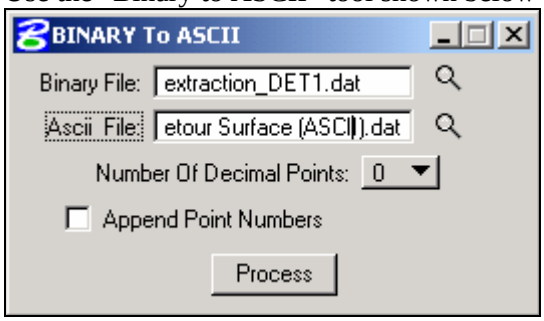
The "Utilities" tool set option on the "DTM" palette allows for the conversion of the final design TIN into a number of possible out file formats. The palette is shown below:



The following file formats of the proposed roadway grading surface, as well as the existing ground surface, will be generated and provide to the Office of Contracts prior to letting:

1. Bentley Format
   This is the final TIN file generated by the pervious instruction and the existing ground TIN created by Photogrammetry.

2. ASCII Format
   Use the “Binary to ASCII” tool shown below to generate this file format.



3. Land XML Format
   Use the “Export Land XML” tool shown below to generate this file format.

4. Trimble Format
   Use the “Export DTM” tool shown below and select the “Triangle TIN to Trimble TTM” option as shown below: