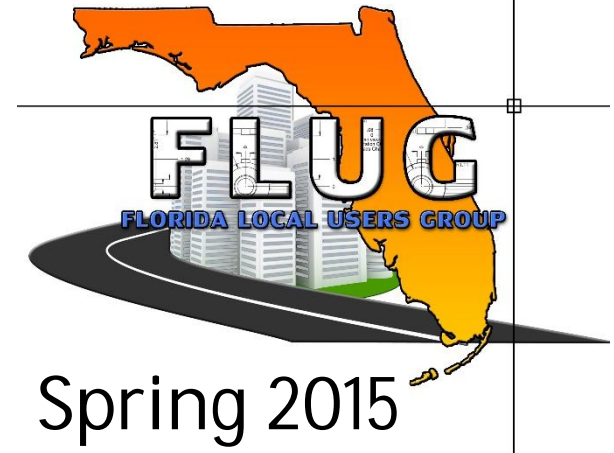# FDOT SURVEY WORKFLOW WITH BENTLEY'S OPEN ROADS TECHNOLOGY FOR 3D MODELING PROJECTS


Spring 2015

SS3/SS4 DESIGN SURVEYS

3D Design Survey - Getting Started

- You have FDOTSS2, it is currently implemented by FDOT. You know the workflow, you know the deliverables, why would you use FDOTSS3?

  1. Determining what level of surveying is needed by design is crucial in answering this question. Some design will not need any surveying, or very little. A DTM may be limited to areas that need rehabilitation. Those types of projects may not be using 3D Design. If so FDOTSS3 is not necessary.

  2. 3D design requires a full DTM of the existing surface throughout the limits of the project. No gaps, no lapses in coverage, and not just any DTM will do. It must be a Bentley "Terrain Model". This terrain model will only be found in Bentley's Select Series 3 products.

  3. Criteria based design is being phased out by FDOT. FDOTSS2 will be available until 2016. Don't wait until FDOTSS2 is gone or you will find yourself unprepared for design survey requirements.

THE SURVRD.DGN SURVEY DEVELOPMENT MODEL
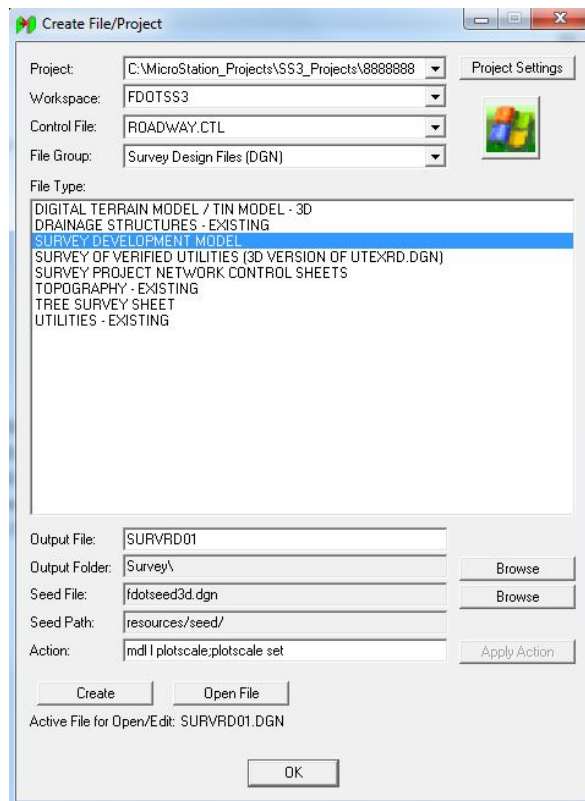
- Using the "Create File/Project" tool is a quick way to create your 3D Survey Development Model.

- The SURVRD.DGN file is your FDOTSS3 survey database containing Point and Linear Features

- Note that the fdotseed3d.dgn is the seed file used. Only this seed file has the appropriate filters built into the file.
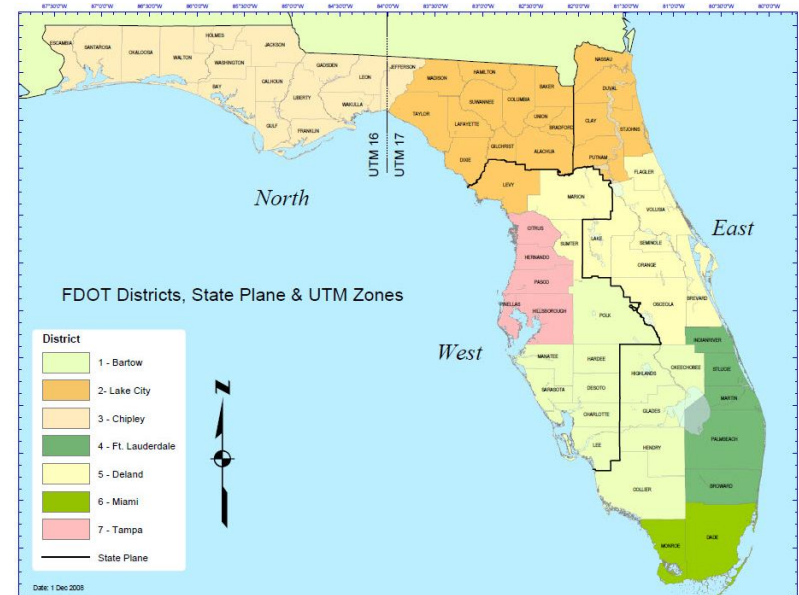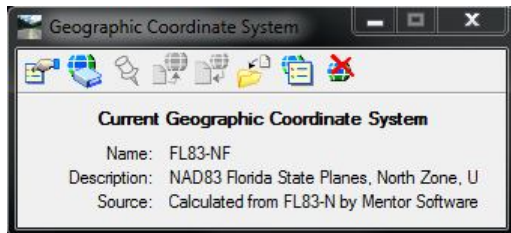
# SET GEOGRAPHIC COORDINATES (two different ways)
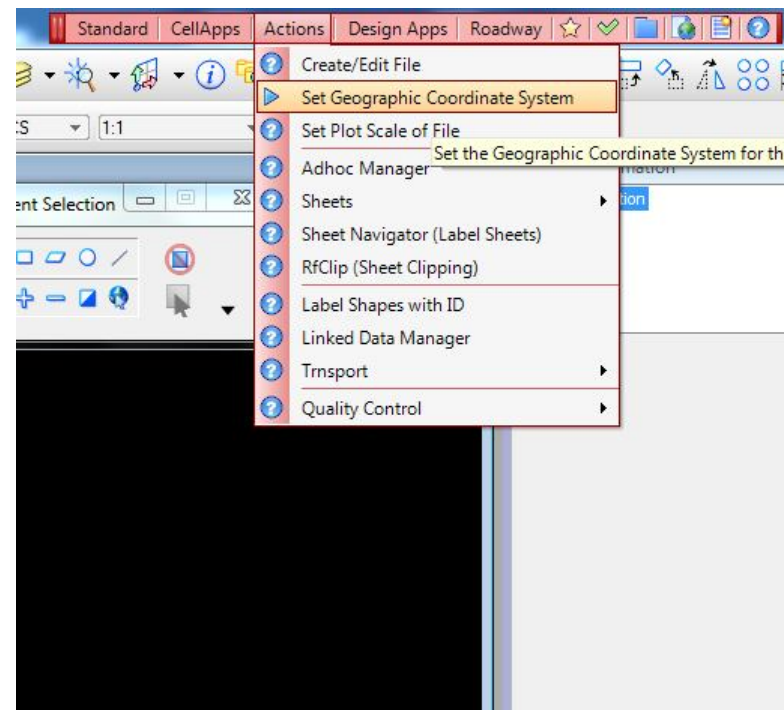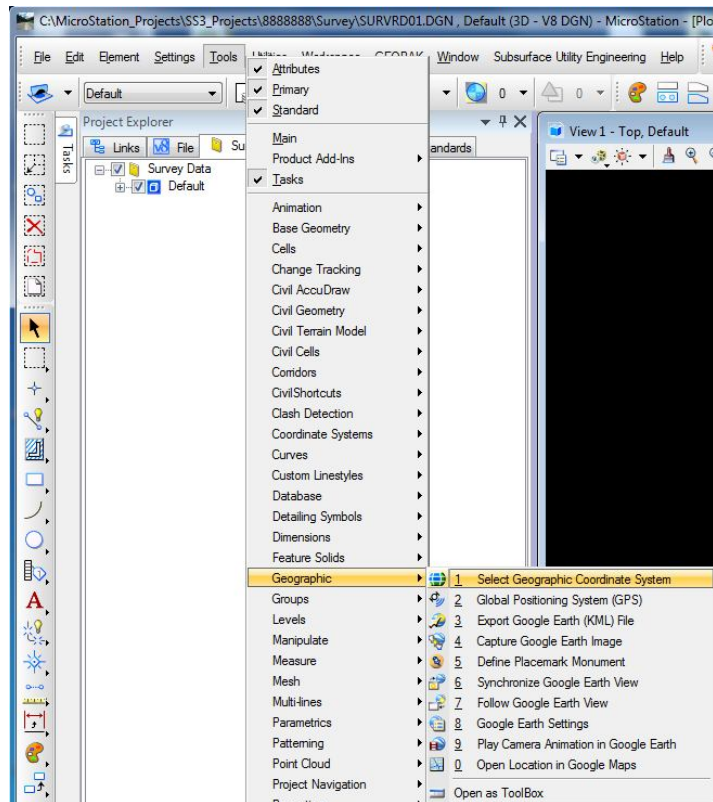
SET GEOGRAPHIC COORDINATES (two different ways)

- Set the Geographic Coordinate system manually from library. Choose one of the following State Plane Survey Foot Zones.

  1. FL83-NF   North Zone
  2. FL83-EF   East Zone
  3. FL83-WF   West Zone

- Or Set the Geographic Coordinate system automatically by clicking on the Florida map.

FDOT Districts, State Plane & UTM Zones

District
- 1 - Bartow
- 2 - Lake City
- 3 - Chipley
- 4 - Ft. Lauderdale
- 5 - Deland
- 6 - Miami
- 7 - Tampa
- State Plane

Geographic Coordinate System

Current Geographic Coordinate System

Name: FL83-NF
Description: NAD83 Florida State Planes, North Zone, U
Source: Calculated from FL83-N by Mentor Software

SET WORKSPACE CONFIGURATIONS

- Note that a new configuration selection has been added.

- "Include Survey Features" must be selected to set survey features and Bentley Civil configuration variables for Survey.
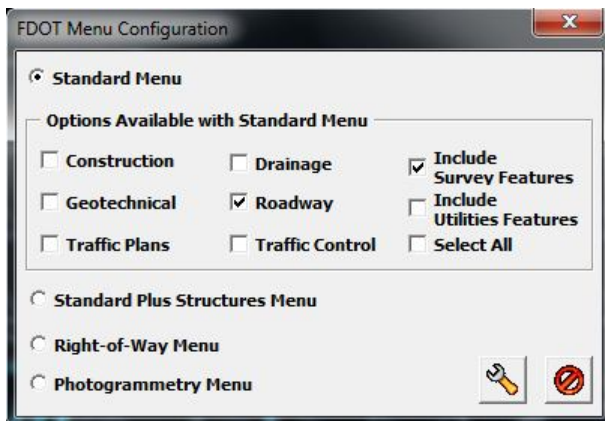
BENTLEY SURVEY

- Data Acquisition was introduced to the FDOT state kit with the implementation of FDOTSS2. However, at some point in the workflow the user would have to take a left turn and use GEOPAK.

- In SS3 more functionality was added. The left turn to GEOPAK is further down the road and Bentley renamed Data Acquisition to Survey.

- For the user **Bentley Survey has been added to the "PROJECT EXPLORER"** which already had a Links and File tab. Now the Project Explorer has a tab for Links, File, Survey, Civil Model, and Civil Standards. The Project Explorer Survey tab is where Survey data will be imported into the DGN file which also serves as a Survey Database.

PROJECT EXPLORER
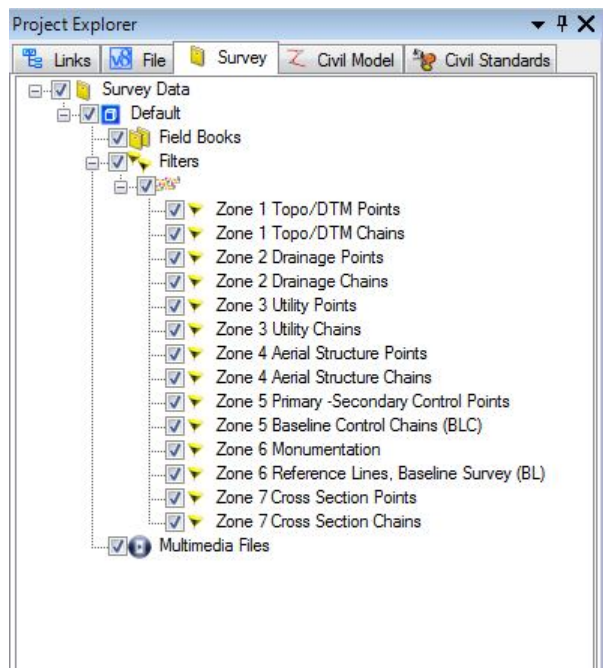
- The "Survey" tab is organized into a tree format with check boxes for visualization.
- When Survey data is added it will show under "Field Books".
- Expanding the "Filters" category will reveal preset filters based on the FDOT standard zones.

PROJECT EXPLORER
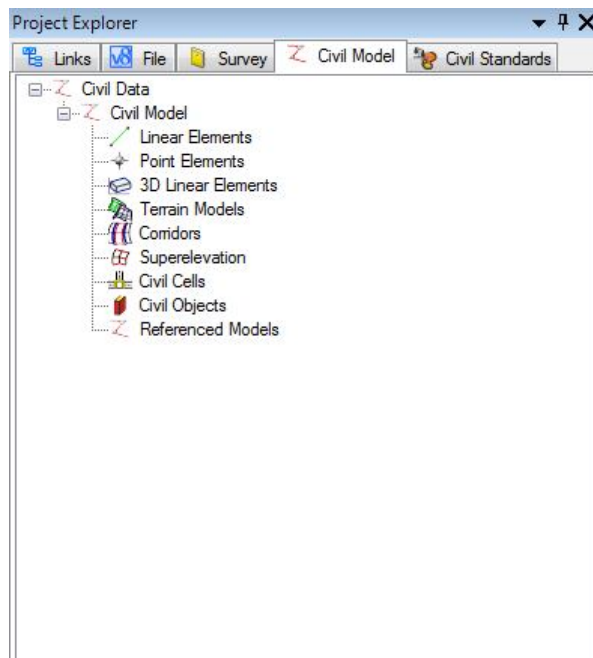
- Terrains (surfaces) built from project data will display in the "Civil Model" tab under the "Terrain Models" tab.

- Multiple terrains can be built but only one terrain is the "active" terrain.

- Terrains can be renamed when selected in the properties dialogue box.

PROJECT EXPLORER
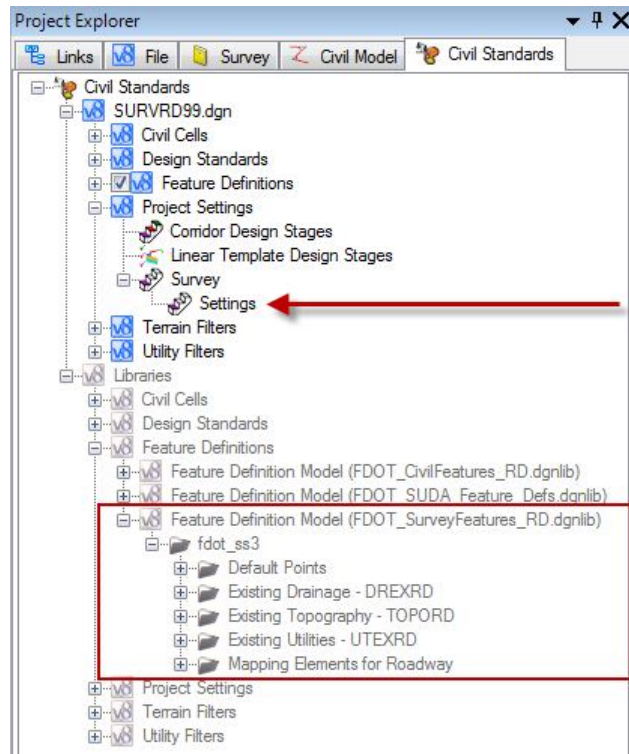
- The "Civil Standards" tab is where you will find the active file survey settings. Right click on "Settings" and select "Properties" to activate the Element Information dialogue box where changes to the settings can be made.

- Under Libraries is where the active feature tables can be found. Features are preset by the FDOTSS3 software

ELEMENT INFORMATION BOX

ELEMENT INFORMATION BOX

Adjustment Defaults	^
Adjustment Type	Least Square
Combined Scale Factor Option	Do Not Use
Combined Scale Factor Value	1
Display errors in Message Center	True
Add-on for Distance constant	0.03
Add-on for Distance PPM	5
Add-on for Horizontal angle	10
Add-on for Azimuth	5
Add-on for Trig level constant	0.3
Add-on for Trig level PPM	50
Add-on for Differential leveling constant	0.01
Default Distance constant error estimate	0.03
Default Distance PPM	5
Default Horizontal angle error estimate	10
Default Azimuth error estimate	0.1
Default Trig Level Constant error estimate	0.05
Default Differential Leveling Constant err	0.01
Distance tolerance	0.05
Angle tolerance	20
Elevation tolerance	0.05
Setup Error	0.005
XYZ Decimal Places	0.001
Use repetition errors PLUS add-ons for e	False
Compute Coordinate standard error and (	True
Balance Angles	True
Compute earth curvature and atmospheri	False
Refraction Constant	0.14

- Survey will process OBS files (observation field files) based on an imported CTL (control) file, the set projection, scale factor and adjustment defaults.

- Survey will also import an XYZ file and automatically import chains from an OBS file in the same folder with the same file name as the XYZ file.

IMPORTING CAiCE DATA INTO THE SURVRD.DGN FILE

- There are two ways to import data into Bentley Survey.

    1. In project explorer, under the Survey tab, right-click on "Field Books", select "New…", and a new field book will be created (Field Book 1). Right-click on the new field book, highlight "LOAD" and select "File…". From the Select File dialogue box, choose the file type from the drop down, navigate to the CAiCE project directory and choose the file to be imported. If choosing a CAiCE PT4 file, the import CAiCE dialogue box will open. Choose "Combine Segments" or "Separate Segments" and then "Accept" to import into the field book. To rename the field book, select Field Book 1 and rename in the Element Information dialogue box.

    2. The **preferred method** is from the Windows Explorer, drag and drop the desired file anywhere into the Project Explorer, Survey tab.

IMPORTING CAiCE DATA INTO THE SURVRD.DGN FILE
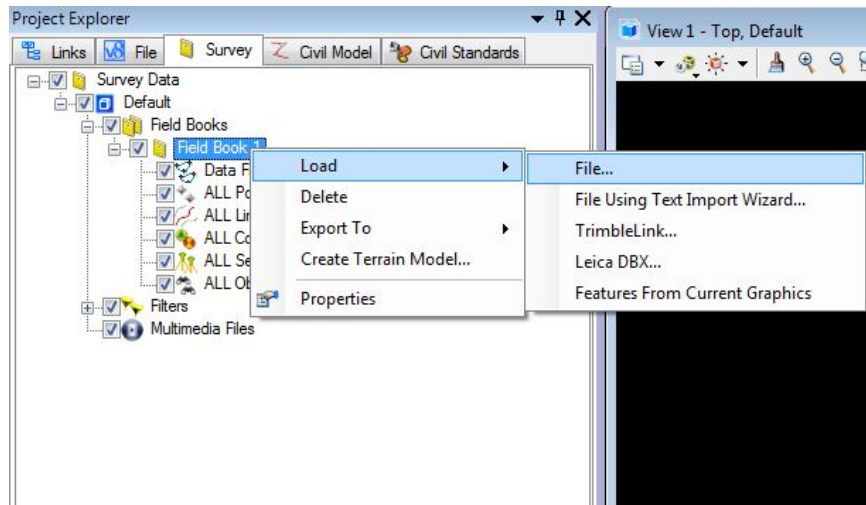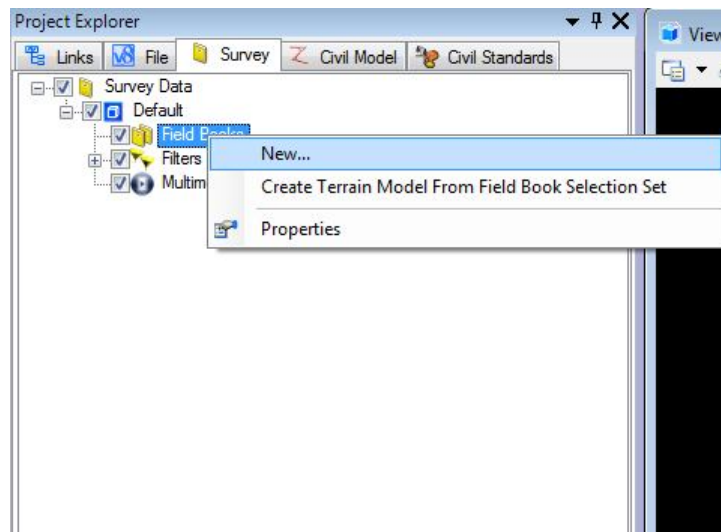
DRAG & DROP CAiCE DATA INTO THE SURVRD.DGN FILE

- When dragging and dropping a CAiCE PT4 file into Bentley Survey the field book automatically takes on the name of the CAiCE project. Note that the PT4 file is not a stand alone data file. It must be in the CAiCE project folder for this to work.

- Importing a CAiCE KCP file will also work however, note that curve and point geometry may require additional adjustment to get the desired graphics.

- A CAiCE SRV file can also be imported into Bentley Survey. Note CAiCE SRV files do not honor EFB chain gaps.

- CAiCE XML files have issues with Survey interpreting Comments and Descriptions fields as features. It is not recommended at this time to import a CAiCE XML file.

DRAG & DROP CAiCE DATA INTO THE SURVRD.DGN FILE
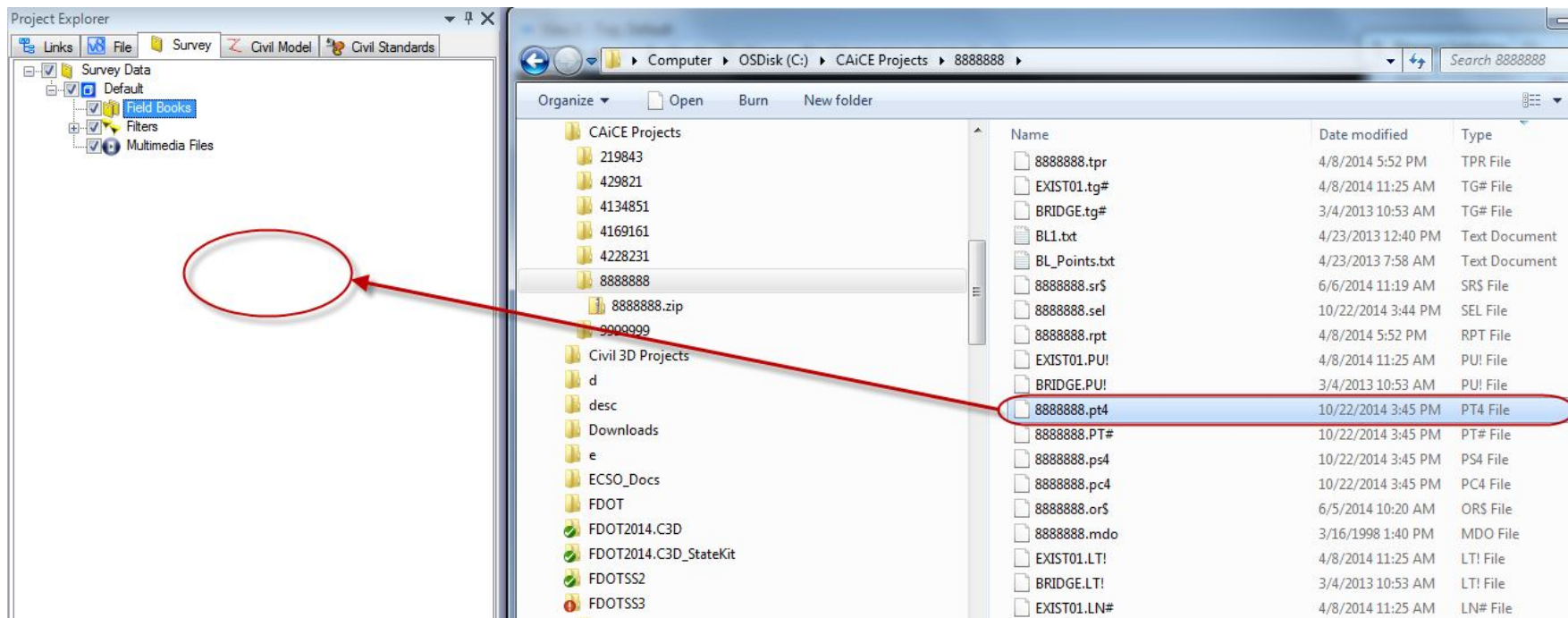
DRAG & DROP CAiCE DATA INTO THE SURVRD.DGN FILE
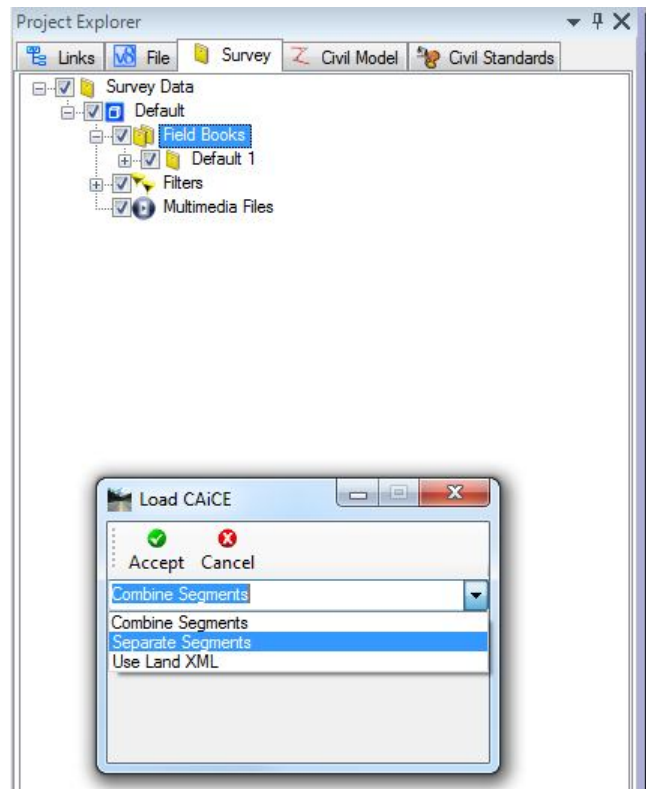
- After dropping the PT4 file into the Project Explorer Survey tab, the "Load CAiCE" dialogue box will open.

- Choose "Combine Segments" or "Separate Segments" if you wish to keep all segments separate.

- Choose "Accept" to load CAiCE into Bentley Survey.

- Graphics are automatically displayed

DRAG & DROP CAiCE DATA INTO THE SURVRD.DGN FILE
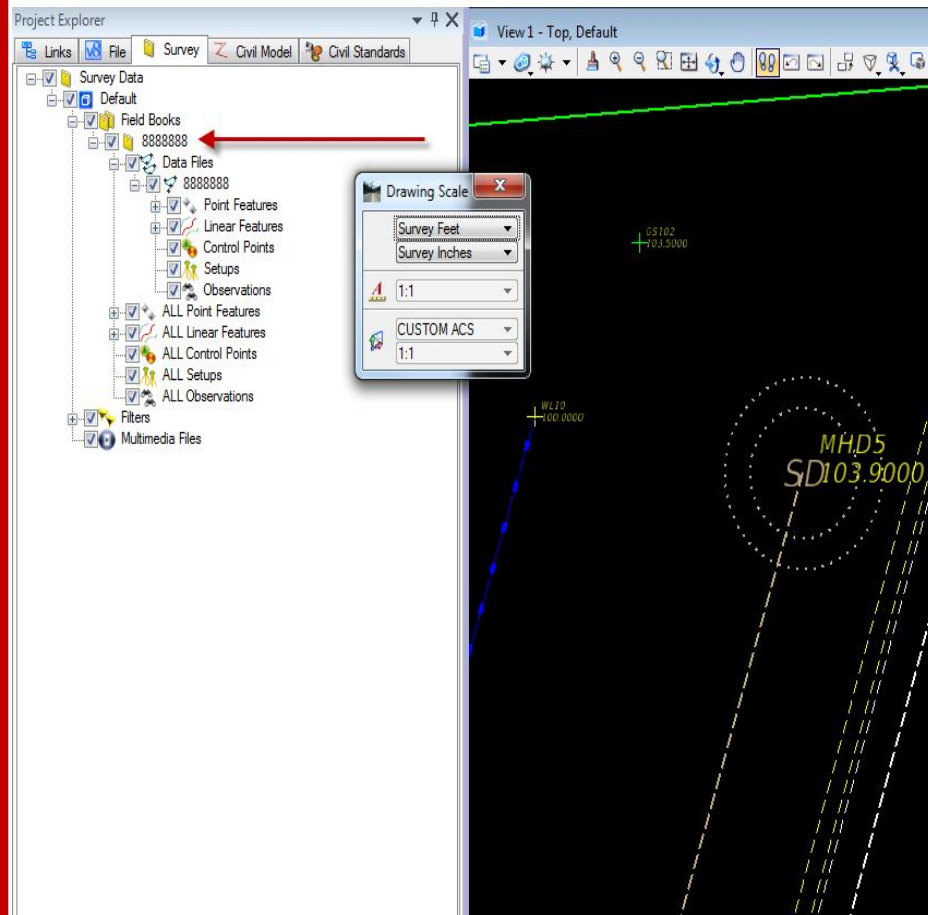
- Note that the CAiCE project is automatically named as the Field Book.

- This name can be changed in the Element Information dialogue box by selecting it.

- The drawing scale is set 1:1 in the seed file and the annotation scale lock should be "OFF". Whenever data is brought in or "Redrawn" make sure the scale is 1:1 and the annotation scale lock is OFF or the labels will not display correctly.

IMPORTING EFB DATA INTO THE SURVRD.DGN FILE

- Drag and Drop the processed segment "XYZ" file into Project Explorer Survey tab.
- Chains will automatically be extracted from the corresponding OBS file with the same name.
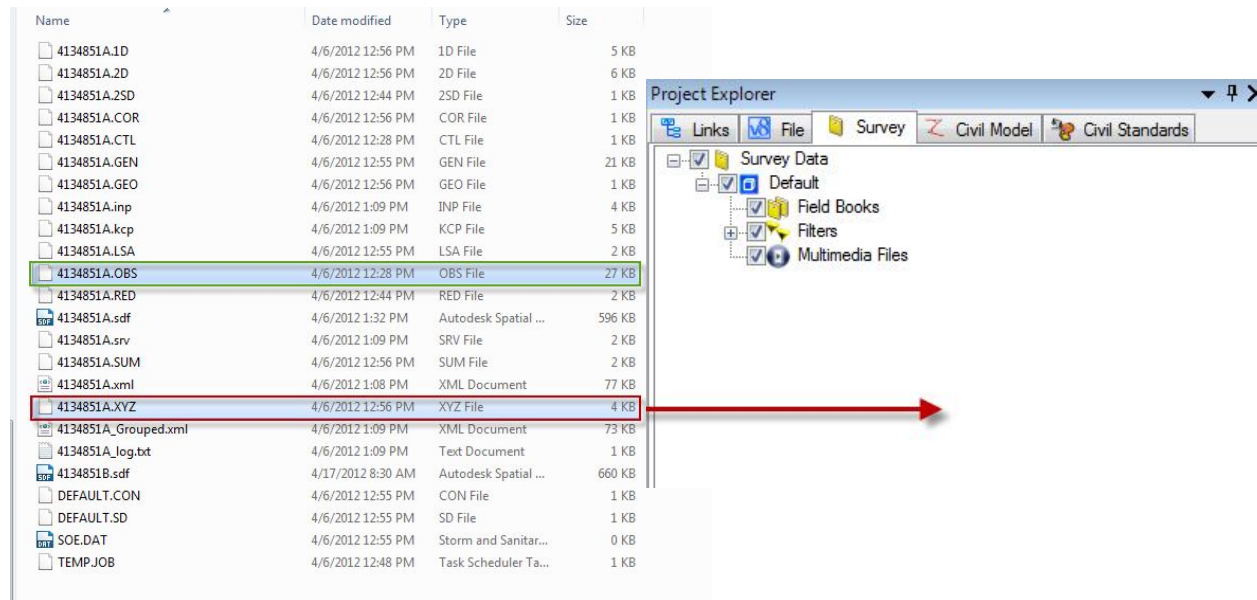
SURVEY REDRAW

- The "survey redraw" command can be keyed in or selected from the "Survey Processing" task pane.

- This is an important command because it will redisplay point and chain features based on the active feature table and drawing scale.

- Use survey redraw if labels are misplaced due to annotation scale, features have been erroneously moved ore deleted or if switching between the Roadway and Right of Way configurations. Always set the drawing scale to 1:1 before using survey redraw.
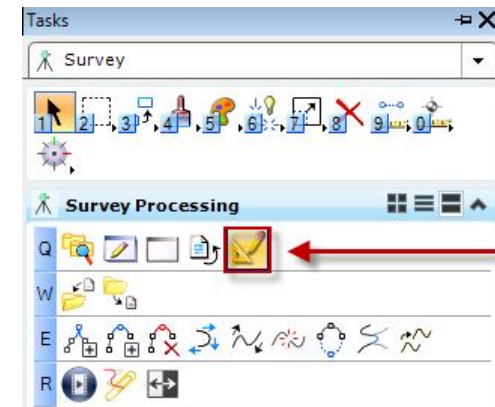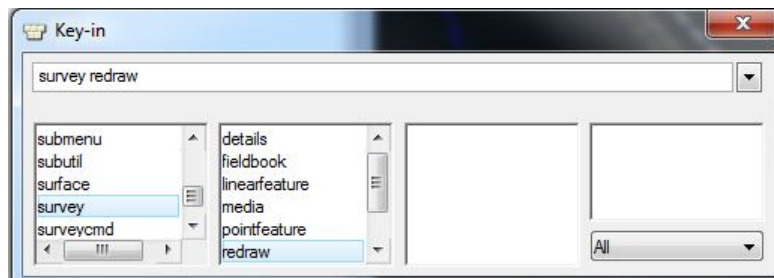
DRAWING SCALE

- When brought into the survey file point feature labels will display normally at 1:1 if the drawing scale is set to 1:1. Note the Annotation Scale lock should be off (not highlighted) and scale set to 1:1, during import and anytime there is a "Survey Redraw" situation.
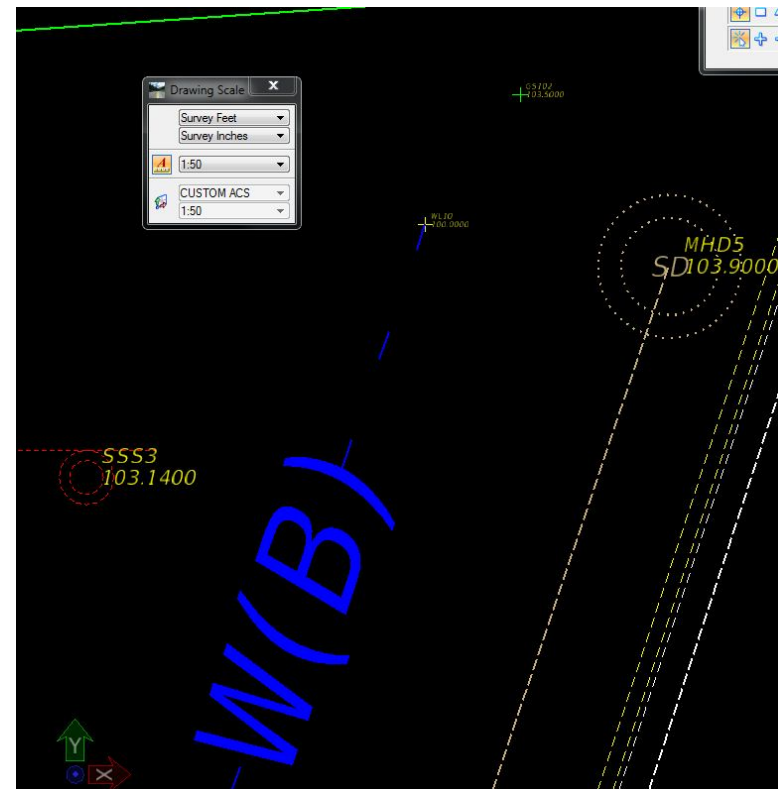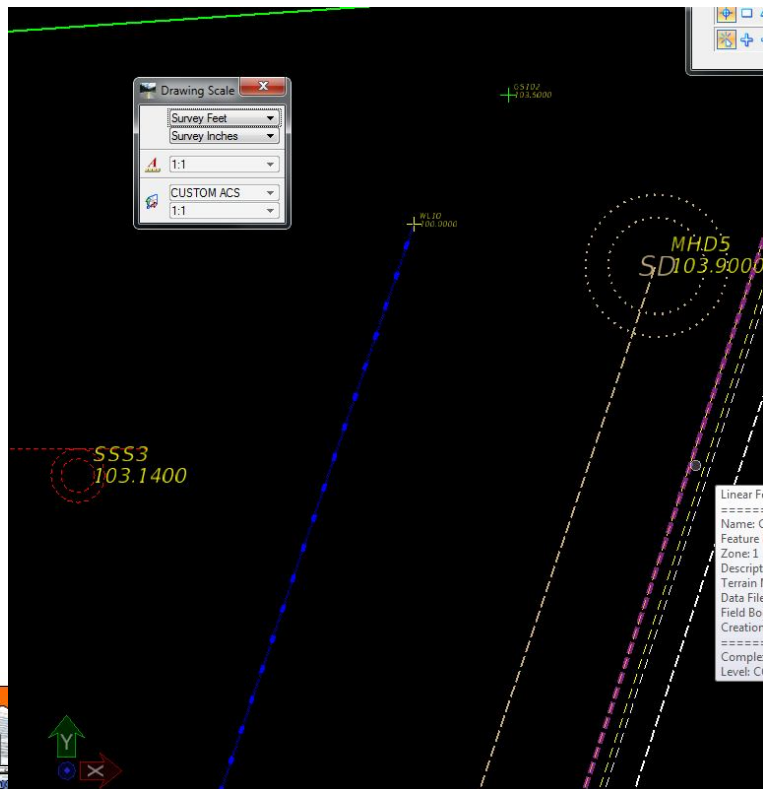
SURVEY VISUALIZATION
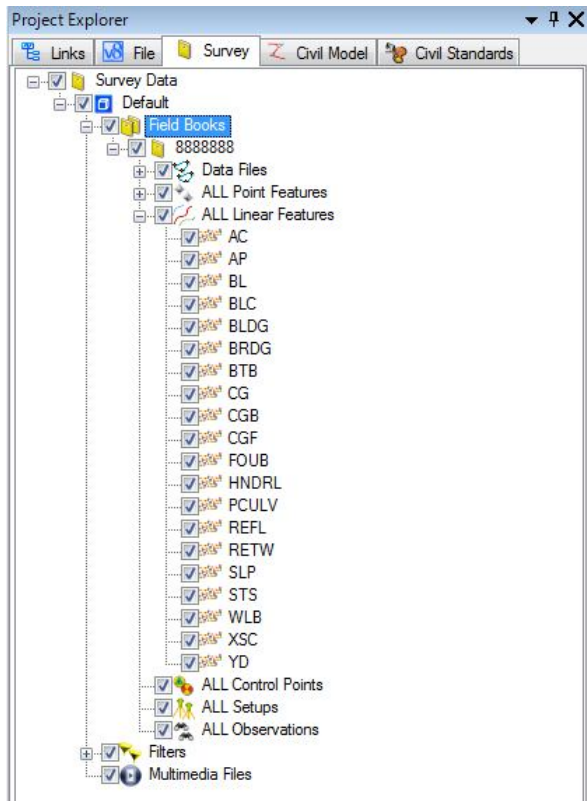
- Visualization of survey features can be controlled by checking or un-checking display boxes in the tree under Field Books.

- Expand the tree to see various options for visualizing survey data.

- In this example "All Linear Features" have been expanded.

- Check or un-check to change the chain feature display.

SURVEY VISUALIZATION
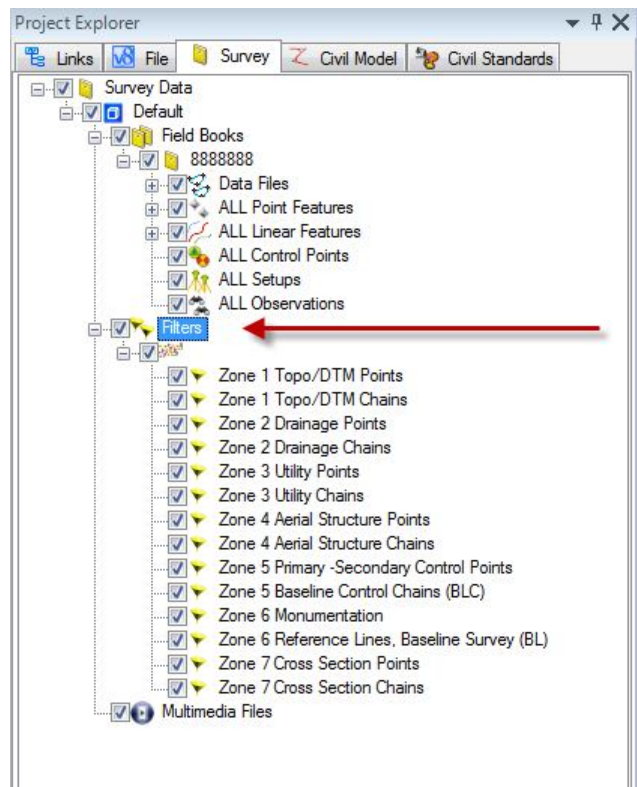
- Survey filters have been added to the fdotseed3D.dgn seed file that correspond to the FDOT standard zones.
- Expand the filters category to view the survey filters.
- The filters have been organized into point and chain zones. Use the filters to visualize points and chains by zone.

SURVEY VISUALIZATION
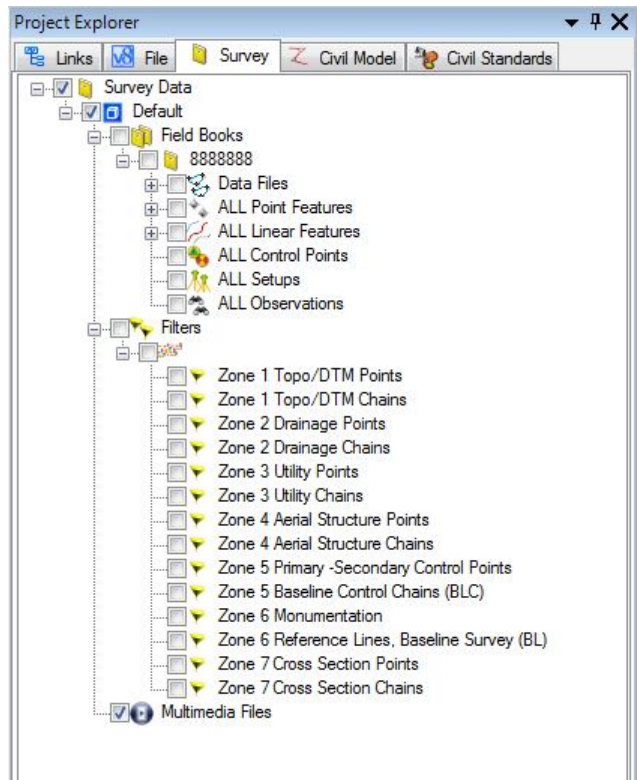
- To visualize point and chain features by zone first all field book and survey filters must be turned off (un-checked).

- Once all features have been turned off, individual zones can be checked on for survey to visualize.

SURVEY POINT FEATURE VIEW ANNOTATION OPTIONS

- Right-clicking on point features in the Field Book.
- Also right-click on a point feature in the view will reveal additional options
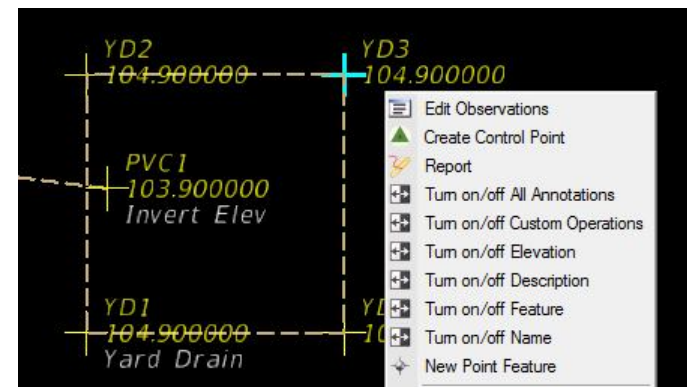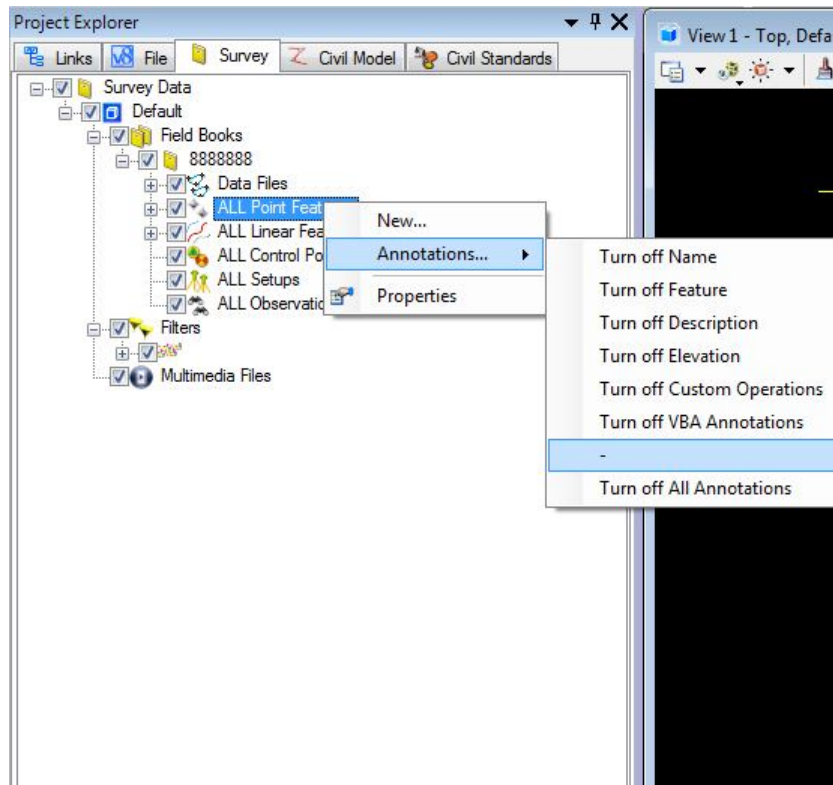
SURVEY POINT AND CHAIN FEATURE SELECTION OPTIONS

- Selecting a point or chain feature and then hovering will reveal information and various options related to the feature that can be selected.
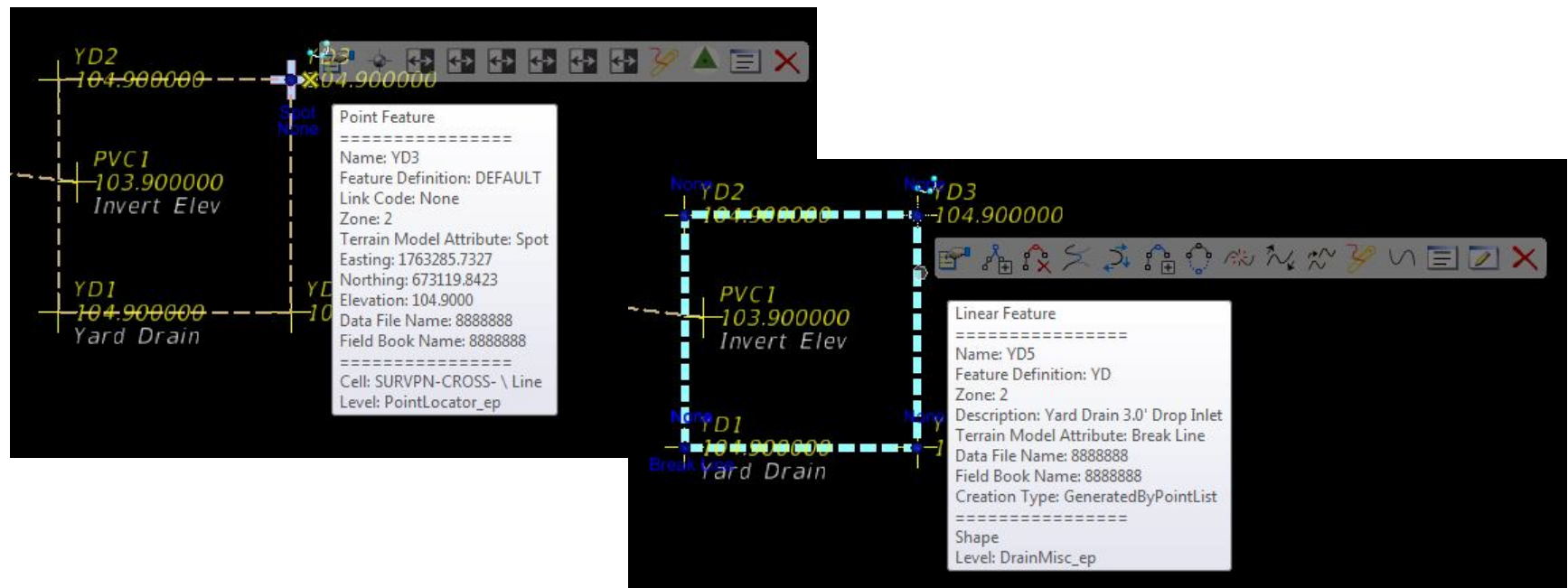
ADDITIONAL RIGHT-CLICK OPTIONS
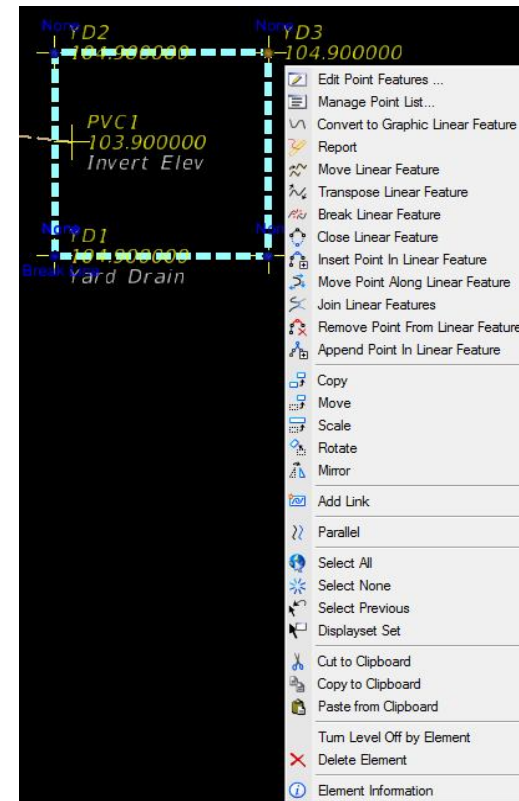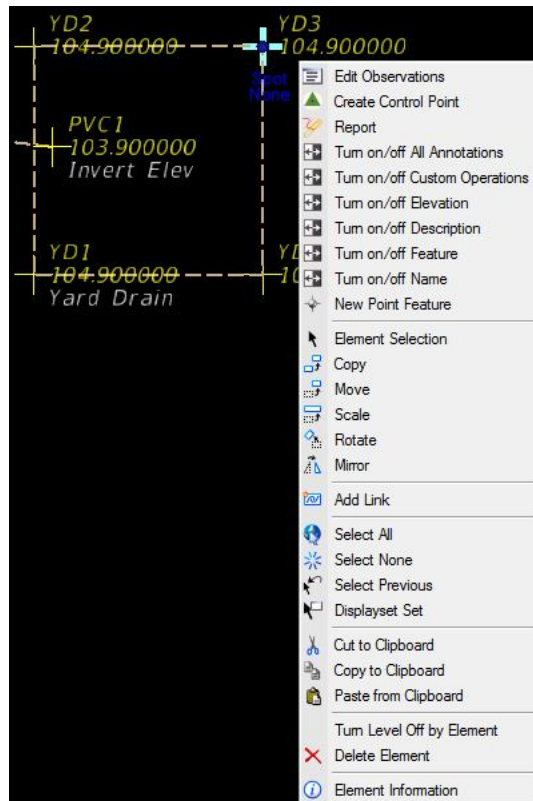
THE SURVEY DATABASE

- The survey database is embedded in the DGN file. But where is it? How do you view/edit points and chains?
- The "Show Details" dialogue box was provided to interface with survey features and can be activated via the Task pane or under the MicroStation menu "Tools"
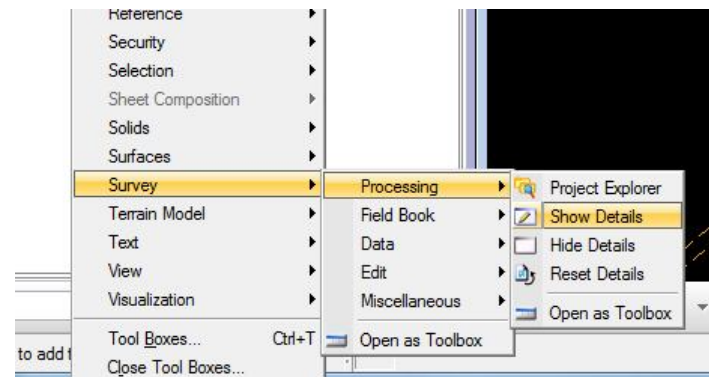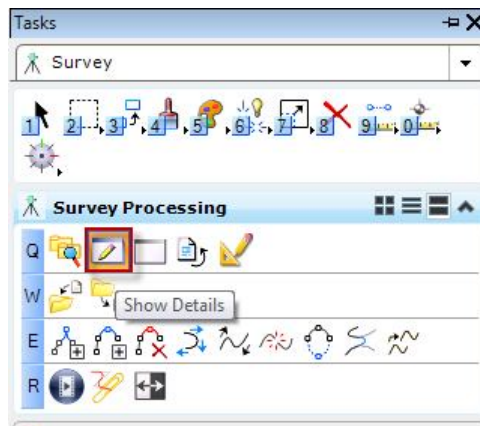
THE SURVEY DATABASE

- Highlighting point(s) or feature(s) in the Survey Field Book and selecting "Show Details" will bring up the details dialogue box for those features.

THE SURVEY DATABASE
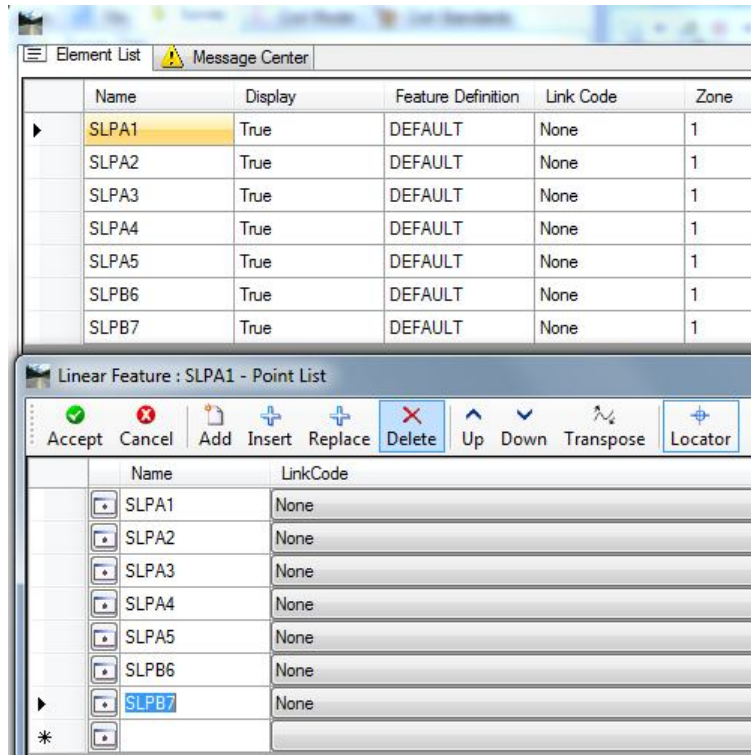
THE SURVEY DATABASE

LINEAR FEATURE (CHAIN) EDITS

- There are various ways to perform chain edits. One is to manually manage the point list.
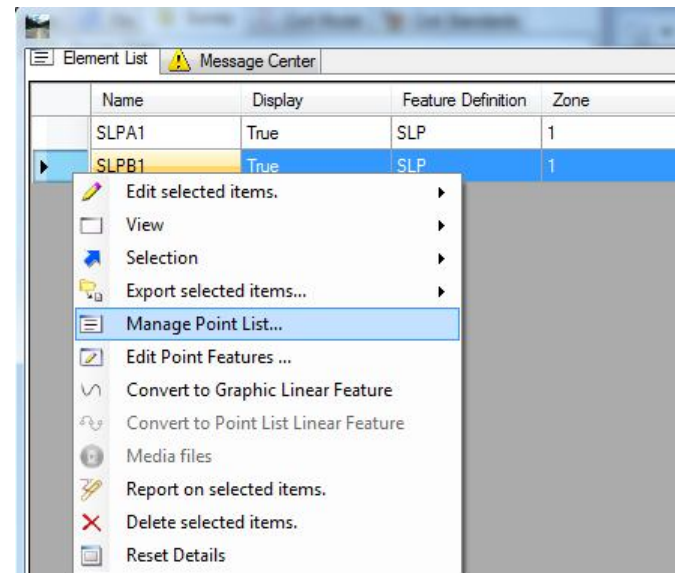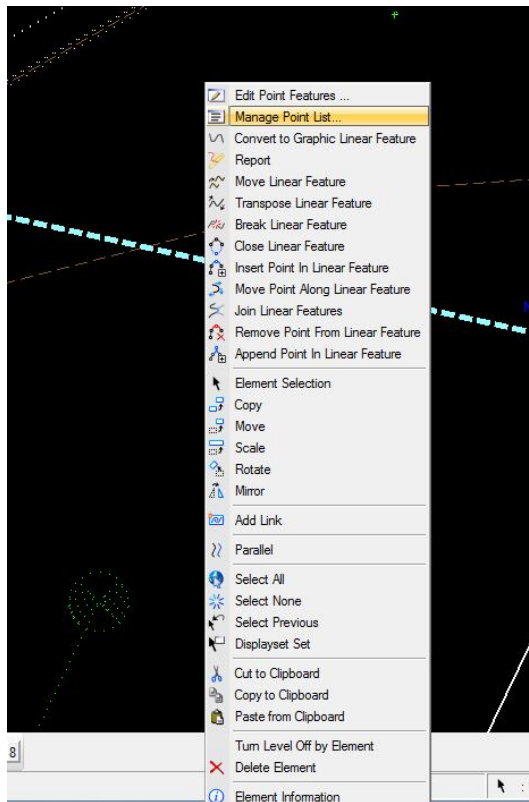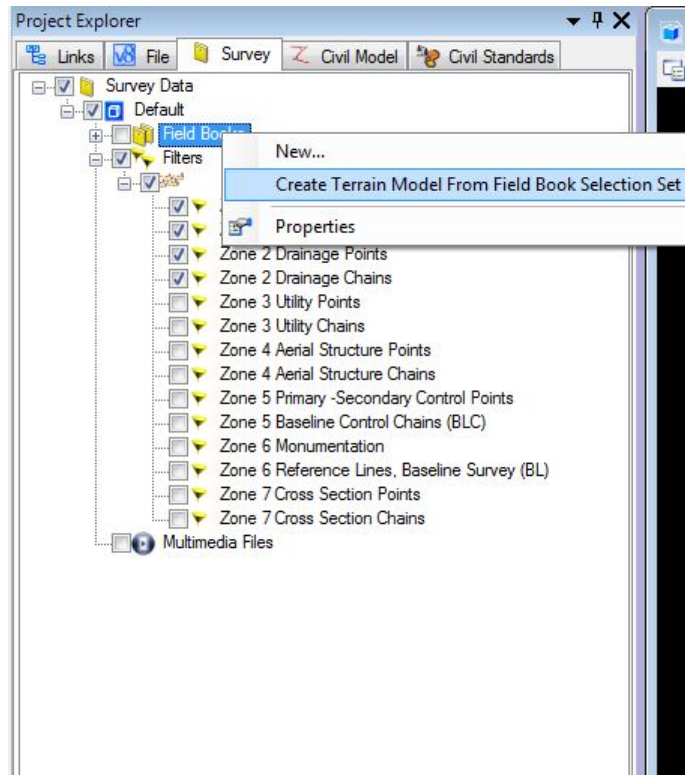
LINEAR FEATURE (CHAIN) EDITS

- Editing the Linear Features (chains) will update the graphics automatically. All changes are made directly to the survey database.
- Points within a chain also can be edited. Again all changes are made directly to the survey database.
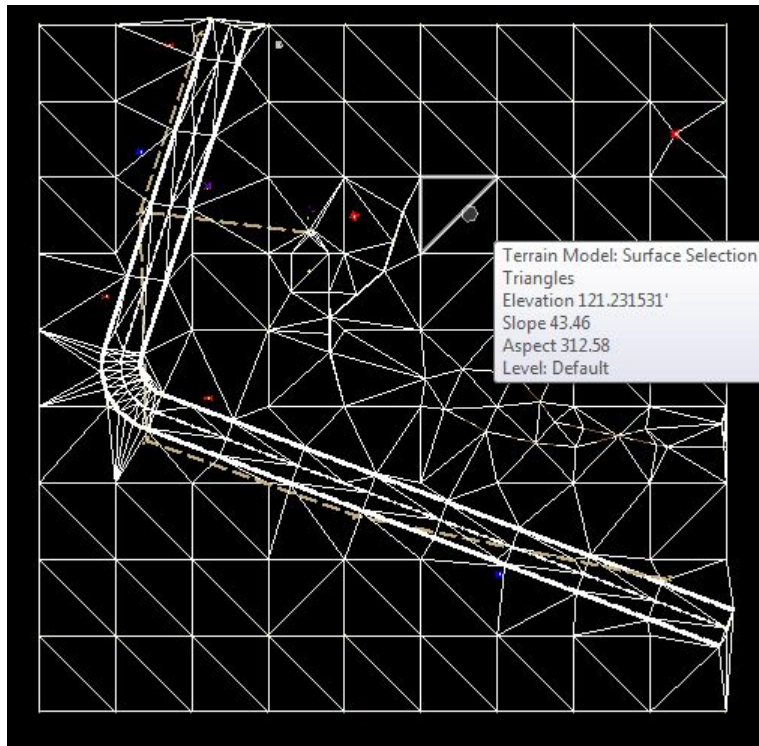
TERRAIN MODELS

- Use the Survey Zone filter to visualize the features to be included in the Terrain Model.
- Select all visualized elements with the element selection tool.
- Right-click on field books and select "Create Terrain Model From Field Book Selection Set
- Note that the breakline triangle tolerance is set at 50.0' by a configuration variable.
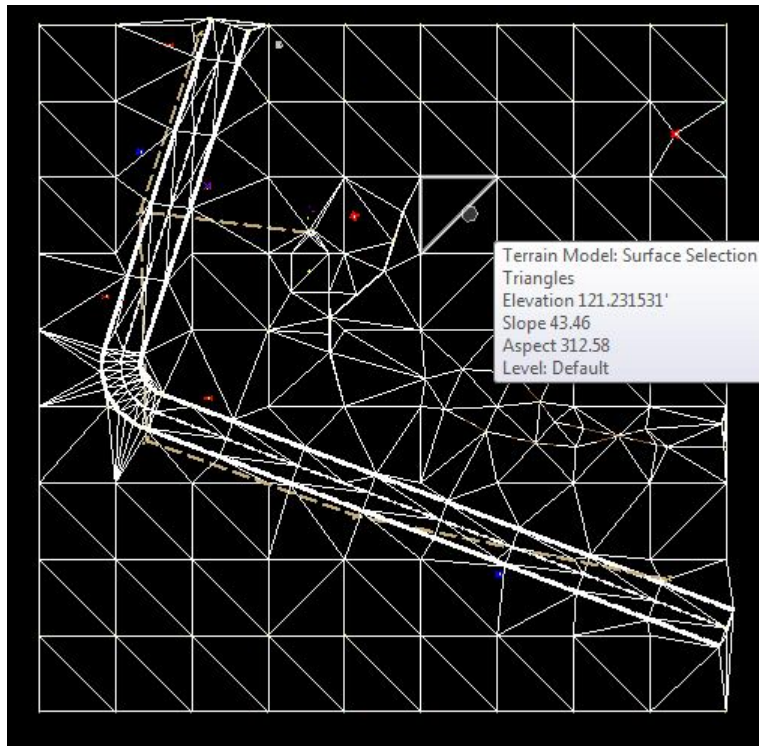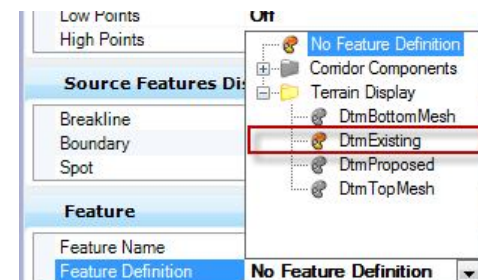
TERRAIN MODELS

- Note that the Terrain Model is built based on the DTM "G" attribute from EFB. If the DTM attribute is "F", "U" or "X", the feature will not be included in the Terrain Model. This gives the crew full discretion on what will and will not be included in the Terrain Model from the field.

- Manual changes can be made in SS3 to the attributes and the Terrain will update.
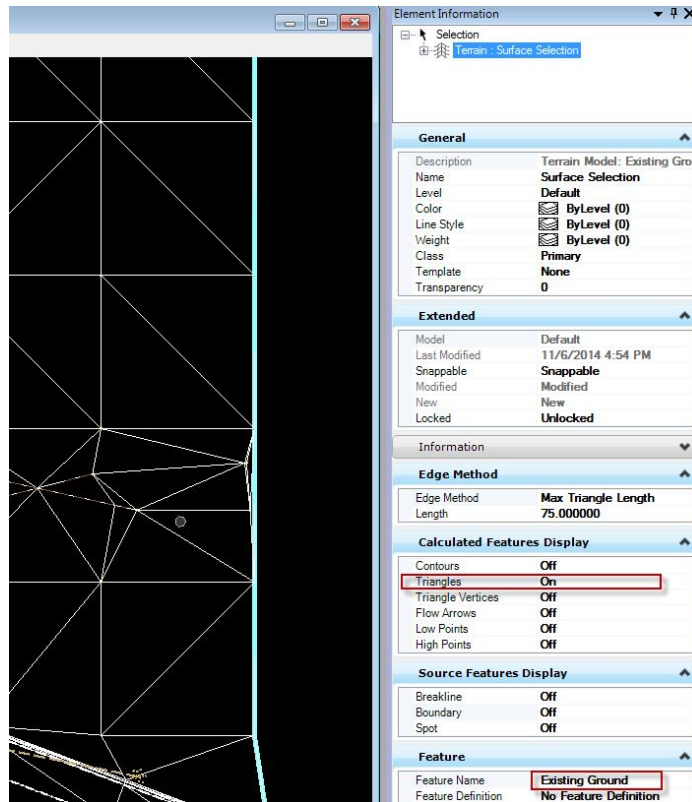
TERRAIN MODELS

- Also note that there is "No Feature Definition" attached to this Terrain and the associated level is "Default". Due to a defect in display, the Feature Definition "DtmExisting" should not be selected until all edits have been completed.
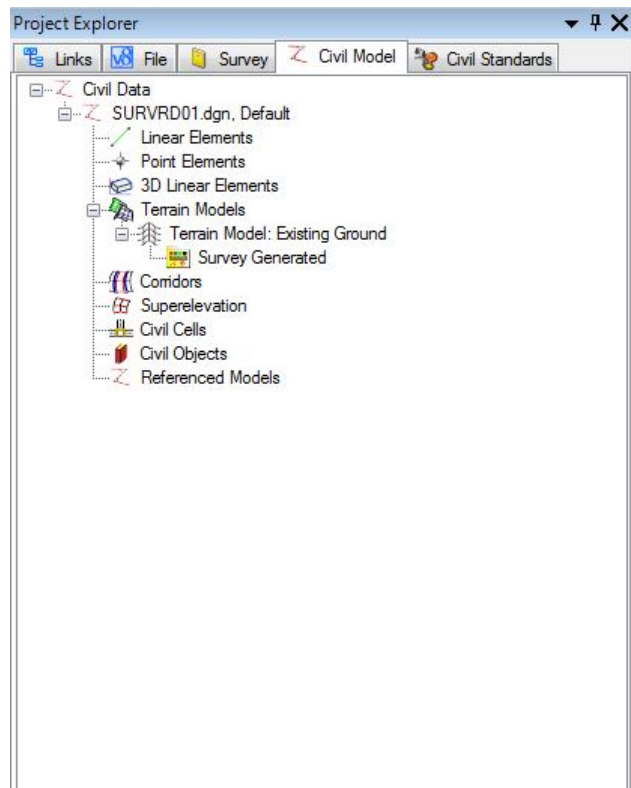
TERRAIN MODELS

- Once the Terrain is selected, Terrain attributes can be modified.
  1. Edge Method/ Max Triangle Length.
  2. Calculated Feature Display (Contours, Triangles, Vertices, etc. can be turned on or off).
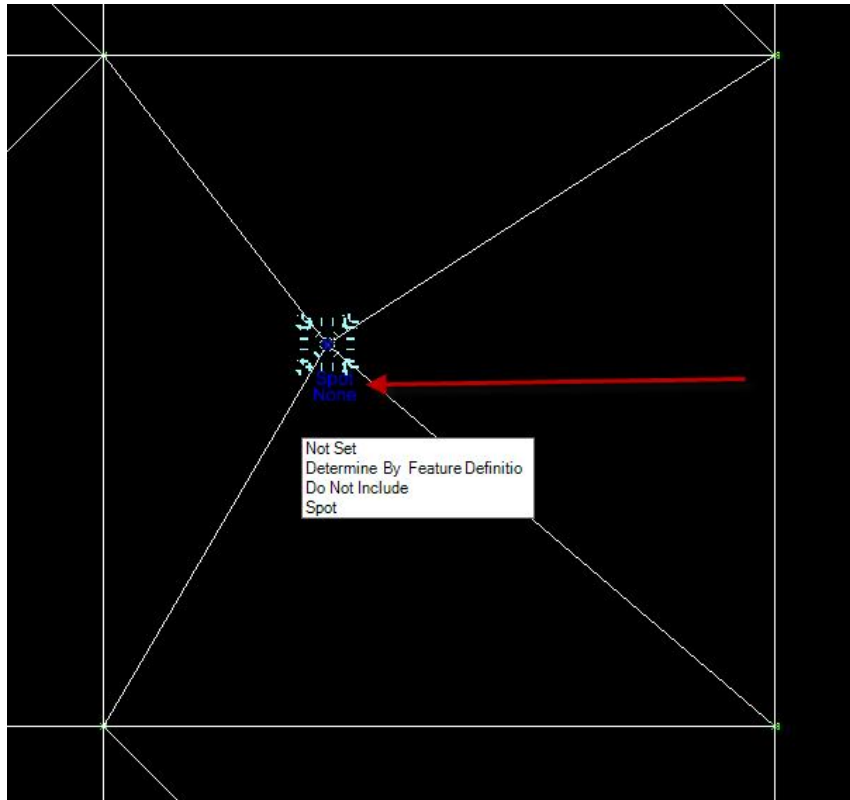 3. Feature Name.
  4. Feature Definition.

TERRAINS LISTED IN PROJECT EXPLORER

- When a Terrain is built it will show up in Project Explorer.
- Terrains generated from Survey Data will be noted as "Survey Generated".
- Survey Generated Terrains are not editable unless the Survey Processing Rules are deactivated.
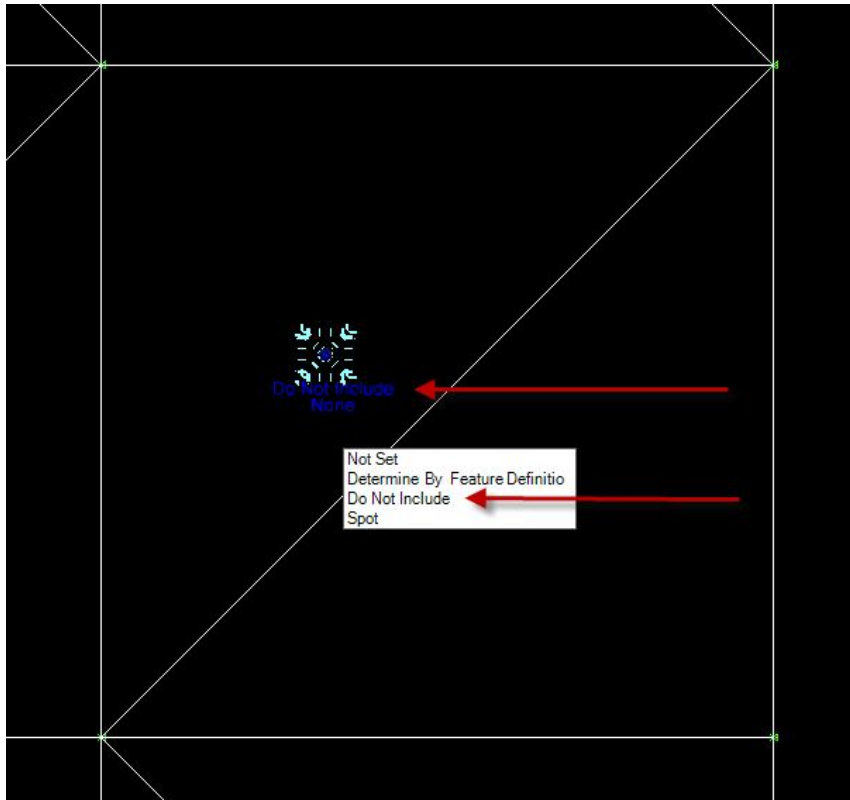
TERRAIN MODEL FEATURE ATTRIBUTES

- Selecting either a Point or Linear feature will display the DTM and Link Code (curvature) attribute associated with the feature.

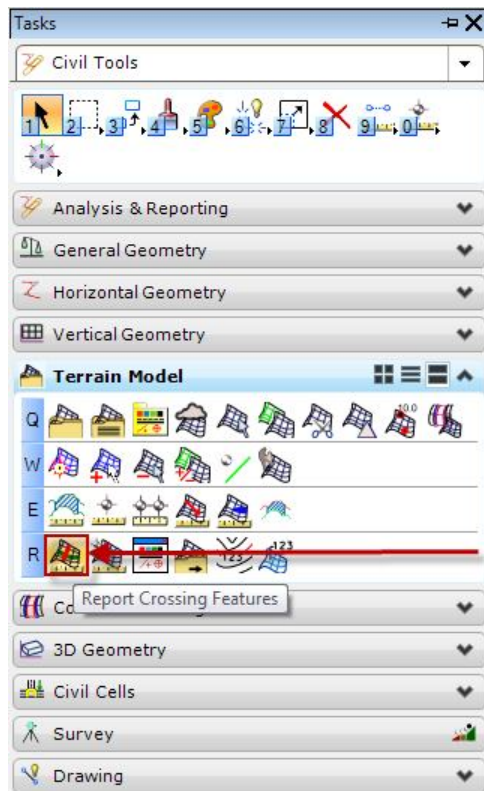- Changing the DTM attribute will automatically update the Terrain Model.

TERRAIN MODEL FEATURE ATTRIBUTES

- Selecting either a Point or Linear feature will display the DTM and Link Code (curvature) attribute associated with the feature.

- Changing the DTM attribute will automatically update the Terrain Model.

TERRAIN MODELS: REPORT CROSSING FEATURE

- SS3 has a "Report Crossing Features" tool for identifying and resolving crossing features (chains).

- Depending on the type of correction needed the tool will walk you through fixing or use the Feature editor to manually fix the crossing feature.

TERRAIN MODELS: REPORT CROSSING FEATURE
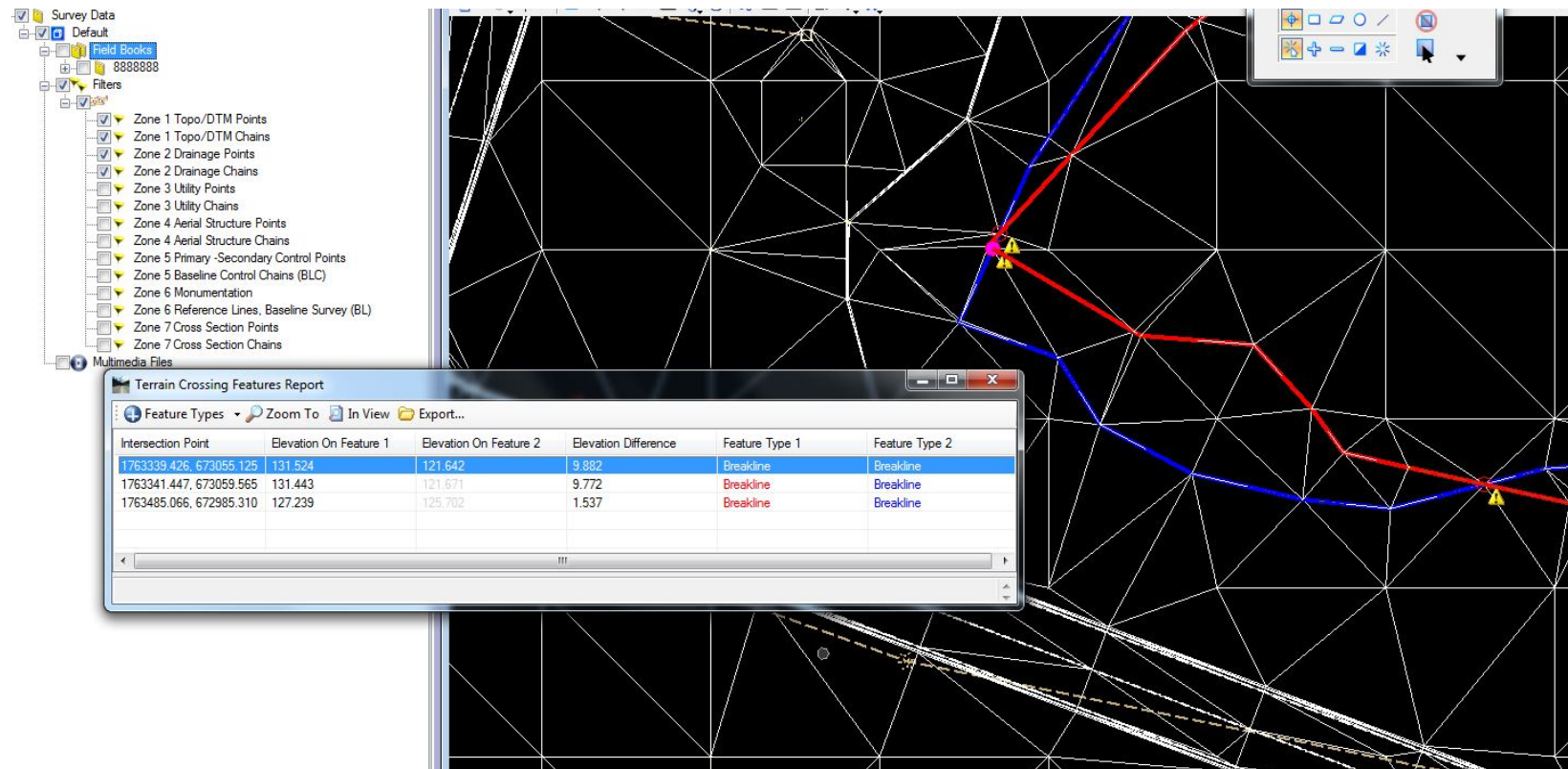
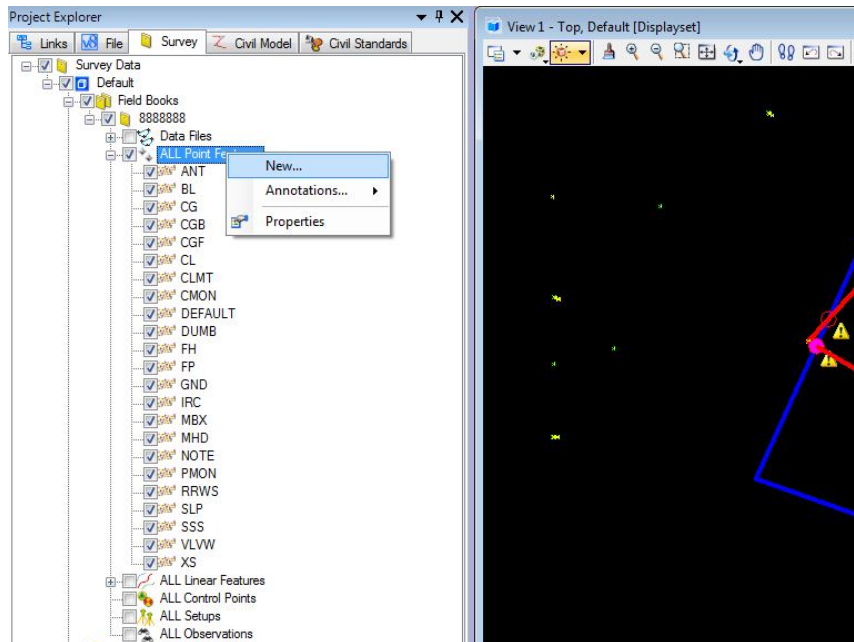# *TERRAIN MODELS: RESOLVE CROSSING FEATURES*
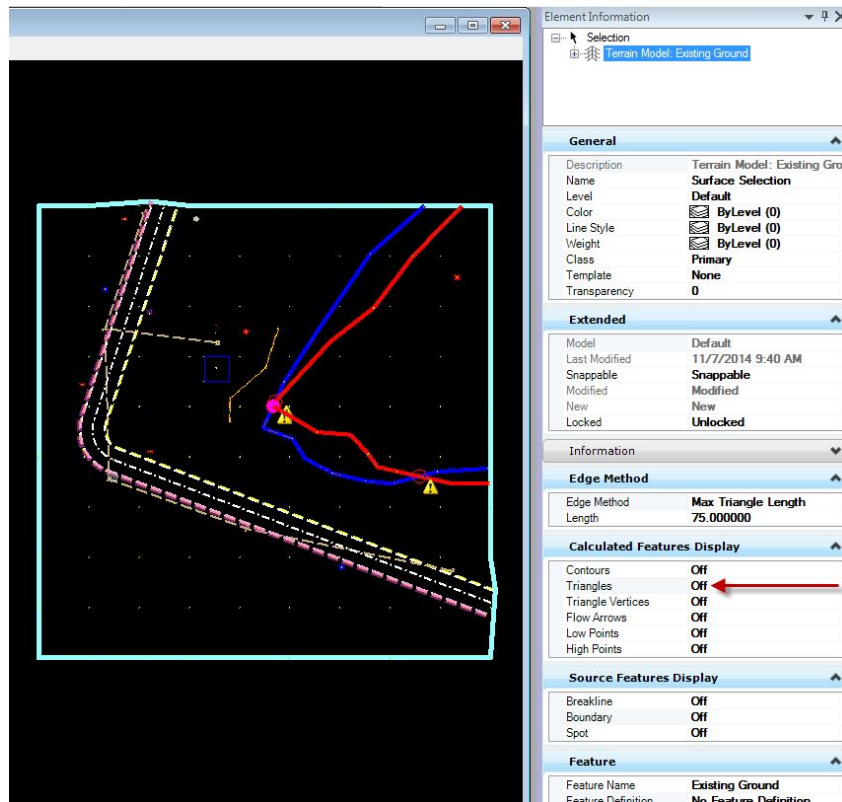
- Turning off triangles will allow you to work within the terrain without the visual clutter.

- When all Terrain Model display features are off. The boundary will still show. Only turning off the level will completely hide an existing terrain.
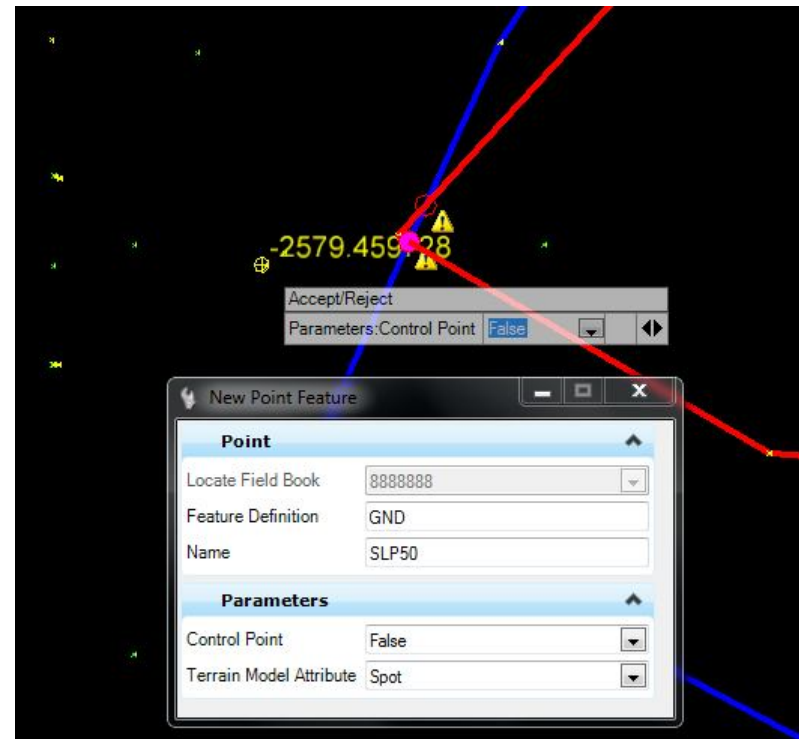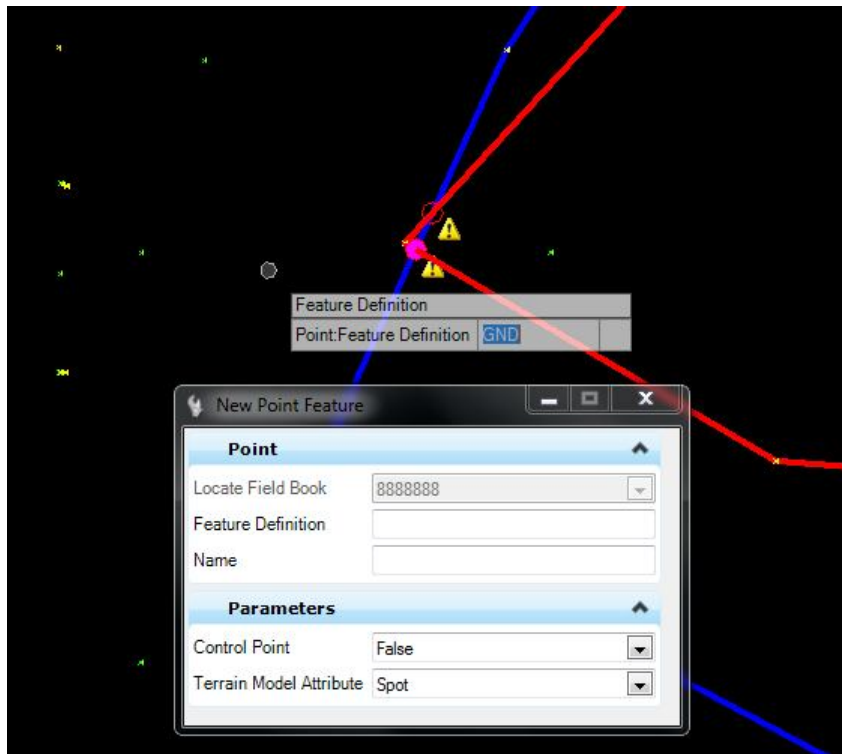
TERRAIN MODELS: RESOLVE CROSSING FEATURES

- Adding a point to the field book can be done manually by selecting the Point Features, right-clicking and selecting "NEW"

- If it is a ground shot, the Feature Definition (code) will be GND.

- Select the point position by clicking on the view.

- Pressing the F6 button will release you from the command.
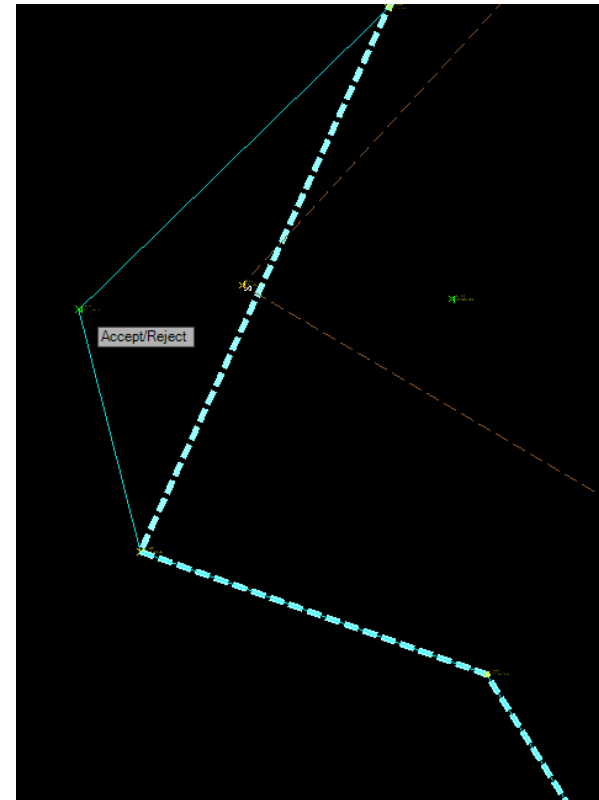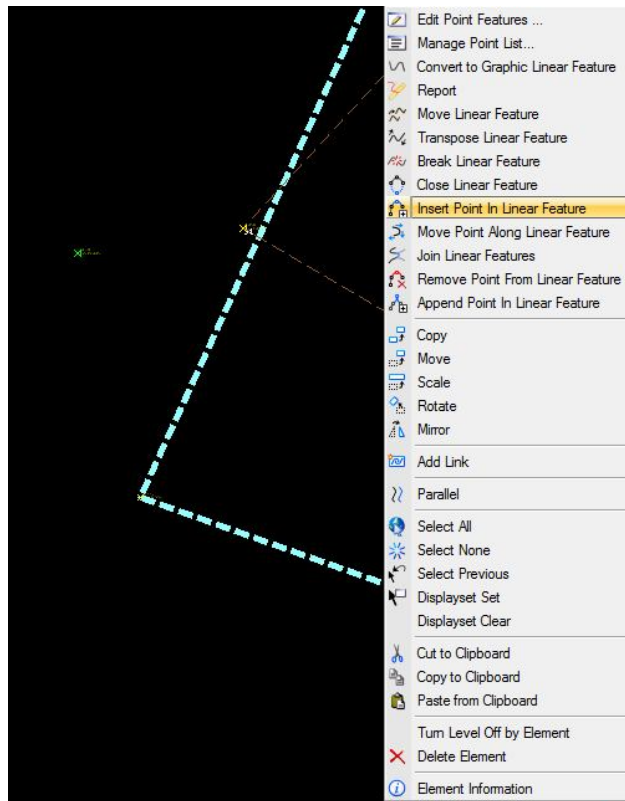
TERRAIN MODELS: RESOLVE CROSSING FEATURES

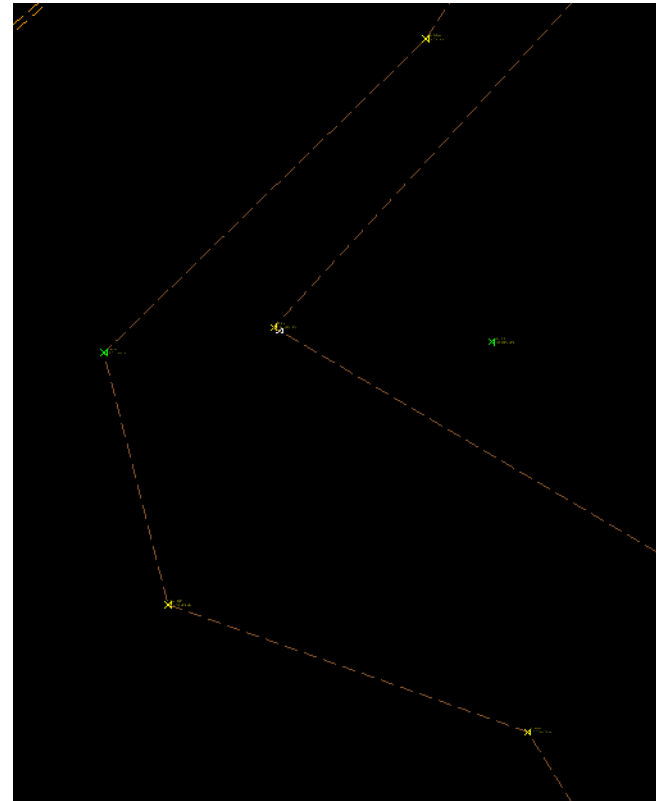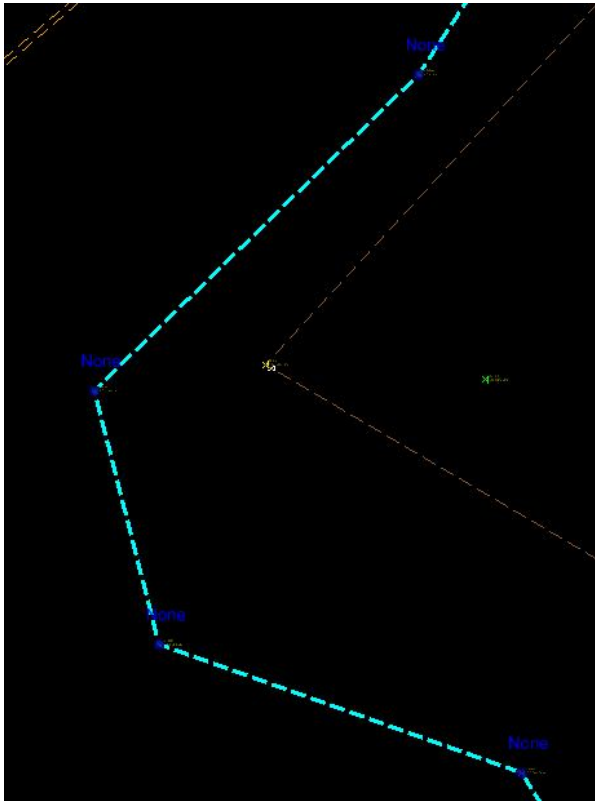# TERRAIN MODELS: RESOLVE CROSSING FEATURES
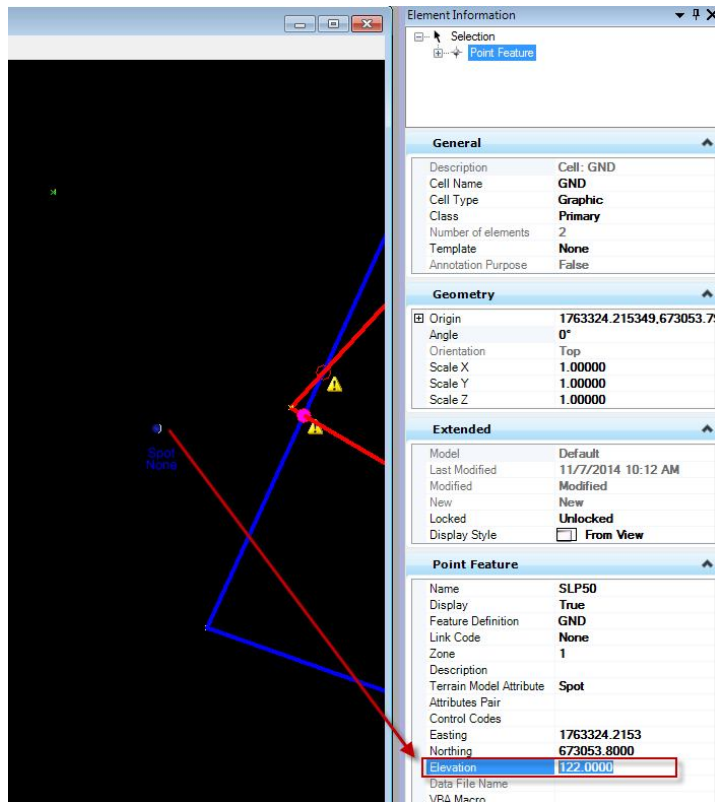
- The default elevation will be negative.
- Select the point feature and use the Element Information dialogue box to insert the desired elevation of the point.
- The point now can be used as a spot shot in the DTM and added to the Linear Feature with the feature edit tools.
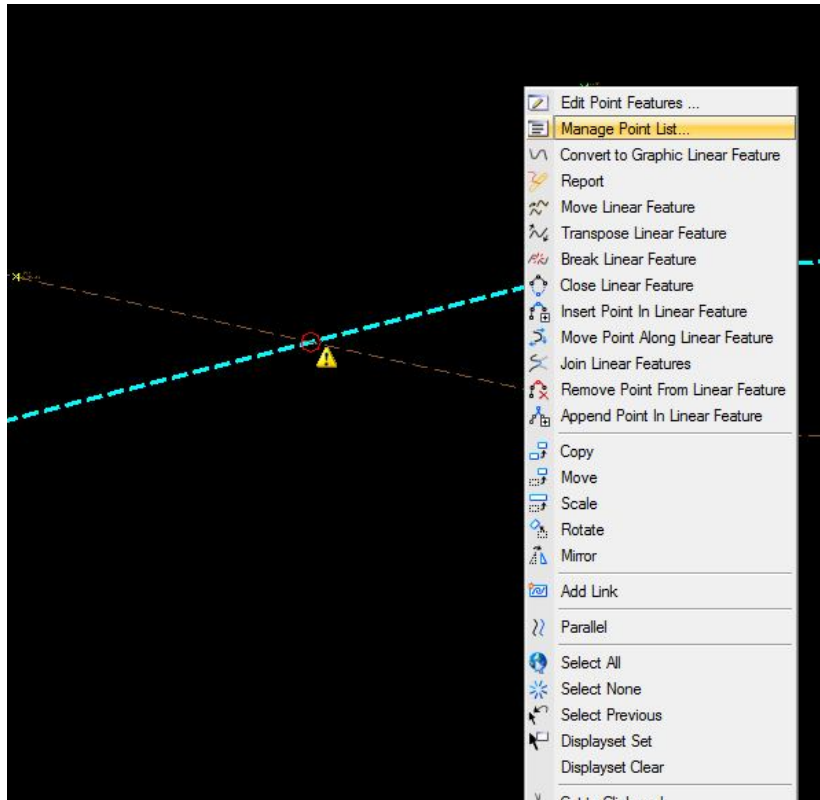
TERRAIN MODELS: RESOLVE CROSSING FEATURES

TERRAIN MODELS: RESOLVE CROSSING FEATURES

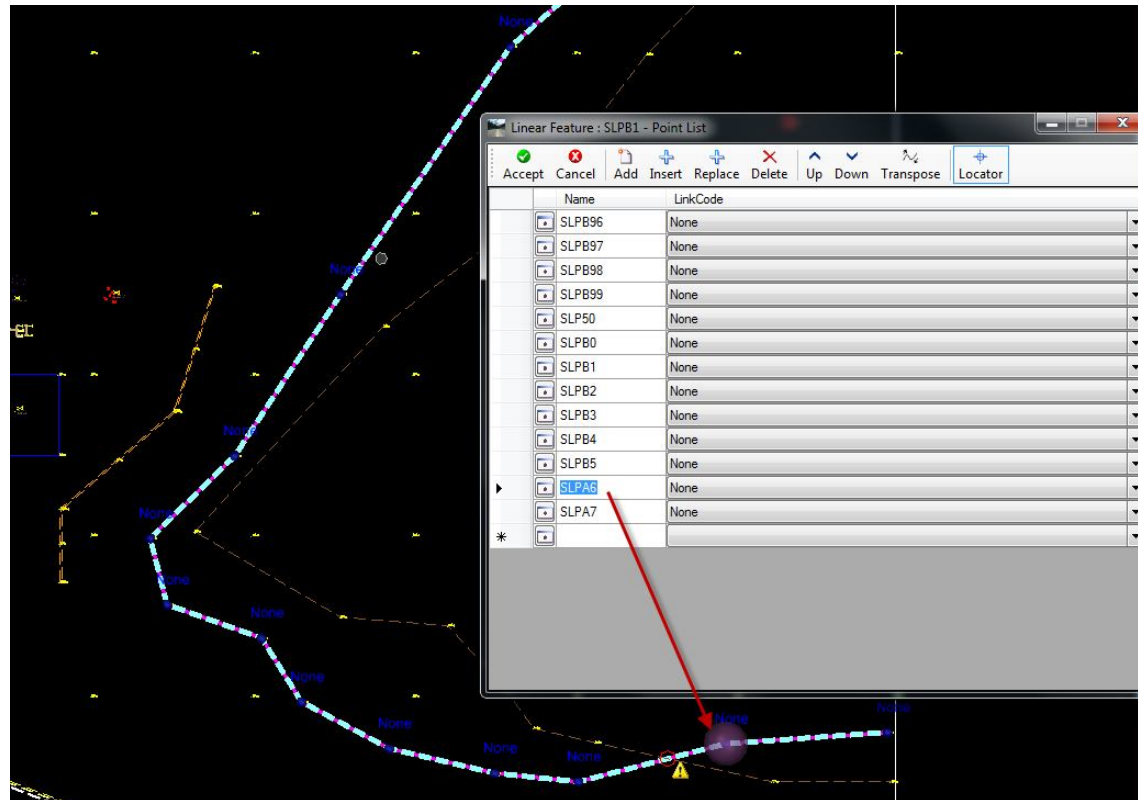# TERRAIN MODELS: RESOLVE CROSSING FEATURES

- Editing the point within a Linear Feature is often needed to correct misconnected Point Features.

- Choose "Manage Point List…" to edit the points within a chain.

- Note that a purple location circle appears in the view on the point selected in the Manage Point List dialogue box.
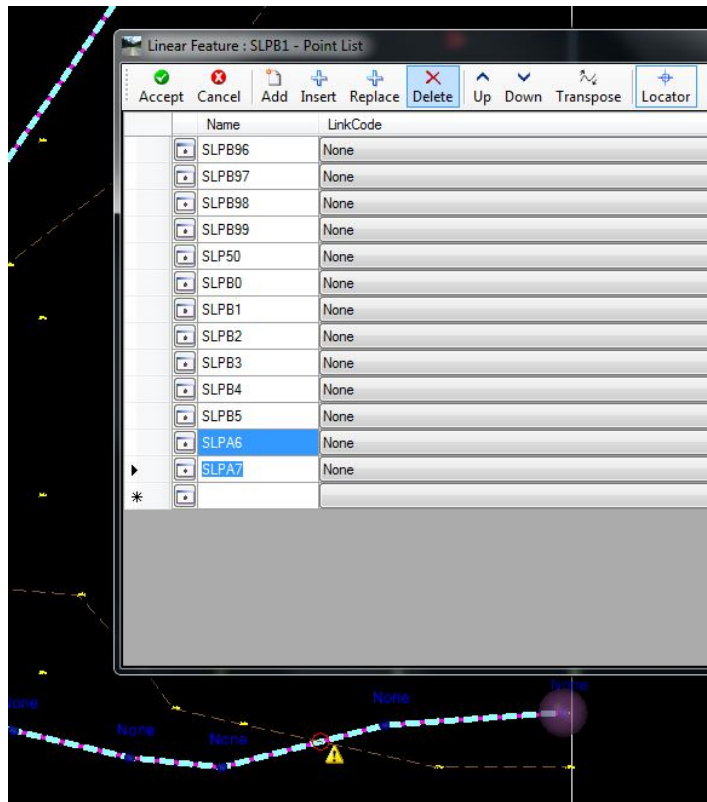
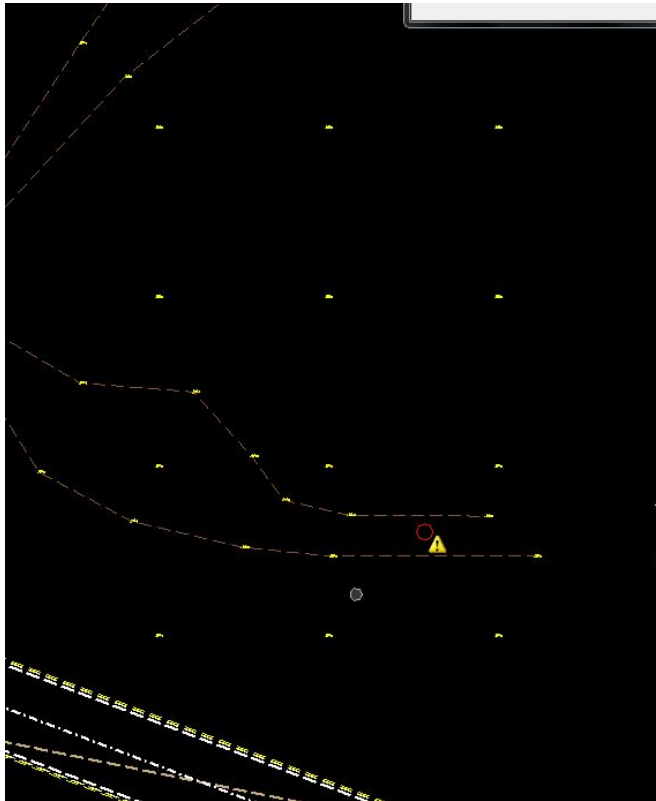# TERRAIN MODELS: RESOLVE CROSSING FEATURES

TERRAIN MODELS: RESOLVE CROSSING FEATURES

- In this case, deleting the last two points of each crossing chain and adding the two correct points to each chain will fix the crossing features.

- Note the crossing features are repaired however, the yellow warning triangle and red circle will is still visible..

TERRAIN MODELS: RESOLVE CROSSING FEATURES

- In this case, deleting the last two points of each crossing chain and adding the two correct points to each chain will fix the crossing features.

- Note the crossing features are repaired however, if the yellow warning triangle and red circle will is still visible, it will be gone the next time MicroStation opens.

EDITING A SURVEY GENERATED TERRAIN MODEL
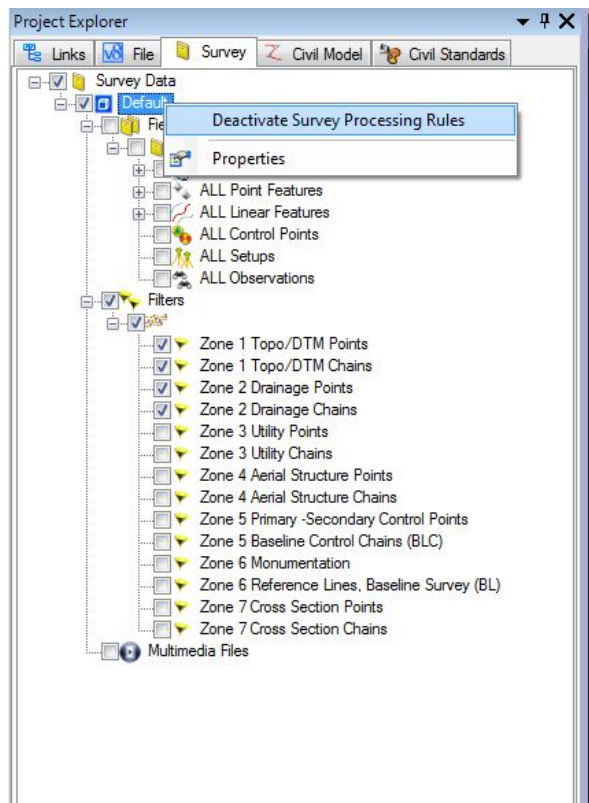
- NOTE: It is important to understand that all Point and Linear Feature issues must be resolved before editing any triangles.

- Bentley Survey continually updates the Terrain Model from the survey data. The only way to stop this process is to "Deactivate the Survey Processing Rules" from the Project Explore Survey tab.

# *EDITING A SURVEY GENERATED TERRAIN MODEL*
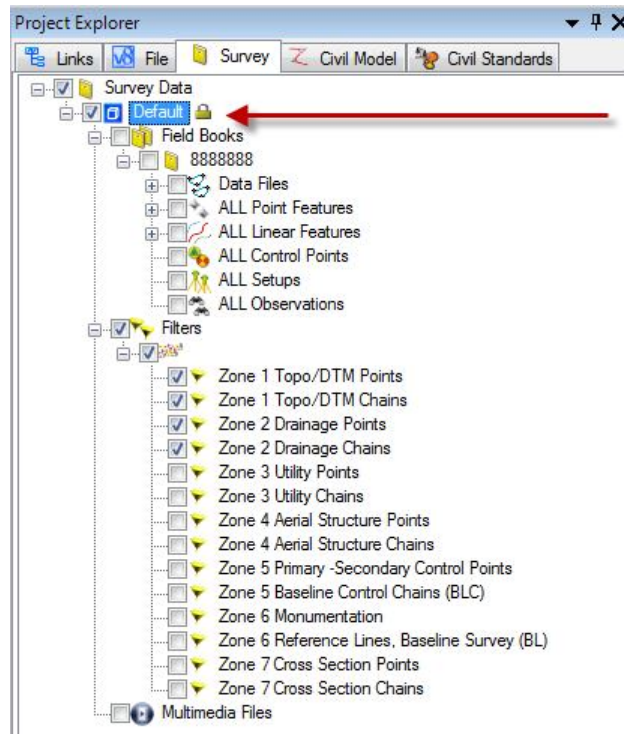
- Once the survey processing is deactivated a lock will appear in the Survey tab next to the category under "Survey Data".
- Only with the survey processing deactivated can triangles be edited.
- **WARNING** if the survey processing is reactivated it will reverse all triangle edits back to their original state.

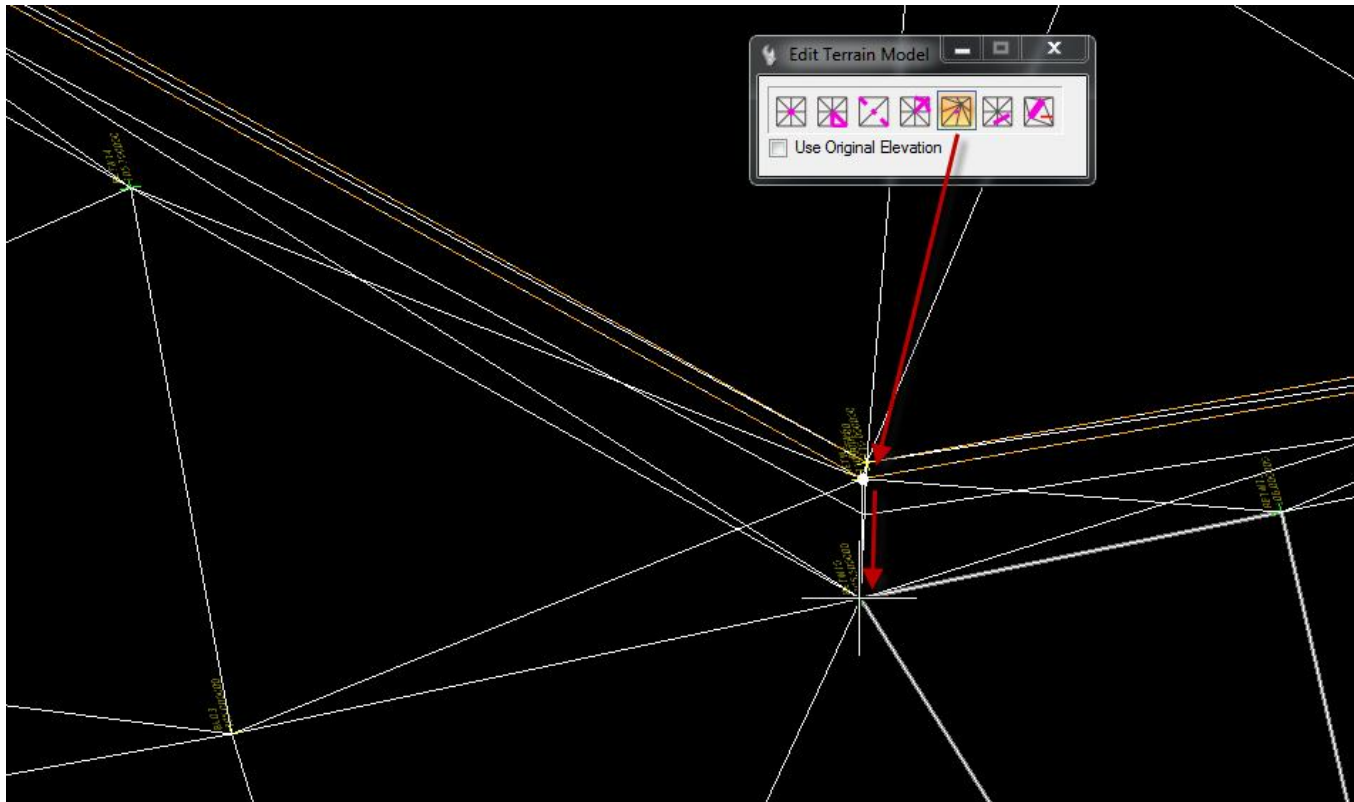# EDITING A SURVEY GENERATED TERRAIN MODEL
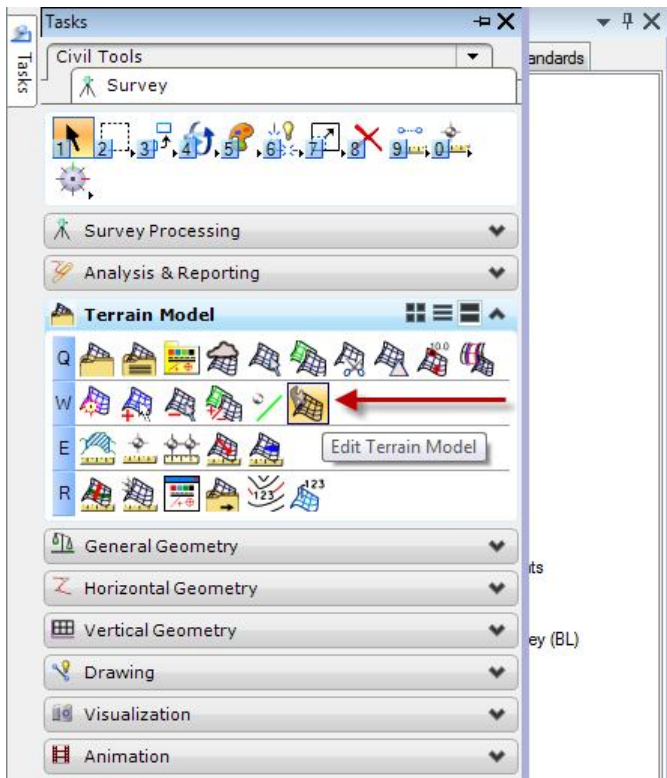
- Select the Edit Terrain Model tool from the Terrain Model task bar.
- Select the Terrain Model to edit with the element selection tool.
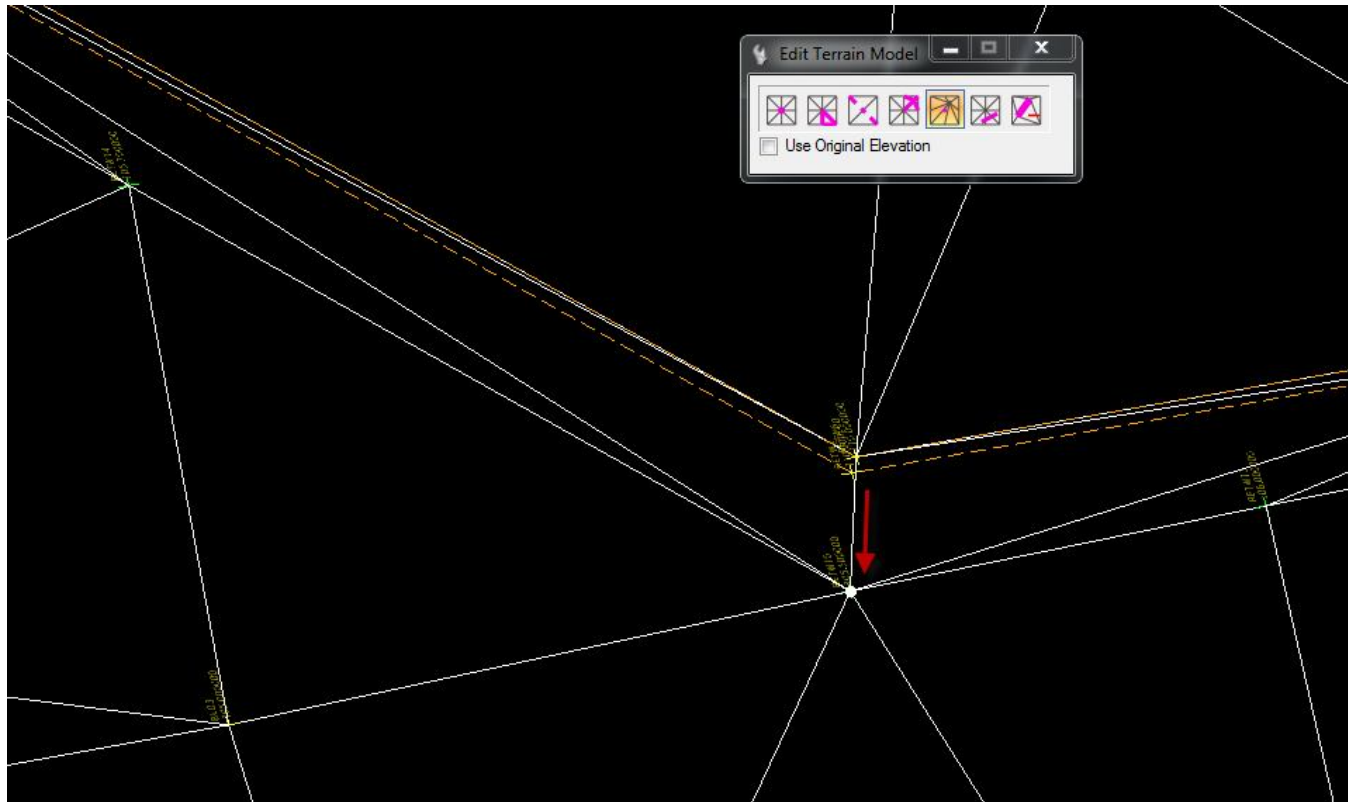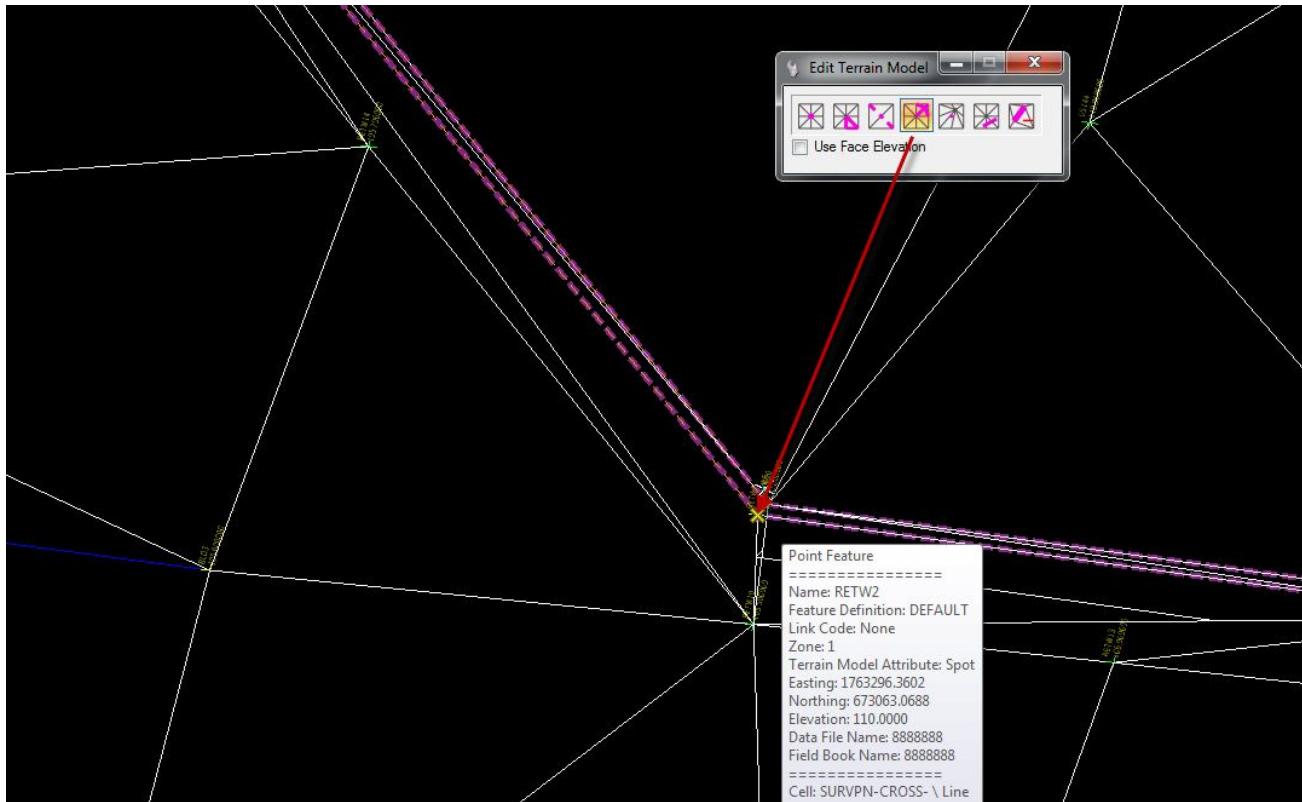- The Edit Terrain Model tools will automatically become active.
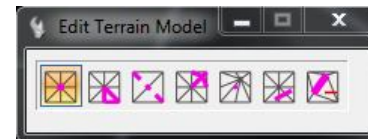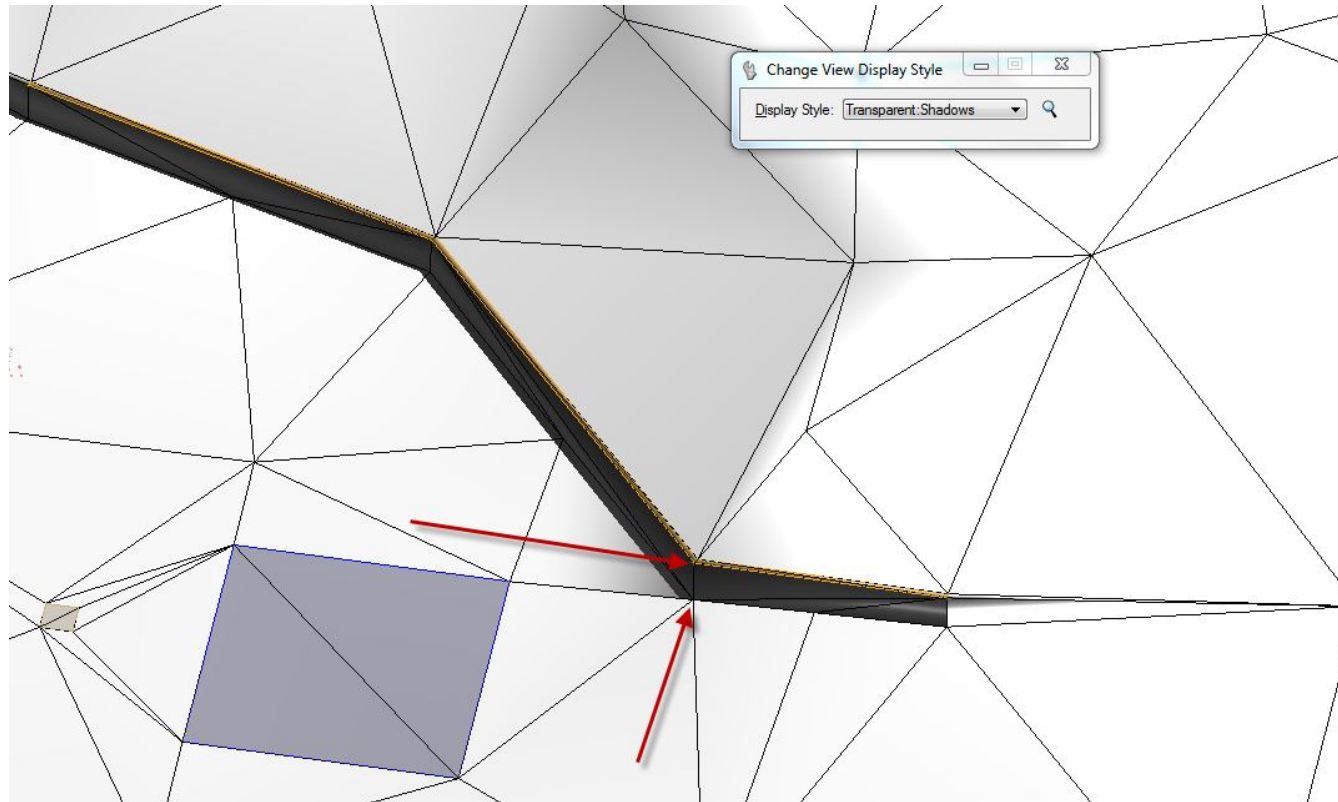
MOVING A TRIANGLE VERTEX
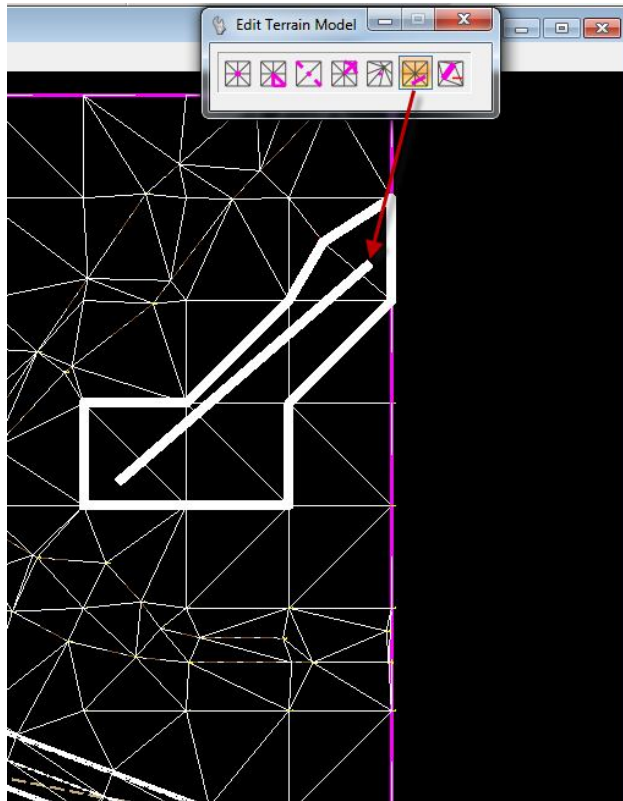
MOVING A TRIANGLE VERTEX

INSERT A VERTEX
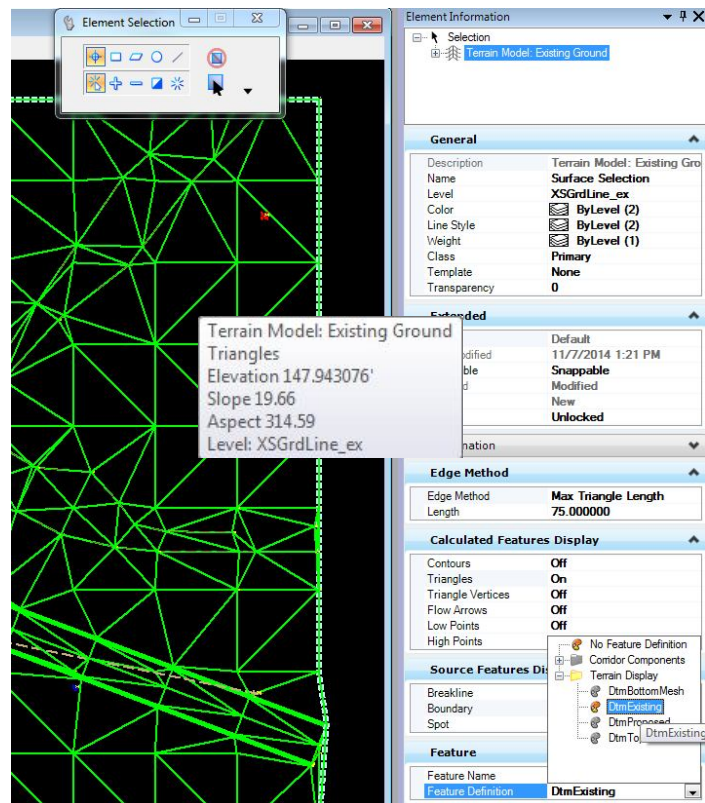
RENDERING SHOWS THE TRIANGLES CORRECTLY EDITED

EDIT TERRAIN MODEL TOOLS

- Note that the "Delete Triangle By Line" tool only works if the line reaches an edge triangle.
- Bentley has this logged this as a defect and will correct the function of this tool.
- Until then use the MOVE, DELETE and INSERT Vertex commands.

EDIT TERRAIN MODEL TOOLS

- Due to another logged defect, only after all edits are complete, should you apply a terrain display Feature Definition to the Terrain Model. In this case the existing ground feature is "DtmExisting".

- Note the level shown for the Terrain Model: "DTM_ex". This is in order to show the correct existing ground level when cross sections are cut.
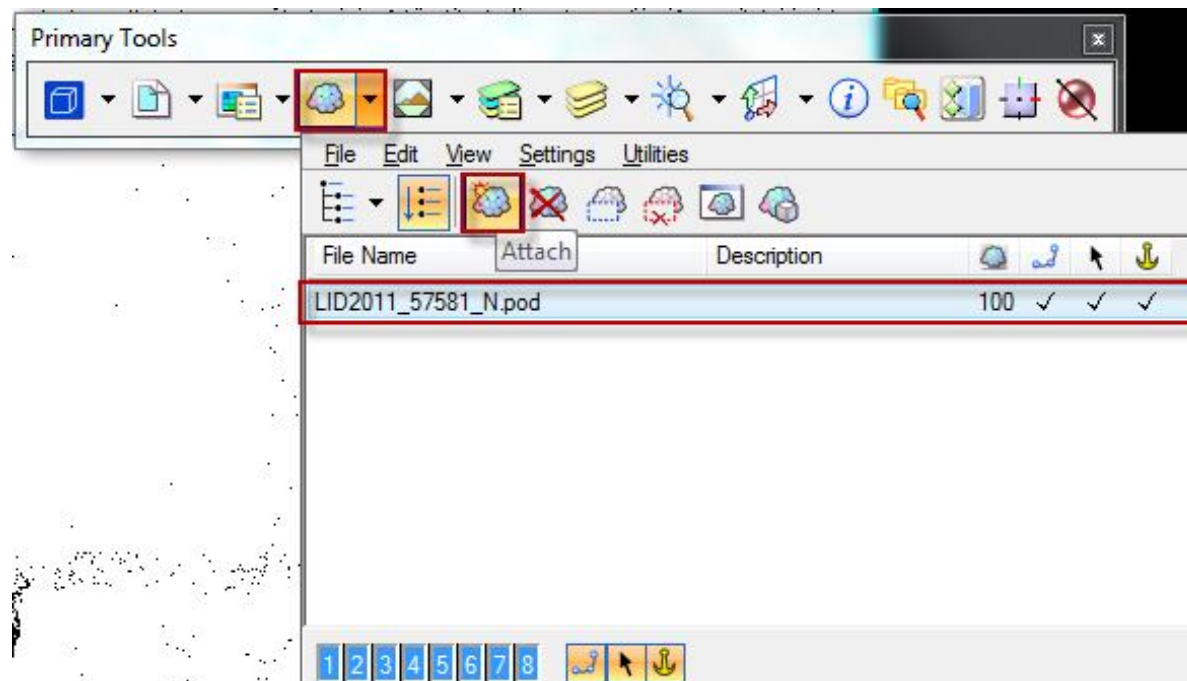
CREATING TERRAIN MODEL from LIDAR "LAS" file

- The LAS file must be classified with the existing ground surface segregated (typically Ground or Low Point).

- OR the point cloud within the LAS file must be existing ground points only

- Due to issues with direct LAS import into Terrain Models, a POD (Bentley point cloud format) must be used to build the Terrain Model.

- Open a new 3D file and attach the LAS file using the Bentley Point Clouds tools.

CREATE A BENTLEY POD FILE FROM THE LAS FILE

CREATING TERRAIN MODEL from LIDAR "POD" file

- In the Bentley Point Clouds dialogue box, under "Settings", select "Presentation"

- Highlight the classification category (choose style).
- Check box only the classification that represents the existing ground surface (usually "Ground").
- Click on the "Apply to Open Views" button to visualize only the existing ground surface.
- Close the Presentation dialogue box.
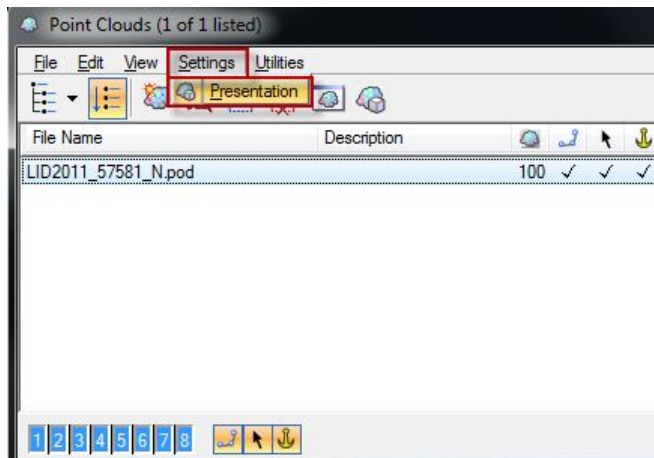
CREATING TERRAIN MODEL from LIDAR "POD" file

- After visualizing the existing surface with the POD file, the Terrain Model can be created.
- From the Terrain Models task pane select "Create from Point Cloud".
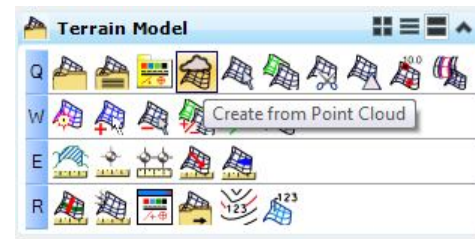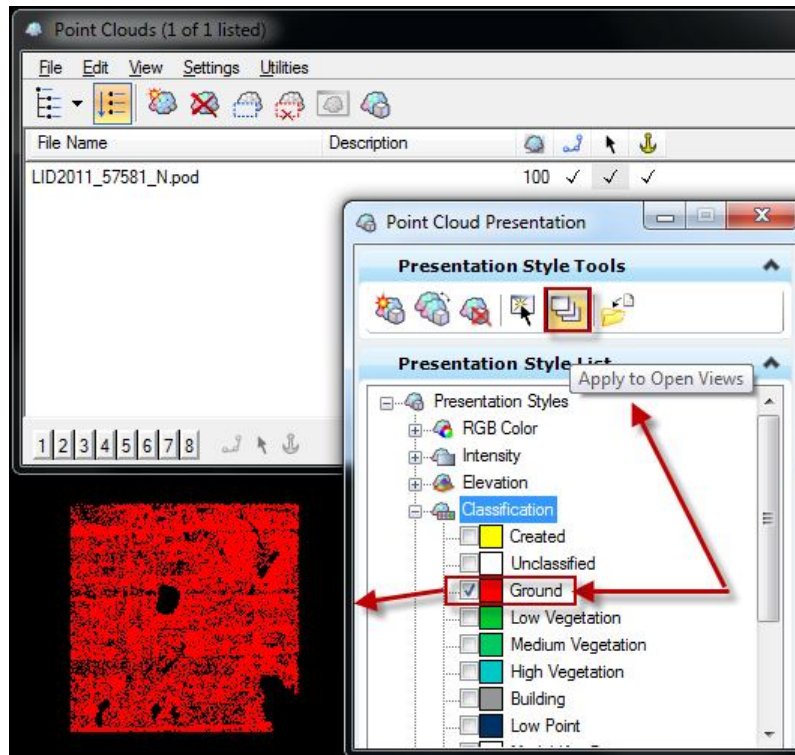
BENTLEY SUGGESTED SETTINGS FOR POD file IMPORT

➢ **In the Import Terrain Model From Point Cloud dialogue box**

- Always use the "Tin Filter".
- Input the "Z" Tolerance.
- Always use the "Coarse" option.
- Always use "Reinsert Points" option.
- Click "Import" to create the Terrain Model from the visualized point cloud.
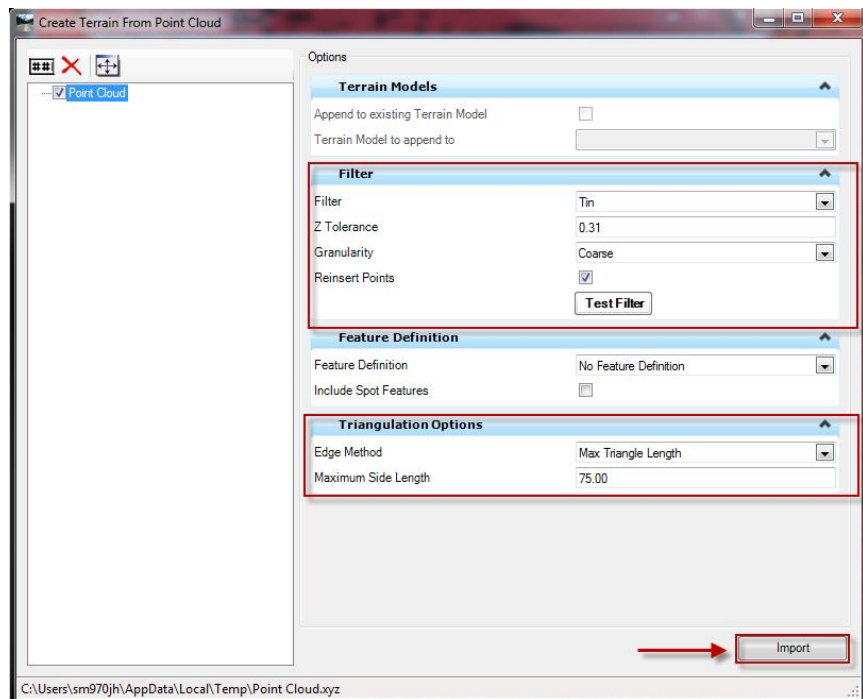
"Z" TOLERANCE

- What is the "Z Tolerance" ???

- An unaltered TIN (no filtering) will produce a huge file that could be difficult to work with. The Z tolerance is the amount of error that you are willing to accept in order to produce a TIN that is not too large to use.

- Bentley reports that if you want to be absolutely sure that your final filtered TIN is within a certain accuracy of your original unfiltered TIN then Z tolerance should be ½ of that acceptable error (vertical accuracy).
  - ✓ The Survey Report should give you an idea of the vertical accuracy within a point cloud at a 95% confidence level.

CREATE FROM POINT CLOUD "Test Filter"

- The "Test Filter" button allows you to test various settings before actually creating the Terrain Model.

- Default Triangulation Options can be changed here, before the Terrain Model is created.

- Note: do not select a Feature Definition until after the Terrain Model is created.
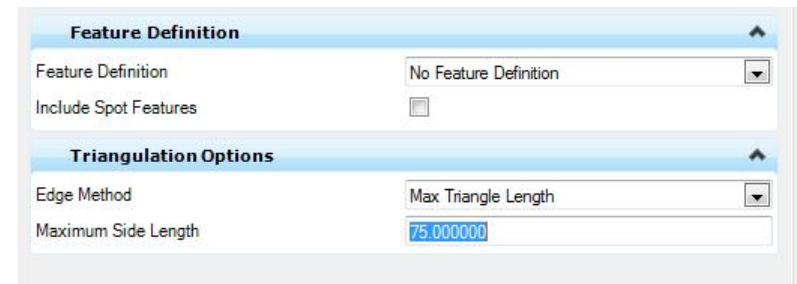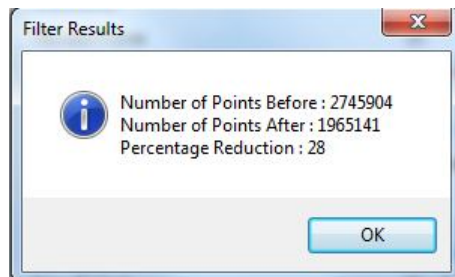
DETACH THE POD FILE and SELECT FEATURE DEFINITION

- After the Terrain Model has been created. The POD File is no longer needed and can be detached from the design file.
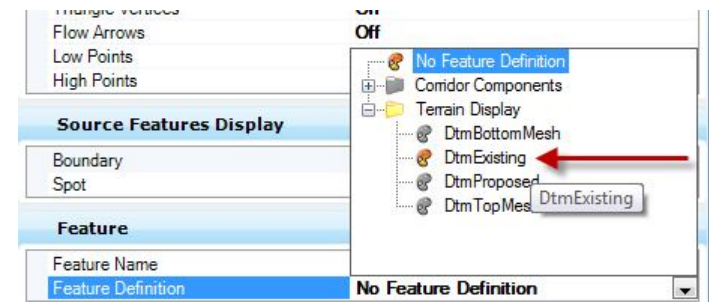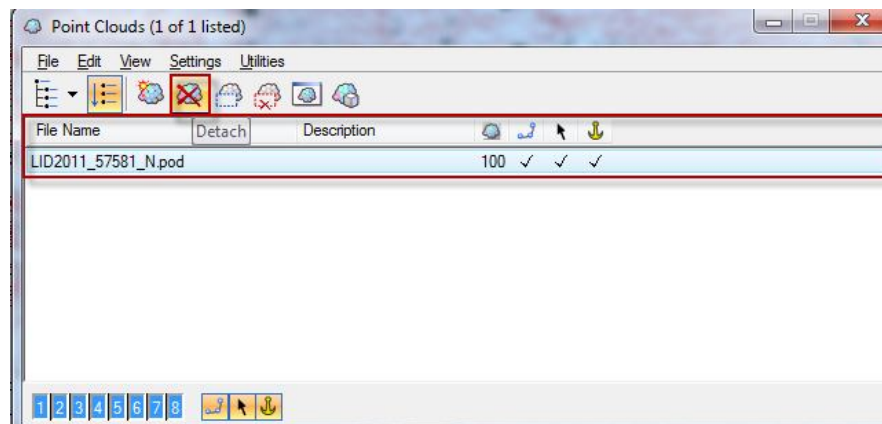
- Select the Terrain Model with the selection tool and change the Feature Definition to "DtmExisting" in the Element Information dialogue box.

EXPORT THE TERRAIN MODEL
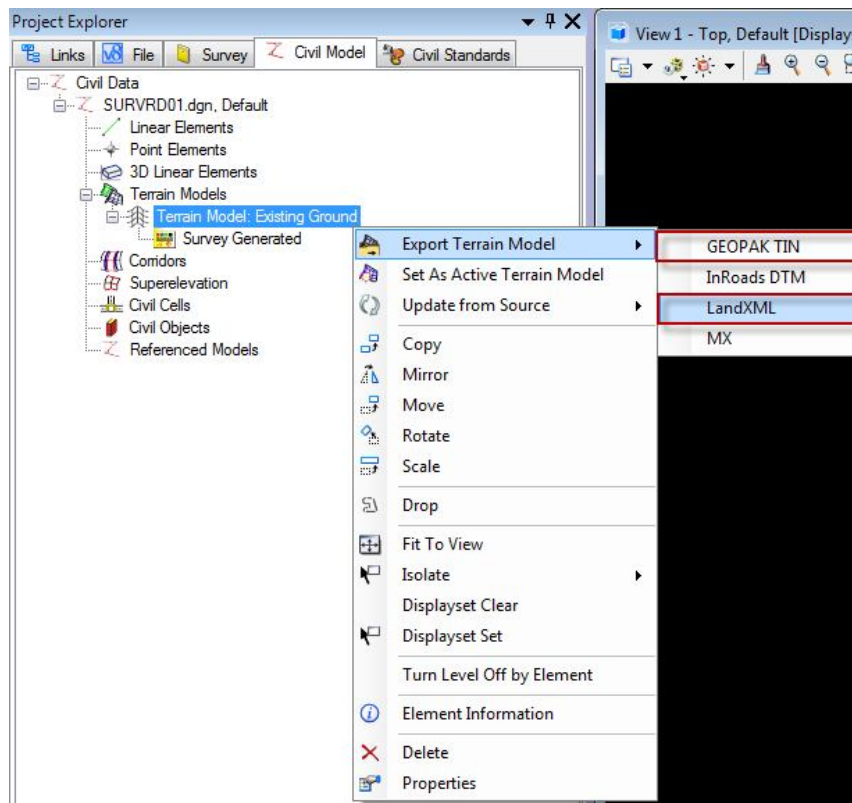
- At this point it would be a good idea to export the Terrain Model as a Land XML file. Possibly even a GEOPAK Tin if needed.
- If for some reason the Terrain Model is deleted or corrupted it can be imported from the Land XML or GEOPAK Tin file.
- Use the Create From File tool from the Terrain Model task pane to import a Terrain Model.

TURN LEFT & EXPORT THE SURVEY DATABASE TO GEOPAK

- Open a <u>NEW</u> GEOPAK file.

- Right-click on the Survey Project Field Book.

- Hover on the "Export To" and select "GEOPAK Format".

- Select the GPK file to export to.
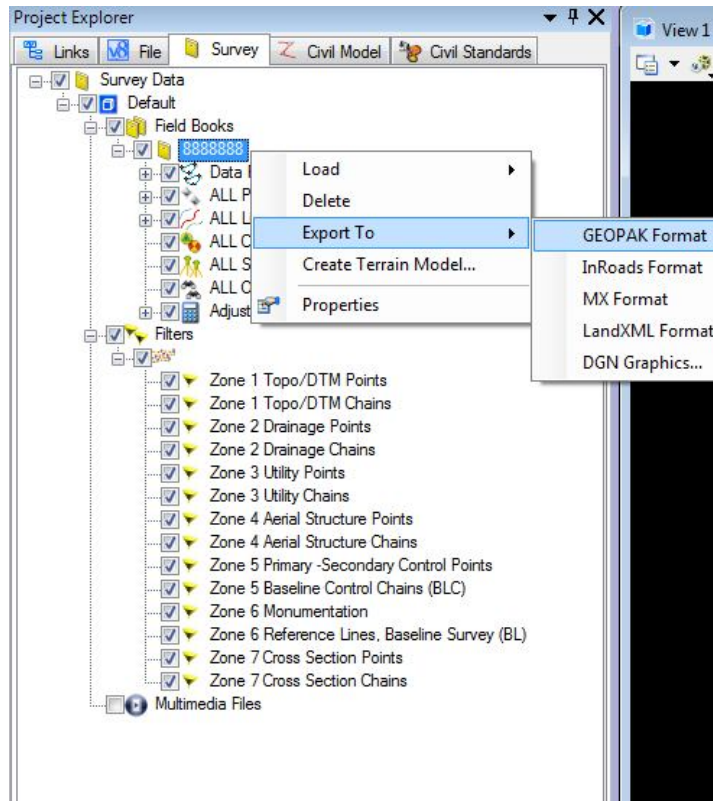
CREATING AN ALIGMENT IN THE SURVRD.DGN FILE

- The alignment in OPEN ROADS is a "Civil Model" element and should be placed in the SURVRD file.

- Most likely it will be the Baseline Survey Field, Baseline Survey (Calculated) or a provided Centerline Construction.

- This alignment can be easily placed directly from the GPK file chain representing the alignment.

- Use the Import Geometry tool in the General Geometry task bar to create a "Civil Model" alignment.

- Use the D&C Manager to annotate the alignment. For file readability it is suggested that the annotation is visualized at a 1"=20' scale

CREATING AN ALIGMENT IN THE SURVRD.DGN FILE
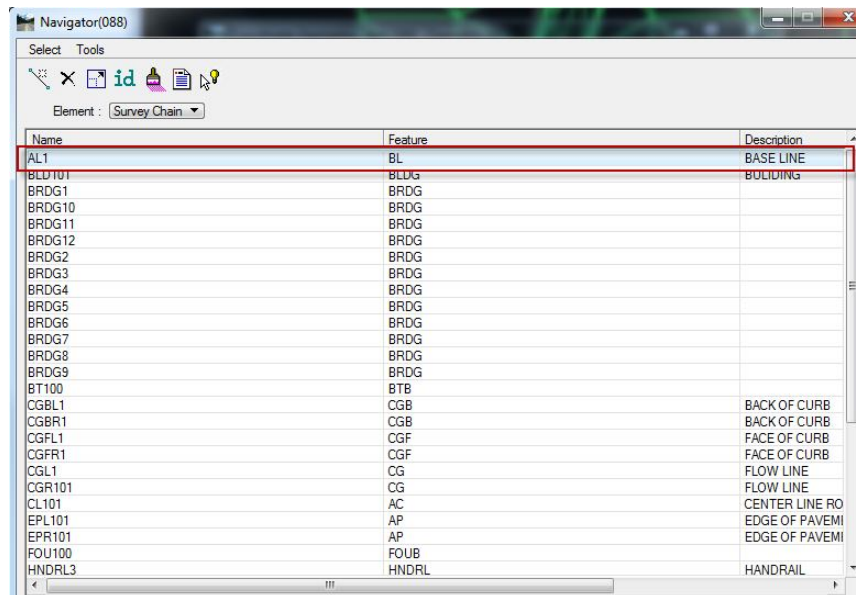
- When the GPK file contains your alignment as a chain, use it.

- In the Task Bar under General Geometry tools, use the "Import Geometry" tool to import a chain to use as an alignment.

- Select the chain and press "Import"

- View the alignment
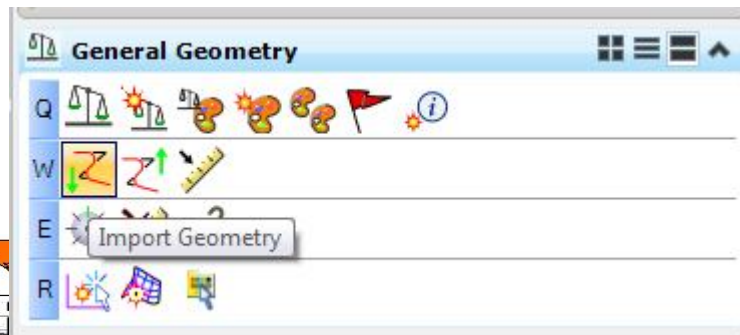
CREATING A CAiCE ALIGNMENT XML FOR GPK IMPORT
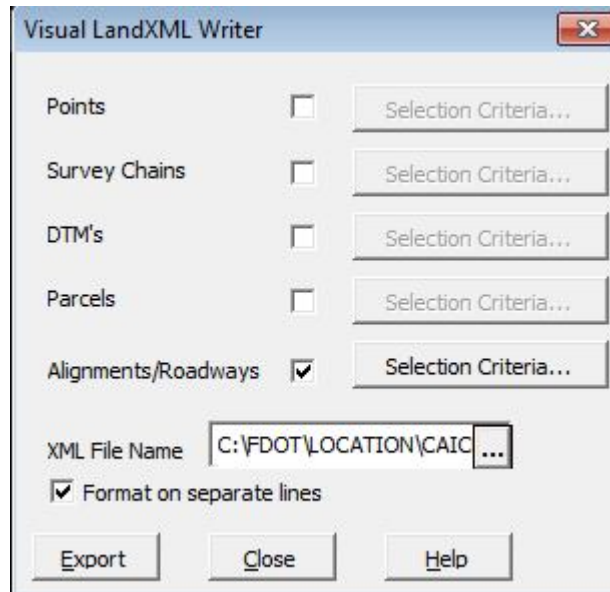
- Create an alignment XML with the CAiCE LandXML writer (Win32)

- Open a GPK file with GEOPAK COGO and use the Import LandXML 1.2 Geometry function to import a geometry chain.
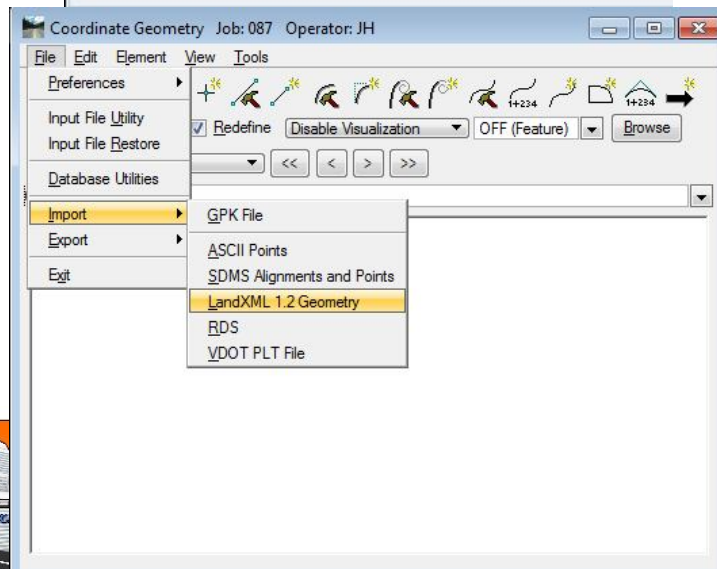
CREATING AN ALIGNMENT GRAPHCALLY FROM AN ELEMENT
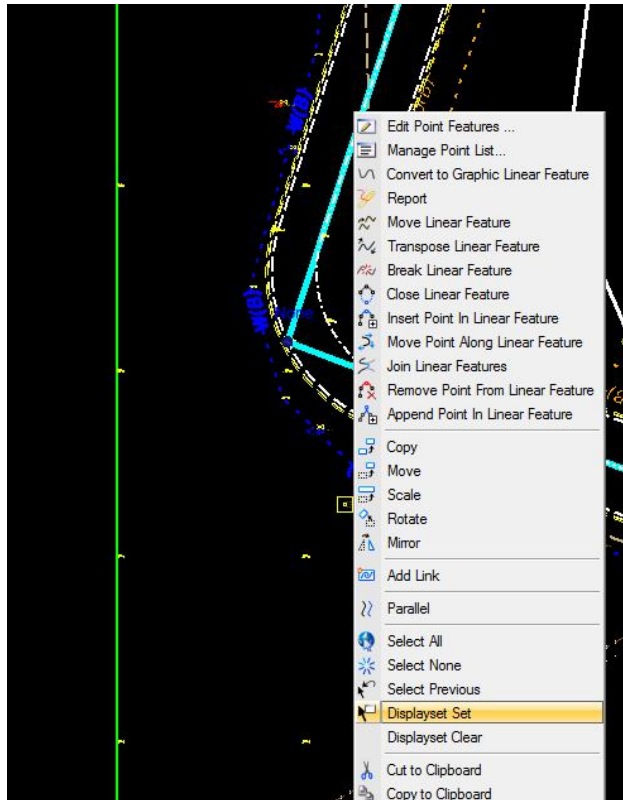
- Select the element such as the survey baseline field feature and right-clicking to bring up options.
- Select Display Set to isolate the baseline.
- From the Horizontal Geometry task pane, draw civil geometry lines and curves along the survey baseline.

CREATING AN ALIGNMENT GRAPHCALLY FROM AN ELEMENT

- Select "Line Between Points".
- Select a Feature Definition.
- Draw the line. Each segment is drawn separately.
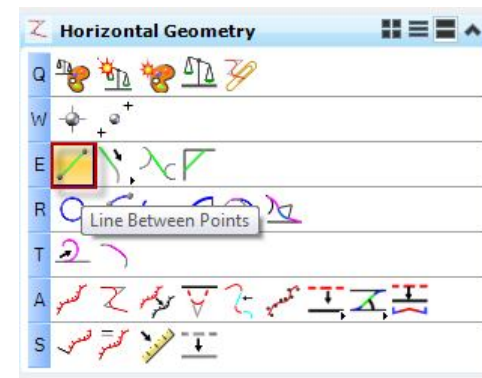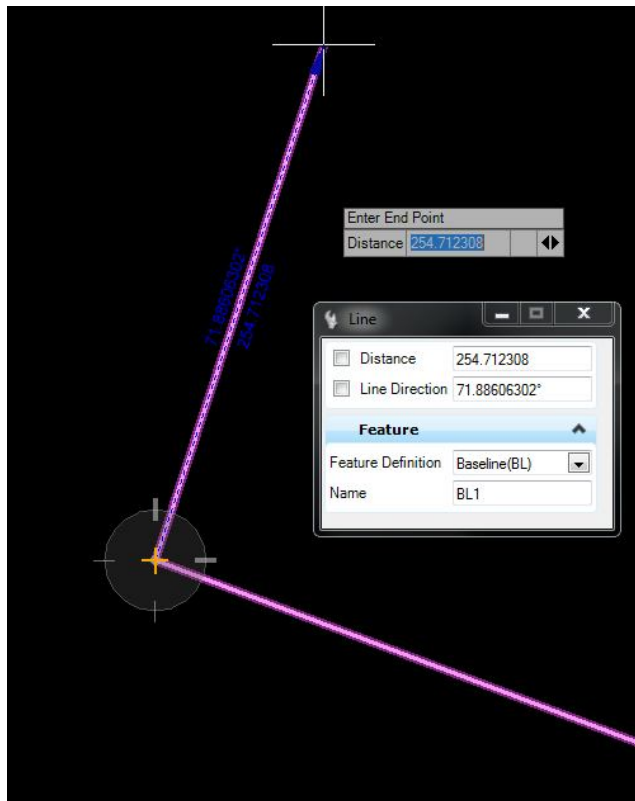
CREATING AN ALIGNMENT GRAPHCALLY FROM AN ELEMENT

- Select "Complex By Element"
- Select a Feature Definition.
- Select the Lines previously drawn using Horizontal Geometry tools. Start near the starting end and watch the arrows.
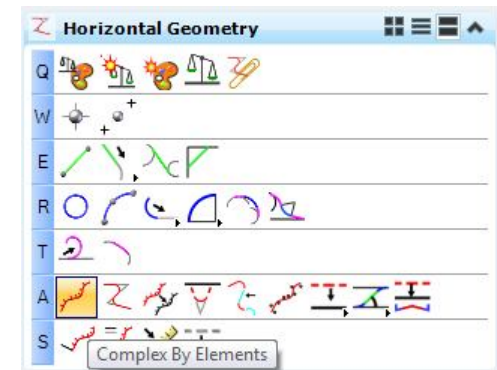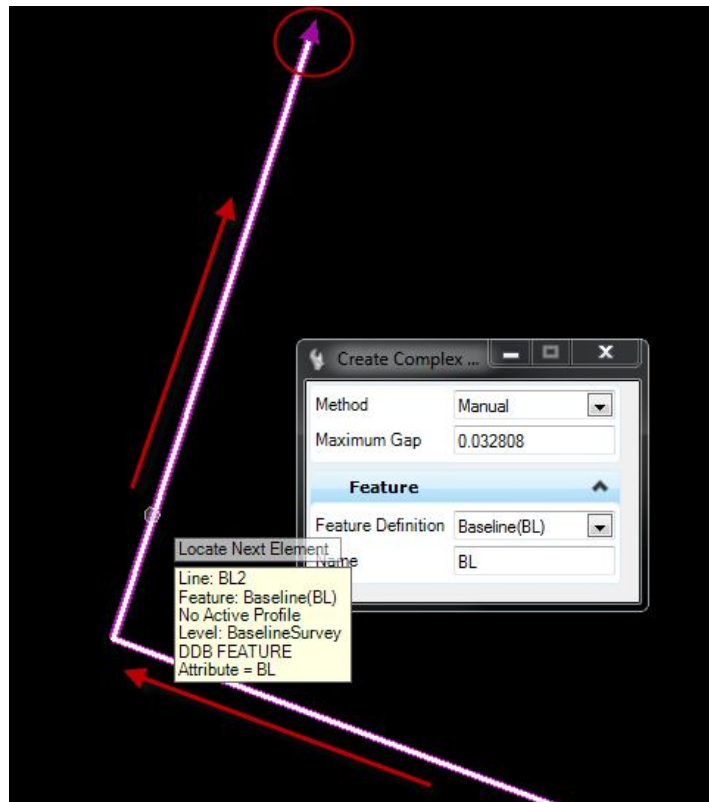
STATIONING AN ALIGNMENT
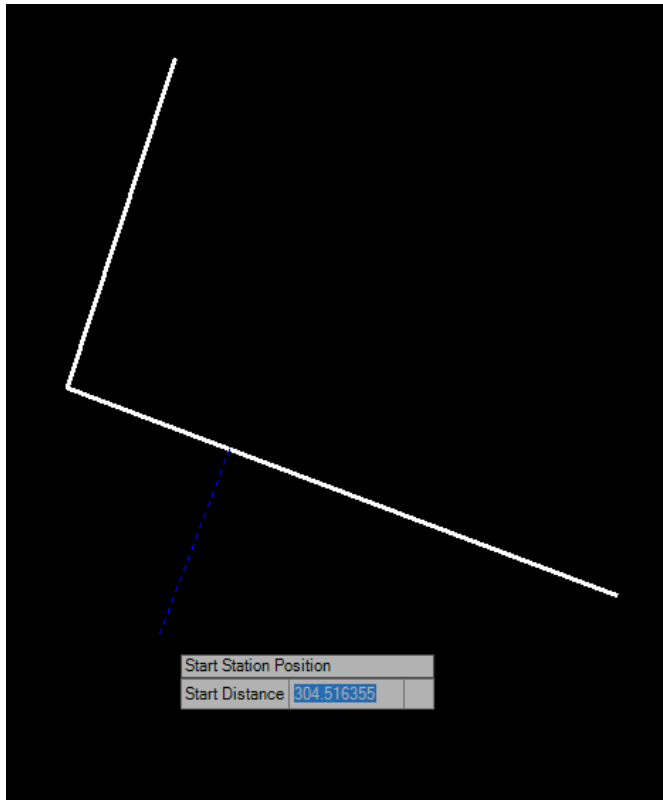
- Select "Start Station" and follow prompts.
- Stationing can begin at any "Start Distance". Generally the Start Distance will be at 0.00'
- Left click to accept Start Distance.

Start Station Position
Start Distance | 304.516355

Horizontal Geometry
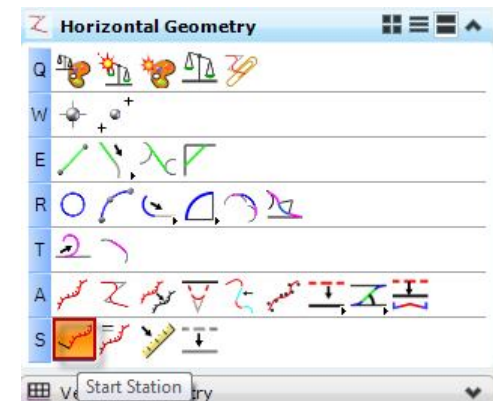
Start Station

STATIONING AN ALIGNMENT
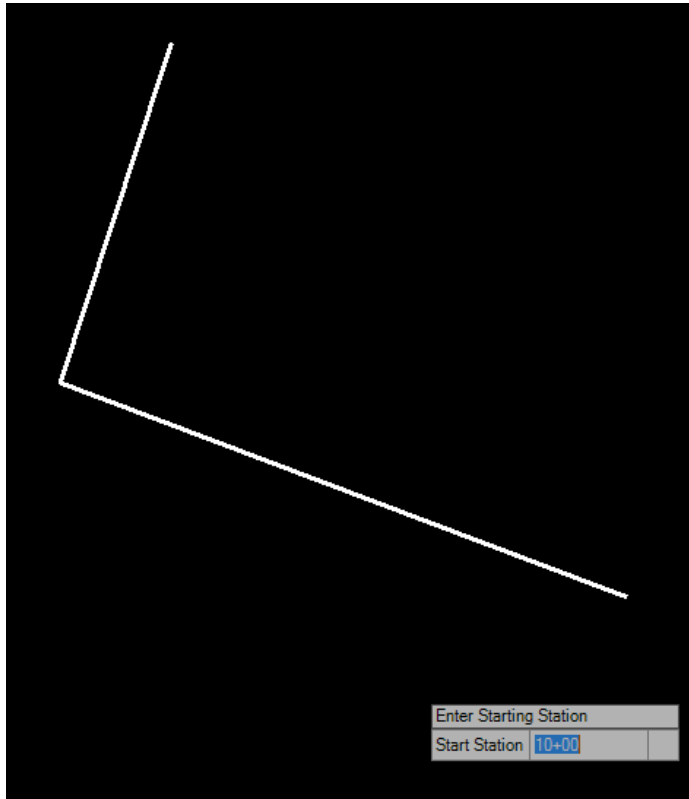
- After selecting the starting point (Start Distance) for stationing. Type in the Station for that point.

- REMINDER: Press the **F6** button to release the Civil Geometry tool.

- TURN LEFT and export the alignment to GEOPAK.
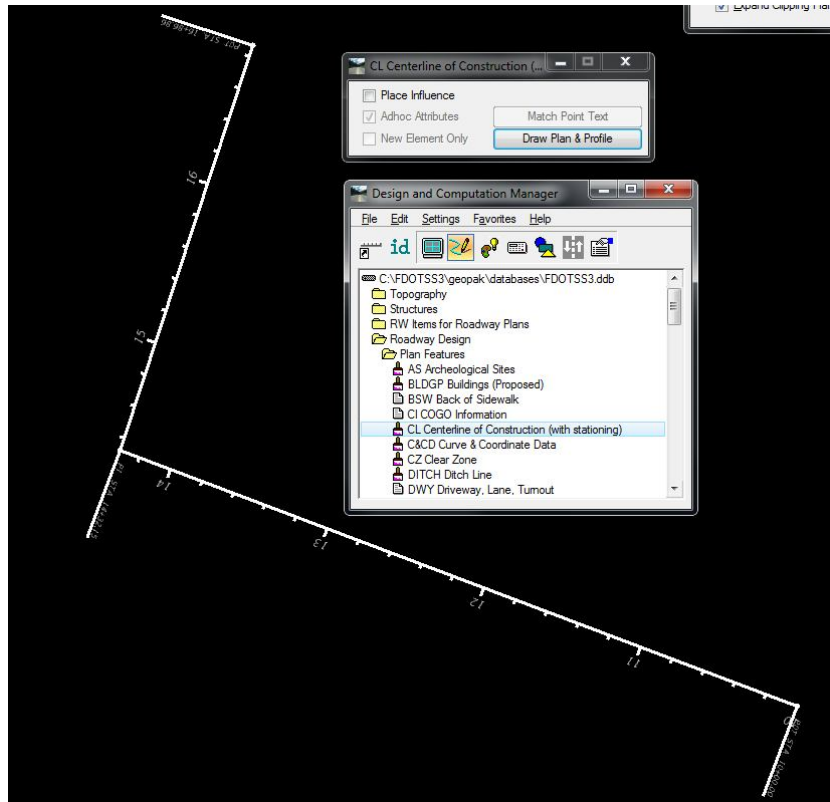
EXPORT ALIGNMENT TO GEOPAK
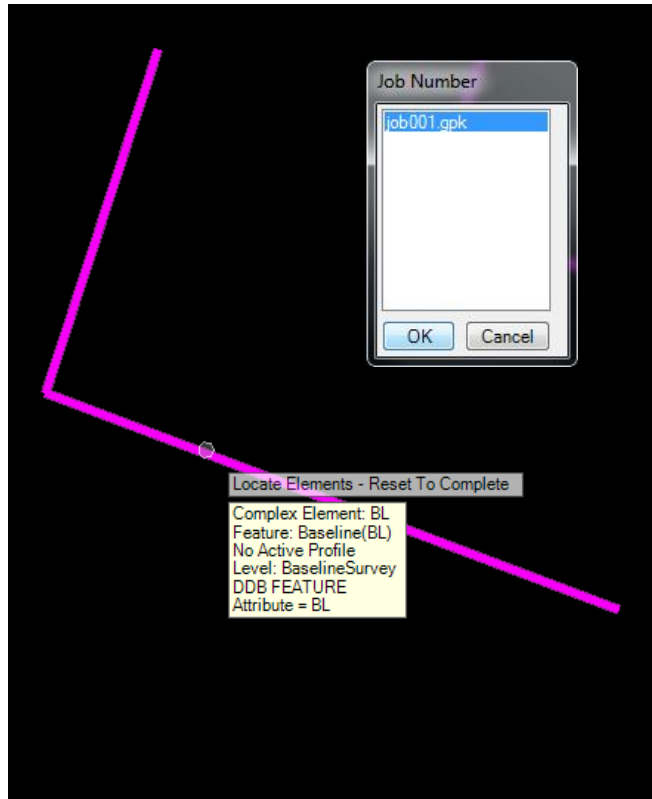
- Select the "Export to Native" tool on the General Geometry task bar
- Choose the Alignment.
- Reset To Complete (right-click)
- Select the GPK file to receive the exported geometry.
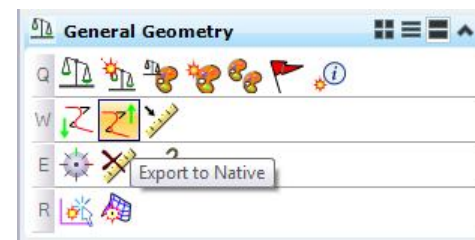
USE D&C MANAGER TO ANNOTATE ALIGNMENT STATIONS

ALIGNMENT HORIZONTAL GEOMETRY REPORT

- Alignments will show up in the Project Explorer under the Civil Model Tab as "Linear Elements"
- Right-clicking on the element will activate options including the Horizontal Geometry Report
- Right-click directly on the alignment in the view pane will also bring up the option to view the Horizontal Geometry Report.

ALIGNMENT HORIZONTAL GEOMETRY REPORT

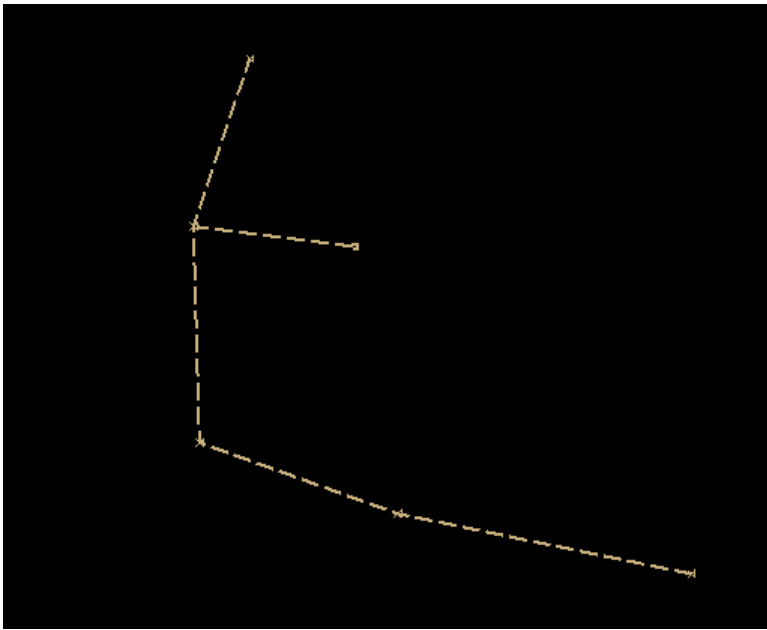# *HORIZONTAL GEOMETRY DISPLAYSET CLEAR*
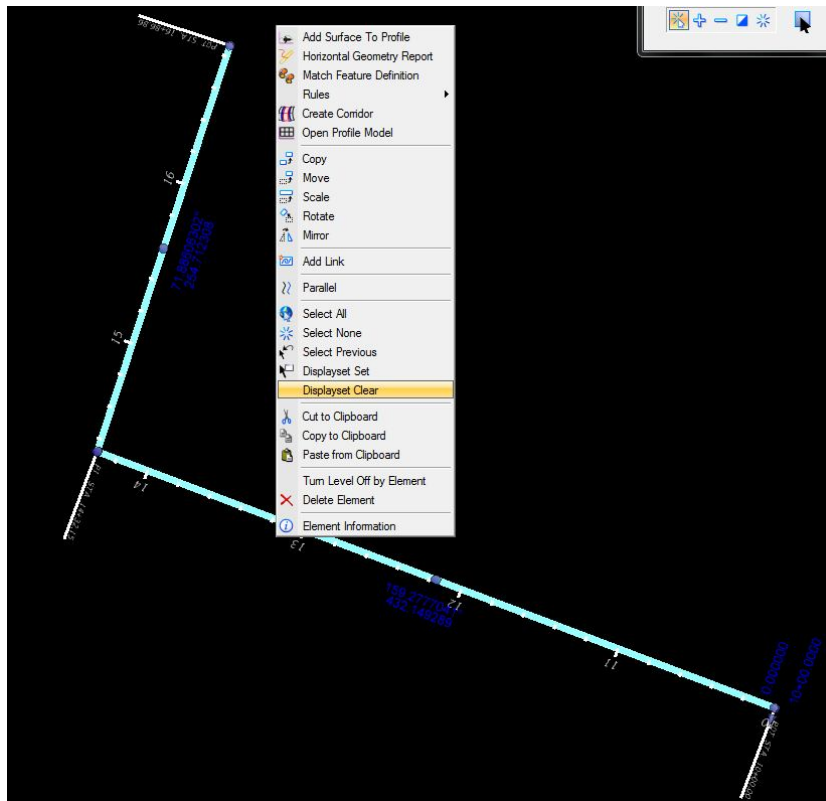
- Right-click on the alignment and bring up options.
- Choose "Displayset Clear" to remove the alignment isolation set earlier.
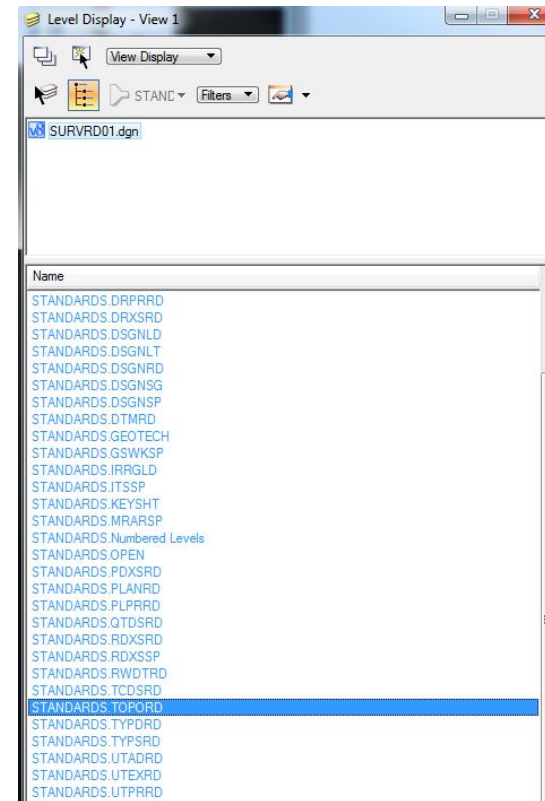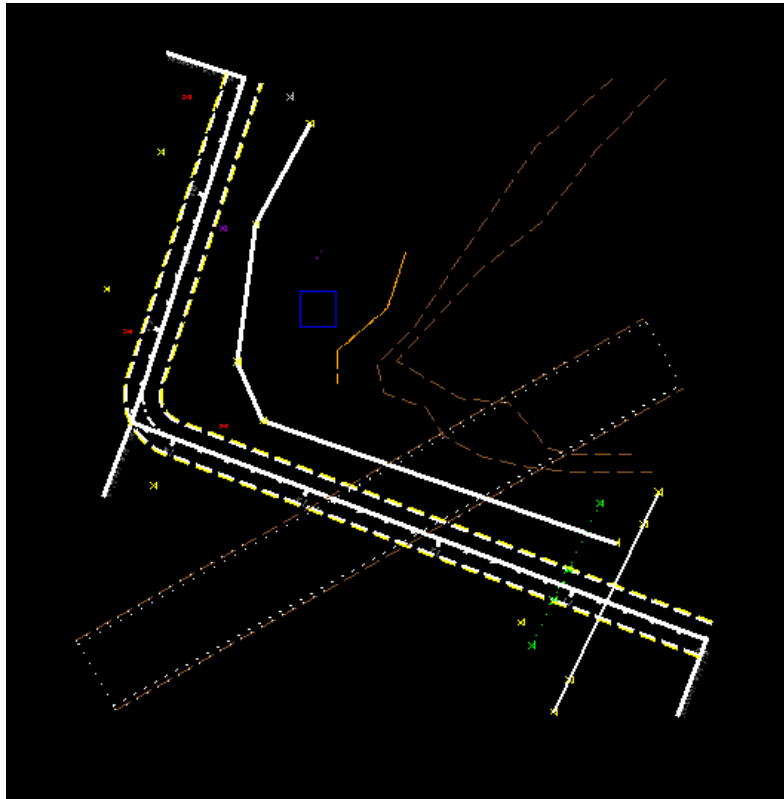- Note that the Alignment is automatically put on an elevation of zero.
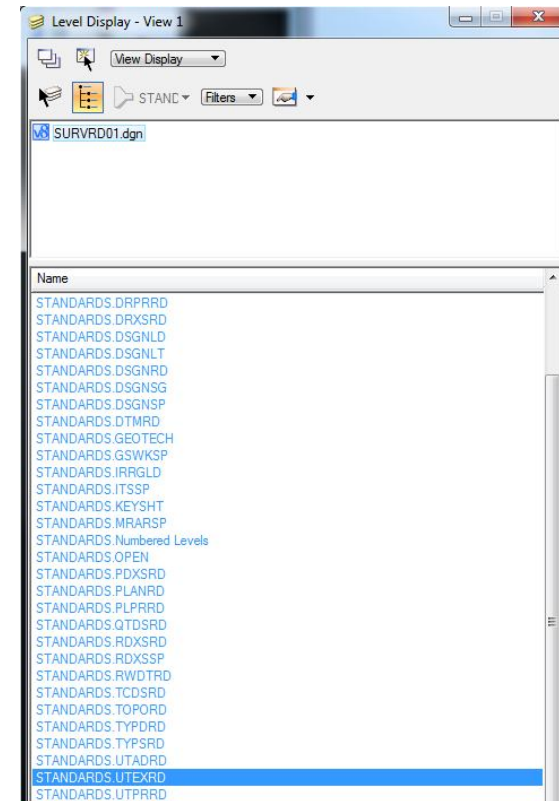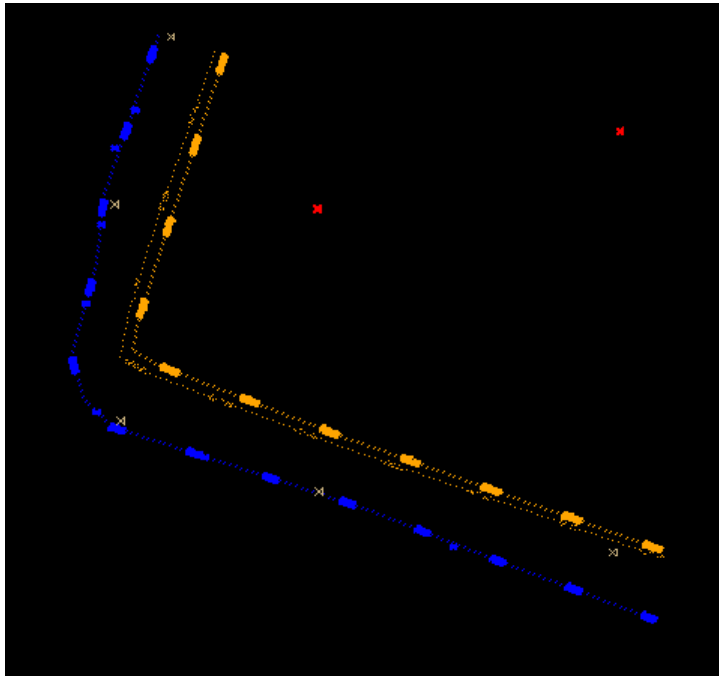
SURVRD.DGN 3D SURVEY DIGITAL DELIVERABLE
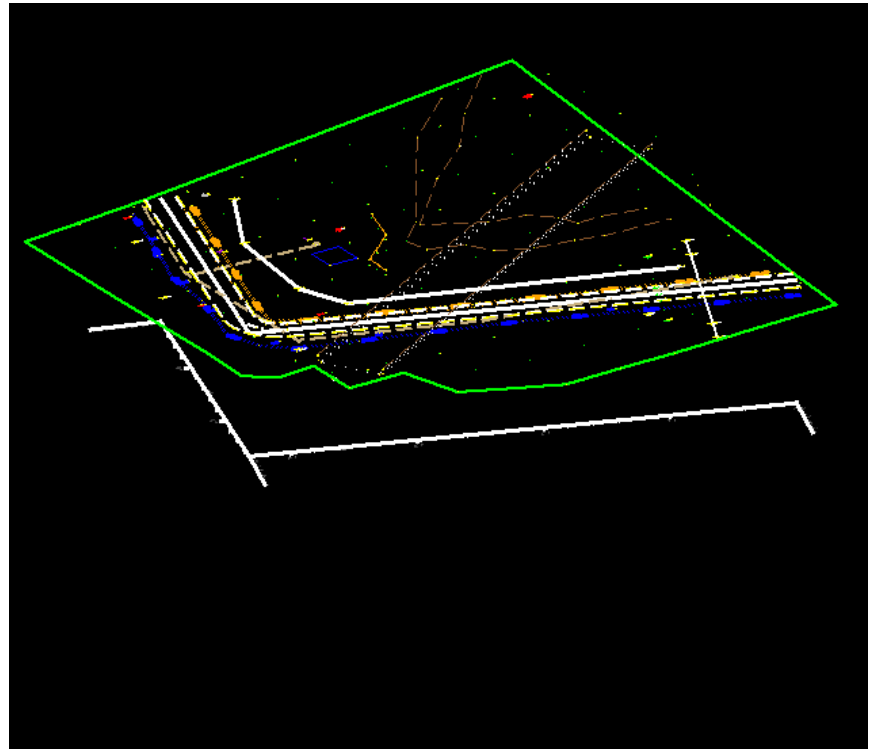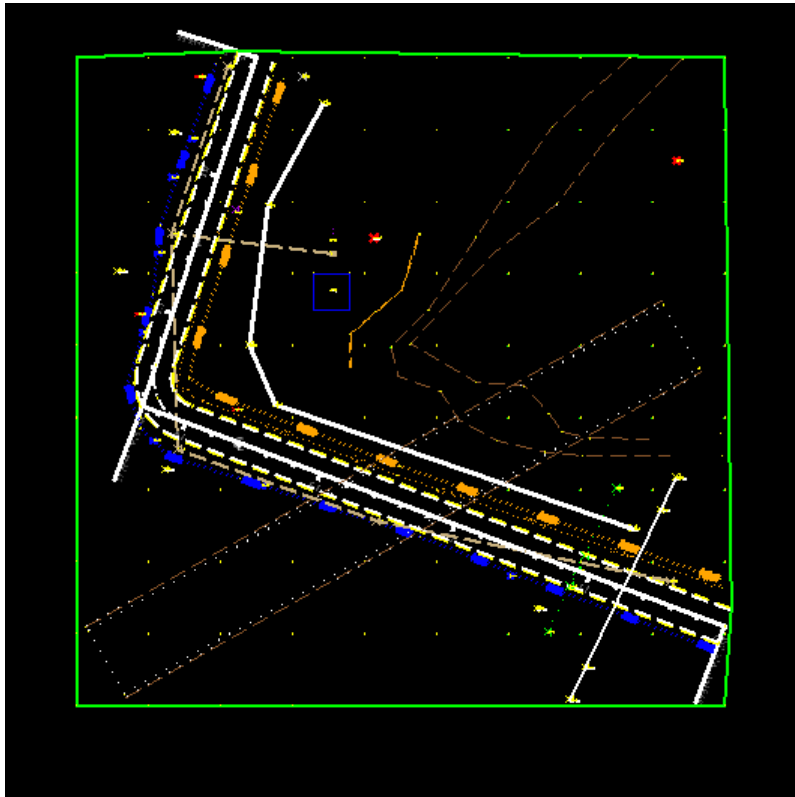
DRAINAGE – DREXRD FILTER
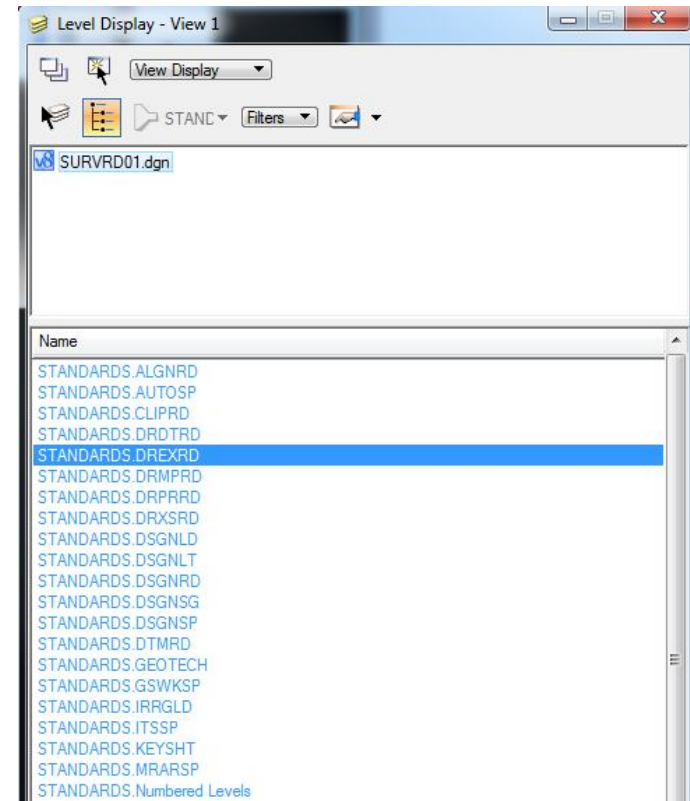
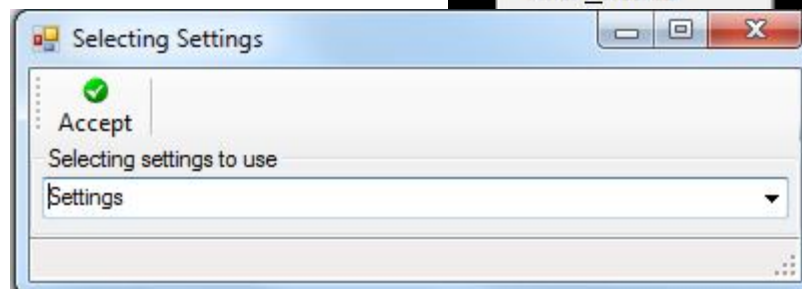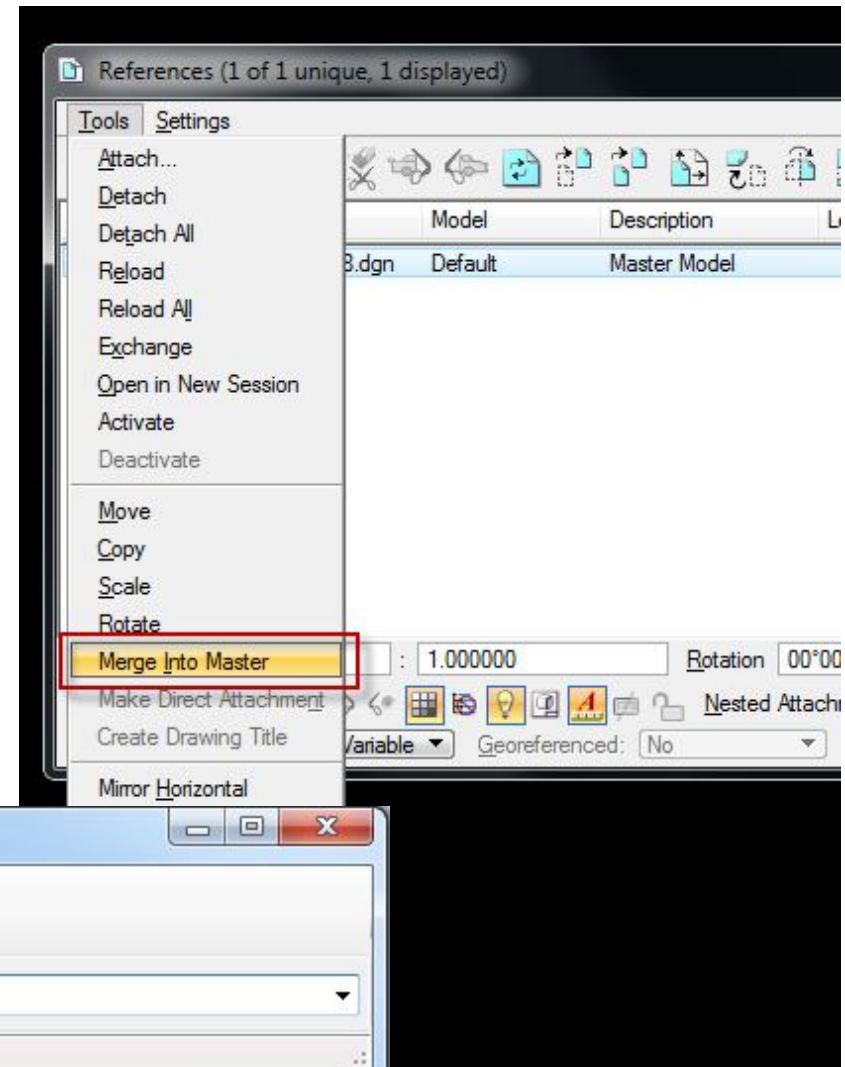# *TOPOGRAPHY – TOPORD FILTER*

UTILITIES – UTEXRD FILTER

CREATE SURVRW SURVEY MASTER 2D FILE

1. Switch to the Right of Way configuration.

2. Create a new 2D RW file.

3. Suggestion: Save this file as SURVRW.DGN to the rwmap project folder.

4. Reference in the SURVRD.DGN

5. In the reference tools "Merge to Master"

6. Click on the View.

7. Click on "Accept" - Settings

SURVRW.DGN FILE

- Note that when switching to the Right of Way configuration, the right of way survey features are automatically attached.
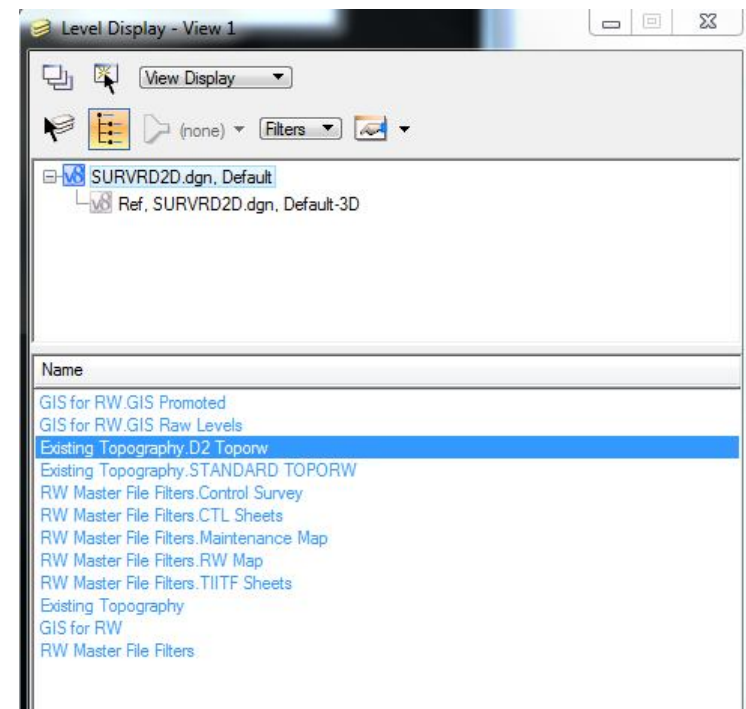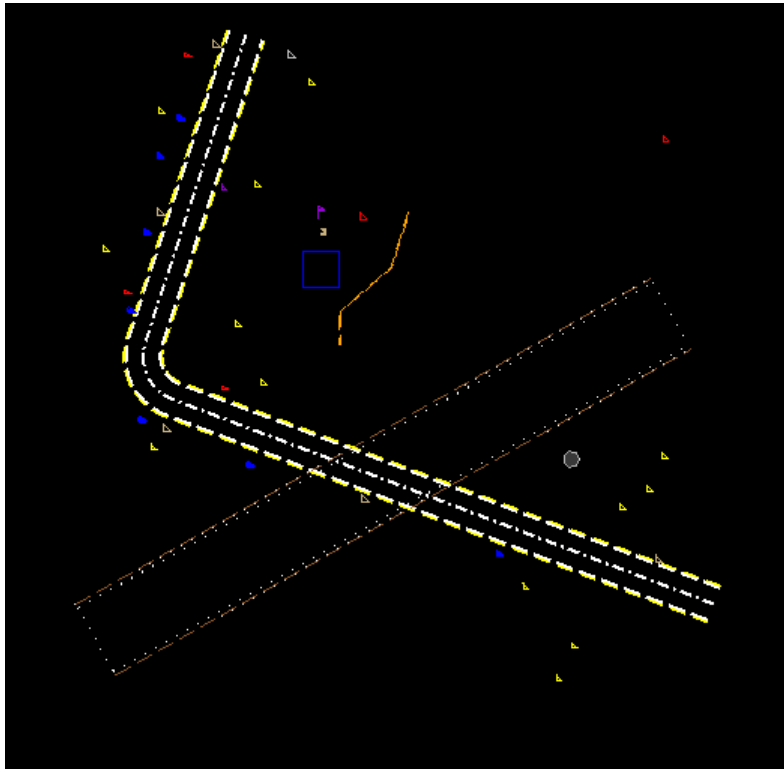
- Use "Survey Redraw" to re-visualize these features.
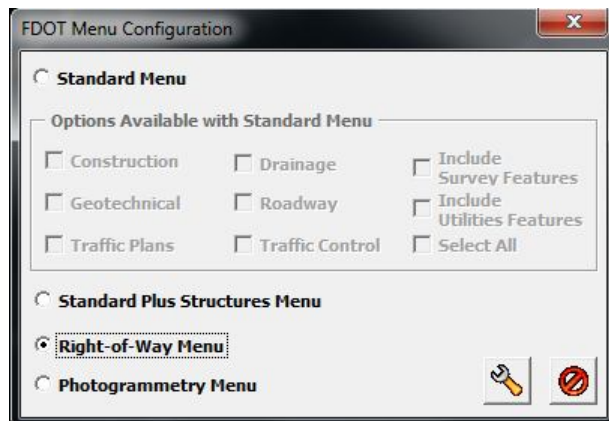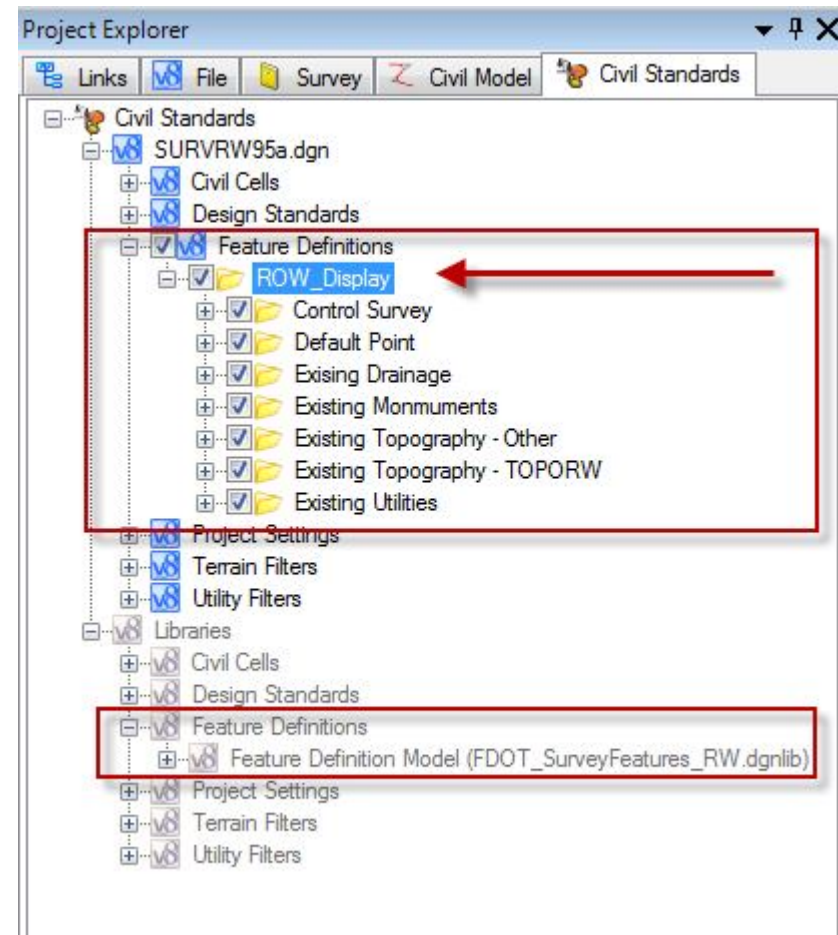
SURVRW.DGN FILE

- Note that the Terrain Model in 2D becomes a cell and is no longer a surface.
- Delete the 2D "Cell: from DTM". It is not needed in building the TOPORW, Control Survey or Right of Way map.
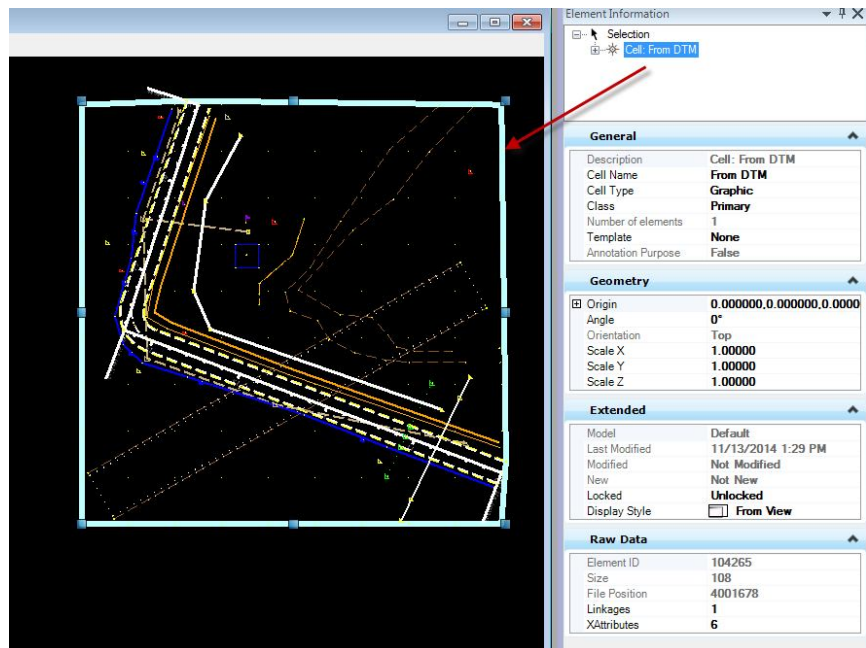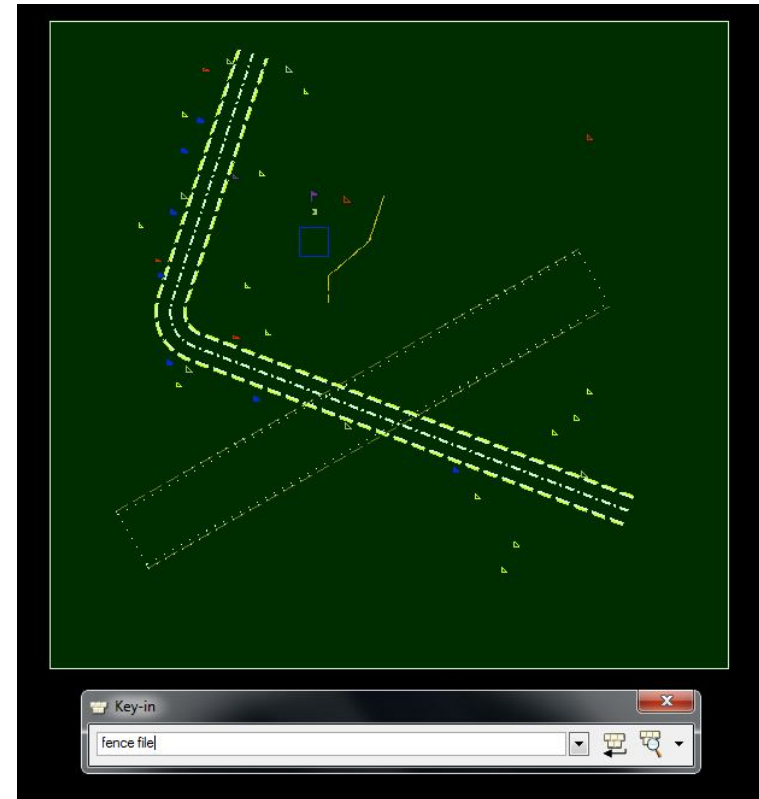
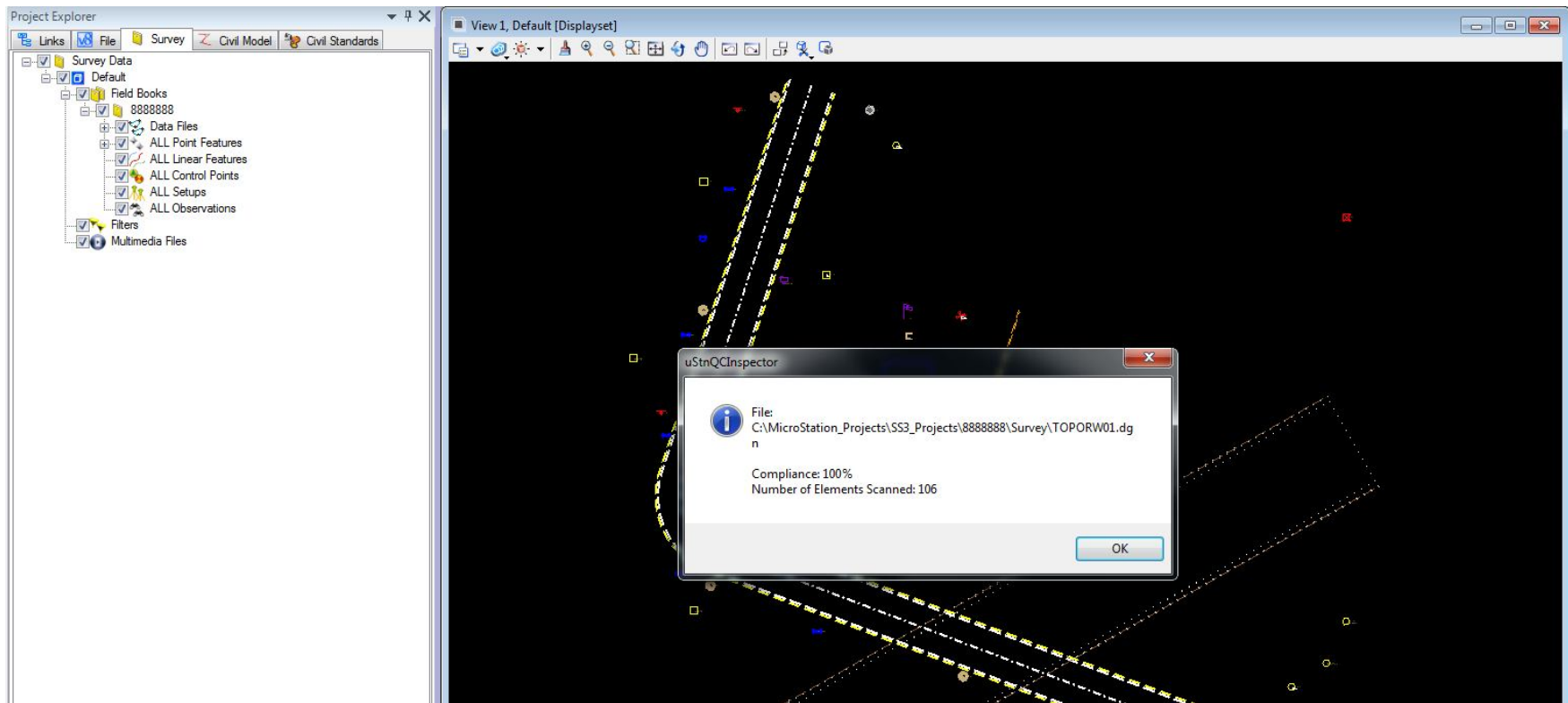# VISUALIZE THE DESIRED TOPORW ELEMENTS

CREATE TOPORW01.DGN

1. Put a fence around all elements in the temporary 2D file.
2. Key-in "Fence File".
3. Type in the file name "TOPORW01" in the file save dialogue box
4. Click in the view to complete the fence file creation. If you don't click in the view, the file will not be created.
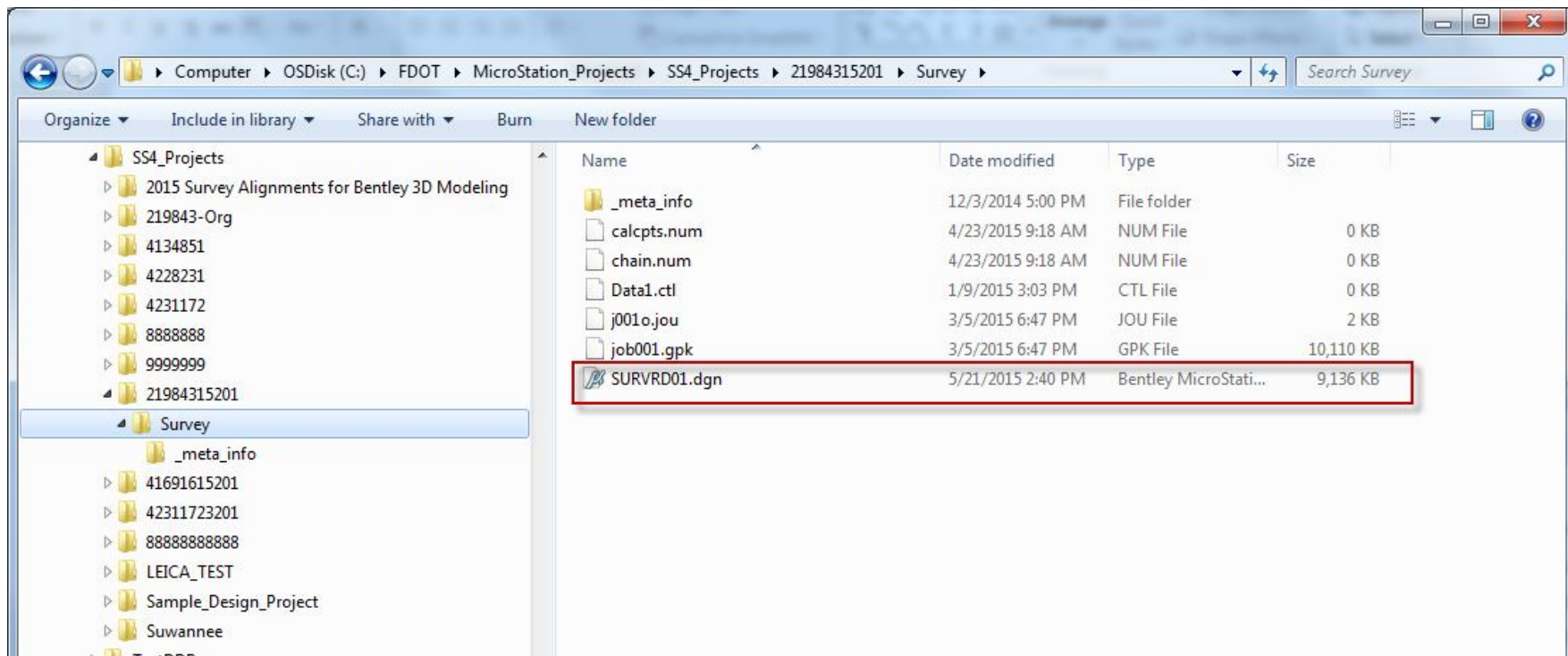
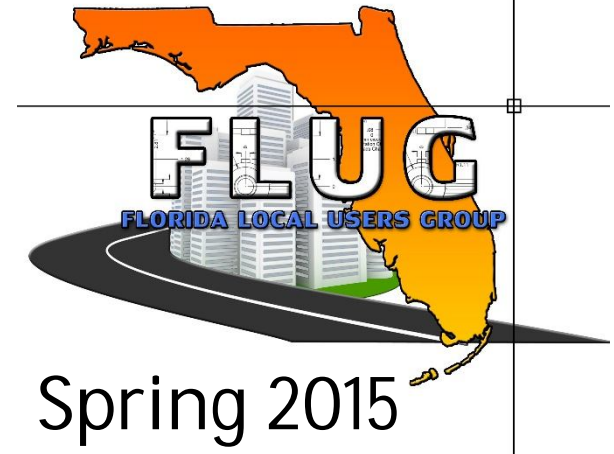# THE TOPORW RULE FILE IS NOW OPEN, ALL ELEMENTS PASS

THE SURVEY DELIVERABLE

FDOT SURVEY WORKFLOW WITH BENTLEY'S OPEN ROADS TECHNOLOGY FOR 3D MODELING PROJECTS

Spring 2015

DIRECT QUESTIONS TO:

john.hazlip@dot.state.fl.us