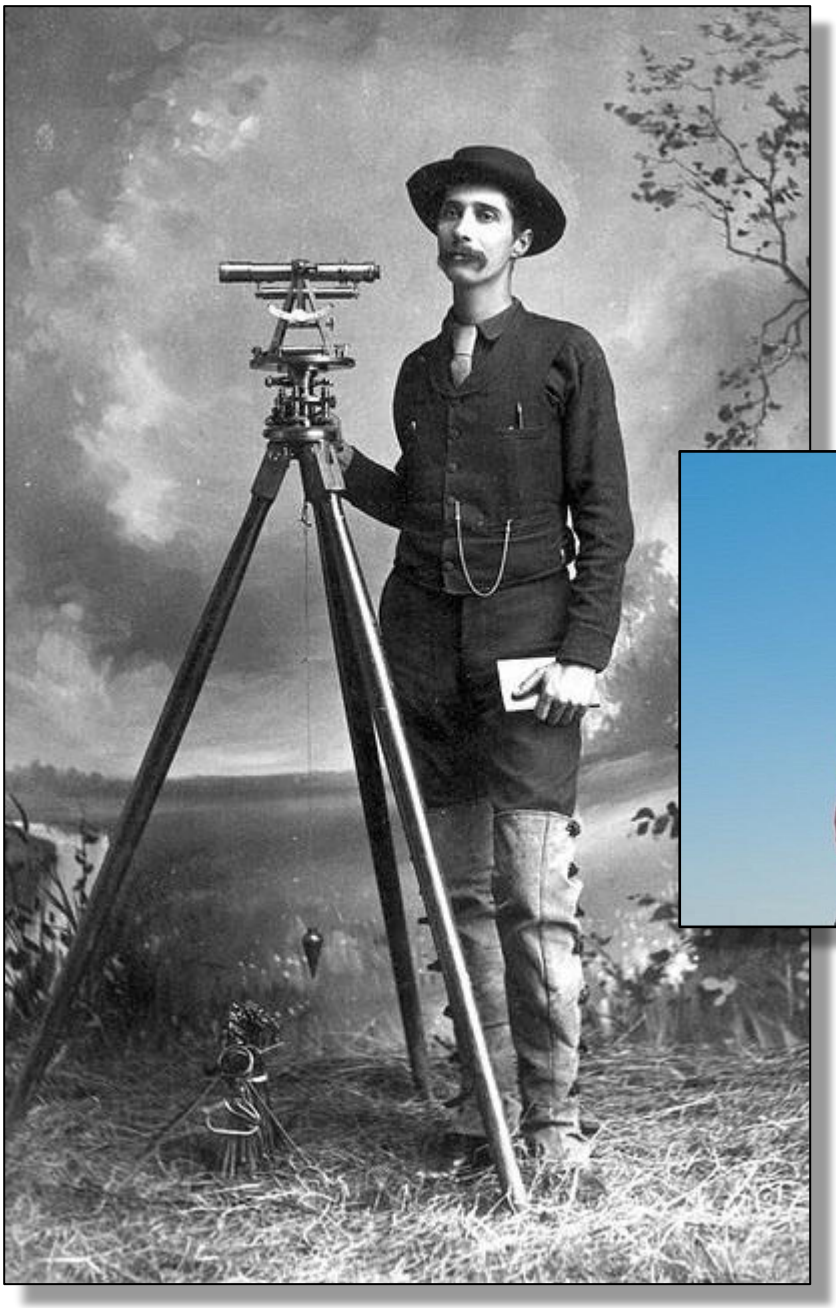
GEOPAK Survey with OpenRoads Technology



Prepared on behalf of
The Ohio Department of Transportation,
Office of CADD and Mapping Services by

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Revised: October 25, 2016

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This training guide was prepared with the following software versions:

Bentley PowerGEOPAK V8i (SELECTseries 4) 08.11.09.845
Windows 7 Enterprise, Service Pack 1

This version of the training guide requires ODOT's CADD Standards for SELECTseries 4 which use the ODOTcadd folder structure to house the CADD Standards.

Prepared for the Ohio Department of Transportation, Office of CADD and Mapping Services by
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1 Introduction

Course Prerequisites

This training course is intended for ODOT Survey personnel directly involved in the acquisition and processing of field collected survey data. This course is intended as an overview of survey data processing and is not a comprehensive reference guide. For additional information regarding specific software functions please refer to Bentley's online help information.

It is recommended that students meet the following prerequisites:

- Familiarity with ODOT's design policies, procedures, and CADD Standards
- Data collection and survey processing experience
- A working knowledge of Windows 7
- A working knowledge of MicroStation V8i

CPD Credit

Participants in the class are eligible for CPD credit*. A certificate for CPD credit is available upon request from the instructor at the completion of this course.

*Please note that final determination on what qualifies for CPD credit ultimately lies between the license holder and the State Board for Professional Engineers and Surveyors.

Course Outline

During this training course we will use Bentley's OpenRoads Survey product to process survey data using a variety of datasets provided by ODOT personnel. The following topics are covered in the class:

- An overview of the Bentley OpenRoads Survey software
- Field Codes and Point Element Names
- ODOT CADD Standards for Survey
- Annotation Scale
- Working with 3D MicroStation Files
- Importing Survey data from various sources
- Geographic Coordinate Systems
- Correcting Code Errors
- Graphic Linear Features
- Bridge Surveys
- Ground Survey and LiDAR Data
- Linear Crossings
- Exporting Data for GEOPAK SS2 Users

The training data for this course uses several different datasets that are separate examples of various Survey processing options and tools. The use of separate datasets also helps illustrate ODOT's use of MicroStation Project Configuration files.

Course Schedule

	Start Time: 8:00 AM **End Time**: 3:00 PM
	Breaks: 15 Minutes per half day
	Lunch: 30 Minutes
	Web Browsing: Please limit web browsing to break times and lunch.
	Email: Please limit email usage to break times and lunch.
	Cell Phones: Please set cell phones to vibrate and take calls only at break times and lunch unless absolutely necessary. Please refrain from texting during the class

CADD Standards and Support

ODOT CADD Standards for MicroStation, GEOPAK, and OpenRoads are maintained and distributed by the ODOT Office of CADD and Mapping Services.

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Pages/default.aspx

The ODOT CADD Engineering Standards manual is available in Adobe Acrobat PDF format on the ODOT Website:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Standards/Pages/Manuals.aspx

OOOT's Design Resource Reference Center is a centralized online reference center to help locate online or printed material. Additionally, several mailing lists are available to keep you informed about updates to ODOT standards. Visit the Design Resource Reference Center at the following URL:

http://www.dot.state.oh.us/drrc/Pages/default.aspx

Support for Bentley OpenRoads Survey is the responsibility of the Office of CADD and Mapping Services. Support questions can be sent to the CADD Support staff using the following form:

http://www.dot.state.oh.us/Divisions/Engineering/CaddMapping/CADD_Services/Support/Pages/ServiceRequest.aspx

This version of the training guide has been updated to use the new ODOT CADD Standards configuration for MicroStation/GEOPAK SS3 using the "ODOTcadd" folder structure. The CADD standards are installed to the following folder for a normal ODOT installation:

I:\ODOTcadd\Standards

2 OpenRoads Survey Overview

What is OpenRoads?

You may have heard of Bentley's "OpenRoads" technology and the Select Series 3 release of MicroStation and Bentley Civil products. But exactly what is OpenRoads?

OpenRoads is described as follows on the Bentley Website:

"OpenRoads technology represents the continued evolution of merging functionality for Bentley's road design, drainage analysis and design, data input and reduction, and bridge modeling products. This shared technology is embedded in InRoads, GEOPAK, MXROAD, and PowerCivil. It expands these products to include information-rich 3D modeling integrated with CAD, mapping, GIS, and business tools like PDFs, i-models, and hypermodels."

"OpenRoads technology provides the common workflow, data structure, and modeling tools that civil engineering organizations need to meet today's information modeling and accelerated project delivery requirements."

But what does this mean for ODOT's GEOPAK Road and GEOPAK Survey users? It means that a new generation of Bentley Civil products is upon us that will eventually supersede Bentley's current civil products InRoads, GEOPAK and MXROAD.

How does OpenRoads Survey differ from GEOPAK Survey?

There are several key differences between OpenRoads Survey and GEOPAK Survey. Some of these differences are summarized below.

- Unlike GEOPAK Survey, *all* OpenRoads data is stored in a MicroStation design file
  - The GPK file is no longer used to store survey points and survey chains
  - The Terrain Model is stored directly in the DGN file
  - OpenRoads Survey no longer generates all the external text files and reports that were automatically generated by GEOPAK Survey
  - OpenRoads Survey information must be exported from the design file to GEOPAK GPK and TIN files if the designer will be using GEOPAK Road for the project. This export is not necessary for designers using the OpenRoads Civil tools.

- 3D MicroStation Design Models are required for OpenRoads survey processing
  - Some tools within OpenRoads Survey require a 3D Model to operate as expected

- The GEOPAK SMD file is not used directly to define the field codes
  - Field codes are stored in a DGN Library that references the SMD file

- Survey mapping is generated using the MicroStation Annotation Scale functionality

- MicroStation is opened using a desktop shortcut to open MicroStation using either the legacy ODOTv8i CADD Standards or the new ODOTcadd Standards. Users must use the MicroStation Manager dialog to open design files in order to ensure that the correct User Configuration file (UCF) and Project Configuration file (PCF) are selected. It is no longer acceptable to open MicroStation files by double-clicking on the file name in Windows Explorer.

- Default project settings for OpenRoads Survey are now stored in DGN Libraries that are included in the ODOTcadd workspace configuration.

- Geographic Coordinate Systems (GCS) can be defined to establish the coordinate system for the data which allows easy translation between grid and ground coordinates

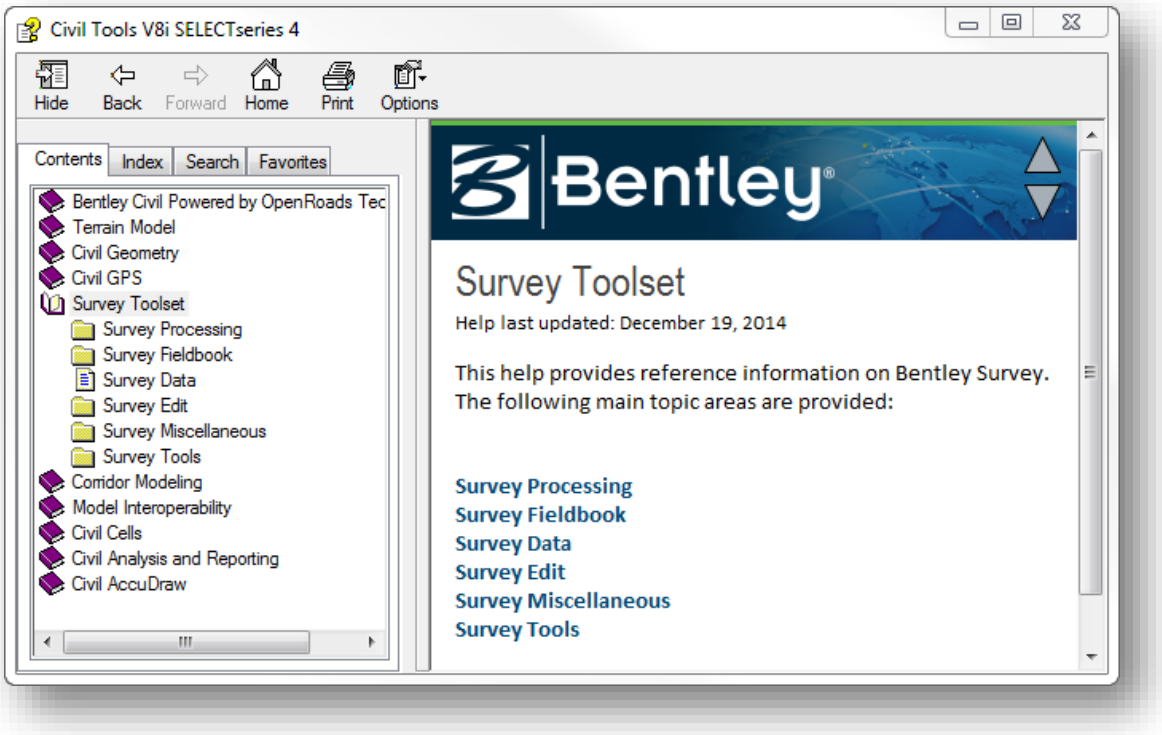
- Changes to the Survey graphics are dynamic and automatically update the Terrain Model.

- The user interface has changed. OpenRoads Survey tools are built into the MicroStation Tasks menu and are no longer accessed through the **Applications > GEOPAK** pull-down menu

- Undo. If you make a mistake while editing survey data, just click the MicroStation Undo command. It's that simple!

OpenRoads Survey Online Help

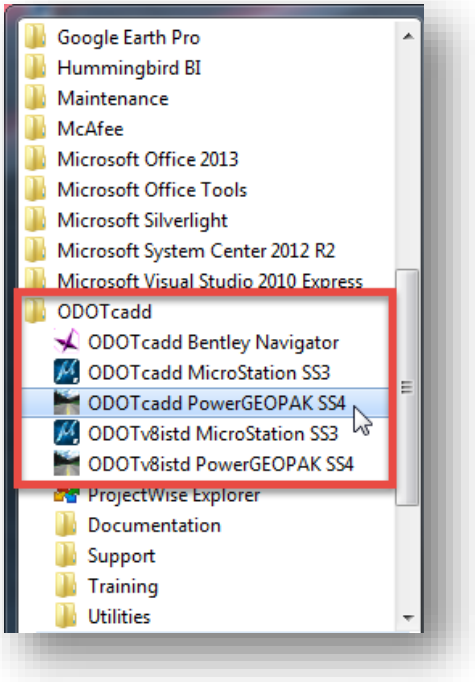
The help file for OpenRoads Survey is accessed From the MicroStation *Tasks* menu by selecting *Tasks > Civil Tools > OpenRoads Help*. To access the OpenRoads Survey help information, the **Survey Toolset** item.



The ODOT Workspace

A Workspace is a custom MicroStation environment or configuration. By selecting a workspace, you are customizing MicroStation and the Civil products for a specific discipline, project, or task. The workspace contains pointers to the CADD standards, DGN libraries, cell libraries, seed files, symbology resources, etc. necessary for the project.

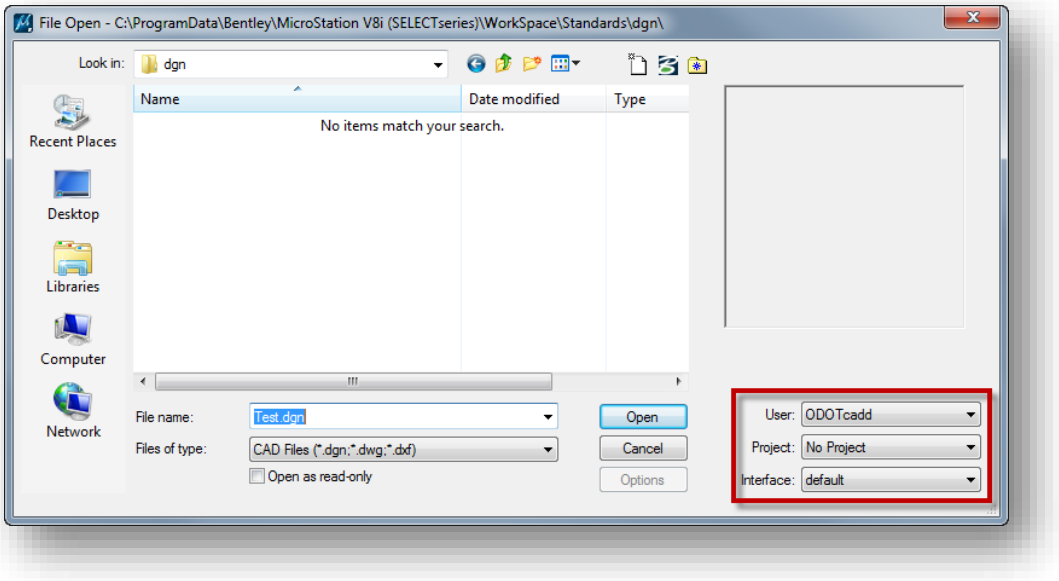
ODOT's Standard configuration provides two workspaces for MicroStation and GEOPAK projects. These workspaces are selected by choosing the appropriate item from the Windows Start Menu as shown below.



The workspaces are configured to access MicroStation/PowerGEOPAK with either the legacy V8istd CADD Standards or the new ODOTcadd Standards.

Care must be taken to select the appropriate item for the project that you intend to open to ensure that the correct CADD standards are accessed.

When the **ODOTcadd PowerGEOPAK SS4** item is selected, the MicroStation *File Open* dialog shown below is opened.



User Configuration

The **User** option is used to select the MicroStation user configuration file (.ucf). When MicroStation is opened the **User** option will default to **ODOTcadd** as shown above.

Project Configuration

With MicroStation and PowerGEOPAK V8i (SELECTseries 4), ODOT will transition to using a MicroStation project configuration (.pcf) file for each project that has been assigned a PID number. The PCF file is used to define project specific MicroStation variables. The **Project** menu will contain a list of the available projects. When a project is selected from the list, the *File Open* dialog will default to the root folder that has been defined for the project.

Important!

Many users are in the habit of opening MicroStation files by double-clicking the file name in Windows Explorer. When a MicroStation file is opened in this fashion, the **User** and **Project** configuration files that were active the last time MicroStation was opened will be used. In order to ensure that the correct configuration files are selected for OpenRoads projects, users should get in the habit of opening MicroStation from the program shortcut in order to select the appropriate **User** and **Project** configuration files before prior to opening MicroStation design files.

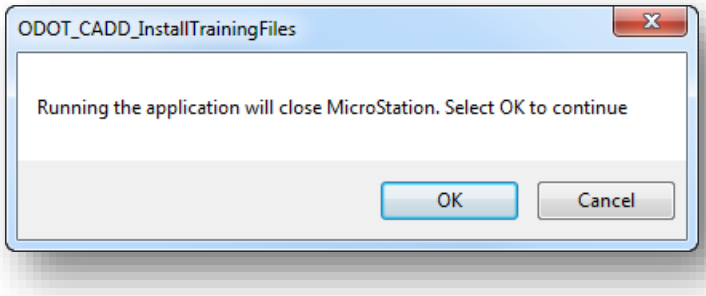
Exercise 1 - Training File Installation

The training files for this class can be installed from the ODOT CADD Standards folder by use of a custom application. To install the training files, run the following program:

I:\ODOTcadd\Standards\ODOT\Training\ODOTcadd_ConfigureTraining.exe

The program can also be accessed from the ODOTcadd program group in the Windows Start Menu by selecting **All Programs > ODOTcadd > Utilities > ODOTcadd_ConfigureTraining**.

The application will prompt you to close MicroStation if it is running. Select **OK** to proceed.



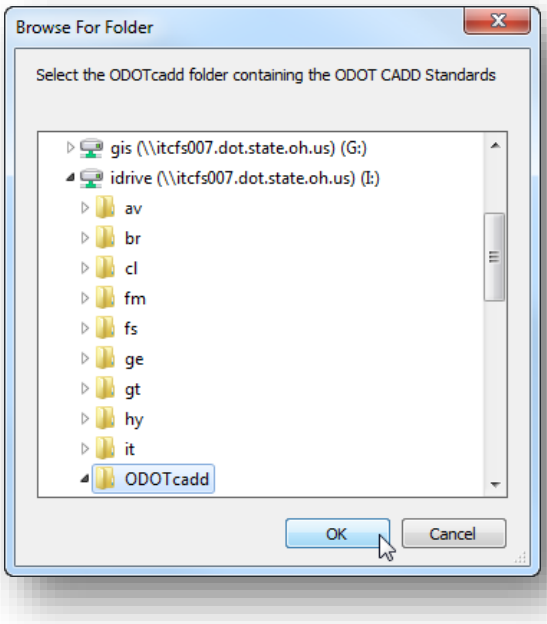
The program must access ODOT's CADD Standards for PowerGEOPAK V8i (SELECTseries 4) in order to install the training files. These standards are housed in the "ODOTcadd" folder. The program will search for the "ODOTcadd" folder in the following location:

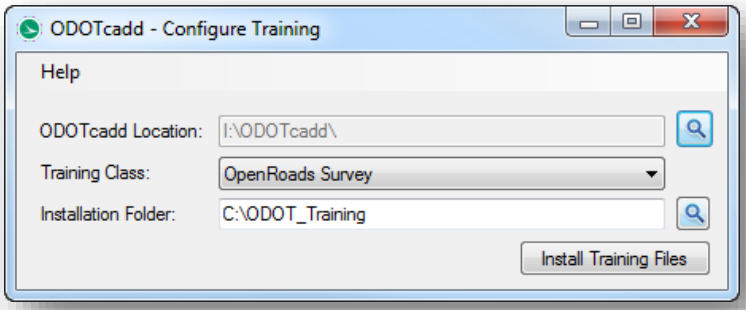
I:\ODOTcadd

If the program cannot find the ODOTcadd folder in the location specified above, the *Browse for Folder* dialog shown at right is opened.

Browse to the ODOTcadd folder and then choose the **Ok** button as shown at right.

After the ODOTcadd folder has been successfully identified, the dialog shown on the following page is opened.





The dialog has the following functions:

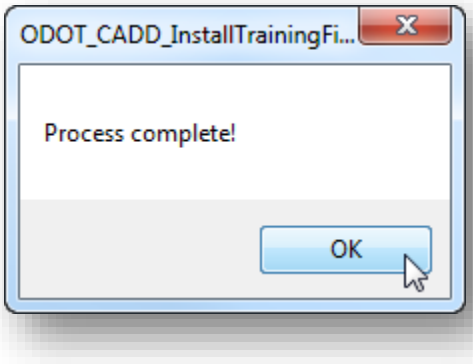
Training Class
Choose the **OpenRoads Survey** option as shown above

Installation Folder
The default location for the training files is set to **C:\ODOT_Training** as shown above. This location can be changed, however if the location is changed is will be necessary to manually edit the **Target** for the MicroStation shortcut that is created when the training files are installed. See *Editing the Training Shortcut* on the following page for more information.

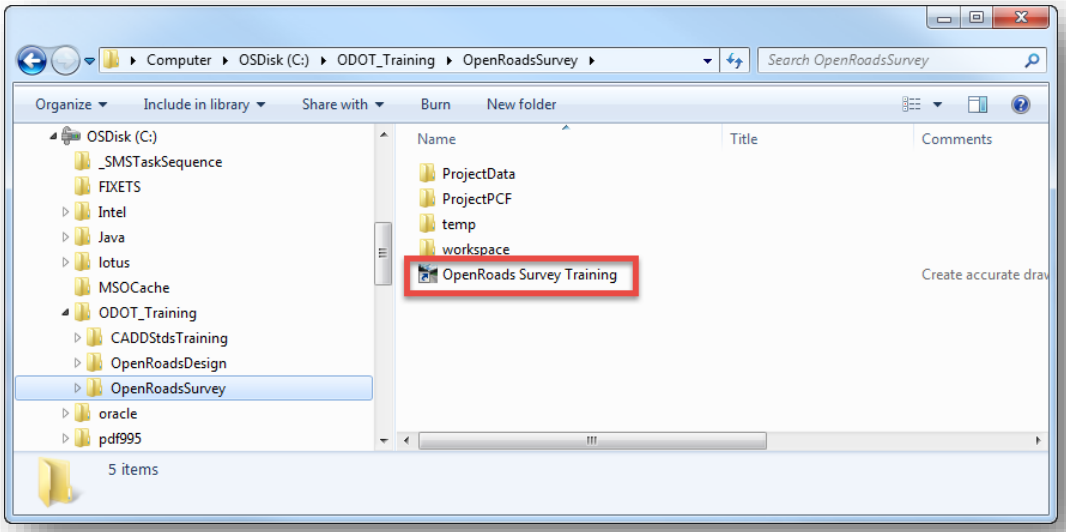
If you change the installation folder, the selected folder will automatically be appended with the "\ODOT_Training" folder name. For example, selecting the path **W:\myFiles** will result in an installation folder of **W:\myFiles\ODOT_Training**.

Install Files
Select the **Install Files** button to begin the installation process.

Upon completion, you will be notified as shown below. If a previous installation of the training files exists on the computer, you will be prompted to remove the old files.



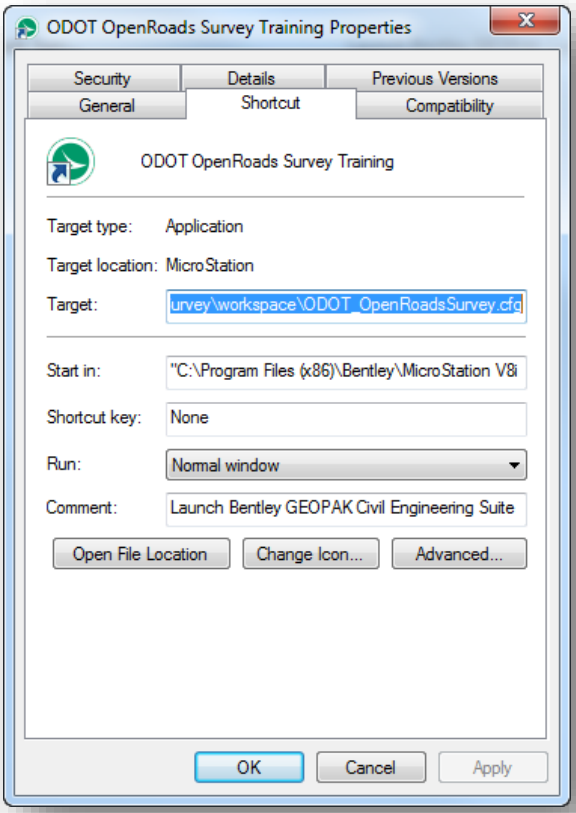
For this training, be sure to open PowerGEOPAK using the shortcut included in the training folder shown below.



Important!
This shortcut should be used for training only. When working on ODOT projects, be sure to open MicroStation using the appropriate shortcut from the Windows Start Menu.

Editing the Training Shortcut

If you elect to install the training files to a location other than the default, the shortcut that is used to open MicroStation for the training must be manually edited to target the correct path for the training configuration. Take the following steps to edit the shortcut:



- ✓ Right-click on the shortcut icon and then select the **Properties** option to open the dialog shown at right.

  The **Target** for the shortcut includes information to launch MicroStation as well as a workspace switch (defined by the **–wc** syntax) to tell MicroStation which configuration file to load when the program is launched.

  The default value for this switch is set as follows in the shortcut:

-wcC:\ODOT_Training\OpenRoadsSurvey\workspace\ODOT_OpenRoadsSurvey.cfg

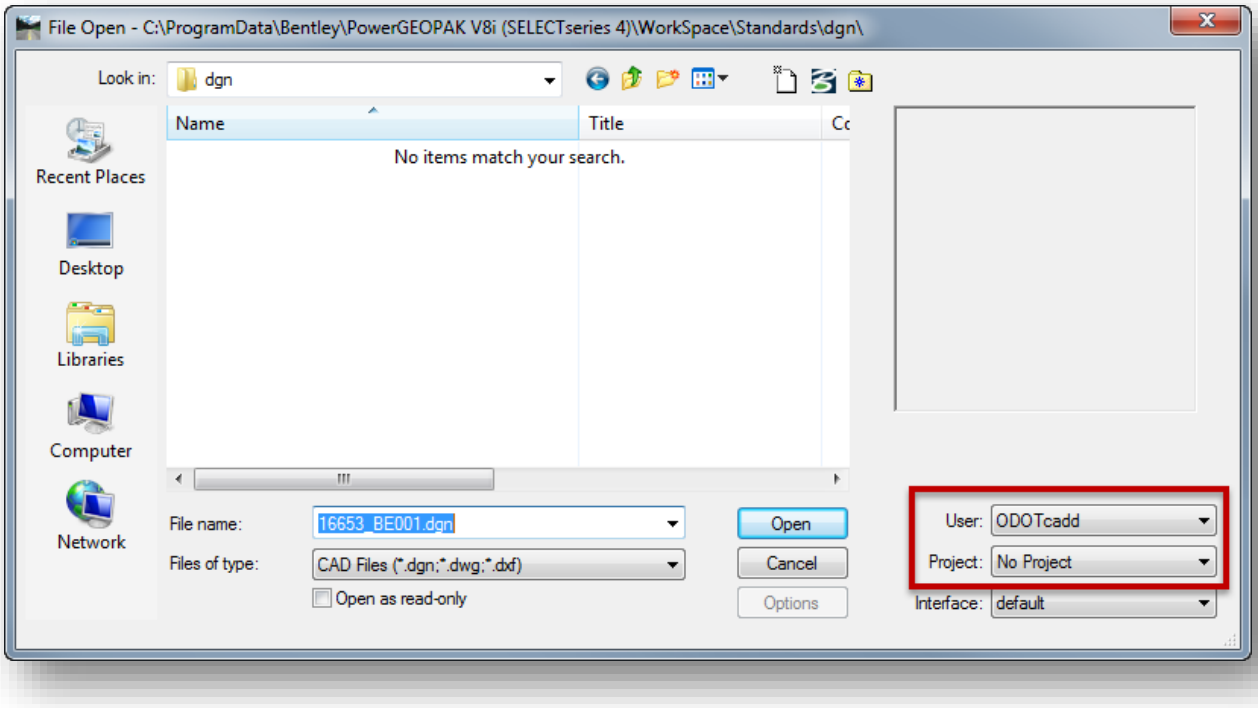
If you have elected to install the training files to a location other than the default, the path for the workspace switch must be manually edited to identify the path where you have installed the training files.

For example, if the installation folder was changed to **W:\myFiles\ODOT_Training**, the –wc switch would be edited as follows:

-wcW:\myFiles\ODOT_Training\OpenRoadsSurvey\workspace\ODOT_OpenRoadsSurvey.cfg

IMPORTANT!
Be careful not to delete or edit anything else in the **Target** field. Also be careful to retain the path to the configuration file from the ODOT_Training folder onwards.

Double-click the training shortcut to launch MicroStation for the training environment. The *File Open* dialog is opened as shown below.



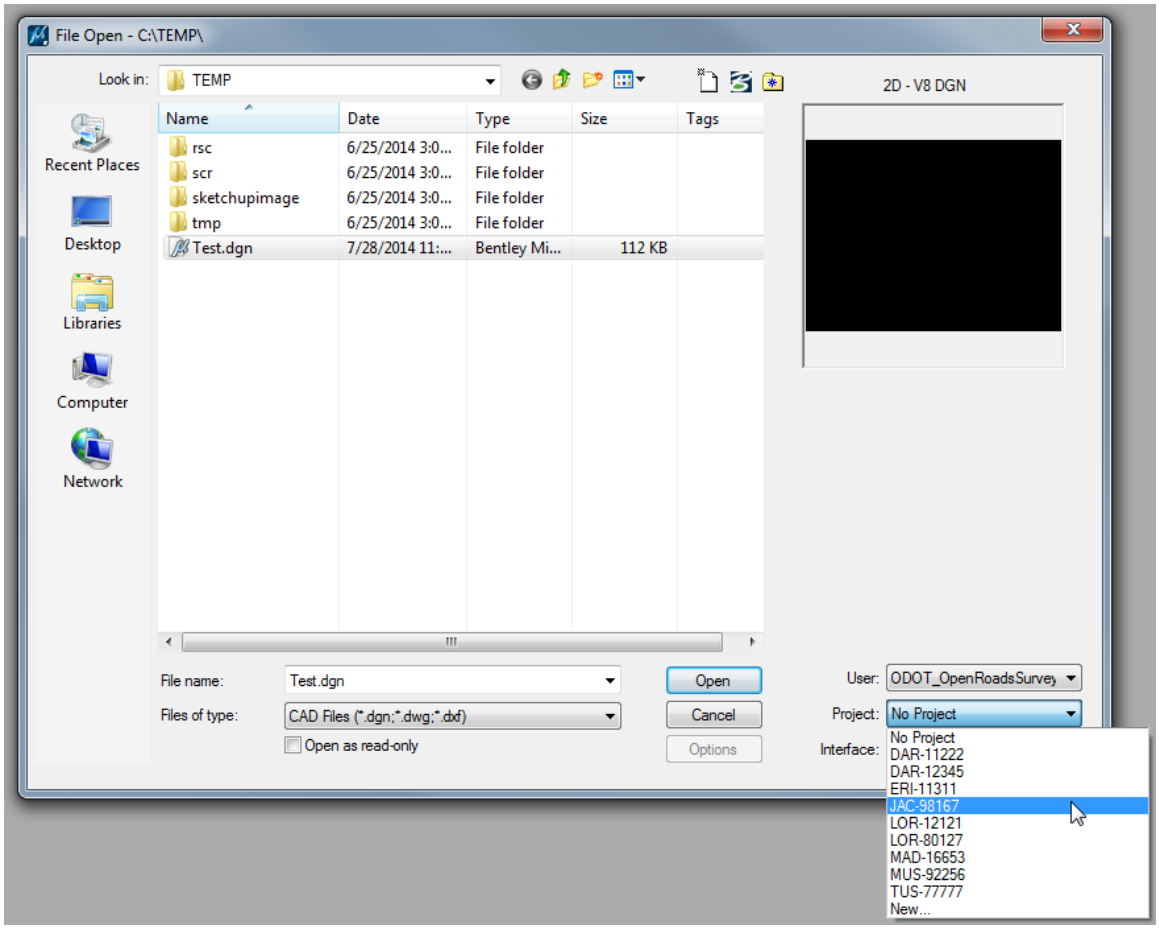
User Configuration
The **User** option is used to select the MicroStation user configuration file (.ucf). When MicroStation is opened using the training shortcut, the **User** option will default to **ODOTcadd** as shown above.

Project Configuration

The training data for this class uses MicroStation project configuration files (.pcf). By default, these files are located in the following folder for the training class:

C:\ODOT_Training\OpenRoadsSurvey\ProjectPCF

The PCF files define project specific MicroStation configuration variables. Each dataset for the training has a unique PCF file that is selected from the *File Open* dialog before accessing the project data, as shown below.



When a **Project** is selected from the list, the *File Open* dialog will automatically change to the parent folder for the selected project.

After installing the training files, take the following steps to open an example Survey project that has already been processed:

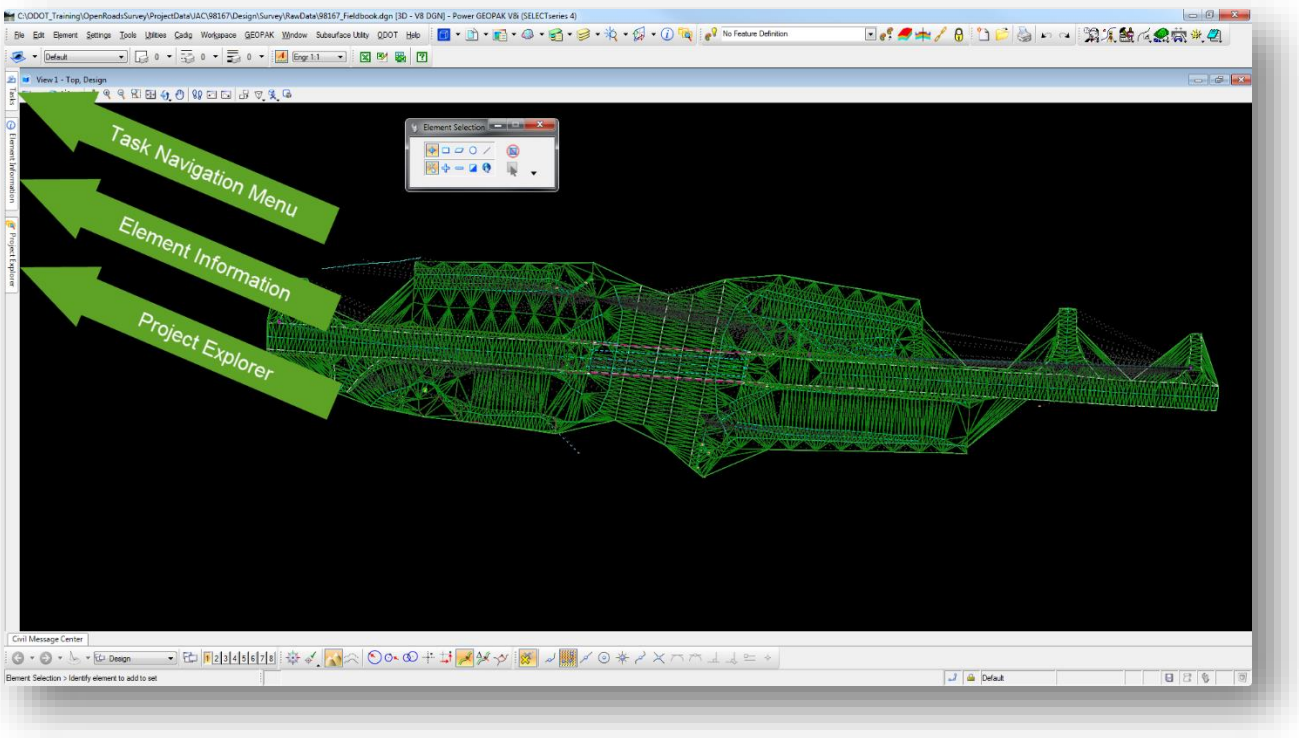
- ✓ Select the **Project** configuration file **JAC-98167** as shown above.

  The *File Open* dialog will automatically change to the PID number folder for the project

✓ Open the following design file:

\Design\Survey\RawData\98167_FB001.dgn

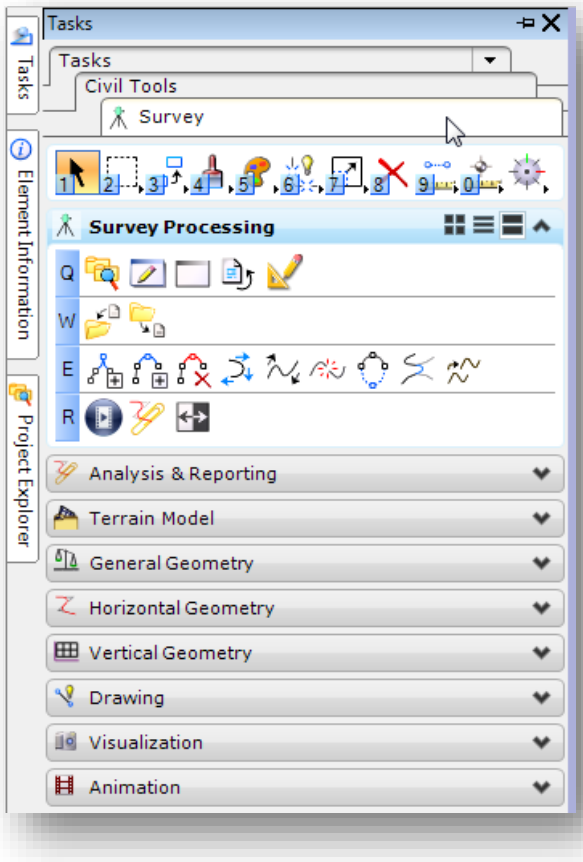
When the file is opened, the interface should appear similar to the example shown below.



The *Task Navigation, Element Information,* and *Project Explorer* dialogs are docked and unpinned to the left of the screen. Each of these dialogs are used for Survey processing and are defined on the following pages.

Task Navigation Menu

By default, the *Task Navigation* menu is docked and unpinned on the left side of the screen as shown in the example on the previous page. When you float the cursor over the **Tasks** tab, the *Tasks* menu will expand as shown below.



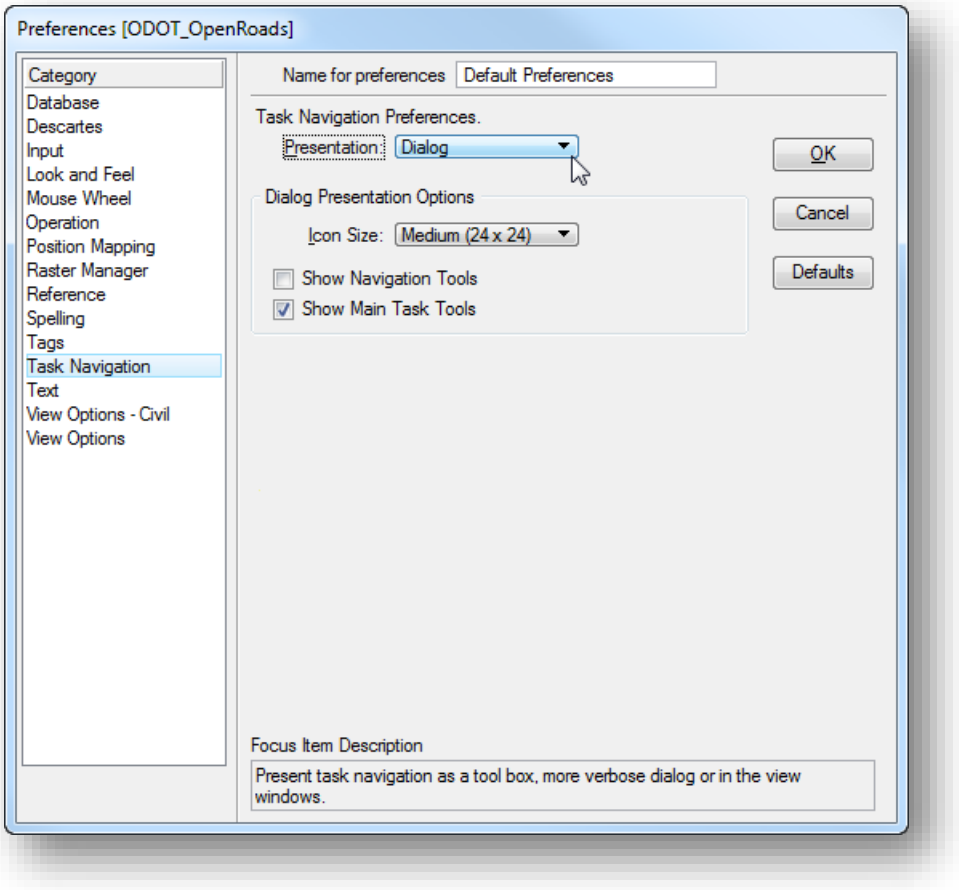
The *Tasks* dialog can be configured as free floating or docked.

Once docked, the dialogs can be "pinned" or "unpinned". An "unpinned" dialog will automatically open when the user floats the cursor over the dialog.

To pin or unpin a docked dialog, select the push-pin icon on the right side of the dialog title bar.

The *Tasks* menu is used to select commands. The **Survey** tools can be accessed by selecting **Civil Tools > Survey** from the *Tasks* menu as shown above.

- If the *Task Navigation* menu is not shown, it can be configured by selecting **Workspace > Preferences** to access the *Preferences* dialog shown below. Set the **Task Navigation > Presentation** option to **Dialog**.


Preferences [ODOT_OpenRoads]
Category
Database
Descartes
Input
Look and Feel
Mouse Wheel
Operation
Position Mapping
Raster Manager
Reference
Spelling
Tags
Task Navigation
Text
View Options - Civil
View Options
Name for preferences
Default Preferences
Task Navigation Preferences.
Presentation:
Dialog
Dialog Presentation Options
Icon Size:
Medium (24 x 24)
Show Navigation Tools
Show Main Task Tools
OK
Cancel
Defaults
Focus Item Description
Present task navigation as a tool box, more verbose dialog or in the view windows.

Project Explorer Dialog

The *Project Explorer* dialog is used extensively with OpenRoads. By default this dialog is docked and unpinned on the left side of the screen as shown on page 12.

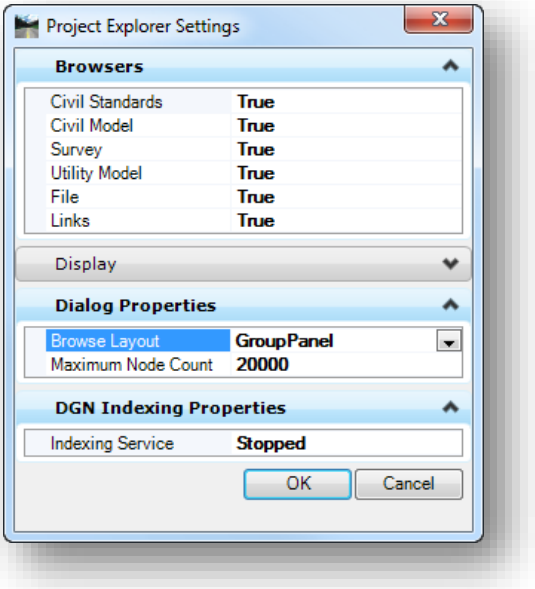
- If the *Project Explorer* dialog is not shown, the dialog can be opened by selecting **File > Project Explorer** from the MicroStation pull-down menu.

The *Project Explorer* dialog contains several tabs which can be toggled on or off in the project explorer settings. To review the settings, select **Settings > Project Explorer** from the MicroStation pull-down menu to open *the Project Explorer Settings* dialog shown at right below.

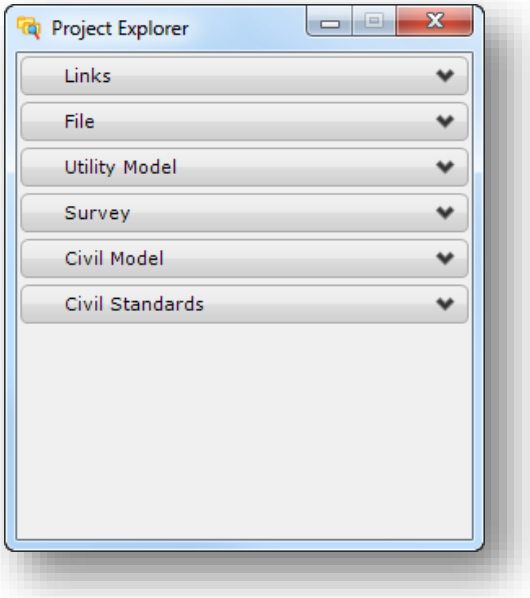
Recommended settings:

Browsers
Set all of the available options to **True**.

Dialog Properties
The **Browse Layout** option is set to **Group Panel** by default.



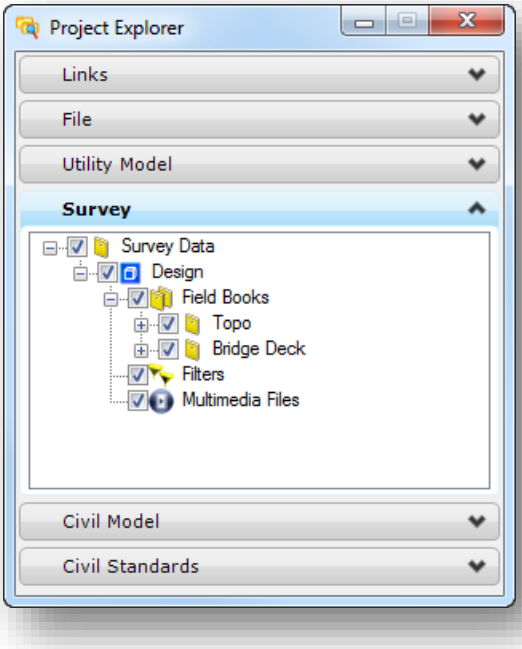
Once configured, the *Project Explorer* dialog should appear similar to the example shown at right.



The Project Explorer Survey Group

The **Survey** group in Project Explorer is used to view information about any survey content contained in the active Model.

Expand the **Survey** group by clicking on the Survey heading. The group opens to reveal a tree of information as shown below.

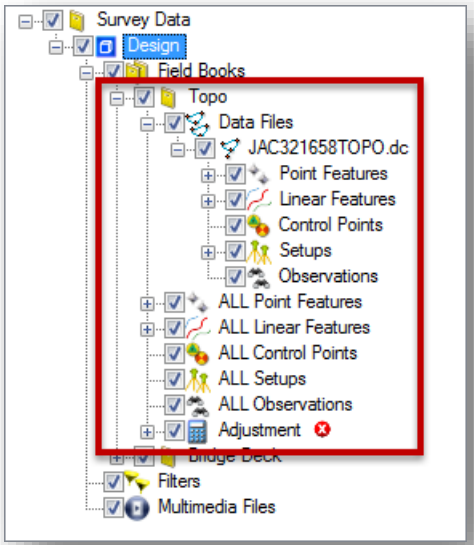


The active MicroStation Model is listed at the top of the tree; "**Design**" in the example at left.

Beneath that is a list of any **Field Books** in the file. A **Field Book** can contain one or more survey **Data Sets**. Each data set in the field book is used to generate mapping and a terrain model for that field book. This example contains two separate field books; one for the topo survey, and one for the bridge deck survey.

In this example, each field book contains one data files that has already been imported. Expanding the **Topo** item reveals any **Data Files**, and information about each data file that has been imported into the **Topo** field book.

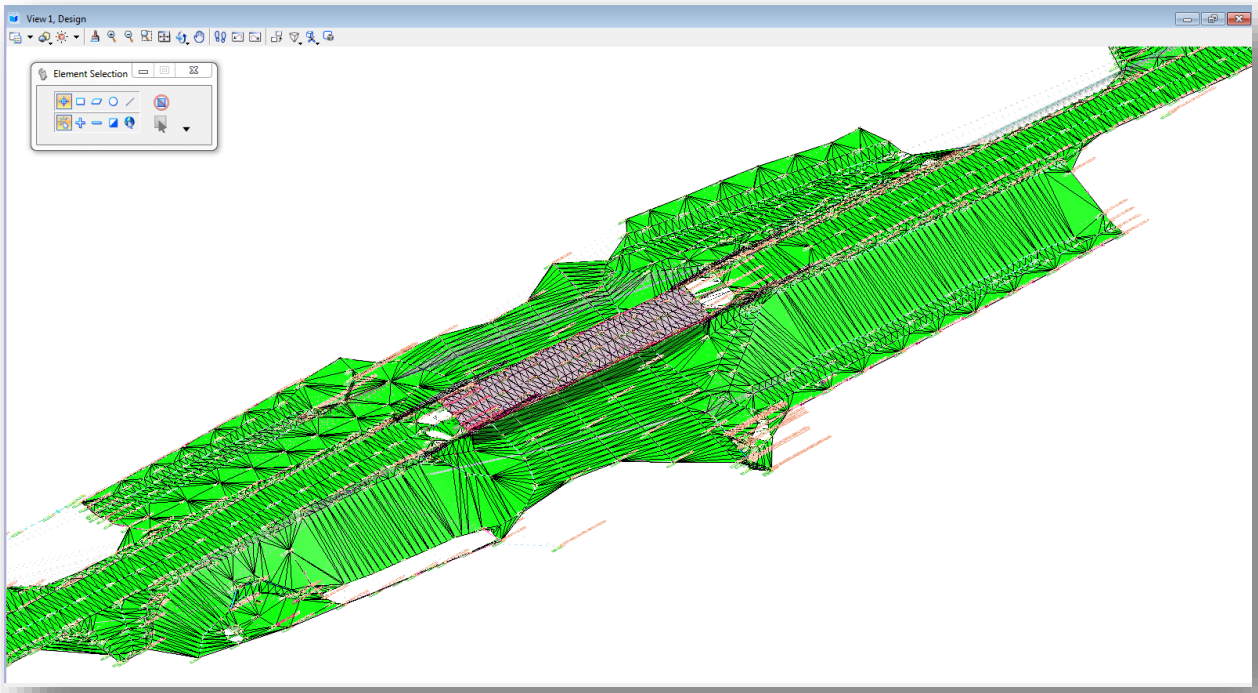
The **Topo** field book has one **Data File** named JAC321685TOPO.dc as shown at right.



Expanding the **Point Features** or **Linear Features** items will reveal a list of the point and linear field codes that are used in the data set.

The display of each item can be turned on/off by use of the check box to the left of the item.

In this example each data set was imported in a separate field book so that a separate terrain model could be made for each data set. The bridge deck data is not included in the topo terrain model, and vice versa. A rotated view of the data is shown on the following page. The terrain model for the bridge deck is shown in gray.

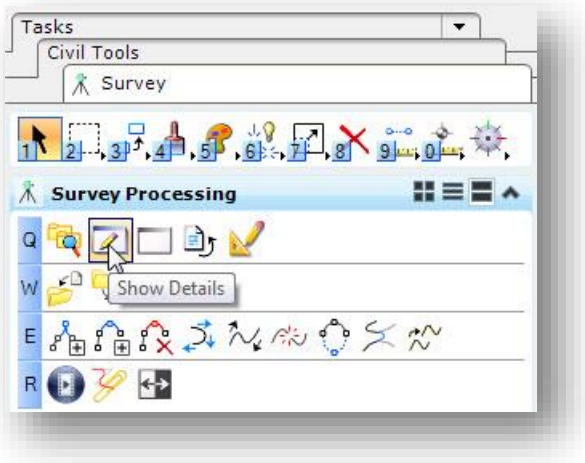


More information about creating field books and data sets can be found on page 23.

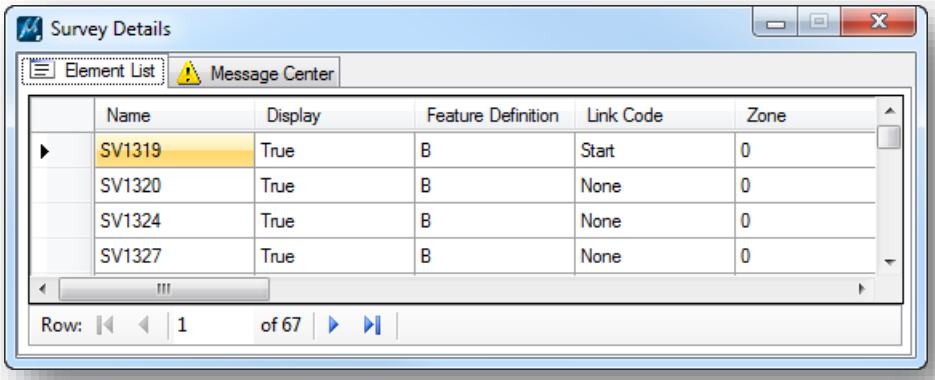
Survey Details Dialog

In addition to the *Task Navigation* menu and the *Project Explorer* dialog, the *Survey Details* dialog is frequently used to display details for the currently selected survey point, line, or terrain model.

- The *Survey Details* dialog is not shown by default in the ODOTcadd workspace. The dialog can be opened by selecting the **Show Details** icon in the **Survey Processing** task group as shown below.



The *Survey Details* dialog consists of two tabs as shown below. The **Element List** displays the currently selected survey information and can also be used for editing the data. The **Message Center** displays any warnings or error messages.



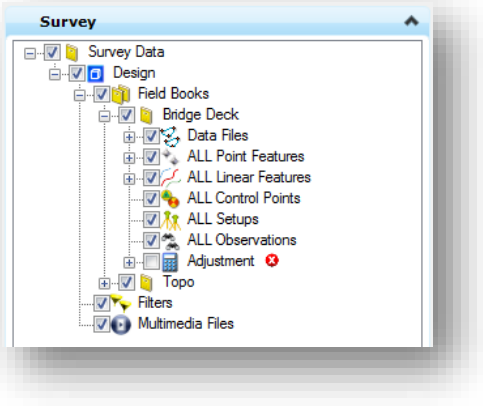
Using the Project Explorer and Survey Details Dialogs

The *Project Explorer* and *Survey Details* dialogs are used extensively with OpenRoads Survey.

Project Explorer is used for several tasks, including the following:

- Importing survey data into one or multiple Field Books
- Reviewing the contents of a survey dataset
- Reviewing and editing the Project Settings
- Exporting data to other formats (GPK, TIN, LandXML, etc.)
- Selecting the information that is displayed in the *Survey Details* dialog

When the **Survey** tab is selected, the *Project Explorer* dialog is used to display the information for the survey project similar to the example at right.



When populated with data, the data tree contains one or more branches. Each branch is accompanied by a checkbox that enables/disables the visualization of the branch and sub-branches.

Field Books – Expands to show all of the survey data loaded into the project. The example at right contains two field books: “Bridge Deck” and “Topo”

Data Files – Expands to show all of the survey data files currently loaded into the project. Each data file expands to show additional branches for **Point Features**, **Linear Features**, **Control Points**, **Setups**, and **Observations**.

Point Features – Lists points loaded from a survey data file. The **Point Features** branch expands to show a list of individual feature names. Selecting one of the feature names will display all the points that use the selected feature definition in the *Survey Details* dialog.

Linear Features – Lists linear features loaded from a survey data file. The **Linear Features** branch expands to show a list of individual feature names. Selecting one of the feature names will display all the linear features that use the selected feature definition in the *Survey Details* dialog.

Control Points – Lists the control points that exist in the selected data file. The list of control points is displayed in the *Survey Details* dialog.

Setups – Shows all setups contained in the data file.

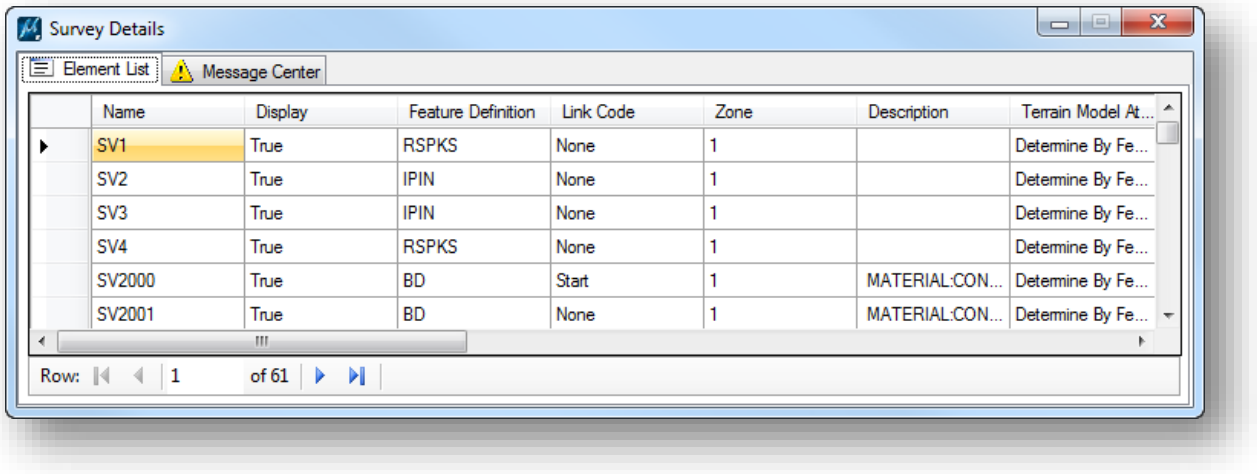
Observations - Shows all observations contained in the data file.

Adjustment – When activated, a Least Squares Adjustment is applied to the entire field book. To activate the adjustment, right-click on “**Adjustment**” and select **Turn On**. The circular symbol to the right of the Adjustment branch will become green when the adjustment option has been enabled. The check box toggles the graphical display of the error ellipses resulting from the adjustment. When active, the

least squares adjustment properties are shown in the Detail Panel. ***Caution: Once enabled, the adjusted data cannot be "unadjusted".***

Filters - The **Filters** branch allows you to create customized data filters for quick viewing of data sub-sets.

Features for the entire field book can be reviewed in the *Survey Details* dialog by selecting one of the **ALL Point Features**, **ALL Linear Features**, **ALL Control Points**, or **ALL Observations** items. Once an item is selected, the details for the item are displayed in the *Survey Details* dialog as shown below.

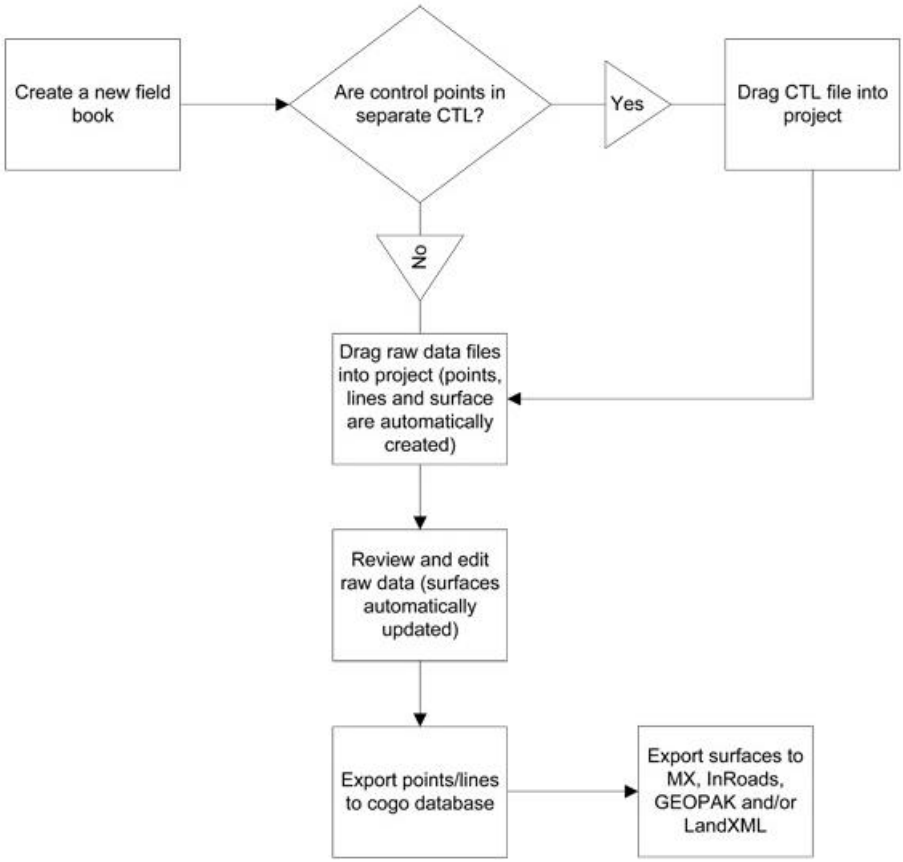


In the example above, the **ALL Point Features** item was selected for the **Bridge Deck** field book.

- The **Element List** tab displays all the features for the selected field book.
- The **Message Center** displays any warnings of error messages for the selected Field Book.

Survey Processing Workflow

All survey data processed using the Bentley Survey tools is stored directly in the active MicroStation design file. No external databases are used to store the survey data or the existing ground terrain model. One sample workflow is depicted below (specific workflows may vary):



Create a new Field Book

Field Books are used to store one or more datasets. For a most ODOT projects, all of the datasets will be imported into a single field book. There are cases where you may want to consider using multiple field books.

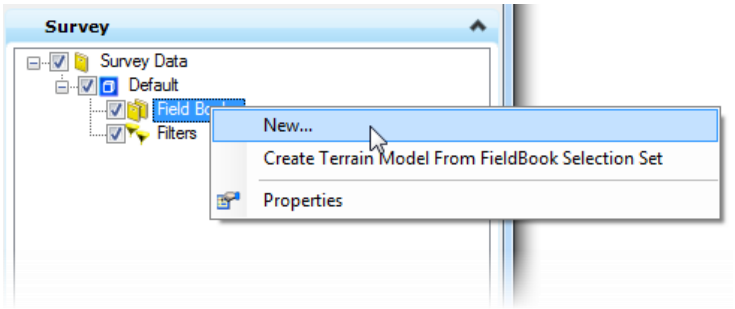
Single Field Book

- A field book can contain multiple data sets
- If duplicate point names are encountered while importing multiple data sets into a field book, the software will allow you to modify the point names during the import process
- You can create linear features that span multiple datasets
- All of the datasets within the field book are used to generate the terrain model

Multiple Field Books

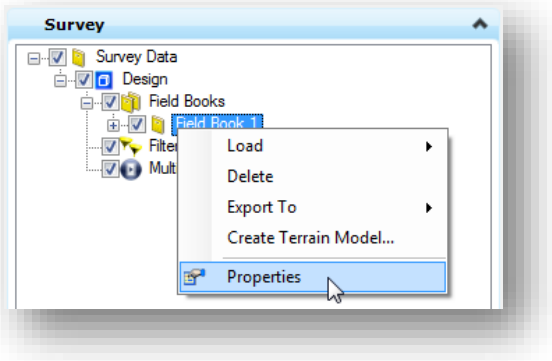
- Use multiple field books if your project has two or more sections that are geographically disconnected from each other.
- Each field book has unique point names so the same point name can exist in each field book.
- Linear Features can only contain points between datasets in the same field book. It is not possible to create linear features that cross from one field book to another.
- Separate Terrain models can be generated for each field book. These terrain models are used wi the OpenRoads tools or can be exported for use with GEOPAK, InRoads, or MXROADS.

To create a new field book, right-click on the **Field Books** branch of the data tree in the **Survey** tab of the *Project Explorer* dialog and then click the **New**… option on the menu.

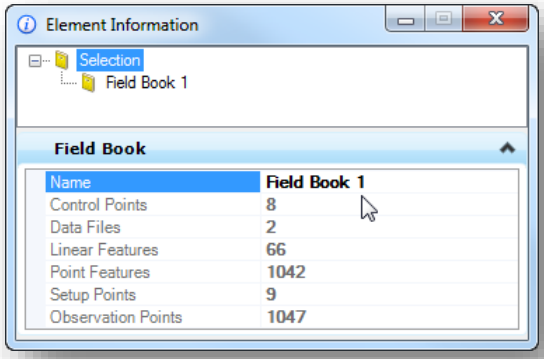


A new field book named "**Field Book 1**" is created.

To change the name of a field book, right-click the field book in the data tree and select the **Properties** option to open the *Element Information* dialog shown below.

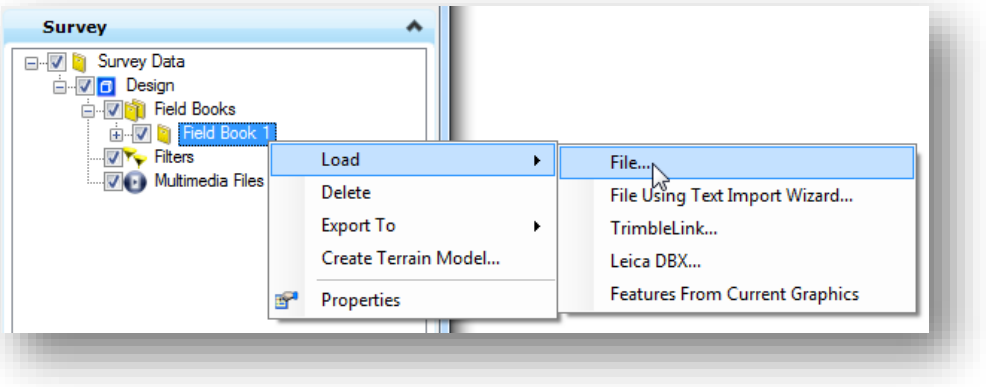


The name can be edited in the *Element Information* dialog.

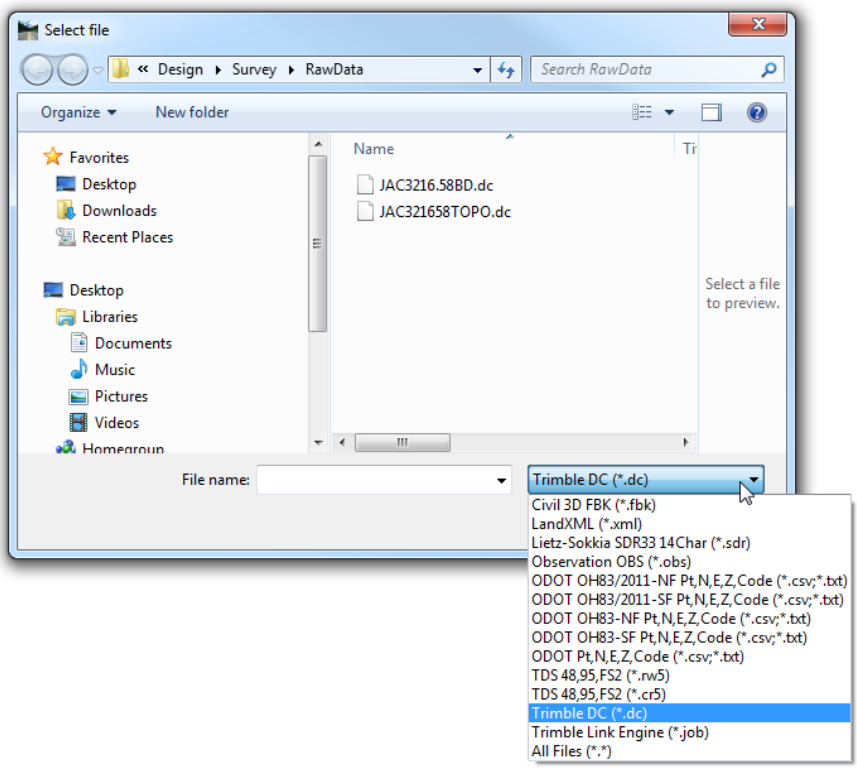


Add Survey Data

If you wish to add survey data, simply drag the appropriate file from Windows Explorer and drop it onto the data tree. Or choose one of the **Load** options shown below.



Several file types are supported by OpenRoads Survey as shown below.



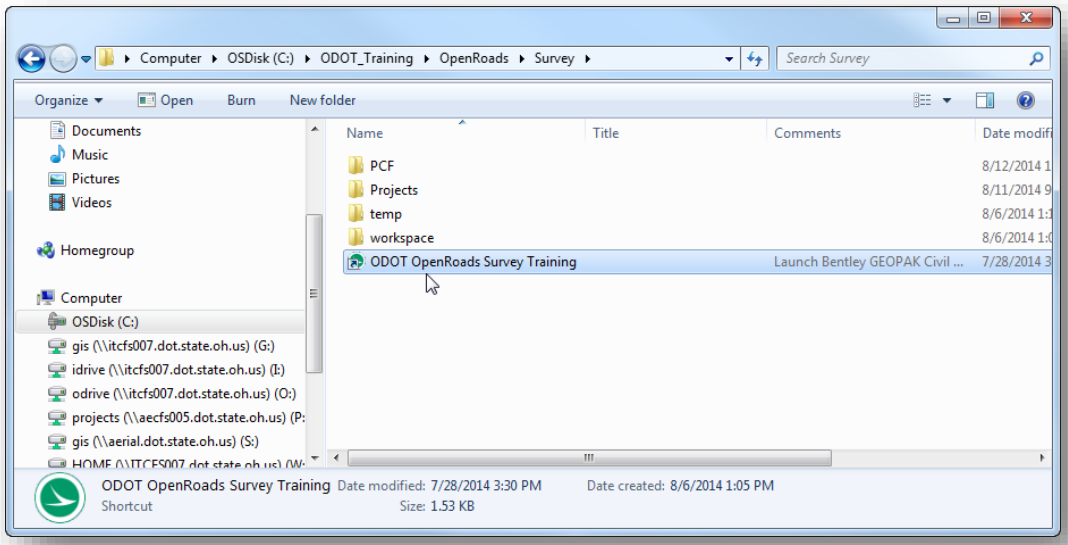
After selecting the file to load, the software performs the following actions:

- Processes the data to produce point features and linear features
- If the **Adjustment** option has been enabled, then the Least Squares Adjustment is applied
- Point and Linear Features are symbolized according to the ODOT Feature Definitions
- Point and Linear Features, Setup, and Observation data are stored in the active design file
- A terrain model named “All Field Books” is produced using the points and lines from the data
- The terrain model is stored in the active design file

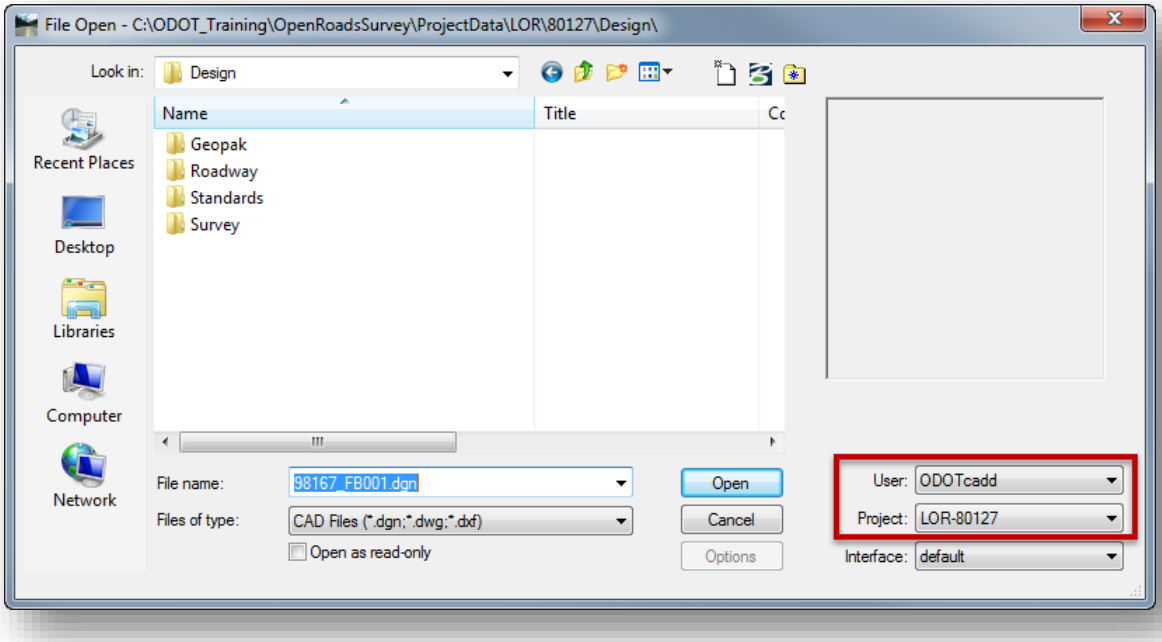
Exercise 2 – Survey Processing Example

In this exercise we will process a sample data set in order to get familiar with the OpenRoads Survey workflow.

- ✓ Start MicroStation by using the shortcut for the training class. By default, the shortcut is located in the **c:\ODOT_Training** folder as shown below when the training files are installed. If you have installed the training files to a different location, browse to that location to access the shortcut.



- ✓ The MicroStation *File Open* dialog is opened. The **User** will default to **ODOTcadd** as shown below. Change the **Project** to **LOR-80127**.



✓ Open the following design file:

…\80127\Design\Survey\RawData\80127_FB001.dgn

✓ In the *Project Explorer* dialog, select the **Survey** tab. By default, the *Project Explorer* dialog is docked on the left side of the screen. If the *Project Explorer* dialog is not displayed, open *Project Explorer* by selecting **File > Project Explorer** from the MicroStation pull-down menu.

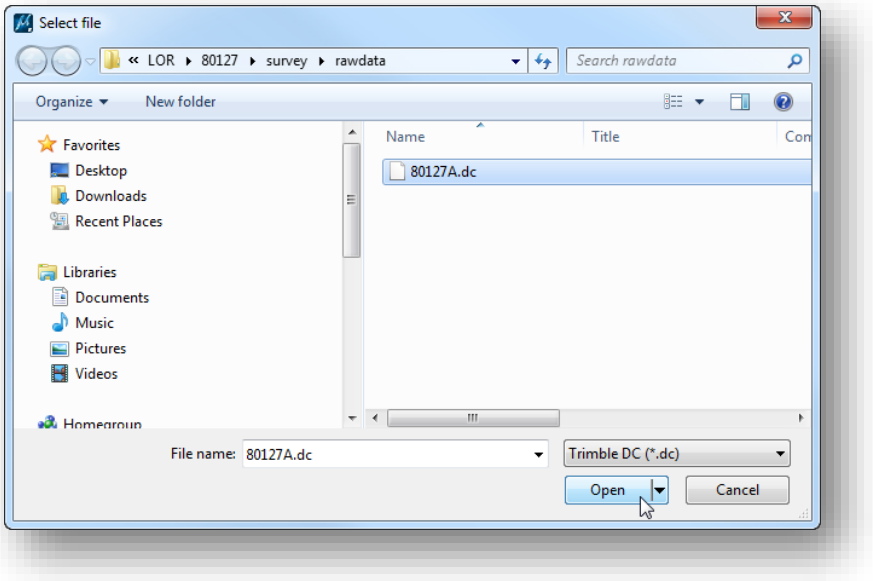
✓ Select the **Survey** group in the *Project Explorer* dialog.

✓ Right-click on the **Field Books** item and select **New…** to create a new field book. A field book named **Field Book 1** is created.

✓ Right-Click on **Field Book 1** and choose the **Load > File** option.

✓ Change the file filter (located in the lower right of the *Select File* dialog) to **Trimble DC (*.dc)** as shown on the following page. Load the following data file

…\80127\Design\Survey\rawdata\80127A.dc



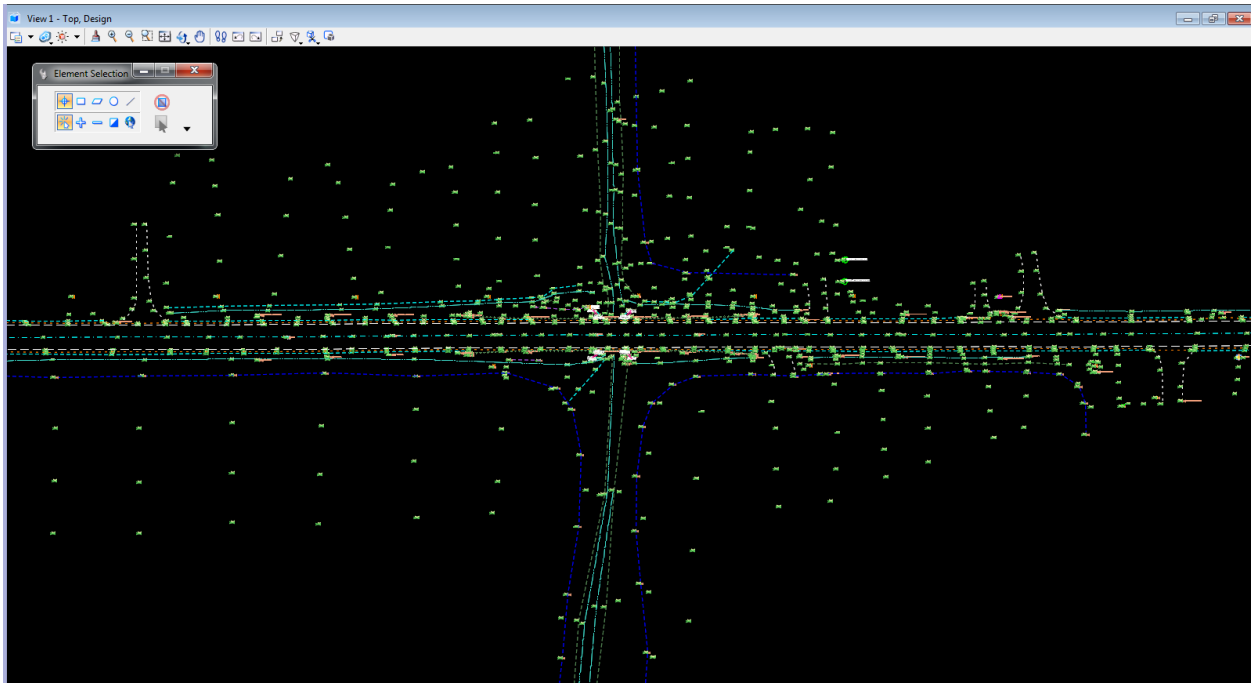
✓ Select **Open** to initiate processing the selected file.

As the survey data is processed, the mapping is drawn and the terrain model is automatically generated.

✓ After the process is complete, select the **Fit View** command to view the survey information.

A portion of the survey data is shown on the following page.

Take a look at the data. Zoom in and out. Turn on or off levels as desired. Change the Annotation Scale to different values, etc…



✓ After you have finished reviewing the data, select **File > Close** from the MicroStation pull-down menu to close the design file and return to the MicroStation Manager.

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3 ODOT CADD Standards for Survey

ODOT Standard Directory Structure

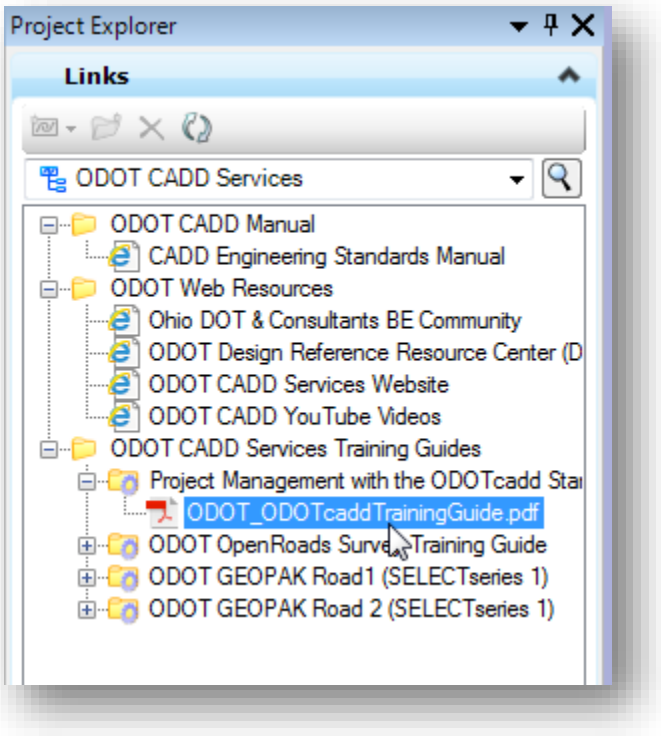
The **ODOT CADD Engineering Standards Manual (ODOTcadd), Section 302** defines the standard project directory structure to be used on all ODOT projects. The examples used in this training guide follow the standard folder structure.

All new projects are to be created using an ODOT program to create the standard folder structure and a MicroStation Project Configuration File (PCF) for the project. ODOT users can access the program can be accessed from the Windows Start Menu by selecting **All Programs > ODOTcadd > Utilities > ODOTcadd_CreateNewProjects.exe**.

Users external to ODOT can find the program in the following location:

\ODOTcadd\Standards\ODOT\ProjectTools\ODOTcadd_CreateNewProject.exe

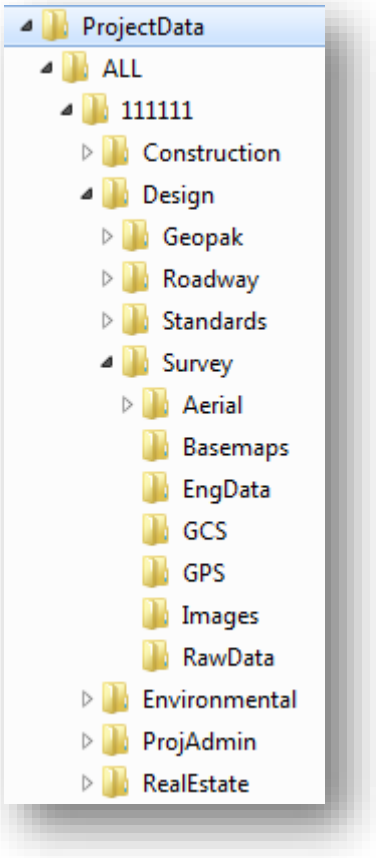
For more information on project creation, see ODOT's **Project Management with the ODOTcadd Standards** training guide which can be accessed from the **Project Explorer** dialog by double-clicking on the link as shown below.



- ***Using the standard folder structure is not optional***!

The parent folder for ODOT projects is named using the PID number for the project and may be appended with a supplemental description according to the requirements of the **ODOT CADD Engineering Standards Manual (ODOTcadd), Section 302**.

Beneath the PID number folder, the **\Design\Survey** folder is used to house the field survey information. An example project folder with the contents of the Survey folder is shown below.



The **Aerial** folder is used to house aerial mapping for the project.

The **Basemaps** folder is used to house the survey basemap design file (nnnnnn_BE###.dgn) that will be accessed by the designers.

The **EngData** folder is used to store spreadsheets, Word documents, or other surveying and engineering data for the project.

The **GCS** folder is used to store the MicroStation .dty file for custom Geographic Coordinate System (GCS) definitions. See Chapter 5 for more information.

The **RawData** folder is used to store datasets for the project as well as the survey processing design file (nnnnnn_FB###.dgn).

Additional folders may be added to the Survey folder as needed on a project-by-project basis to facilitate specific project needs.

In addition to the **Survey** folder, survey personnel will use the **Geopak** folder to store the GEOPAK Coordinate Geometry database (.gpk file) for the project.

The **Standards** folder is also used by survey personnel to house project specific CADD standards. When a new project is initially created using the ODOT program to create the project, the ODOT seed files are copied into the **\Design\Standards\Seed** folder. These seed files will be customized by the surveyor when a project specific Geographic Coordinate System (GCS) us used for grid-to-ground translations. See Chapter 5 for more information.

ODOT Standard Design File Names

The **ODOT CADD Engineering Standards Manual (ODOTcadd). Section 304 File Naming Conventions**, defines the standard MicroStation design file names to be used on ODOT projects.

- ***Using the standard design file names is not optional***.

Two separate Survey design files are designated:

- The Survey "Field Book" design file is used to process and edit survey information. This file will retain all of the survey intelligence and the survey processing "rules".
- When processing is complete, the survey information is exported to a Basemap design file that is used by design personnel. This file contains simple graphics and the terrain model. The survey processing "rules" are removed from the file.

Each of these files is described in more detail below.

Survey Field Book Design Files

When a new project is created using the **ODOTcadd_CreateNewProject.exe** program, a survey Field Book design file is created in the following folder:

..\Design\Survey\RawData\nnnnnn_FB001.dgn

The file is named using the PID number for the project, appended with "_FB001.dgn".

This file is generated as part of the project creation process to be used by the surveyor to process the survey mapping and terrain model for the project. This file is not intended to be accessed by any other personnel.

Survey Basemap Design Files

After the survey processing and any necessary edits are complete, use the **Export DGN Graphics** command to save the survey information and terrain model(s) a Survey Basemap in the following folder:

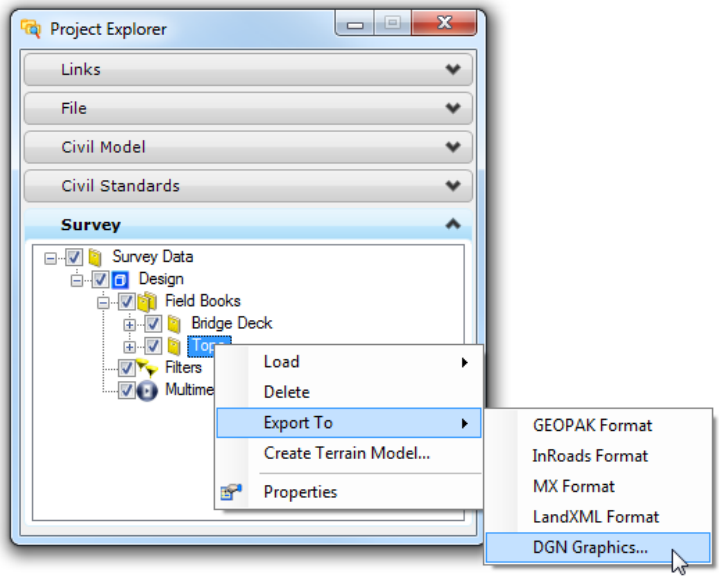
..\Design\Survey\Basemaps\nnnnnn_BE001.dgn

The exported DGN file contains only the mapping and the terrain model(s). The Survey "rules", the intelligence that links the survey points and linear elements to the terrain model(s), are removed from the exported file. If someone inadvertently moves any of the graphics, the terrain model(s) is not affected.

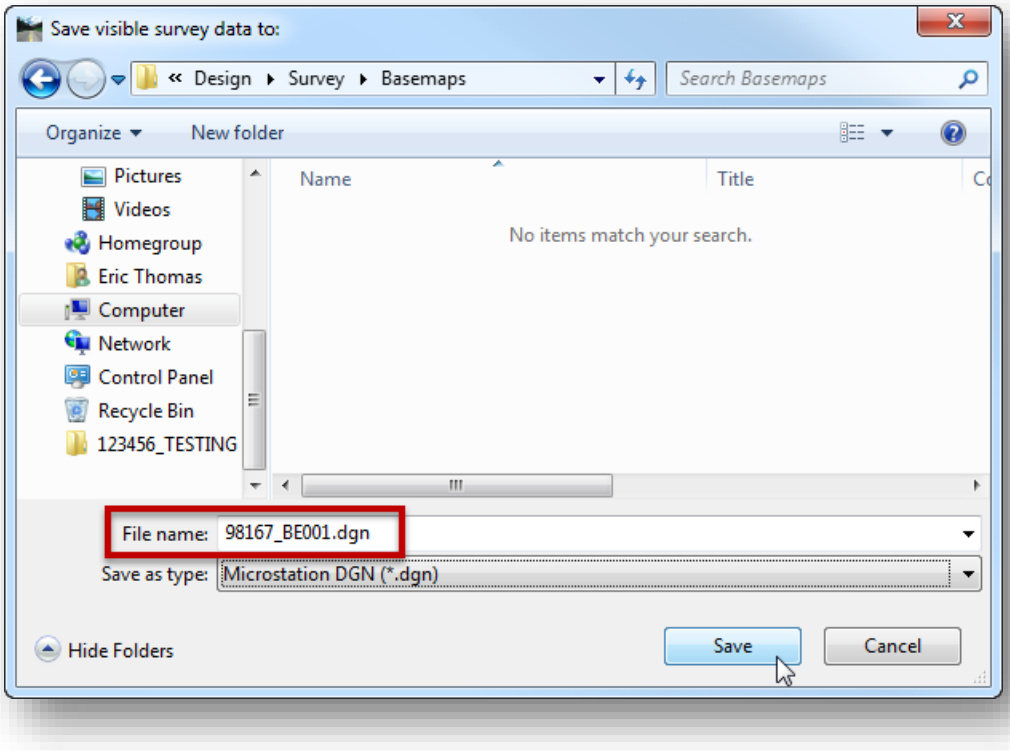
This allows the surveyor to maintain the original field book file with the survey processing rules intact and provide a separate design file for use by other personnel on the project.

Export DGN Graphics to a Survey Basemap

To export the survey mapping and terrain model(s) to a separate survey basemap, right-click on a field book name and select **Export To > DGN Graphics** as shown below.



Enter the name for the new design file and select the **Save** option as shown below. Be sure to name the file according to the ODOT CADD Standards.

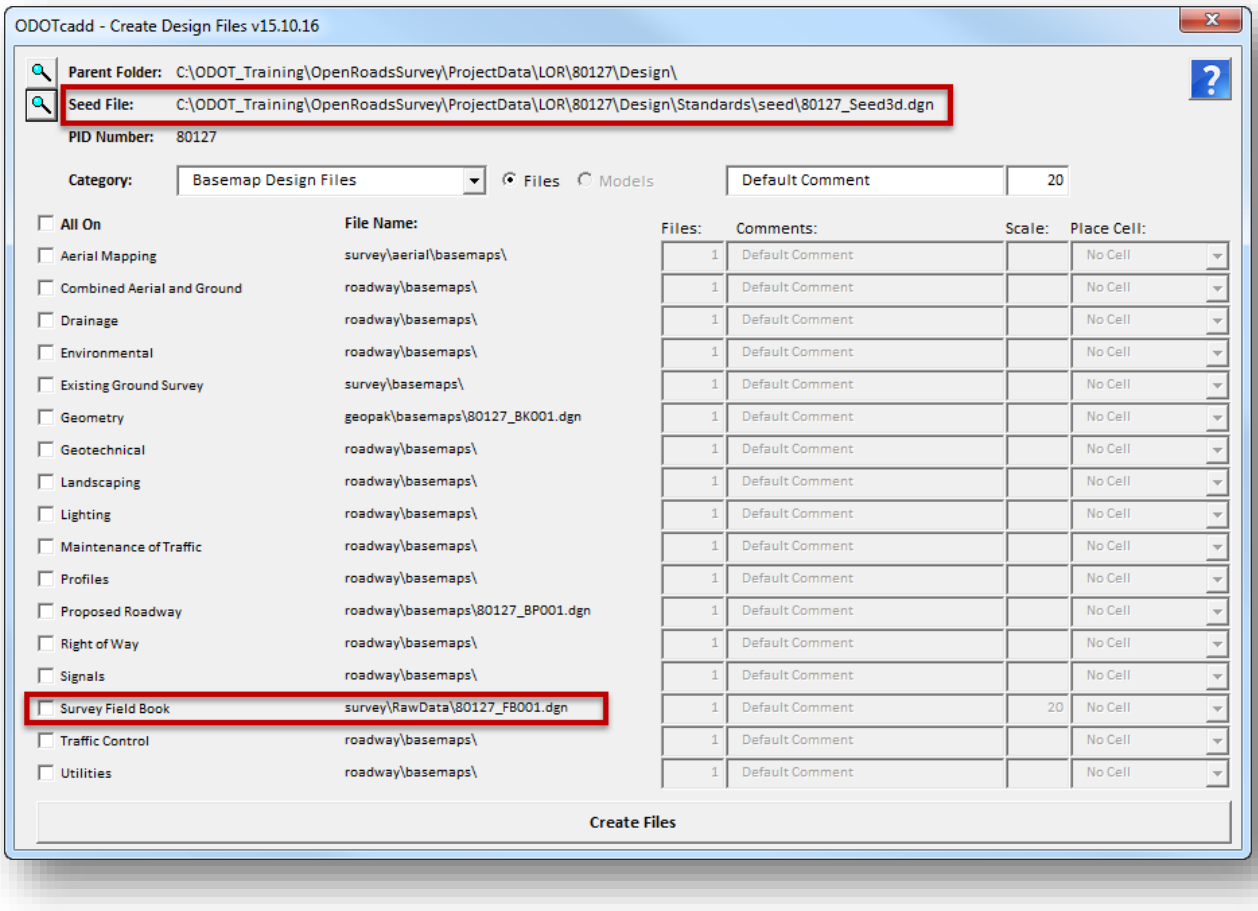


Note: The BE file must be updated if changes are made to the survey data.

Creating Additional Design Files

If additional design files are required by the surveyor, ODOT provides a Visual Basic application to assist with the creation of MicroStation design files using the ODOT file naming convention. The program can be accessed from the MicroStation pull-down menu by selecting **ODOT > File Management > New Design File**.

When the program is initiated, the dialog shown below is opened.



- The program will default to the 2D Seed file for the project. Be sure to change the seed file to the 3D seed file for the project when creating additional Survey Field Book design files.
- The Survey Field Book design file is available in the list as shown above.

Note: This program requires that an ODOT Standard directory structure is in place before creating design files. Use **ODOTcadd_CreateNewProject.exe** to create the MicroStation .pcf file and the directory structure before using this program.

Additional information about the program can be accessed by selecting the help icon in the upper right corner of the dialog.

Feature Definitions

Feature definitions are used to control symbology, annotation, and various other properties that are applied to the geometric elements as the survey information is processed.

A feature definition is assigned to each survey point as the data is collected in the field. The ODOT Standard field code list is available in Adobe PDF format in the ODOT CADD standards as listed below:

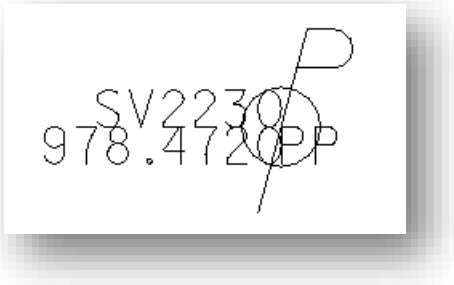
I:\ODOTcadd\Standards\Geopak\Survey\Field_Codes

The feature definitions are used by the software for the following:

- Define what the surveyed information actually represents such as curb, centerline, edge of pavement, a mailbox, etc.
- Control symbology in various views, including capability to define differing symbology in plan, profile, and 3D spaces
- Define terrain modeling attributes (spot, break line, void, etc.) for each surveyed point or linear feature
- Define the display characteristics of terrain models

Point Features

When survey data is processed, each field shot is stored as a **Point Feature** in the current **Field Book** within the active model of the active design file. For example, the field code “PP” is used to designate a power pole. When the survey data is processed, the power pole code is plotted in MicroStation using an ODOT standard cell element as shown below:



Notice that text elements for the point name (SV2230), elevation (978.4720), and field code name (PP) are plotted along with the power pole symbol. Each of these text elements are placed on their own level and can be toggled on/off as desired.

Point Names

Each survey point in the Field Book must have a unique point name. Point names are assigned in the field by the surveyor as the data is collected. There are no specific point name restrictions for the OpenRoads Survey product other than ensuring that each point name is unique.

If the survey information will be exported to a GEOPAK Coordinate Geometry database (.gpk file) it is important to remember to follow the point naming restrictions inherent to the GPK format. To review, the following restrictions apply to GEOPAK COGO point names:

- Point names can be numeric (eight characters max) or alphanumeric (15 characters max)
- Alphanumeric point names must have an alpha prefix followed by a numeric suffix. For example, RD22 is acceptable while R2D2 is not. The numeric portion must be greater than zero.
- Special characters, such as % * < etc. are not supported.

Section 306.2 of the **ODOT CADD Engineering Standards Manual** details standard GEOPAK COGO Element names for field collected data.

- Survey shots are to be given the two character prefix “SV” followed by a numeric value. For example: SV1000, SV1001, SV1002, etc…
- Monumentation shots can be given the two character prefix “MN” followed by a numeric value.

Care should be taken to avoid the use of duplicate point names when collecting data in the field. The OpenRoads Survey product provides options for editing duplicate point names if duplicates are encountered during the import process. See Chapter 8 for more information on duplicate point names.

Linear Features

A series of points representing curvilinear features can be connected together as a **Linear Feature**.

Linking Codes, which are special characters that are entered ***after*** feature in the field as the data is collected, are used to define the linear features. The following liking codes are configured for ODOT use:

BL* - Begin Line
EL* - End Line
OC* - Point on Curve (begin/end non-tangent curve)
CL* - Close

Important Note!
This is a change from previous versions of the ODOTcadd Standards.

Previously, the linking code was included after the feature code. In the October 16, 2015 release of the ODOTcadd Standards, the default value for the linking code location has been changed to specify that the linking code is included after the feature name. This change has been made to facilitate drawing the linework on the data collector and in Trimble software.

All field data collected after the October 16, 2016 update shall be collected with the linking code listed after the field code.

When processing old datasets with the OpenRoads Survey tools, it is necessary to reconfigure the Survey Settings for an individual Field Book design file to specify the location of the linking code before the feature code. Instructions on how to make this change are presented later in this chapter.

The mapping codes can also be entered as numeric values. The numeric values are defined in the ODOTcadd Workspace as shown below:

1 = BL*
2 = EL*
3 = OC*
4 = CL*

To collect a series of 3 points representing a fence line; each point would be coded as follows in the field:

FEN BL*
FEN
FEN EL*

If you elect to use the substitution linking codes, the fence line would be coded as follows:

FEN 1
FEN
FEN 2

Linear Features are named according to the feature code name used to collect the shots that define the chain. In the above example, a Linear Feature named “FEN” will be created in the field book. If a second fence line is collected, the software will increment the name by 1. For example, a second fence line would be named “FEN_1”. Subsequent fence lines would be incremented by 1.

Field Attributes

Many of the ODOT field codes allow for the use of attributes to store additional information with a specific survey shot. For example, the feature code “PP”, used to specify a Power Pole, has the following attributes:

Material
Owner
Pole#

The attributes are plotted in the file similar to the example shown below.

See the ODOT Code list for a summary of feature codes and the associated attributes.

Dual Coded Points

Combining two unique feature codes and line descriptions within a single point description is supported. For example a single field shot could be coded as follows to begin two separate linear features:

EP BL* DR BL*

The above example specifies the beginning of an edge of pavement line (EP BL*) and also the beginning of a driveway line (DR BL*).

Since each survey point can only have one field code, two separate points must be stored for dual coded survey shots. Point SV2112 is stored at the location of the shot with the field code EP. An additional point is stored at the same location with the field code DR. The additional point is named with the same point name that was present in the data and appended with “_1”. In the example above two points will be stored in the Field Book named “SV2112” and “SV2112_1”. This allows the double coded shots to represent two features with different feature codes.

Seed Files

A seed file is an empty MicroStation design file that has been configured specifically to meet a particular need. When new design files are created, the seed file is copied and renamed to create the new file.

ODOT provides several seed files for use with OpenRoads. When a new project is created using the ODOT program, the appropriate seed files are copied into the project's \Design\Standards\Seed folder.

The ODOT seed files are located in the following folder:

i:\ODOTcadd\Standards\seed\

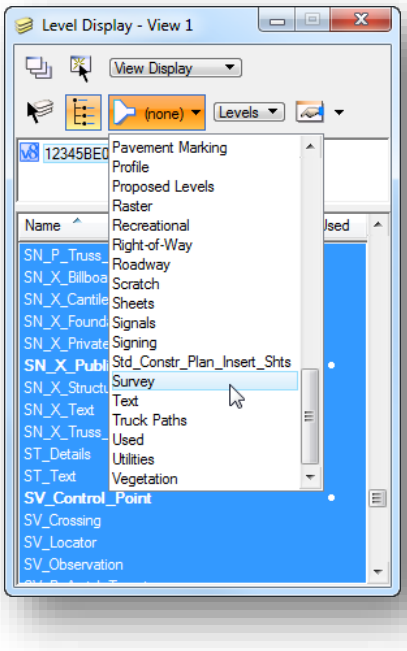
- Information on the available seed files is presented in Chapter 5
- 3D seed files should always be used for OpenRoads Survey projects.

MicroStation Levels

ODOT's CADD Standards include several levels specific to survey information. These levels are grouped in the level library using the prefix "SV".

The levels can be turned on/off using the MicroStation *Level Display* dialog. The *Level Display* dialog can be opened by selecting **Settings > Levels > Display** from the MicroStation pull-down menu, or from the **Level Display** icon in the *Primary Tools*.

The *Level Display* dialog includes the ability to filter the dialog to only show specific levels. By selecting the **Survey** filter, the dialog will show only the survey levels.

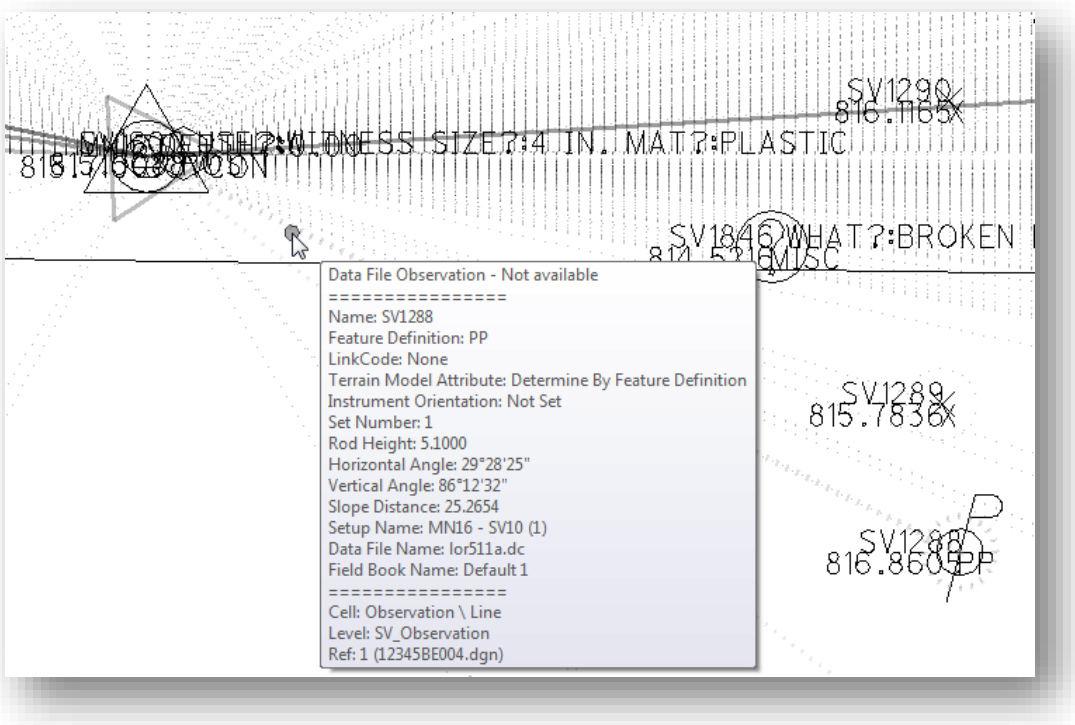


The survey levels include several levels specific to survey data that has been mapped using OpenRoads Survey. Each survey point displays text on the following levels:

- SV_X_Text_Comment
- SV_X_Text_Description
- SV_X_Text_Elevation
- SV_X_Text_Name

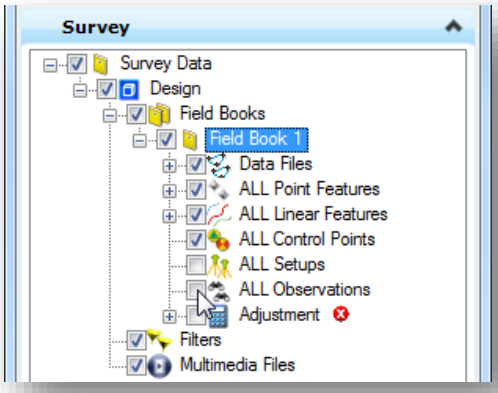
These levels can be toggled on or off as desired using the *Level Display* dialog.

For raw datasets, the software also draws **Observation Lines** and **Setup Lines**. An example of the observation lines is shown below.



- Observation Lines are drawn on the level **SV_Observation**
- Setup Lines are drawn on the level **SV_Setup**

These lines can be turned on/off using the MicroStation *Level Display* dialog, or by turning on/off the **All Setups** and **All Observations** items in the **Survey** tab of the *Project Explorer* dialog.



Annotation Scale

MicroStation's annotation scale is used to control the display of the following items:

- Text
- Dimensions
- Detailing Symbols
- Cells
- Custom Line Styles

Cells, text, and custom line styles placed by OpenRoads Survey are drawn according to the current MicroStation annotation scale value.

Think of the annotation scale as a multiplier. The original size of the element is multiplied by the current annotation scale value to determine the display size of the element.

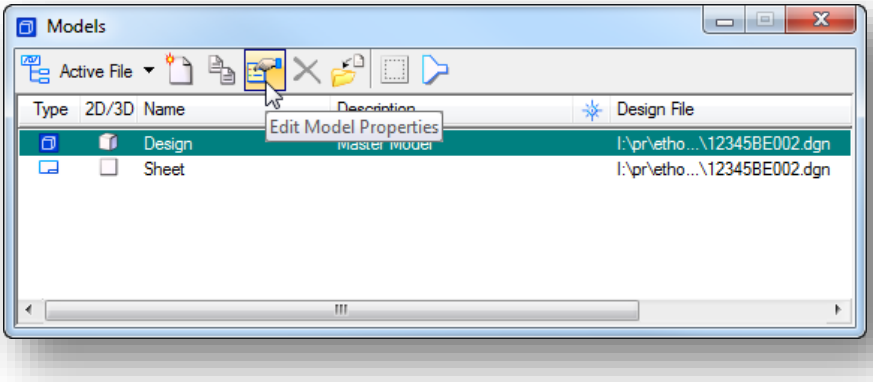
The cells and custom line styles defined in ODOT's CADD Standards are defined in one of two ways:

- "Cosmetic" cells and linestyles are used to represent the location of an item, but not the actual size of the item. These items are placed in the design file using a scale of 1.0. The display of cosmetic cells and linestyles is scaled automatically by MicroStation using the active Model Annotation Scale value.
    - A mailbox is an example of a cosmetic cell that is used to designate the location of the item, but not the actual size of the item.
    - A fence line is an example of a cosmetic line style. The location of the "x" on the fence line is used as a symbolic representation of the line type and does not represent specific post spacing for the fence line.
    - These cells and linestyles will change size when the MicroStation Annotation Scale is changed.

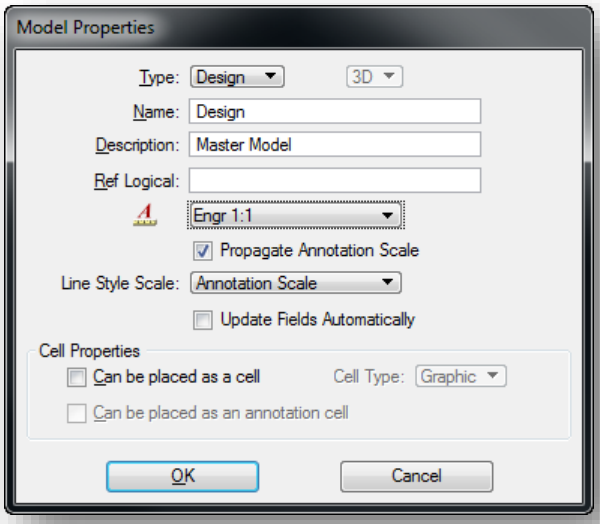
- "Physical" cells and linestyles are used to represent both the location and the size of an item. These items have been drawn at their actual physical dimensions and are placed in the design file, by the user, at a scale of 1.0.
    - A pavement marking right-turn arrow is an example of a physical cell which is always placed at its actual size.
    - A pavement marking line, such as a lane line, is an example of a physical line style that is always placed using the actual dash and gap dimensions of the line.
    - These cells and linestyles will not change size when the MicroStation Annotation Scale is changed.

Whether an individual cell or line style can be scaled is defined within the cell and linestyle definition.

The display size of cosmetic features can be controlled by the **Annotation Scale** settings in the *Model Properties* dialog. To access the *Model Properties* dialog, select **File > Models** from the MicroStation pull-down menu. The *Models* dialog shown below is opened.



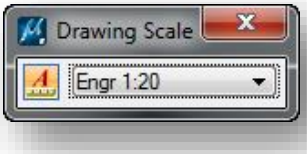
Select **Edit Model Properties** to access the dialog shown below.



- Toggle on the **Propagate Annotation Scale** option to allow controlling the display size of cells and text in the design file by use of the *Drawing Scale* dialog.

- The *Model Properties* **Line Style Scale** option is used to set the display scale for custom line styles. Set this value to **Annotation Scale** for ODOT projects.

Another way to access the **Annotation Scale** setting is by use of the *Drawing Scale* dialog. The dialog can be accessed by selecting **Settings > Drawing Scale** from the MicroStation pull-down menu. Dock the dialog to the top of the window for quick access to the **Annotation Scale** value.



Changing the **Annotation Scale** value in the survey basemap file does not typically affect the way the file appears to other users who may be referencing the file.

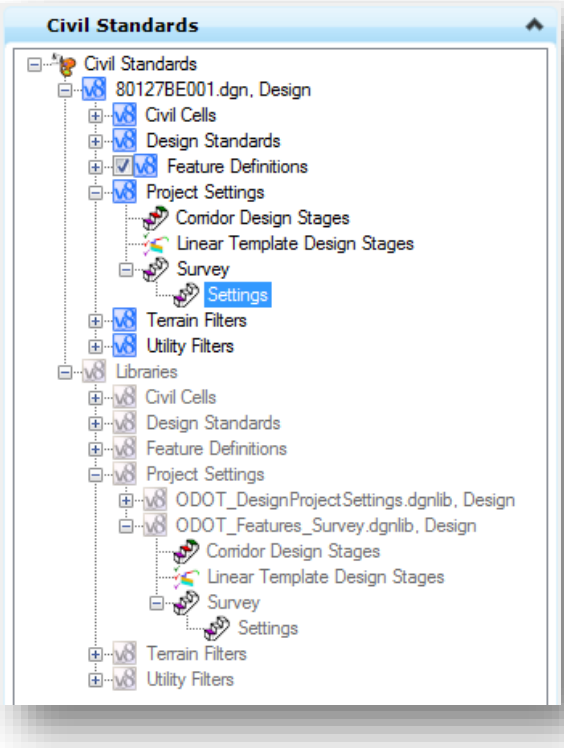
ODOT OpenRoads Standards

Project Explorer > Civil Standards

The OpenRoads software uses MicroStation DGN Libraries extensively to define various standards used by both the Civil and Survey software functions. These DGN libraries are defined by the ODOTcadd workspace.

In the ODOT configuration, the file **ODOT_SurveyFeatures.dgnlib** defines most of the survey standards. When a new MicroStation design file is created, these standards are referenced by the configuration and can be reviewed from the **Civil Standards** tab of the *Project Explorer* dialog.

The **Civil Standards** tree contains two main branches; one for the active design file, and one for **Libraries**, as shown below.



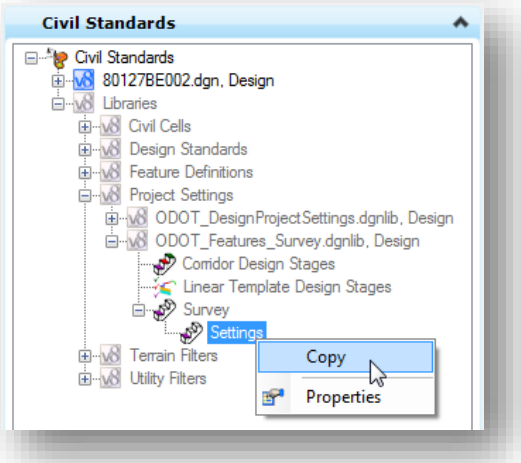
Within these branches, there are two main branches that are used by the Survey software: **Feature Definitions** and **Project Settings**.

When a new file is created, the standards are initially listes only in the **Libraries** branch. These are the default standards that are defined for ODOT projects.

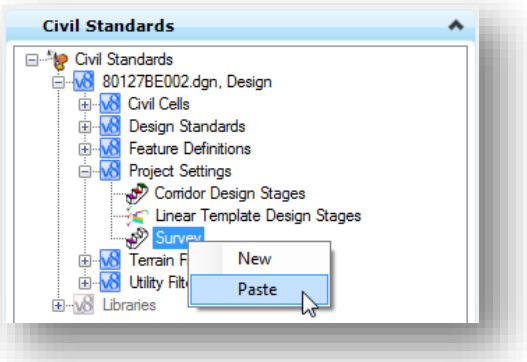
When survey data is processed, the standards are read from the library and are copied to the active file.

The default Survey Settings can be modified as necessary for a specific survey project. If you need to make changes to the default values, the default **Settings** must be copied to the active file and modified before processing survey data is initiated.

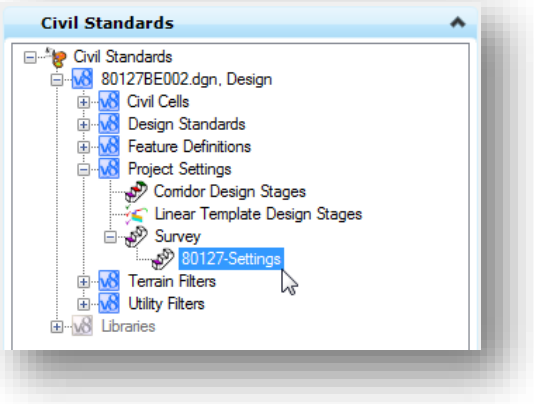
To edit the default settings before processing the data, right-click on the **Survey Settings** item in the **Libraries** branch and select **Copy** as shown at right.



The copied settings can be pasted into the active file by right-clicking on the **Project Settings > Survey** item in the active file branch, and then selecting **Paste** as shown at right.



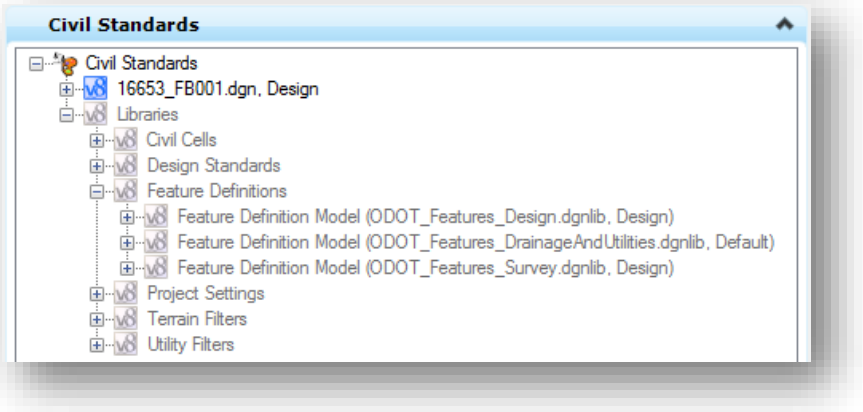
When the data is processed, the software will prompt you to choose the settings file that you would like to use for processing. In order to avoid confusion, it is recommended that you change the name of the copied settings to include the PID number for the project. An example is shown at right. The name can be changed by selecting the **Settings** item, and then selecting it again to edit the name.



Note: It is only necessary to copy the settings if you wish to make changes to the default values. Changes must be made ***before*** processing the data.

Civil Standards > Feature Definitions

The **Feature Definitions** branch of the **Civil Standards** tab defines the feature library used for mapping the survey data and generating the terrain model. When using the ODOTcadd configuration, the ODOT_Features_Survey.dgnlib is attached as shown below.



Three types of features can be defined:

- Linear
- Point
- Surface

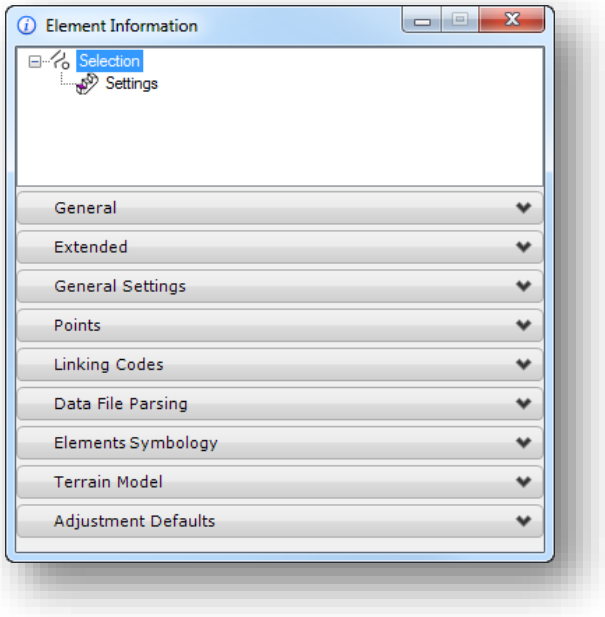
Linear and point features for ODOT use are defined by a linked GEOPAK SMD file, ODOT_SMD.xml. This link is established in ODOT_Features_Survey.dgnlib as shown above and contains all the feature definitions for the field codes. The linear and point features defined by ODOT_SMD are merely pointers to the .xml file and cannot be edited.

ODOT_Features_Survey.dgnlib also contains the surface feature definitions for existing ground terrain models. These features are used for terrain model display and are explained in more detail in Chapter 7.

Civil Standards > Project Settings

The **Survey Settings** branch defines the default project settings for the Survey software. Once a dataset has been processed, these settings are copied to the active design file where then can be edited by the user.

To review the default settings, right-click on the **Settings** item and select **Properties** to access the *Element Information* dialog shown below.

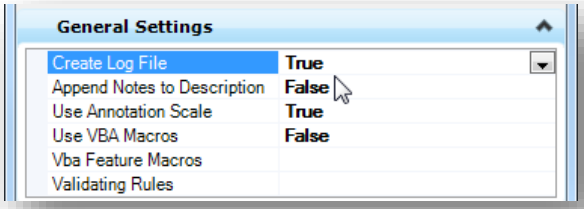


These settings are set appropriately for ODOT projects; however there are occasions where you may wish to change some of the parameters on a per-project basis.

Items that you may occasionally need to edit are documented on the following pages. See the online help for information not presented here.

General Settings

A log file of activity can be optionally saved to track changes to the Survey information. In the **General Settings** tab, set the **Create Log File** option to **True** as shown below.



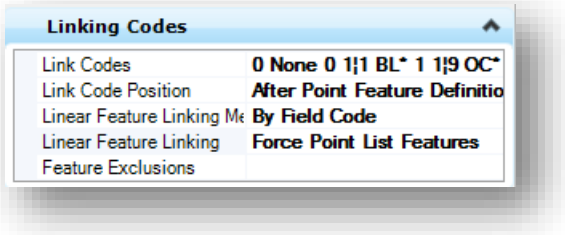
The log file is placed in the same folder as the DGN file.

The log file is named with a .log extension using the name of the design file model.

The log file contains the name of the user, the date and time, and a description of the action performed. An example of the log file contents is shown below:

ethomas Thursday, December 05, 2013 11:14:08 AM New FieldBook Field Book 1
ethomas Thursday, December 05, 2013 11:14:16 AM Load Data
I:\pr\ethomas\OpenRoads\ERI\11311\survey\rawdata\ERI11311-FNL.dc
ethomas Thursday, December 05, 2013 11:16:35 AM Linear Feature PAINTL1_2 Feature Definition: from: PAINTL1 to: EP
ethomas Thursday, December 05, 2013 11:17:19 AM Convert to Point List Chain PAINTL1_2
ethomas Thursday, December 05, 2013 11:17:33 PM Delete Point Feature SV2920
ethomas Thursday, December 05, 2013 11:18:06 PM Move Point Along Linear Feature Field Book Field Book 1 Linear Feature R_34 Point Feature SV1088

Linking Codes



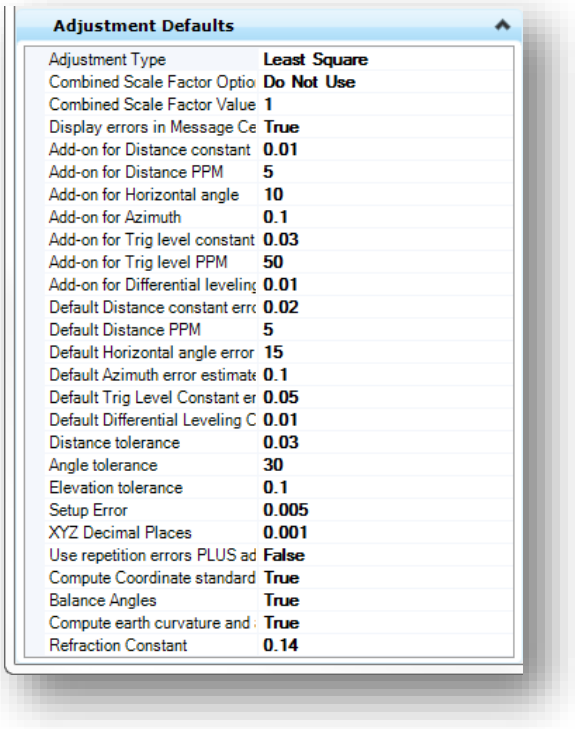
Note: As previously stated, the **Link Code Position** parameter has been changed to A**fter Point Feature Definition** with the October 16, 2015 update to the ODOTcadd Standards. Datasets field collected after the October 16, 2015 update should be field collected with the mapping code positioned after the feature code name. When processing older datasets containing the linking code before the feature name, the survey preferences must be copied into the active file and the value of the **Link Code Position** parameter changed to **Before Point Feature Definition** before processing the data.

Adjustment Defaults

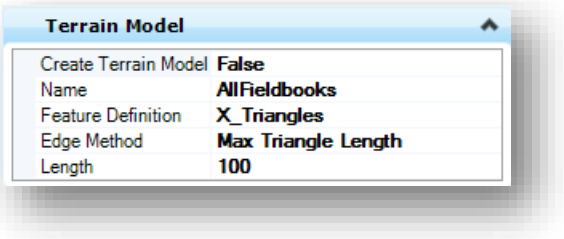
Various adjustments and blunder detection may be applied to survey raw data. The adjustments and adjustment settings apply to the entire field book.

Most of these settings are device-dependent. For example, the **Add-on for Distance constant** value is dependent on the device used to measure distances.

The **Adjustment Defaults** defined in the ODOTcadd workspace have not been changed from the Bentley default values.



Terrain Model

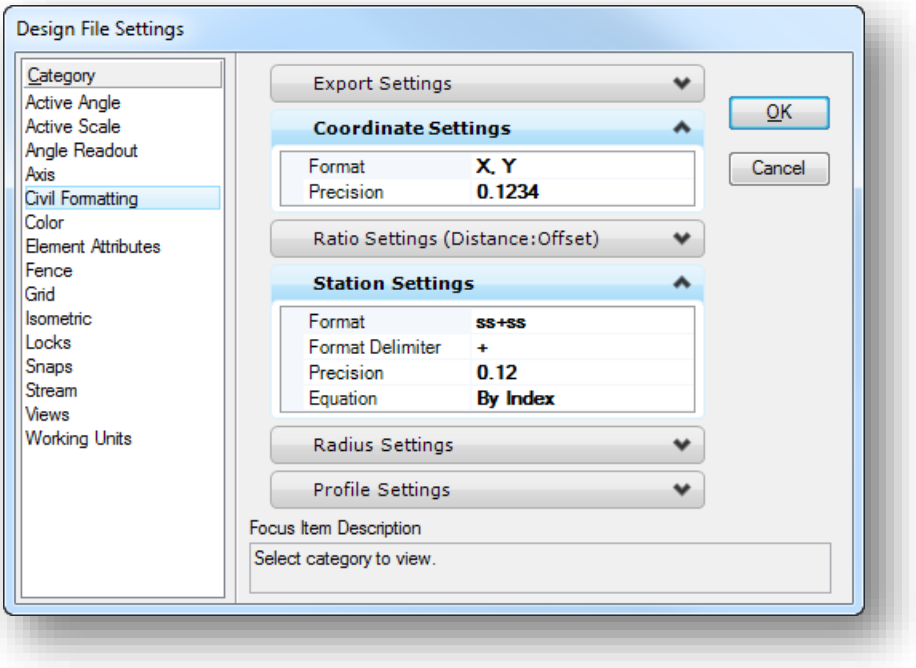


The initial settings for terrain models are defined in the ODOTcadd workspace as shown above. These values can be changed before processing survey data or after the fact by editing the terrain model properties. See Chapter 7 for more information on reviewing and editing terrain models.

Note: The value of the **Create Terrain Model** parameter was changed from **True** to **False** with the October 16, 2015 update to the ODOTcadd Standards. Terrain models are no longer automatically created when the survey data is initially processed.

MicroStation Design File Settings

The design file itself also has several settings used by the OpenRoads Survey software. To access these settings select **Settings > Design File** and then click the **Civil Formatting** item from the list on the left of the dialog.



These settings are initially defined in the ODOT Seed files and have been configured appropriately for ODOT projects. However, you may wish to change the following settings on a file-by-file basis.

Coordinate Settings

- The **Format** can be set to **X,Y,** or **N,E** as desired.
- The **Precision** setting is used to control the display and precision of coordinates within the various civil and survey dialogs.

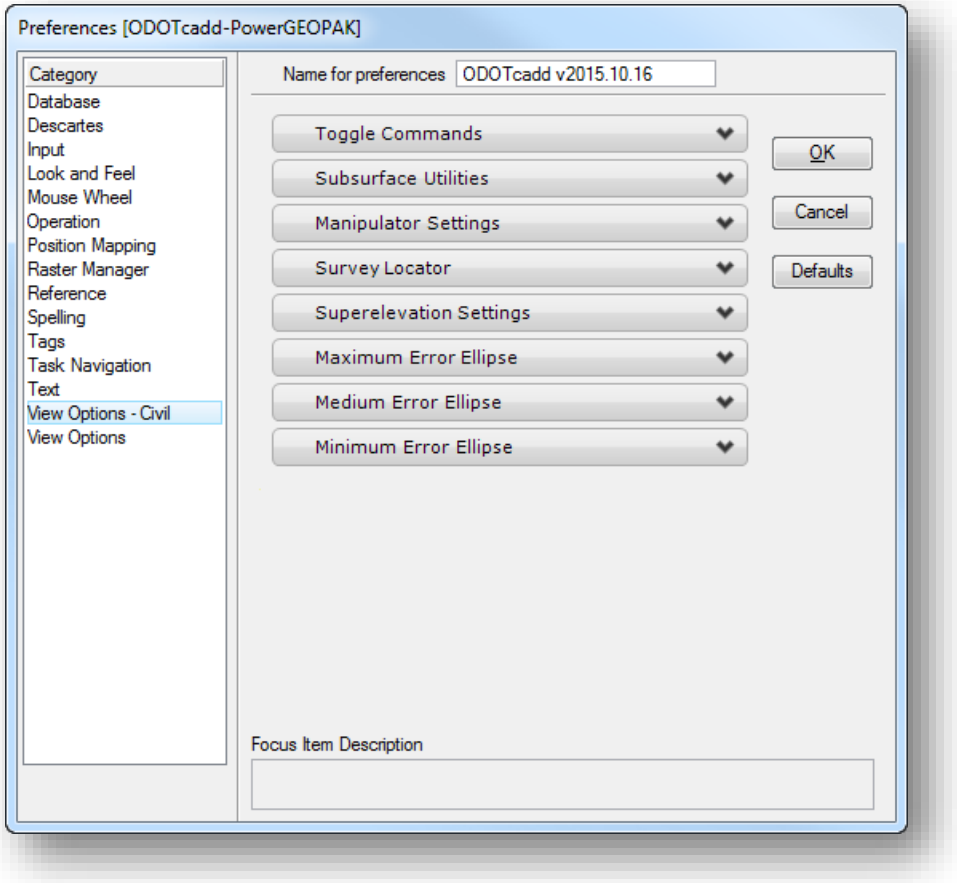
Station Settings

Controls the format, delimiter and precision of the station values to be used and displayed in the various civil dialogs. In addition, there are two options to control how equations are represented within the station values.

- **By Name** - This is the standard InRoads presentation (A100+00, B105+00, etc.)
- **By Index** - This is the standard GEOPAK presentation (100+00 R 1, 105+00 R 2, etc.)

MicroStation User Preferences

The MicroStation User Preferences includes several options for the civil products. These parameters are accessed by selecting the **View Options – Civil** item on the *Preferences* dialog as shown below. These options have been configured as necessary in the ODOT workspace. See the Bentley Survey online help for more information.



Exercise 3 –Linking Codes before the Feature Name

In this exercise we will process an older dataset that contains the linking code before the feature code. The data for this example is contained in a Trimble JOB file and must first be converted to an ASCII text file in Comma Separated Valued (CSV) format. The Trimble ASCII File Generator is used for the conversion.

Before running the ASCII file generator, the following files must be copied from the ODOTcadd Standards to the appropriate folder. This task has already been completed on the ODOT computers and is detailed here reference.

Copy the following files from ODOTcadd:

Copy the Geoid files from:
\ODOTcadd\Standards\Trimble\GeoData

To the following location:
C:\Program Files (x86)\Common Files\Trimble\GeoData

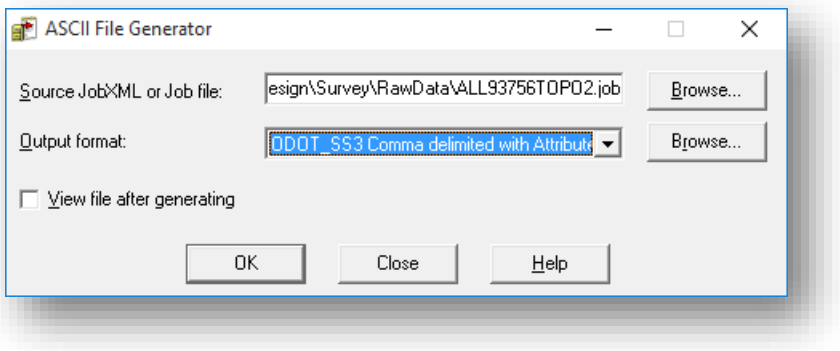
Note: The Geiod Files must also reside on the Data Collector when the data is collected

Copy the Style Sheet Files from:
I:\ODOTcadd\Standards\Trimble\ODOT_SS2 Comma delimited with Attributes.xls
I:\ODOTcadd\Standards\Trimble\ODOT_SS3 Comma delimited with Attributes.xls

To the following location:
C:\Trimble Style Sheets\Custom ASCII Files

With these files in place, take the following steps to convert the JOB files to CSV files:

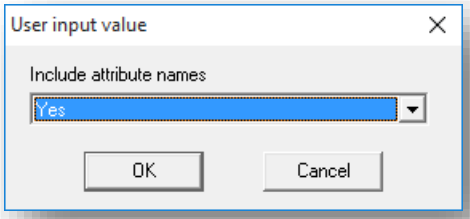
- ✓ From the Windows Start Menu, select **All Programs > Trimble Office > ASCII File Generator**



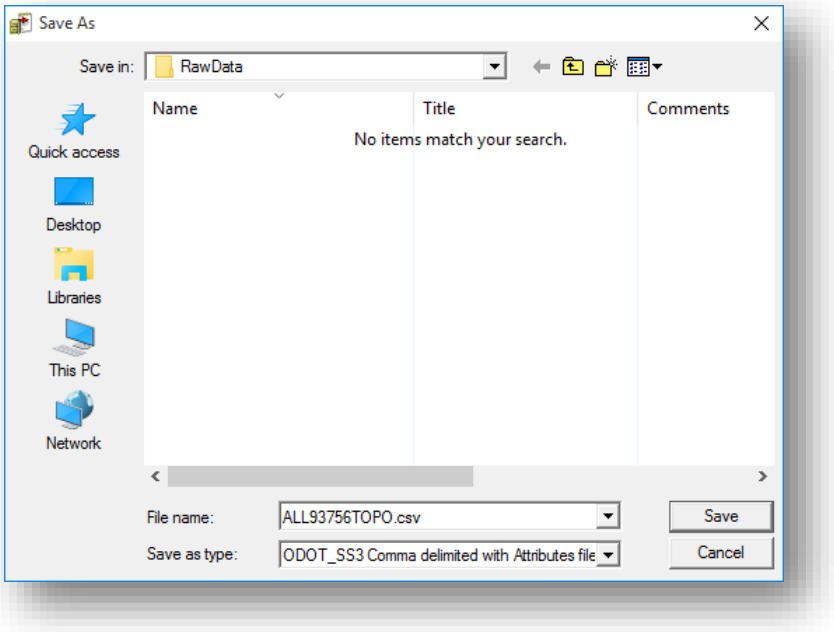
- ✓ Use the **Browse…** button to select the **Source JobXML or Job File**. Select the following file:

C:\ODOT_Training\OpenRoadsSurvey\ProjectData\ALL\93756\Design\Survey\RawData\ALL93756TOPO.job

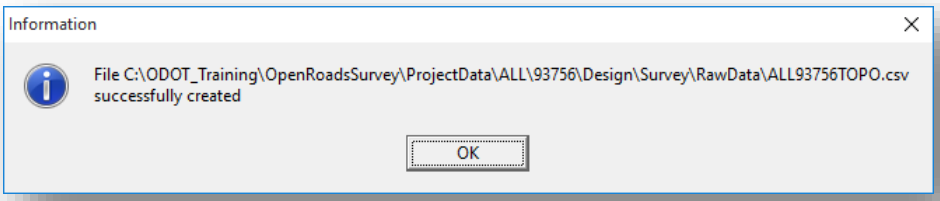
- ✓ From the **Output format** drop down menu, select the **ODOT_SS3 Comma delimited with Attributes** option.
- ✓ Select the **OK** button to initiate the process.
- ✓ You are prompted to **Include attribute names** as shown below, Select the **Yes** option and choose the **OK** button.



- ✓ Next you are prompted to save the CSV file as shown below. Save the file in the RawData folder for the project using the same name as the original Job file but with a .csv file extension.



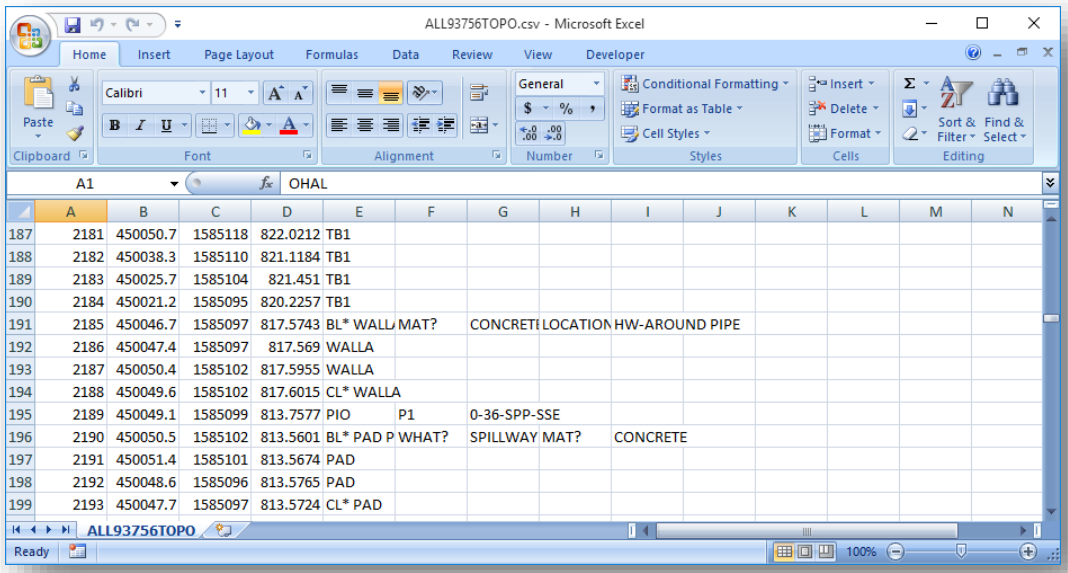
- ✓ Finally, you are notified that the file was successfully created. Select **OK** to complete the process.



- ✓ After converting the first Job file to CSV format, do the same for the second Job file contained in the data for this example. Use the ASCII File Generator to convert the following file:

  C:\ODOT_Training\OpenRoadsSurvey\ProjectData\ALL\93756\Design\Survey\RawData\ALL93756TOPO2.job

- ✓ The CSV file content can be reviewed with an ASCII text editor, or with Microsoft Excel. A portion of the first file we converted is shown in Excel below:



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
187	2181	450050.7	1585118	822.0212	TB1									
188	2182	450038.3	1585110	821.1184	TB1									
189	2183	450025.7	1585104	821.451	TB1									
190	2184	450021.2	1585095	820.2257	TB1									
191	2185	450046.7	1585097	817.5743	BL* WALL	MAT?	CONCRETI	LOCATION	HW-AROUND PIPE					
192	2186	450047.4	1585097	817.569	WALLA									
193	2187	450050.4	1585102	817.5955	WALLA									
194	2188	450049.6	1585102	817.6015	CL* WALLA									
195	2189	450049.1	1585099	813.7577	PIO	P1	0-36-SPP-SSE							
196	2190	450050.5	1585102	813.5601	BL* PAD P	WHAT?	SPILLWAY	MAT?	CONCRETE					
197	2191	450051.4	1585101	813.5674	PAD									
198	2192	450048.6	1585096	813.5765	PAD									
199	2193	450047.7	1585097	813.5724	CL* PAD									

In the default ODOT configuration, the linking code position is assumed to be after the point name. This dataset has the linking codes before the feature name. We must change the setting that defines the linking code position before processing the data. Take the following steps to open the MicroStation file or the project and modify the default settings:

- ✓ Open MicroStation using the shortcut defined for the training class.

- ✓ From the MicroStation *File Open* dialog, select the Project **ALL-93756**

- ✓ Open the following MicroStation design file:

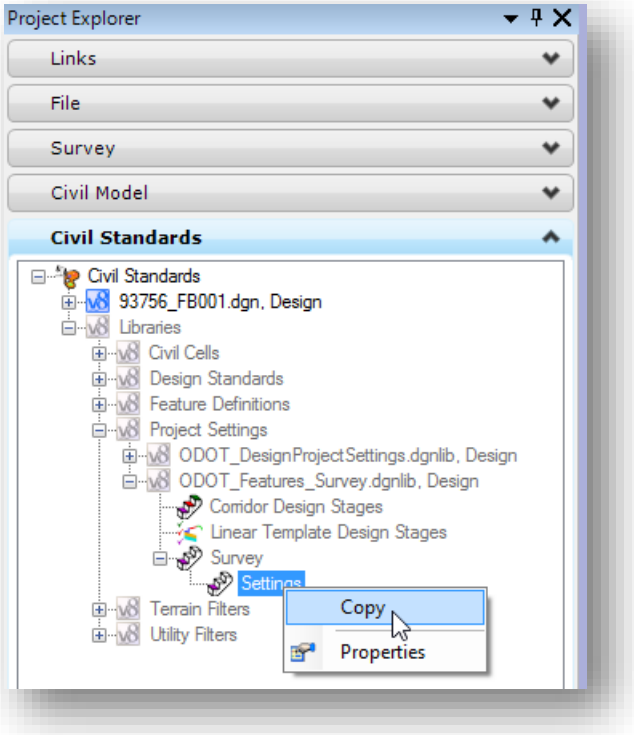
..\Design\Survey\RawData\93756_FB001.dgn

✓ From the *Project Explorer* dialog, open the **Civil Standards** tab.

The **Libraries > Project Settings** item lists the dgn libraries in the ODOT workspace that define the default project settings for survey.

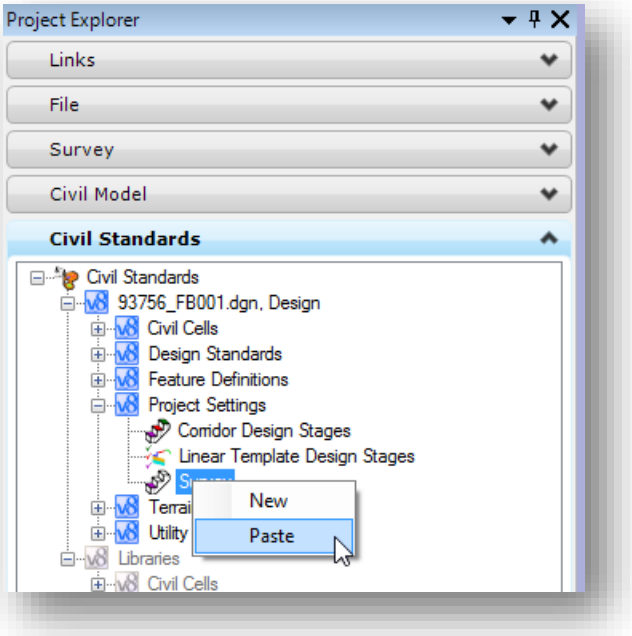
The default **Survey Settings** are defined in **ODOT_Features_Survey.dgnlib** as shown at right.

These settings can be copied to the active file and then edited before processing the survey data.



✓ Right-click on the **Survey Settings** item and select the **Copy** option as shown at right.

✓ **Paste** the settings into the **Survey Settings** for the active file as shown at right.

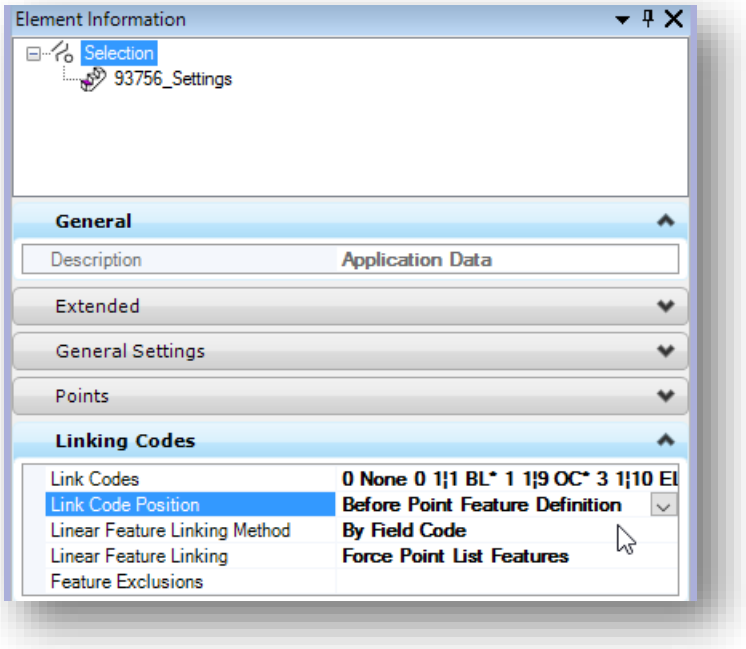


- ✓ After copying the settings, the name of the settings can be changed by right-clicking on the **Settings** item and choosing the **Rename** option. This is optional, but is recommended to eliminate any possible confusion of which settings are in use. The name of the settings should be changed to include the project's PID number.

  Example: 93756_Settings.

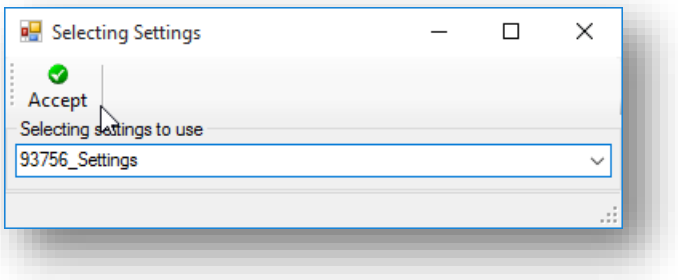
- ✓ Right-click on the new copy of the settings and pick the **Properties** option to edit the settings.

- ✓ Change the **Link Code Position** parameter to **Before Point Feature Definition** as shown below. Close the *Element Information* dialog after making the change.



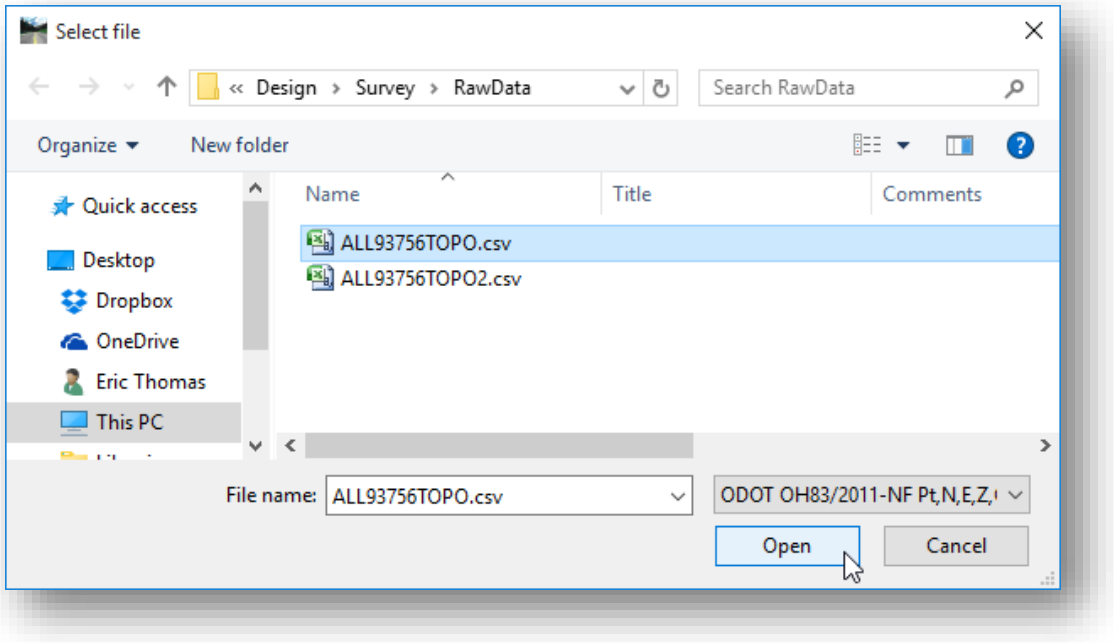
Now that the settings have been changed to specify the correct Link Code Position, we are ready to process the survey data.

- ✓ Create a new Field Book. You are prompted to choose the survey settings as shown below. Choose the **93756_Settings** option and then pick the **Accept** button.



After the **Accept** button is selected, the *Select File* dialog is opened as shown below.

- ✓ Select the file type that you wish to import in the lower right corner of the dialog. For this example, choose the **ODOT OH83/2011-NF Pt, N, E, Z, Code (*.csv, *.txt)** filter. All of the csv or txt files contained in the current folder are displayed.

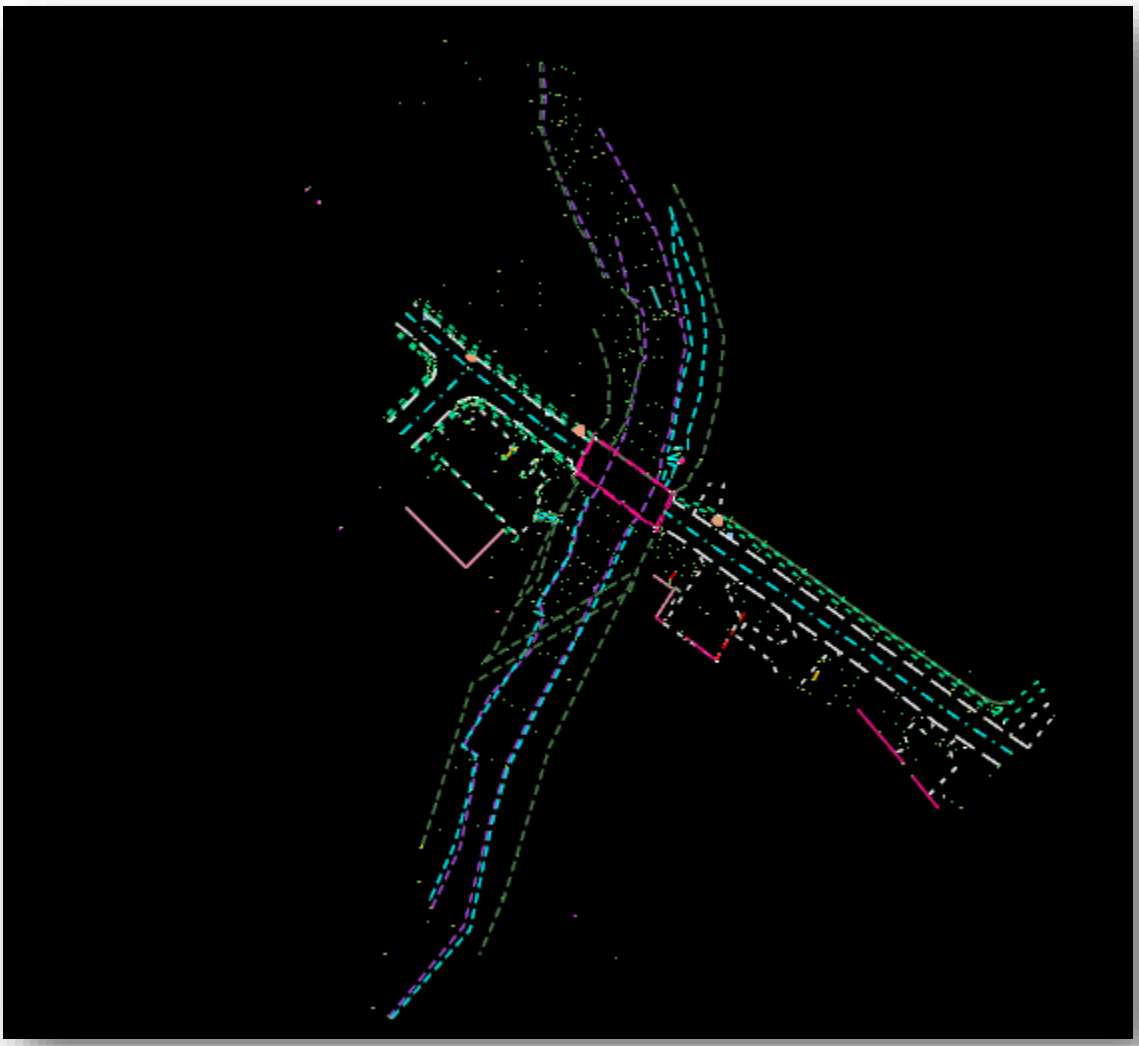


- ✓ Import the following file by selecting the file from the list and choosing the **Open** button.

..\Design\Survey\RawData\ALL93756TOPO.csv

- ✓ Import the second data file using the same Field Book.

The data is mapped to the file as shown on the following page. Notice that a terrain model is not automatically generated for the data.



- ✓ Set the design file **Drawing Scale** to your preferred value to review the data.

This dataset has a few errors that we will fix in a later chapter before creating the terrain model.

- ✓ After looking over the data, select **File > Save Settings** and then **File > Save**.

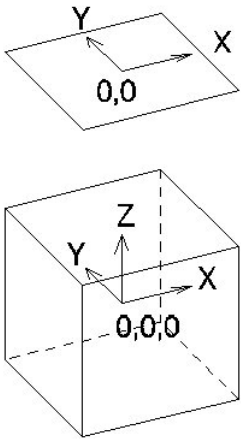
4 Working with 3D Files

3D files are normally used for processing Survey data with OpenRoads; however many users have never worked in 3D before. This intent of this chapter is to cover some introductory basics of working with 3D files and not to provide a comprehensive guide. Further information can be found in the MicroStation online help documentation. Additionally, ODOT employees have access to the Bentley Learn server and can sign up for online MicroStation 3D training. See your CADD Manager for more information about Bentley Learn.

The Design Cube

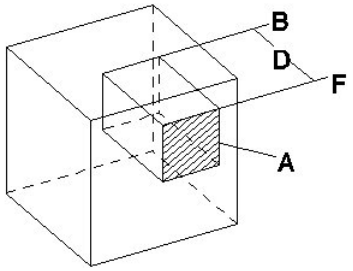
3D DGN files consist of a design cube in which you work. The design cube represents a 3D DGN file's total volume, in which points are defined with x-, y-, and z-values, or coordinates. Points can be placed anywhere within the design cube, and are not restricted to a single plane as is the case when you work in a 2D DGN file.

Design cube coordinates are expressed in the form (x,y,z). The global origin in the 3D seed files provided with MicroStation is located at the exact center of the design cube and assigned the coordinates (0,0,0). Any point above the global origin has a positive z-value and any point below it has a negative z-value.



The 2D design plane (top) and 3D design cube (bottom)

The view volume (sometimes called the display volume) is the volume of the design cube that is displayed in a 3D view. In most cases, only a part of the design cube is displayed in a view.

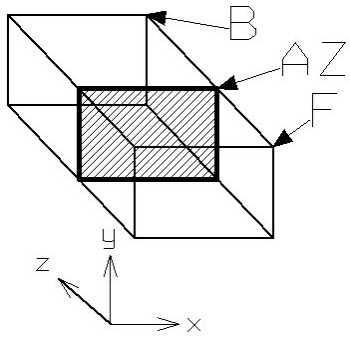


"A" denotes the window area (hatched).
"D" denotes the Display Depth, bounded by the front "F" and back "B" clipping planes.
The large cube shows the design cube, part of which is displayed in each view.

Any elements or parts of elements, not contained in the view volume are not displayed in the view. Unless a clip volume has been applied to a view, the view volume is bounded by the window area, and its display depth.

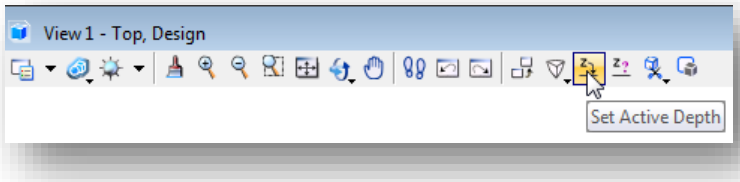
Active Depth

The **Active Depth** in a view defines the position of a plane, parallel to the screen, on which data points are placed.



The active depth is denoted by "AZ."
"x," "y," and "z" denote the View axes.
"F" and "B" denote the front and back clipping planes, respectively.

You set the active depth graphically with the **Set Active Depth** view control.



1. Select the **Set Active Depth** view control.
2. Select the view in which you want to set the active depth.
3. Enter a data point at the desired location.

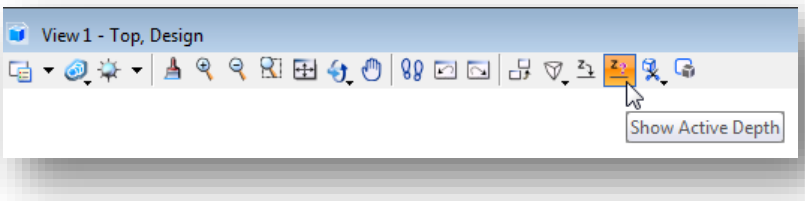
You can also set the active depth for a specific view window using a key-in command.

1. Key in ACTIVE ZDEPTH ABSOLUTE <depth>.

or Key in **AZ=** <depth>.

2. Select the view(s).

You can also query a view window for the current active depth value with the **Show Active Depth** command.



1. Select the **Show Active Depth** view control.
2. Select the view. The view's active depth setting is shown in the status bar.

Viewing a 3D Model

A 3D view can display part of the design cube from any point, looking in any direction.

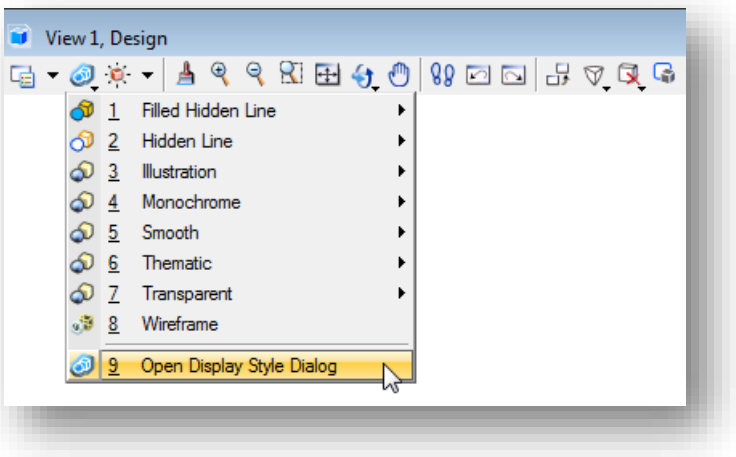
- As in 2D, elements to the left, right, above, or below, can be excluded from a view by zooming in or windowing so that the elements are outside the view's area.
- 3D views also have depth. You can exclude the display of elements located in front of, or behind, a required object by changing the view's display depth, or by applying a clip volume. See the MicroStation online help for information on changing the display depth or applying a clip volume.

Note: In the ODOT seed files for OpenRoads, the view attribute for the **Clip Volume** has been turned off for all views.

Display Styles

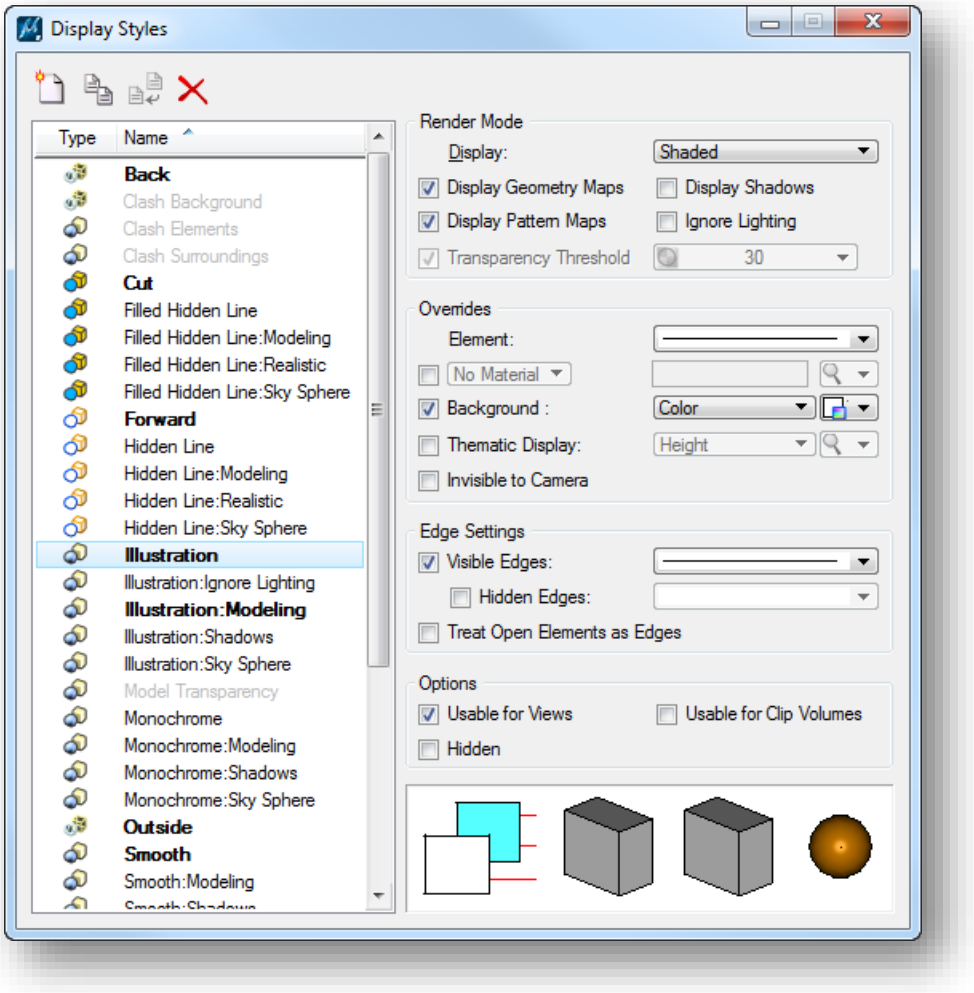
The *Display Styles* dialog is used to select from a list of predefined render overrides that can be assigned to a view.

In the view control bar, select the **Choose View Display Style** icon. A list of available styles is presented as well as the option to **Open Display Style Dialog**.



By default, the display style is set to **Wireframe** when using the ODOT seed files.

Select the **Open Display Style Dialog** option to access the *Display Styles* dialog shown on the following page.

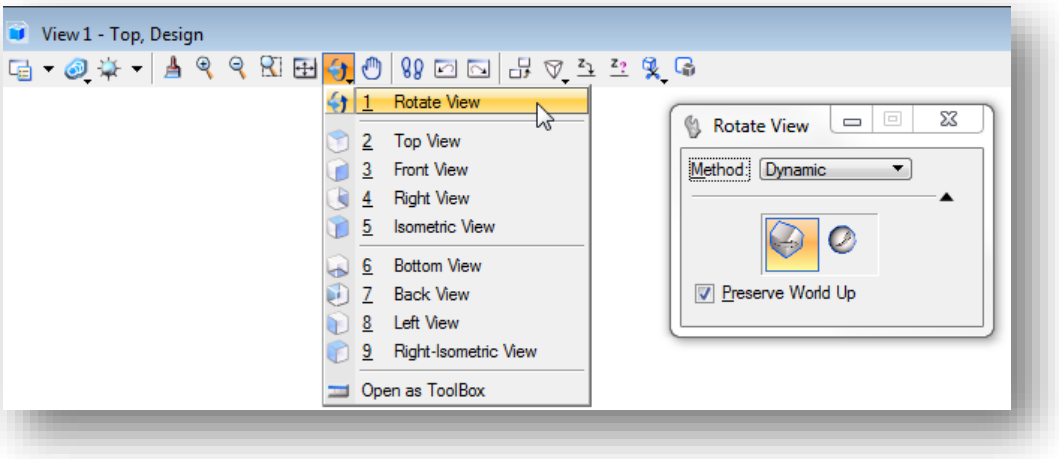


The predefined list of display styles can be selected and edited using this dialog. When a style is selected the preview pane, located at the bottom right of the dialog, shows an example of how the display will appear using the selected style. In the example above, the **Illustration** style is selected.

See the MicroStation online help for more information about editing and defining display seyles.

Rotating Views in 3D

The **Rotate View** control is used in 3D files to rotate a view to a custom orientation or one of the standard views (**Top**, **Front**, **Right**, etc.) as shown below.



When rotating views in 3D, an important point to consider is the axis about which you want the view to rotate. By default, the pivot point is the center of the view, at the active depth. If the active depth is far behind the elements in the view, then you can quickly rotate the geometry out of sight. You can, however, move the pivot point to another location prior to rotating the view as follows:

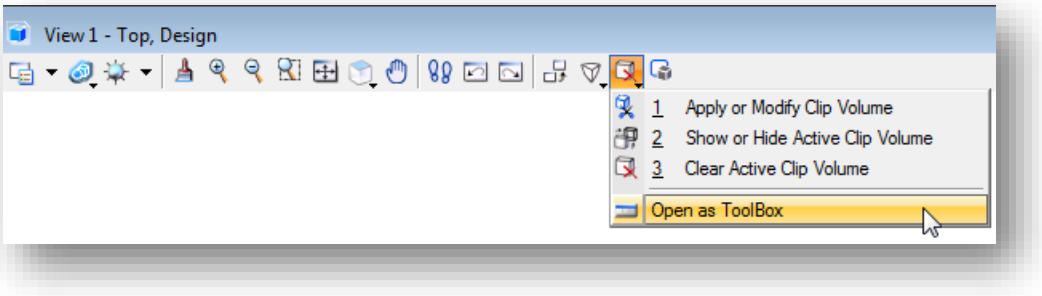
1. Select the **Rotate View** view control.
2. Set **Method** to **Dynamic**. A plus sign (+) appears at the center of the view.
3. Click on the plus sign at the center of the view.
4. Enter a data point to reposition the pivot point.

Clip Volumes

Clip Volumes can be used to limit the display of the survey data to a specific portion of the model without being hindered by elements outside the area of interest. When a clip volume is applied to a view, only elements located within the clip volume are displayed, or can be snapped to, in that view. Each view may have a different clip volume displayed.

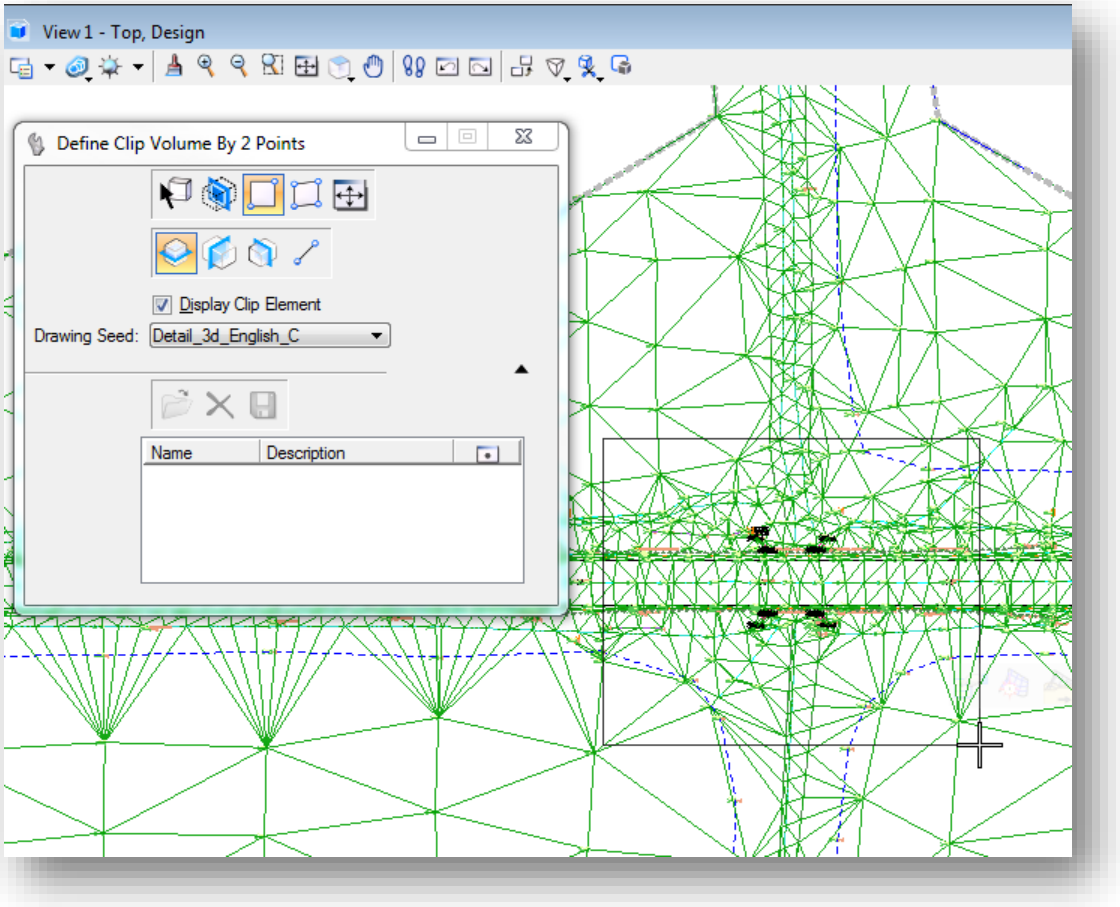
Once a clip volume has been defined, operations such as view rotation, fence processing, and rendering honor the clip volumes. Elements that are not displayed within the defined volume are ignored.

The Clip Volume tools can be accessed from the View window as shown on the following page.

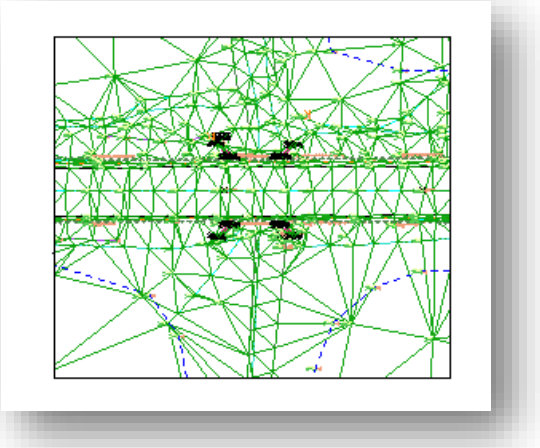


See the Bentley Online Help for complete documentation of these commands. An example using the **Apply Clip Volume by Two Points** command is documented below.

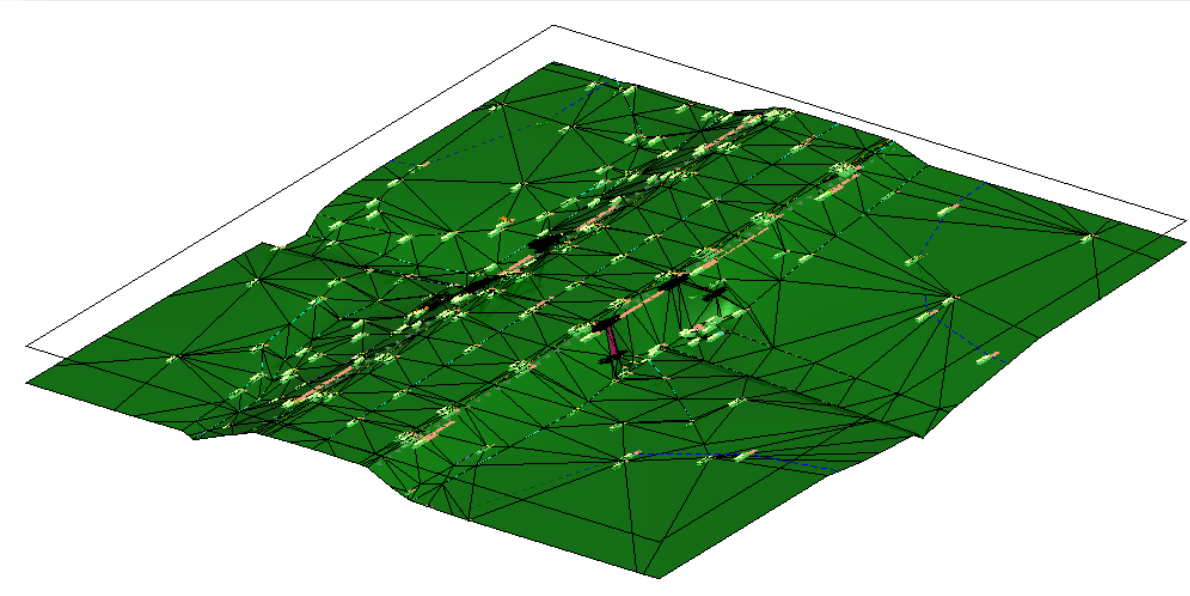
In the example below, the **Apply or Modify Clip Volume** command has been selected. The **Clip By 2 Points** command is used to define a rectangular region in the top view to be used to define the clip volume.



Once the rectangular region has been defined, the display of the graphics is clipped as shown below.



If desired, the clipped area can be rotated and rendered as shown below.



The display of the rectangle representing the clipping limits can be toggled on or off using **the Show or Hide Active Clip Volume** command.

The **Clear Active Clip Volume** command is used to remove the clipping mask from the selected view.

Clipping elements can be manipulated/modified with the standard MicroStation tools.

Drawing in 3D with Civil AccuDraw

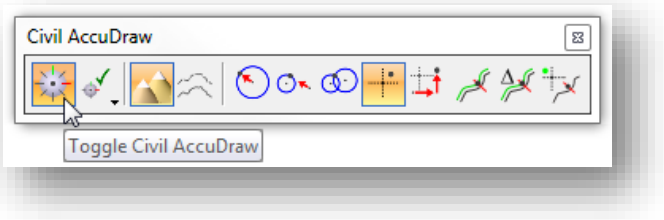
Placing elements in a 2D model is like manual drafting — all elements appear on the same plane, the sheet of paper.

In 3D, you place elements in space — horizontally (for example, a floor), vertically (for example, a wall), or at any other angle or direction (for example, a sloping roof).

By default, data points in a 3D model are placed at the view's Active Depth. Where you snap a tentative point or place a data point in a blank part of a view, it will be located at the active depth. You can, however, snap a tentative point to an existing element at any depth in a view. When you accept such tentative points, the data point is placed at the level of the snap point.

Civil AccuDraw and its drawing plane let you place elements away from the active depth. Often this improves productivity, since you need not constantly change the active depth.

Select **Tools > Civil AccuDraw > Activate Toolbar** from the MicroStation pull-down menu to open the *Civil AccuDraw* dialog shown below. The first icon is used to turn Civil AccuDraw on or off.

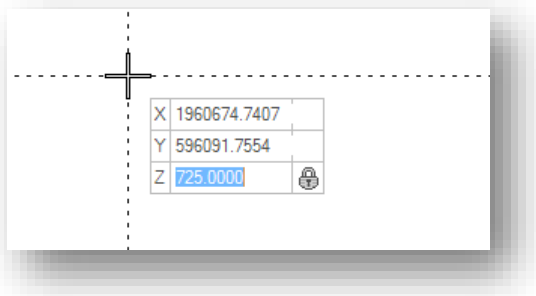


Civil AccuDraw performs many of the same functions as MicroStation AccuDraw but has greatly expanded capabilities for the civil designer.

> **Note:** Simultaneous use of Civil AccuDraw and MicroStation AccuDraw will cause errors. Close MicroStation AccuDraw when using Civil AccuDraw.

This guide will cover only a few of functions available when using Civil AccuDraw. For more information, see the GEOPAK online help by selecting **Applications > GEOPAK > Road > Help**. From the *Civil Help* dialog, select **Civil Tools > Civil AccuDraw**.

The coordinates of the current cursor position are displayed by default in a floating dialog as shown below. You can switch between the floating or fixed dialogs using the up and down arrow keys. The contents of the dialog will depend upon the current ordinate system selected.



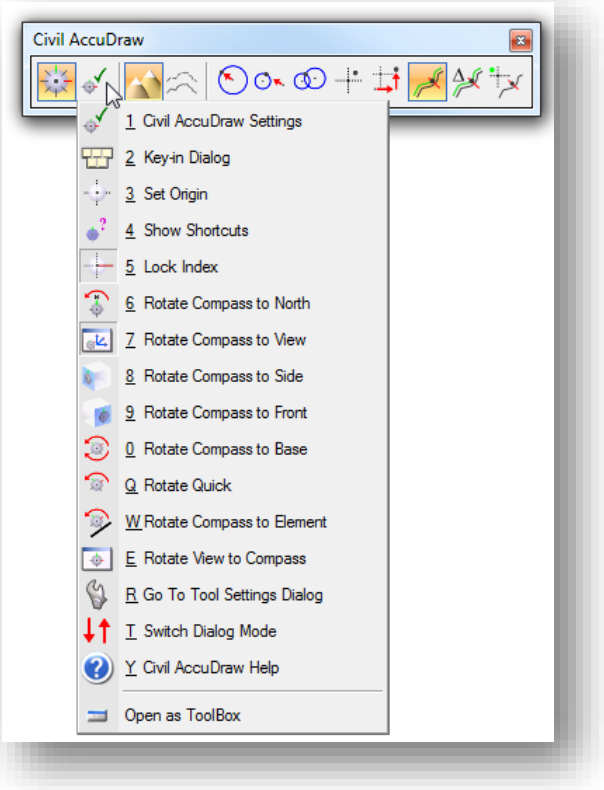
The **Tab** key is used to move through the key-in fields in the dialog.

Values entered in the floating dialog are locked when the **Enter** key is pushed.

To unlock a value, tab to the field and push the **End** key.

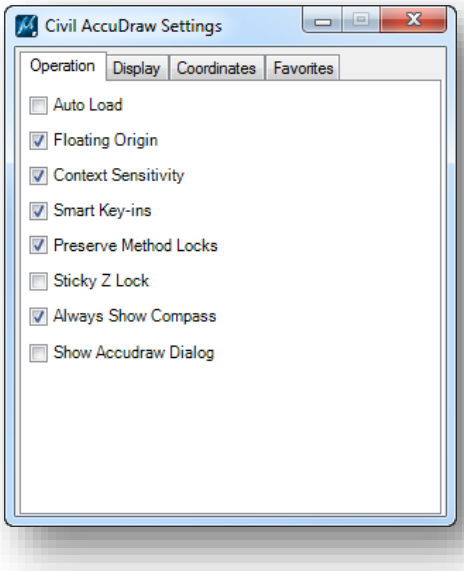
Shortcuts: Civil Accudraw Settings

Civil AccuDraw shortcuts and settings are accessed by selecting and holding down the left mouse button on the second icon as shown below.



These shortcuts are described in the online help by selecting **Tasks > Civil Tools > OpenRoads HElp**.

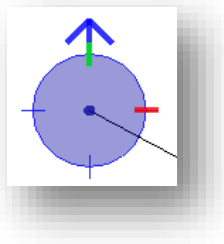
A single-click on the second icon will open the *Civil AccuDraw Settings* dialog shown below.



These settings are described in the online help by selecting **Tasks > Civil Tools > OpenRoads Help**.

Civil AccuDraw Compass

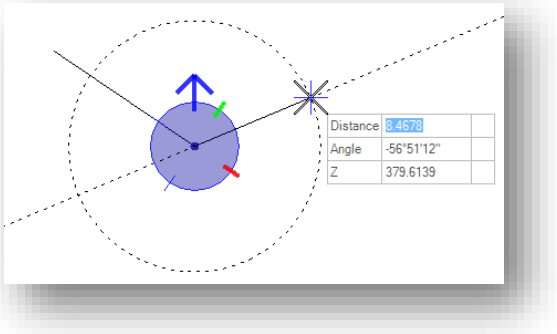
When the **Always Show Compass** setting is toggled on, a compass is displayed at AccuDraw's origin point when Civil AccuDraw is active.



The compass is always circular and is marked by a number of tics. The default is 4 compass points which can be changed in the settings.

The north arrow on the compass will always point to north as defined in **Settings > Design File > Angle Readout**.

If the Civil AccuDraw settings have **Context Sensitive** turned on (default), then the compass auto-rotates in a similar fashion to MicroStation AccuDraw:

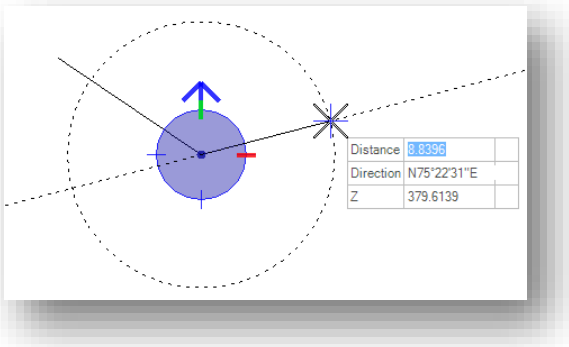


Note that rather than direction being shown, the label and value are now an **Angle**. This is because the context is based on the direction of the preceding line segment rather than an absolute direction.

The compass can be rotated with the **V**, **B**, **T**, **RQ**, **RE** shortcuts.

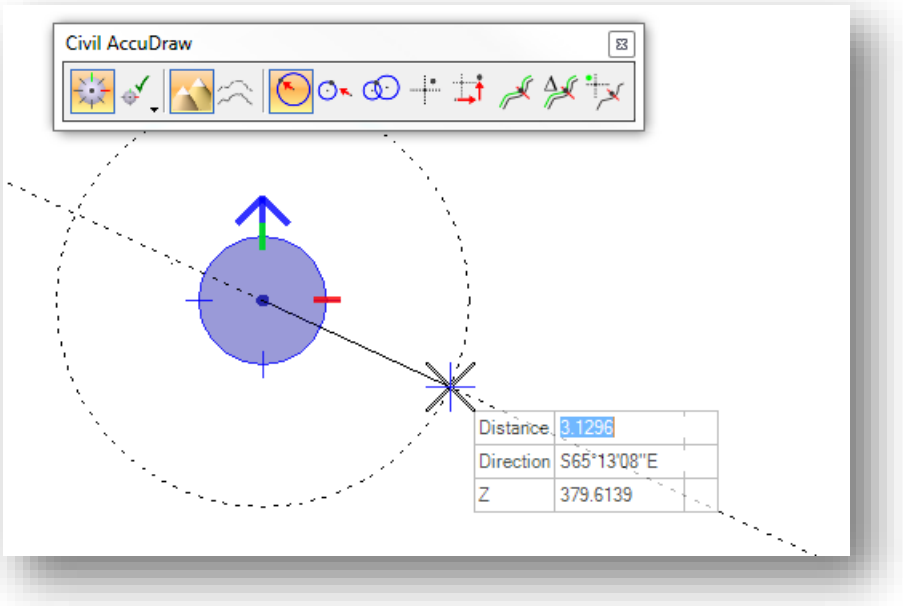
V rotates the drawing plane to align with the view axes.
T rotates the drawing plane to align with the axes in a standard Top view.
RQ is used to quickly and temporarily rotate the drawing plane.
RE rotates the drawing plane to match the orientation of a selected element.

Use the **T** (Top) shortcut or the corresponding drop-down to return to a pure direction.



Distance-Direction

The **Distance-Direction** ordinate is used to enter points in polar coordinates as shown below.



Angle Syntax

The input for angle and direction fields follows the MicroStation **Settings > Angle Readout** settings.

Valid forms for the various settings are as follows:

DD.DDDD, Radians or Grads - Use the customary decimal input.

DD MM SS or DD MM - The following delimiters are supported between degrees, minutes and seconds:

Colon - For example DD:MM:SS

^ (caret) to designate degrees, minute (’) and second (”) - For example DD^MM’SS”

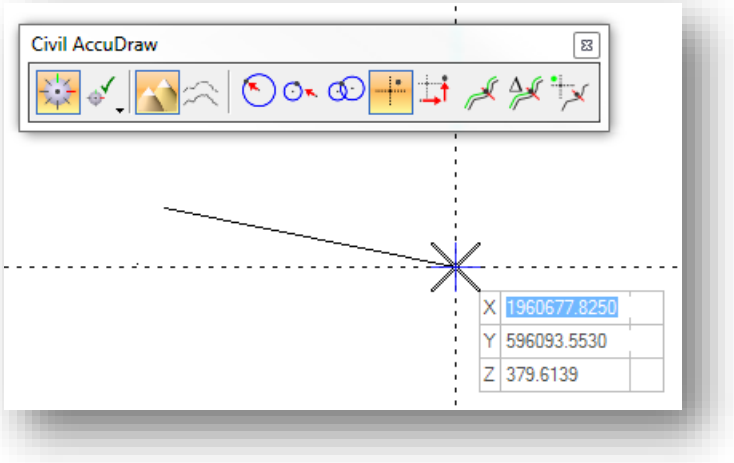
The following are not supported in the current version:

A space between degrees, minutes and seconds because space launches the Civil AccuDraw popup menu

Use of d, m and s to designate degrees, minutes and seconds.

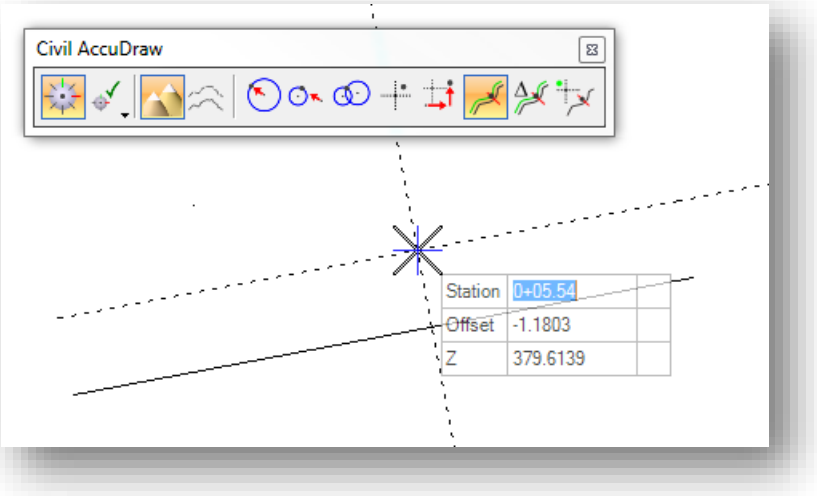
XY

Rectangular coordinates can be entered by use of the **XY** ordinate as shown below.



Station-Offset

The **Station-Offset** ordinate is used with a reference element to enter information as a station and offset relative to a selected element.



The reference element can be a MicroStation element or a Civil Geometry element. If a MicroStation element is selected, the beginning of the element is assumed to be station 0+00. If a civil element is selected with stationing defined, the station value of the selected element is used.

To select the reference element, with the **Station-Offset** ordinate active use the **O** shortcut to select the reference element. Once selected, data can be entered using station and offset values relative to the reference element as shown in the example above.

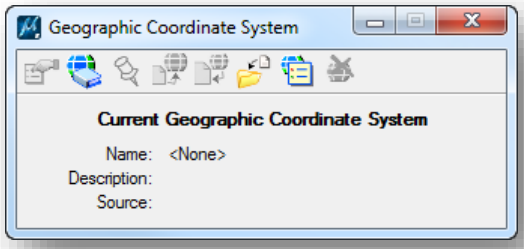
5 Geographic Coordinate Systems

MicroStation V8i contains Geo-Coordination features which allow users to specify the position of your design contents on the earth´s surface. Once that position is established, the design can be easily coordinated with other data for which the geographic location is known. A library of predefined **Geographic Coordinate Systems**, or **GCS** for short, is available in MicroStation.

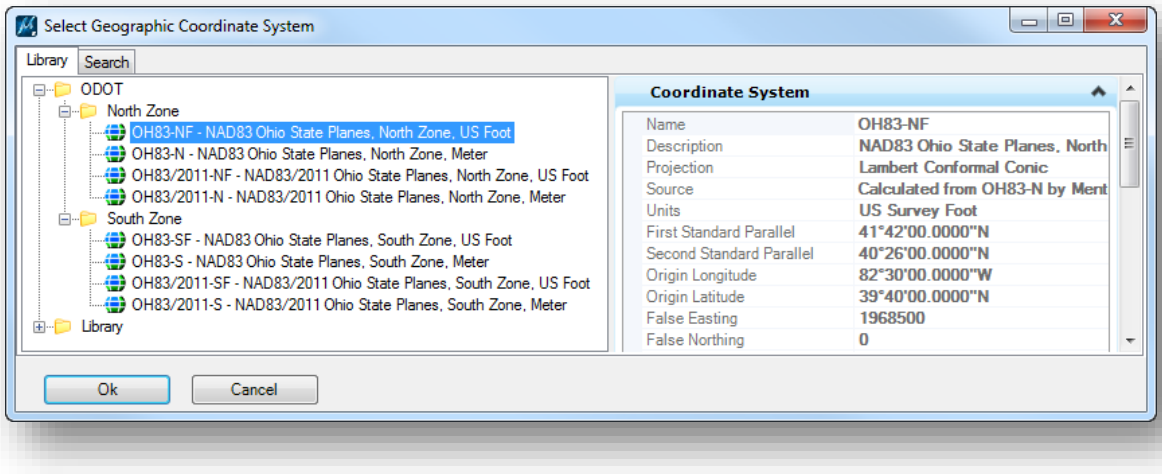
NOTE: The intent of the GCS is to define the location of the data for easy integration with other georeferenced data. It is not intended to be used to translate the data from grid to ground, or vice versa, on the fly. Once defined, the survey data should be left in the defined coordinate system.

Selecting a GCS

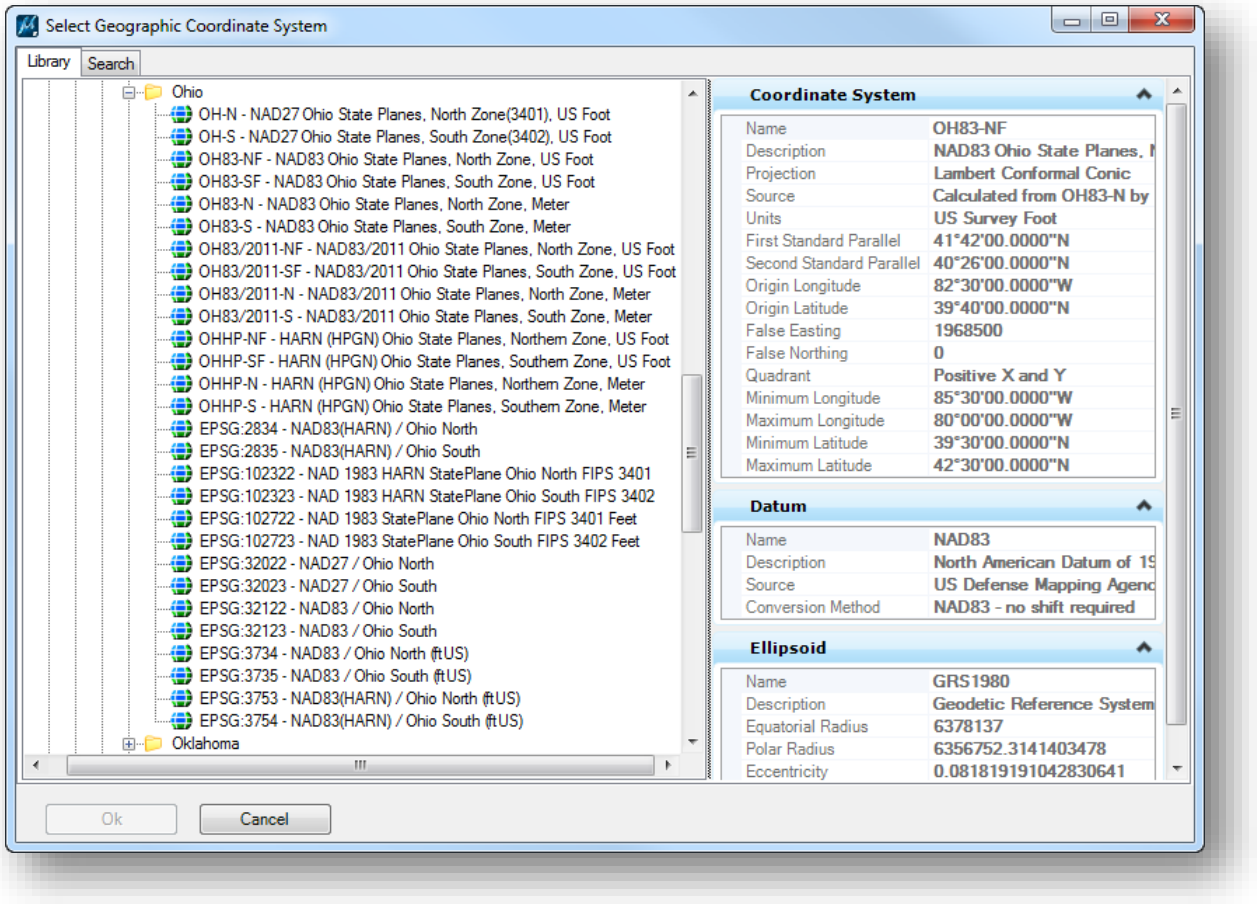
The GCS can be selected by choosing **Tools > Geographic > Select Geographic Coordinate System** from the MicroStation pull-down menu. The *Geographic Coordinate System* dialog shown below is opened.



To choose a GCS from the library, select the second icon, **From Library**. The *Select Geographic Coordinate System* dialog shown below is opened.



The ODOT workspace defines the State Plane coordinate systems typically used on ODOT projects in the **ODOT** folder as shown above. Choose the appropriate GCS from the list. A different GCS can be selected by browsing the **Library** folder. The available GCS definitions in the delivered library for Ohio are shown on the following page.



The GCS definitions for Ohio shown above are available by selecting **Library > Projected (northing, easting) > North America > United States of America > Ohio**.

When a GCS is initially selected, you are simply telling MicroStation where the data resides. It is important to note that choosing a GCS when one has not been previously defined does not re-project existing data in the design file to the selected GCS. The data is only re-projected when changing from one GCS to another.

Once a GCS is defined, MicroStation understands the geographic location of your design and provides additional capabilities such as:

- Referencing other geo-located designs and raster data.
- Displaying geographic latitude and longitude.
- Entering latitude and longitude data.
- Interfacing with a Global Positioning System device to correlate your physical position with the design on a mobile computer.

ODOT Seed Files

When a new project is created using the **ODOTcadd_CreateNewProject.exe** program, the Geographic Coordinate System for the project can be selected. The program then copies the ODOT seed file for the selected coordinate system to the \Design\Standards\seed folder for the project. Coordinate with the person who initially creates the project to ensure that the correct GCS is selected for the project.

The following seed files are available in the ODOTcadd Standards:

North Zone

Seed Files

- i:\ODOTcadd\Standards\Seed\ODOTSeed2d_OH83-NF.dgn
- i:\ODOTcadd\Standards\Seed\ODOTSeed3d_OH83-NF.dgn

GCS used:

- OH83-NF – NAD83 Ohio State Planes, North Zone, US Foot

Seed Files

- i:\ODOTcadd\Standards\Seed\ODOTSeed2d_OH83-2011-NF.dgn
- i:\ODOTcadd\Standards\Seed\ODOTSeed3d_OH83-2011-NF.dgn

GCS used:

- OH83/2011-NF – NAD83 Ohio State Planes, North Zone, US Foot

South Zone

Seed Files

- i:\ODOTcadd\Standards\Seed\ODOTSeed2d_OH83-SF.dgn
- i:\ODOTcadd\Standards\Seed\ODOTSeed3d_OH83-SF.dgn

GCS used:

- OH83-SF – NAD83 Ohio State Planes, South Zone, US Foot

Seed Files

- i:\ODOTcadd\Standards\Seed\ODOTSeed2d_OH83-2011-SF.dgn
- i:\ODOTcadd\Standards\Seed\ODOTSeed3d_OH83-2011-SF.dgn

GCS used:

- OH83/2011-SF – NAD83 Ohio State Planes, South Zone, US Foot

No GCS Defined

Seed Files:

- i:\ODOTcadd\Standards\Seed\ODOTSeed2d.dgn
- i:\ODOTcadd\Standards\Seed\ODOTSeed3d.dgn

GCS Used:

- None

The 3D Seed files should always be used for OpenRoads Survey projects.

Custom Geographic Coordinate Systems for Grid to Ground Conversions

Depending on the project, it may be necessary to convert the data from a State Plane coordinate system to ground coordinates for use by the designer, or use with other information that has already been converted to ground coordinates. This can be facilitated by using Bentley Map software by creating a custom MicroStation GCS. Once defined, the custom GCS can be shared with all users working on the project.

The steps to create a custom GCS are summarized below:

1. Compute the combined scale factor for the project.

2. Copy the MicroStation seed.dty file to the \Design\Survey\GCS folder for your project. This file will be used to define the custom GCS.

3. Define the MicroStation configuration variable MS_GEOCOORDINATE_USERLIBRARIES to specify the custom .dty file that contains the custom GCS definition. Note: This is done for you if the project was created using the ODOTcadd_CreateNewProject.exe tool.

4. Enable Bentley Map to edit the custom GCS definition to enter the combined scale factor.

5. Make the GCS available to other users of the project data by creating seed files for the project.

   Note: If the project folder structure and PCF file were created using the ODOTcadd_CreateNewProject.exe tool, steps 2 and 3 are completed for you.

Defining the GCS when using ODOTcadd_CreateNewProjects

If you used the ODOTcadd_CreateNewProjects.exe application to create the project, the steps to define the GCS have been simplified as much as possible. Take the following steps to define the GCS for the project. Note that this process should be done before the designers start work on the project.

1. **Establish the Combined Scale Factor for the project**
   To convert from grid coordinates to ground coordinates for a limited areal extent, a mean elevation factor and a mean scale factor for a region are multiplied to create a combined scale factor that is used for the custom GCS definition. The combined scale factor must be known before proceeding.

   The process to establish the combined scale factor for the project is outside the scope of this document. If the combined scale factor is unknown, contact the District Survey Operations manager.

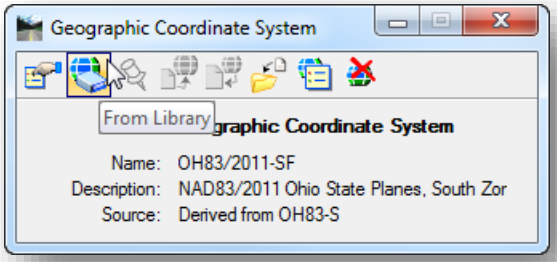
2. **Copy the Seed Files to the project folders.** This task is completed for you when the project is created using the ODOTcadd_CreateNewProjects.exe application.

3. **Define the MS_GEOCOORDINATE_USERLIBRARIES variable.** This step is completed for you when a MicroStation PCF file is created using the ODOTcadd_CreateNewProjects.exe application.

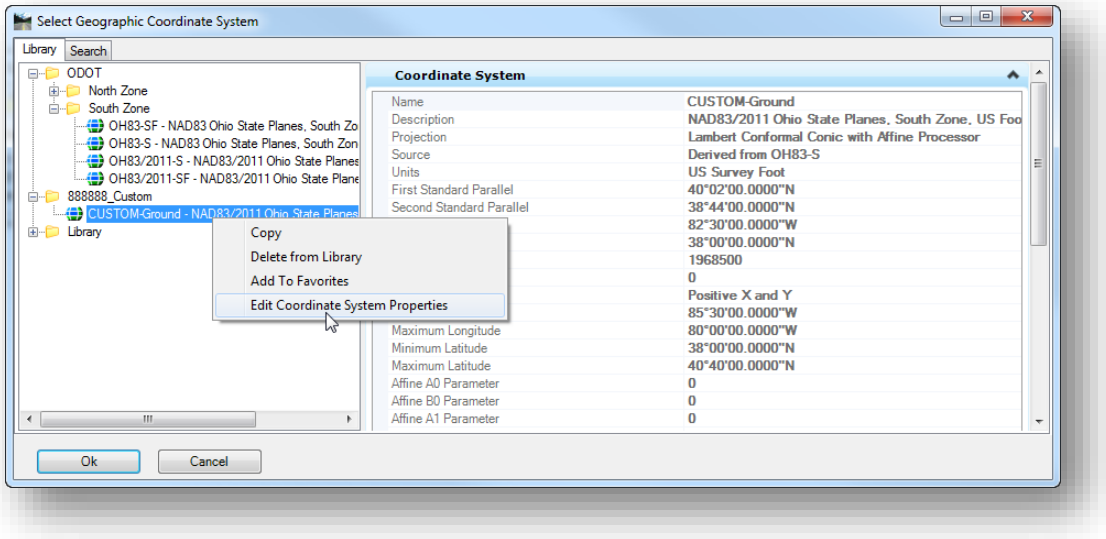
4. **Edit the custom GCS to include the combined Scale Factor.**
   Open the survey Field Book design file for the project. Bentley Map is used to define the custom GCS and must be activated in order to edit the custom GCS definition.

   ✓ Activate Bentley Map by selecting **GEOPAK > Map > Activate Map** from the MicroStation pull-down menu.
   Take the following steps to define the parameters for the custom GCS definition:

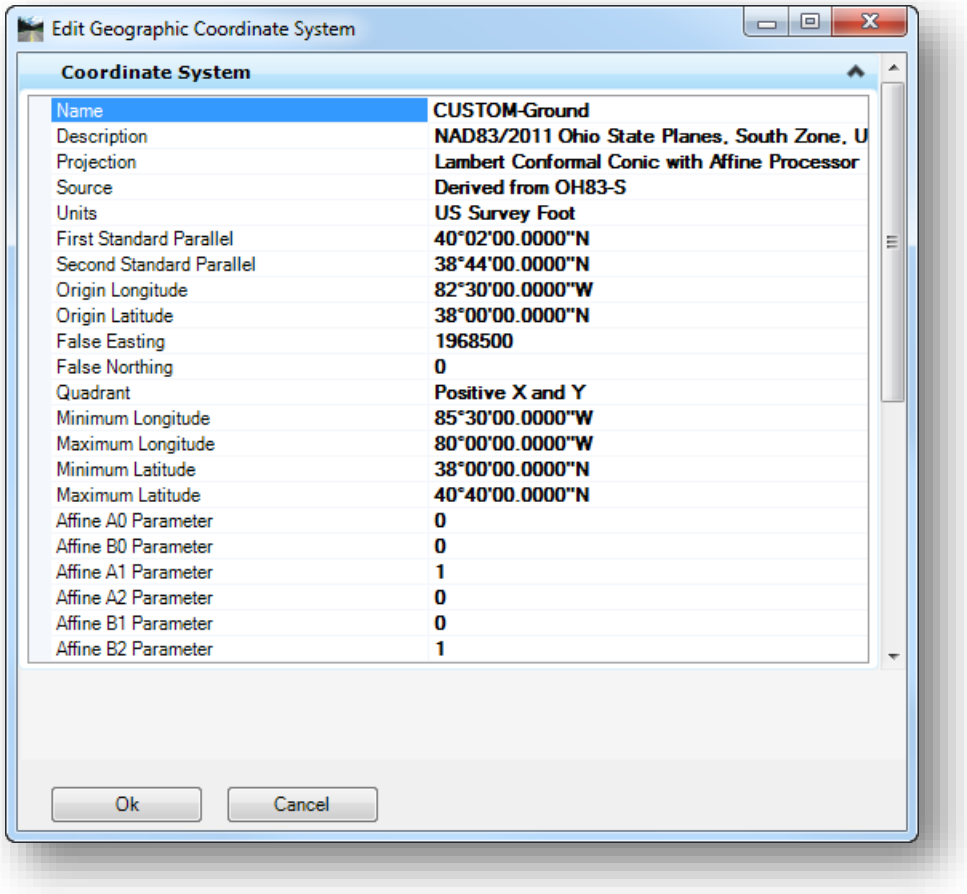
   ✓ Select **Tools > Geographic > Select Geographic Coordinate Systems** to open *the Geographic Coordinate Systems* dialog.



   ✓ Select the **From Library** icon to access the *Select Geographic Coordinate System* dialog. Right-click on the custom GCS name and choose **Edit Coordinate System Parameters** as shown below.



   The *Edit Geographic Coordinate System* dialog shown on the following page is opened.



Take the following steps in order to define the custom GCS for the project:

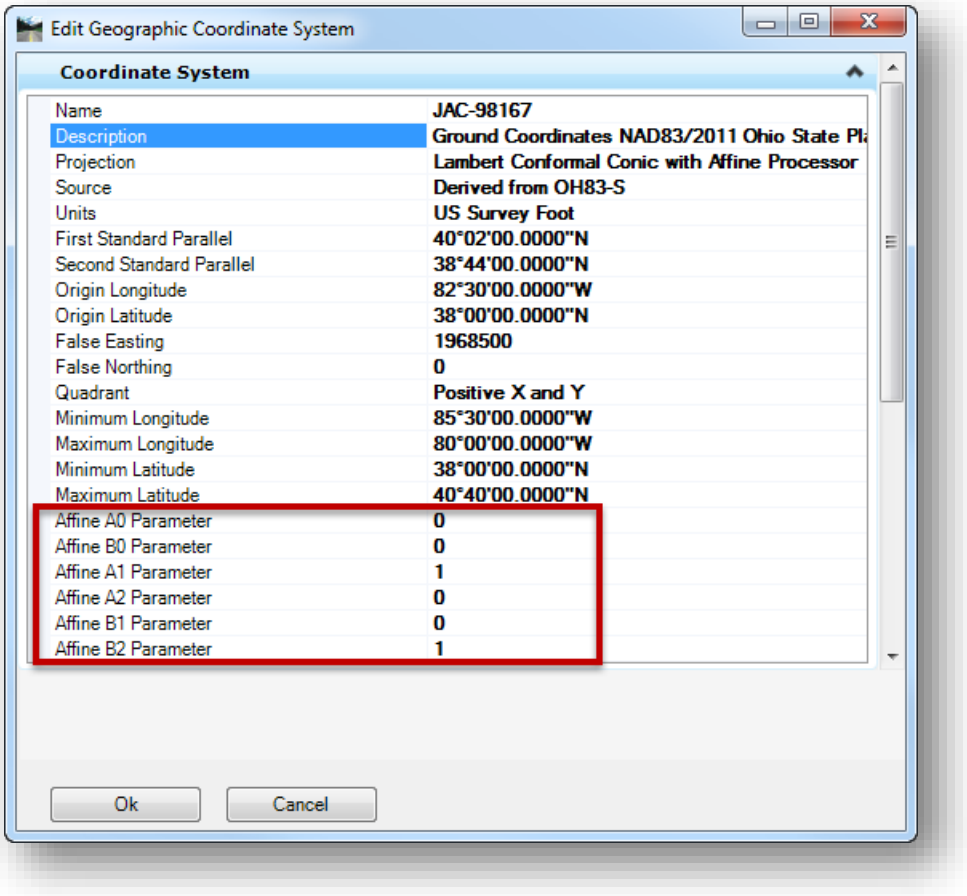
✓ Change the **Name** using the three-character County abbreviation and PID number for the project. ***Note that the name must start with alphabetic characters***.

Example: JAC-98167

✓ Edit the **Description** field to prepend it with the words “Ground Coordinates”.

✓ The **Projection** parameter should already be set to **Lambert Conformal Conic with Affine Processor**.

Map transformations will now initiate two processes: the map projection transformation followed by an affine transformation. Six additional parameters for an affine transformation are added to the *Edit Geographic Coordinate System* dialog as shown below.



✓ Insert the combined scale factor value for the affine parameters **A1** and **B2** which are set to a value of **1** as shown above.

Note: Compute the inverse if you are given the combined ground to grid factor

To help distinguish ground coordinates from grid coordinates, large values can be inserted into A0 for X and B0 for Y. This step is not normally done for ODOT projects.

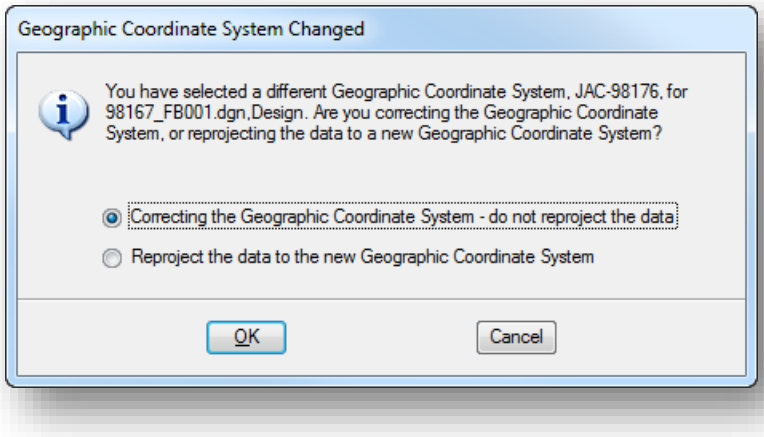
The A2 and B1 parameters should be 0.

✓ Select **OK** on the *Edit Geographic Coordinates* dialog to accept the changes.

✓ Select **OK** on the *Select Geographic Coordinate System* dialog to change to the ground coordinate system that you have just defined.

Note that this only defines the coordinate system for the active model in the active design file. The coordinate system must also be defined in any other models contained in the active file as well as the seed files for the project.

If you are changing the GCS definition to a new coordinate system, you ae prompted as shown on the following page.



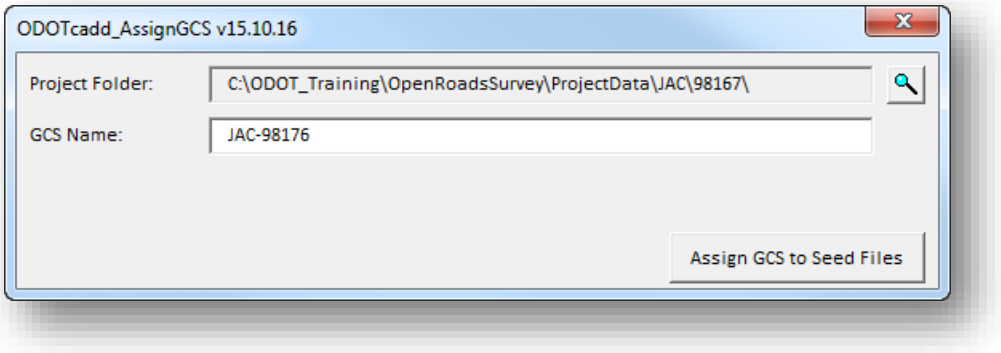
If the survey data is mapped using ground coordinates, and you are assigning a ground coordinate system, choose the **Correct the Geographic Coordinate System – do not reprojec t the data** option.

If the data was mapped in grid coordinates, and you wish to transform the data, choose the **Reproject the data to the new Geographic Coordinate System** option.

If the data was mapped on a grid coordinate system, and you wish to leave it on the grid, then do not choose the new ground coordinate system in the *Select Geographic Coordinate System* dialog. The designers can still use the new GCS definition to create design files in ground coordinates while referencing a survey basemap that is defined in grid coordinate values. The assigned GCS in the designer's file will align the two different coordinate systems as necessary.

5. **Assign the custom GCS to the seed files for the project.**
After the parameters for the custom GCS have been defined in the active Model in the Field Book survey design file, the GCS must also be assigned to the sheet model in the field book file as well as all models of the project specific seed files. An ODOT MicroStation Visual Basic application is provided for this task.

From the MicroStation pull-down menu, select **ODOT > Survey > AssignGCS to Seed Files**. The dialog shown below is opened.



The **Project Folder** value defaults to the current project folder as defined by the variable _USTN_PROJECTDATA which is defined in the PCF file for the project.

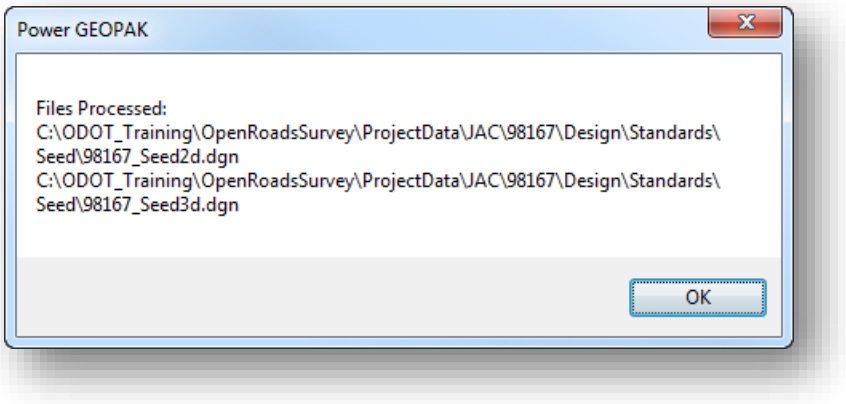
The **GCS Name** defaults to the currently assigned GCS in the active model. If no GCS is assigned, the application terminates.

Select **Assign GCS to Seed Files** to initiate the process. The program will search for dgn files in the following location, starting from the directory specified by the **Project Folder** definition:

\Design\Standards\Seed

In addition to processing the seed files, the program will process all of the models in the active design file.

When complete, the program will issue a message detaining the seed files that were processed.



Data Processing Scenarios

For ODOT projects processed using OpenRoads Survey the recommended procedure is to provide the surveyed information using State Plane coordinates with a custom GCS defined that can be used to reposition the data in ground coordinates if necessary. This provides a consistent product for ODOT's design staff, is consistent with the way Aerial mapping is delivered, and will reduce confusion over exactly what is being provided.

There are several processing scenarios to consider in order to provide the surveyed information in State Plane coordinates. Some common scenarios are presented below.

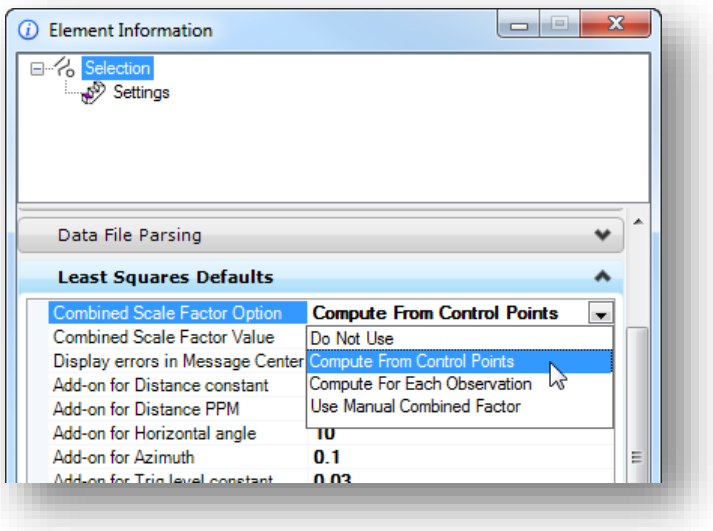
Raw observation data:

- Scenario 1: Control points on the State Plane, observations measured on the ground

  When processing raw data and the control points are in State Plane, set the GCS to the appropriate State Plane Zone before processing.

  - If you would like to have the software compute the combined scale factor, set the *Civil Standards > Survey Settings* **Combination Scale Factor Option** value to **Compute From Control Points** when processing raw data. The combined scale factor is reported in the Adjustment report (right-click on the **Adjustment** option in the *Project Explorer* dialog's **Survey** tree to show reports)

  - If the scale factor is known, select the **Use Manual Combined Factor** option to enter the value in the **Combined Scale Factor Value** field.



  Entering the scale factor, or having the software compute the scale factor, will ensure that the ground distances are scaled to the state plane grid, thus resulting in all your computed survey points being in state plane grid too. After that you can translate the data to ground by selecting a custom GCS for the project.

- Scenario 2: Control points on the ground, observations measured on the ground

  If your control points are ground coordinates, then set your survey settings **Combined Scale Factor Option** value to **Do Not Use** to process the raw data. The data will remain in ground coordinates.

  To translate the ground coordinates to the grid, it will be necessary to make a custom GCS for the ground coordinates using a combined scale factor. The custom GCS can be defined before or after processing as long as you have not previously selected a GCS. Once a custom GCS has been assigned, you can then choose the appropriate State Plane Zone to translate the data to the grid, if desired.

  Reduced Coordinates ASCII files:

- Scenario 3: Coordinates from RTK in State Plane

  When importing ASCII coordinates using an OpenRoads Survey TIW (Text Import Wizard), the coordinate system of the ASCII file can be defined as part of the wizard.

  - If the ASCII coordinates are in a State Plan Zone, the coordinate zone for the ASCII file has been defined in the TIW, and the MicroStation file is set to ground coordinates using a custom GCS, the survey software knows to do a transformation on the fly when bringing in the coordinates.

  - If the ASCII file is in State Plane coordinates, set the GCS to the appropriate State Plane zone and bring in the coordinates. The data can then be converted to ground using a custom GCS.

- Scenario 4: Ground coordinates

  The custom GCS can be defined in the Survey TIW (Text Import Wizard). If a State Plane GCS has been defined in the active file, the survey software will do the translation on the fly when bringing in the coordinates.

CGS Frequently Asked Questions:

- Do I have to define a GCS?

  The GCS is used to coordinate information defined in one coordinate system with information defined in another coordinate system. If you are not working with data that is defined using multiple coordinate systems or you do not need to do any grid-to-ground conversions with the data, then a GCS does not need to be selected. However, defining the GCS for the data may provide advantages for other users of the data.

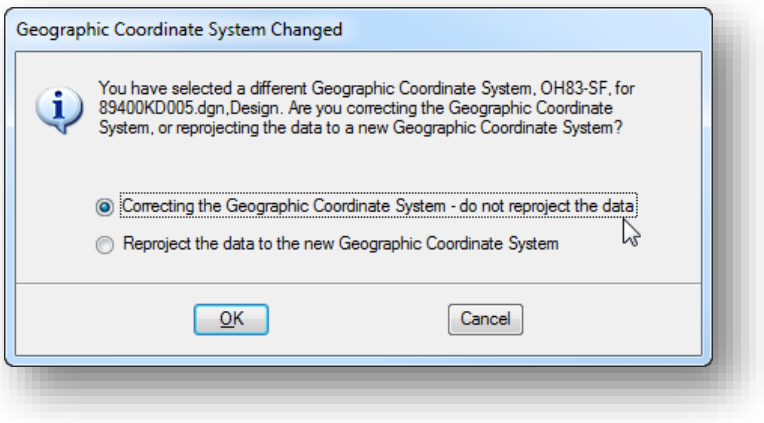
- Does choosing a GCS automatically reposition data already drawn in the design file?

  The initial selection of a GCS does not reposition data that is already drawn in the design file; you are simply telling MicroStation where the data resides.

  If a GCS has been previously defined, choosing a different GCS will transform the data to the newly select GCS.

- What happens if I choose the wrong GCS and need to change it later?

  If a GCS has been previously defined, when a new GCS is selected you are prompted whether to reposition the data as shown below. To correct the GCS, choose the option **Correct the Geographic Coordinate System – do not reposition the data** as shown below.



- What if I have defined a custom GCS for ground coordinates in the Survey design file but the designers are using design files with no zone defined?

  As long as the designers are tying into/referencing the survey data to lay out their design, this really does not matter. If you have created and activated a custom GCS for grid to ground transformation, the designers are working in ground coordinates whether they know it or not. The custom GCS definition can be applied to the designer's files at any time, if needed.

- What do I do if I am adding new survey data that is in grid coordinates to an existing design file in ground coordinates, and the existing design file does not have a custom GCS defined?

  The best way to handle this is to create a custom GCS for the grid to ground conversion before importing the new data. After applying the custom GCS to the existing design file, the existing data can be repositioned on the grid by selecting the appropriate State Plane GCS before importing the new survey data.

  Remember, the initial selection of the GCS does not reposition existing data in the design file, it just tells MicroStation where the data resides.

- What do I do if I am adding new survey data that is in grid coordinates to an existing design file that has a custom GCS defined?

  When survey data is imported, the TIW (Text Import Wizard) can be configured to specify the coordinate system for the data. If the coordinate system is defined in the TIW, the survey software will transform the data on the fly as it is imported.

- What happens if the design file I am in has a GCS defined but I reference a file/model that does not have a GCS defined?

  The reference attachment will be displayed at the coordinates specified in the referenced model as they relate to the selected GCS in the active file. For example, a telephone pole drawn at coordinates (1000, 1000) in the referenced model will display at coordinates (1000, 1000) in the active file.

- What happens if the design file I am in does not have a GCS defined but I attach a reference to a file that does have a GCS defined?

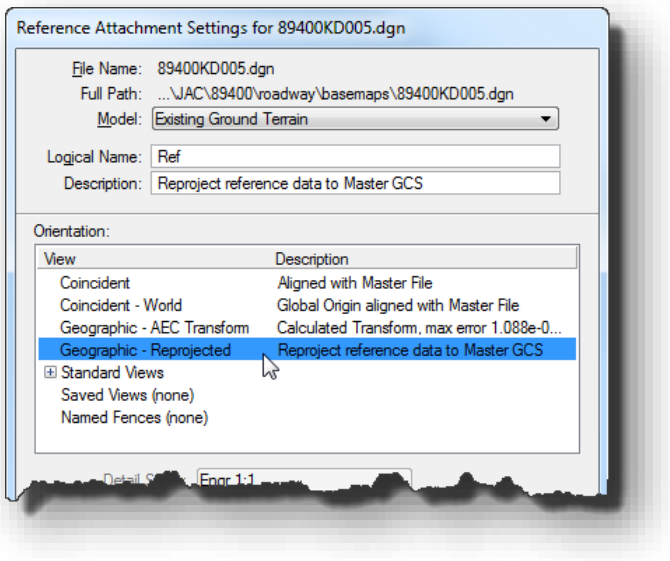
  The reference attachment will be displayed at the coordinates specified in the referenced model as they relate to the coordinates in the active file. For example, a telephone pole drawn at coordinates (1000, 1000) in the referenced model will display at coordinates (1000, 1000) in the active file.

- What happens to reference file attachments if I change the GCS in the active file?

  Reference file attachments are not repositioned when changing the GCS in the active file. If the data needs to be displayed on a different GCS, each file/model must be edited individually to change the GCS.

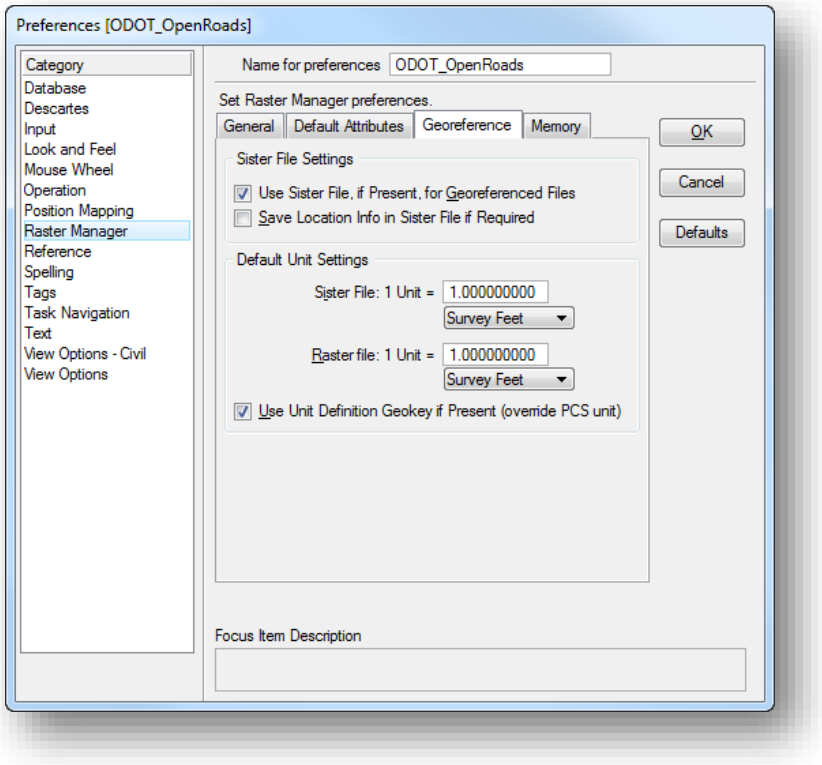
- What happens if I reference a model from a design file that has a different GCS defined?

  When a reference is attached, an **Orientation** option is available to reposition the data using the master GCS as shown below.



- How are OSIP imagery and Mr. Sid files impacted by the GCS?

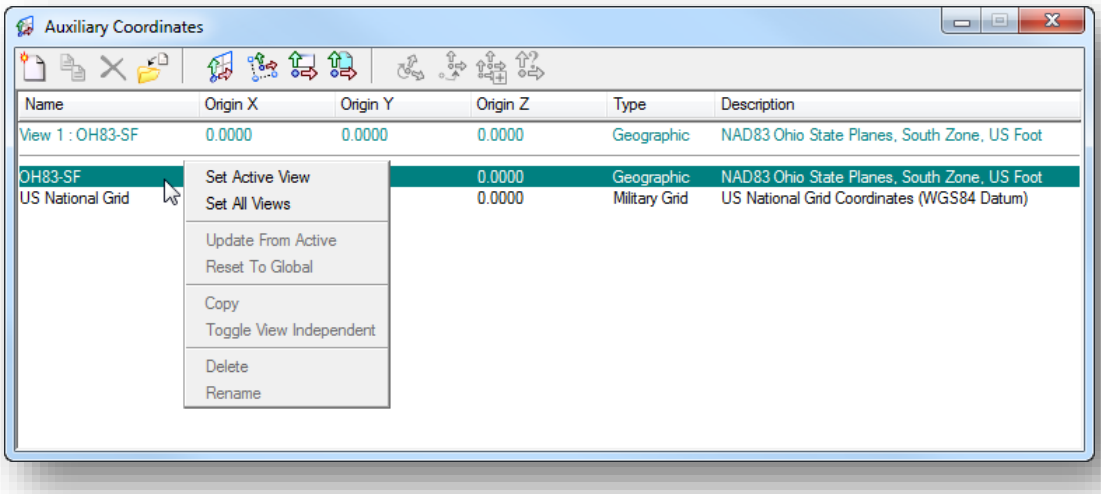
  MicroStation design file preferences have settings for georeferences as shown below. In general, you should not have any problems referencing imagery when a GCS is defined.



Longitude and Latitude Coordinates

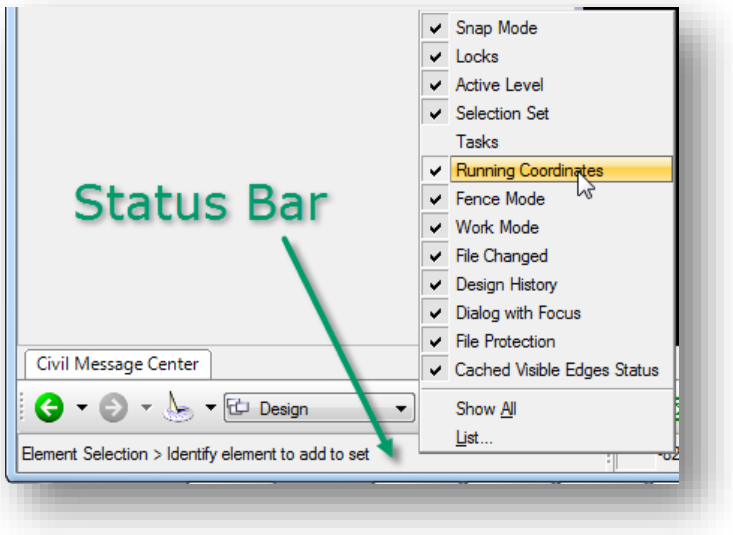
When a geographic coordinate system is assigned to a model, it appears in the *Auxiliary Coordinates* dialog (**Tools > Coordinate Systems > ACS > Auxiliary Coordinates**). When it is made the active auxiliary coordinate system, data can be entered in longitude, latitude format, and coordinate readout can be set to show longitude and latitude.

- Select **Tools > Coordinate Systems > ACS > Auxiliary Coordinates** to open the *Auxiliary Coordinates* dialog shown below.

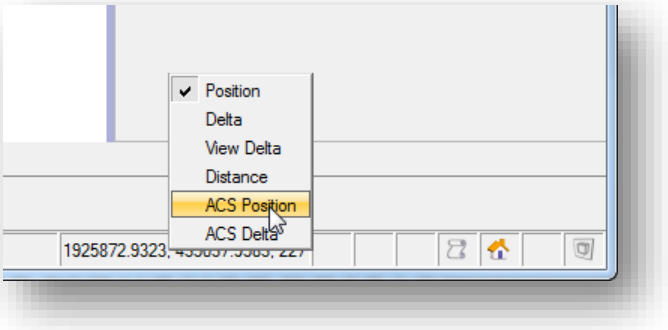


- Right-click on the coordinate system in the list and choose either the **Set Active View** or **Set all Views** option.

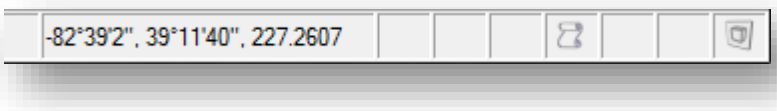
- To get a longitude, latitude coordinate readout, turn on **Running Coordinates** by right-clicking the status bar (located to the lower left of the MicroStation window as shown below).



- Next, click on the coordinates (located at the bottom of the MicroStation window, towards the right side) and select **ACS Position**.



As the cursor is moved in the MicroStation window, the running coordinates will display in longitude and latitude format as shown in the example below:



The mode, precision, and format of the longitude and latitude values are controlled in the *Design File Setting* dialog under **Angle Readout** and **Working Units**.

Click on the coordinates display and select **Position** to change the readout back to X, Y, Z coordinates.

Exercise 4 – Defining a Custom GCS for Grid to Ground Conversions

In this exercise we will create a custom Geographic Coordinate System for the JAC-98167 dataset. The survey data for this example is contained in two .dc files; one for the topography, and one for the bridge deck. The data files are in ground coordinates.

- ✓ When the project was created using ODOTcadd_CreateNewProject.exe, the DTY file for the OH83/2011 South coordinate system was copied into the project folder:

  C:\ODOT_Training\OpenRoadsSurvey\ProjectData\JAC\98167\Design\survey\GCS\98167_custom.dty

  Verify that the file exists in the folder listed above.

- ✓ The MicroStation Project Configuration File (PCF) file for the project contains the configuration variable definition to assign the custom DTY file. Open the following PCF file to verify that the variable definition exists:

  C:\ODOT_Training\OpenRoadsSurvey\ProjectPCF\JAC-98167.pcf

  The variable is defined as follows:

  MS_GEOCOORDINATE_USERLIBRARIES =
  $(_USTN_PROJECTDATA)survey/GCS/98167_Custom.dty

- ✓ Open MicroStation using the shortcut for the training class.

- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **JAC-98167**

- ✓ Open the following design file. The Survey Data has already been processed for the project.

  \Survey\RawData\98167_FB001.dgn

- ✓ From the **Survey** group in the *Project Explorer* dialog, create a new field book for the first .dc file by right-clicking on the Field Books item and choosing the New... option. Right-click on the new field book and choose the **Properties** option to rename the field book to “Topo”.

- ✓ Load the first data file by right-clicking on the new field book and choosing the **Load File** option. Load the following data file:

  \Survey\RawData\JAC-98167-TOPO.dc

- ✓ We will process the bridge deck information in a separate field book. Create a new field book and rename it “Bridge Deck”. Load the following data file into the bridge deck field book.

  \Survey\RawData\JAC-98167-BD.dc

- ✓ Activate **Bentley Map** by selecting **Applications > Map > Activate Map** from the MicroStation pull-down menu.

- ✓ Select **Tools > Geographic > Select Geographic Coordinate System** to access the *Geographic Coordinate System* dialog.

- ✓ From the *Geographic Coordinate System* dialog, select the **From Library** icon to access the *Select Geographic Coordinate System* dialog.

- ✓ A folder containing the GCS definition is available in the library. Right-click on the custom GCS and choose the **Edit Coordinate System Properties** option. Make the following changes:

  Name: JAC-98167
  Description: Ground Coordinates NAD83 Ohio State Planes, North Zone, US Foot
  A1 Parameter: 1.000079806
  B2 Parameter: 1.000079806

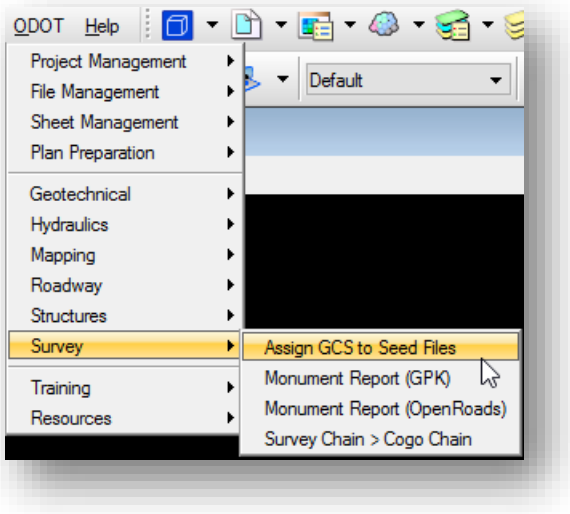
- ✓ Apply the changes to save the new GCS definition. When the *Geographic Coordinate System Changed* dialog opens, select the option: **Correcting the Geographic Coordinate System – do not reproject the data**.

Next we will update the seed files for the project to use the GCS definition.

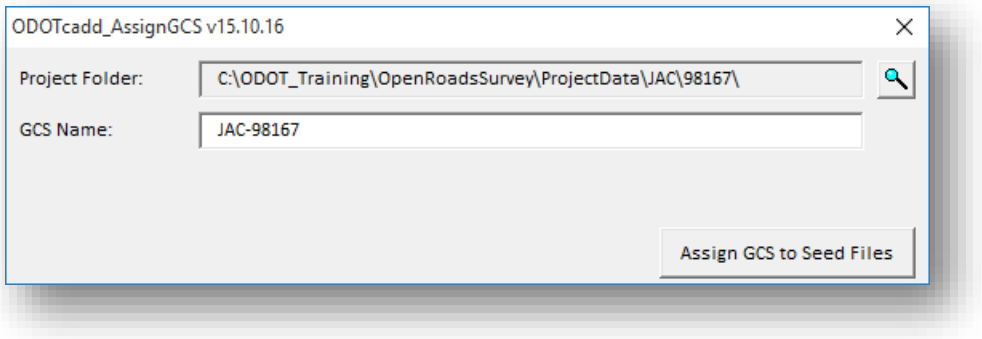
- ✓ When the project was created, the following seed files were copied into the \standards\seed folder for the project:

  \98167\Design\standards\seed\98167_Seed2d.dgn
  \98167\Design\standards\seed\98167_Seed3d.dgn

  The seed files can be updated to use the custom GCS definition by use of an ODOT MicroStation Visual Basic application. From the MicroStation pull-down menu, select **ODOT > Survey > Assign GCS to Seed Files**, as shown below.



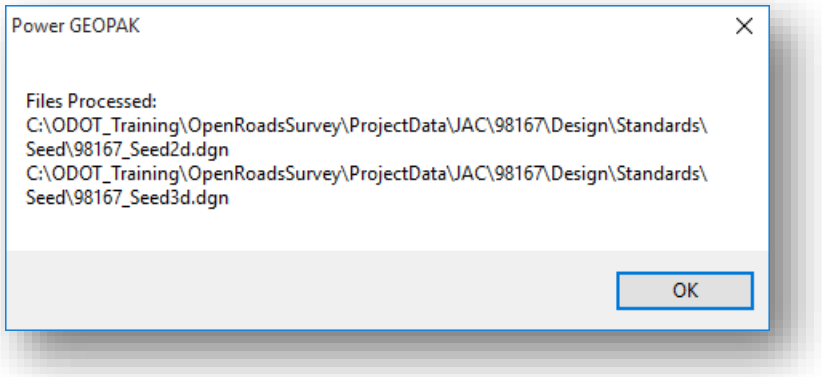
The dialog below is opened.



The **Project Folder** defaults to the value defined for the project in the MicroStation PCF file.

The **GCS Name** defaults to the currently assigned GCS in the active MicroStation model.

Select the **Assign GCS to Seed Files** button to initiate the process. The defined GCS is assigned to the seed files for the project.
When the process is complete, a report is displayed to the user documenting the files that were processed similar to the example below.



- ✓ After the process is complete, open the seed files to verify that the GCS was assigned properly
- ✓ When complete, exit MicroStation.

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6 Processing Reduced Coordinates

Reduced Coordinates CSV File Format

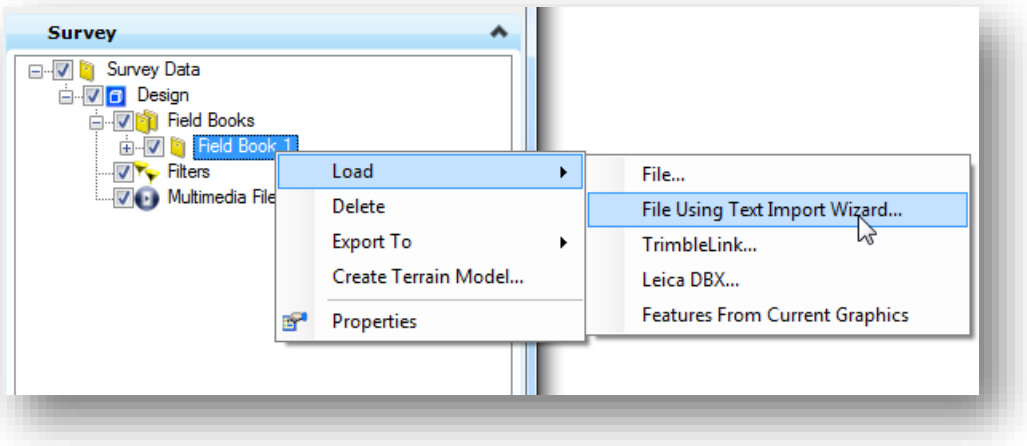
CSV files containing reduced coordinates are normally created from a Trimble JOB file using the Trimble ASCII File Generator as detailed in Chapter 3 of this training guide. When the ASCII File Generator is used to create the CSV file, the format of the CSV file is fixed and can be imported using one of the predefined import formats.

Occasionally it may be necessary to import a CSV file that has the columns arranged in a different order. When you import reduced coordinate files in CSV (Comma Separated Value) format, a TIW (Text Import Wizard) file is used to specify the format of the .csv file. Let's take a look at the procedure to define your own TIW files.

The TIW file is simply an ASCII file that defines the fields contained in the .csv file to be imported. An example of a TIW file with a defined GCS is shown below:

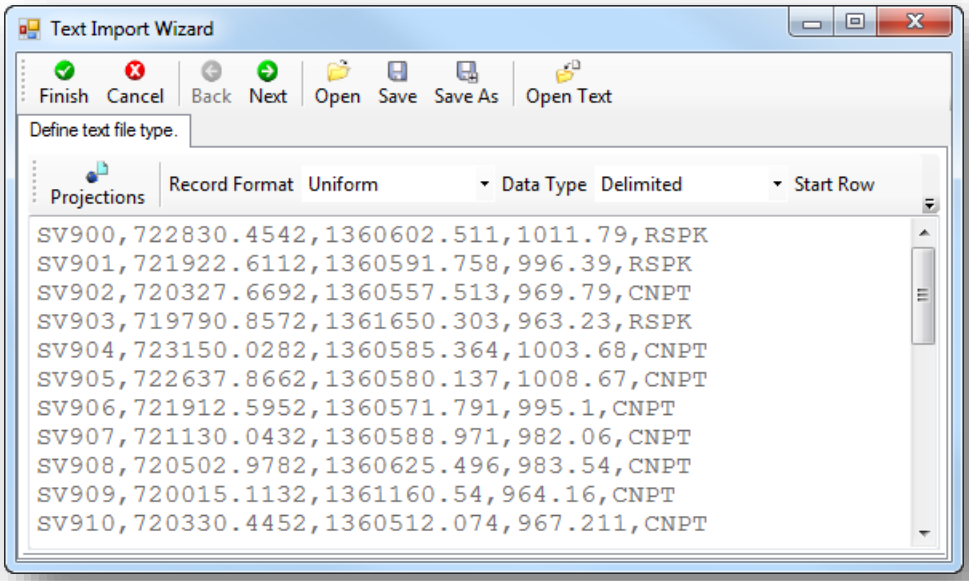
```
Data Type          = Delimited
Start Row          = 1
Record Format      = Simple
Comma              = Yes
Column Format      = Point Name
Column Format      = Northing
Column Format      = Easting
Column Format      = Elevation
Column Format      = Code
Projection Input   = OH83-SF
Projection Output
```

The Text Import Wizard is invoked when importing data into a Field Book by selecting **Load > File Using Text Import Wizard…** as shown below.



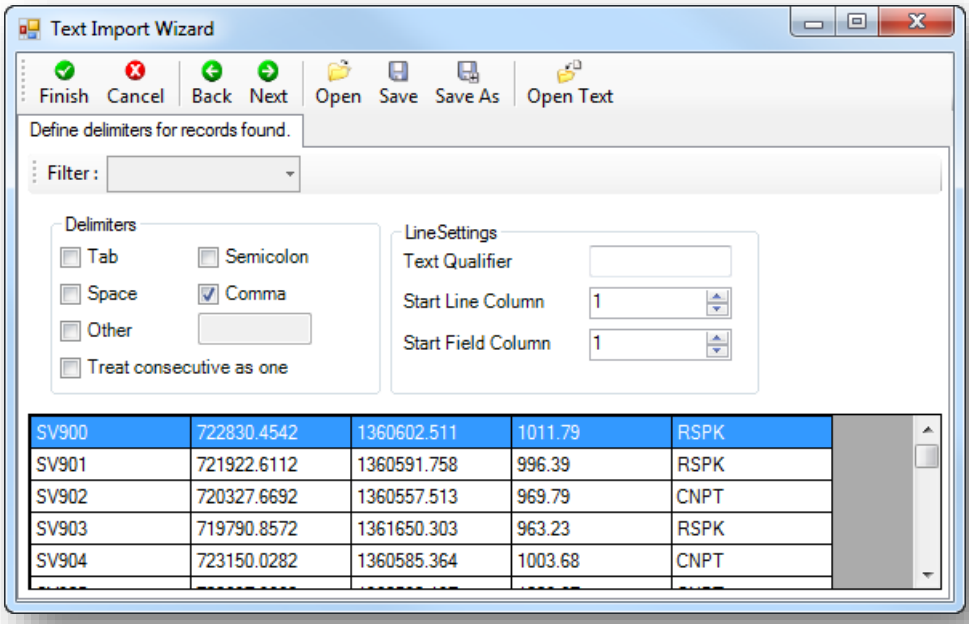
The *Select File* dialog is opened to select the .csv file to import.

After the file is selected, the *Text Import Wizard* dialog is opened as shown below.

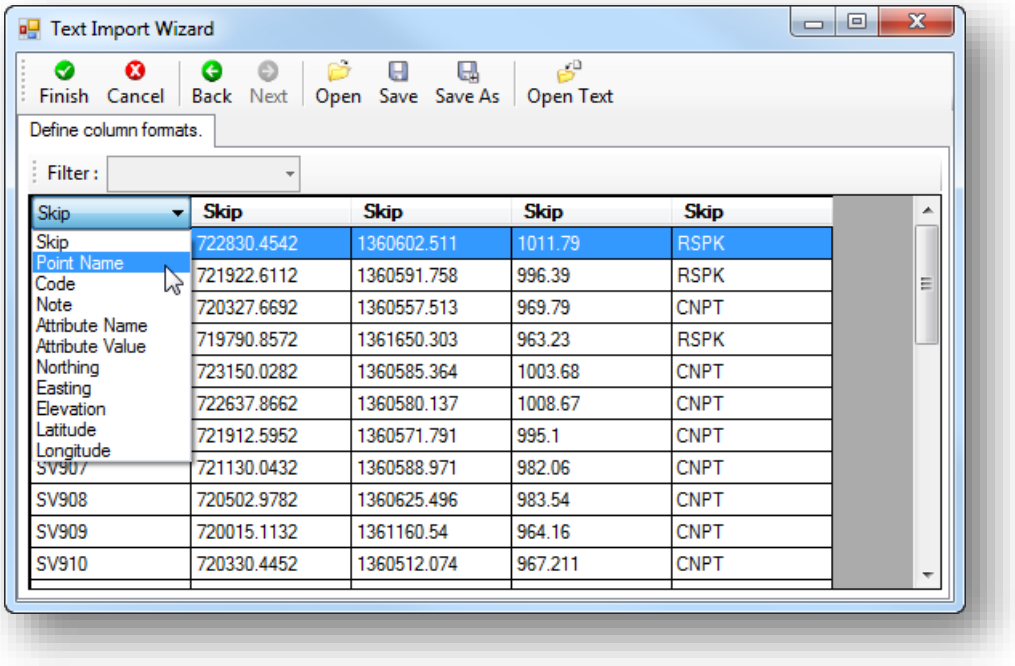


The contents of the selected CSV file are displayed in the dialog.

Use the **Back** and **Next** buttons to step through the options to configure the TIW file. When the **Next** button is selected, the option to define the delimiter is available as shown below. For CSV files, check on the **Comma** option as shown below.



Select **Next** to move to define the contents of each column in the CSV file as shown on the following page.



Each column in the CSV file has a header that is used to define the contents of the column. Each column will default to **Skip** as shown above. Clicking on the column heading will reveal a list of options that can be used to define the column content as shown above.

After defining each column, select **Finish** to complete the TIW configuration. The TIW file can be saved and reused should you need to reimport the data, or copied to another project for reuse without the need to step through the TIW configuration process. You are prompted to save the TIW and to choose a name/location to save the file. Saving the TIW file is optional.

Exercise 5 – Configuring TIW Settings

In this exercise we'll import a comma separated ASCII file containing reduced coordinates for a project using the Text Import Wizard.

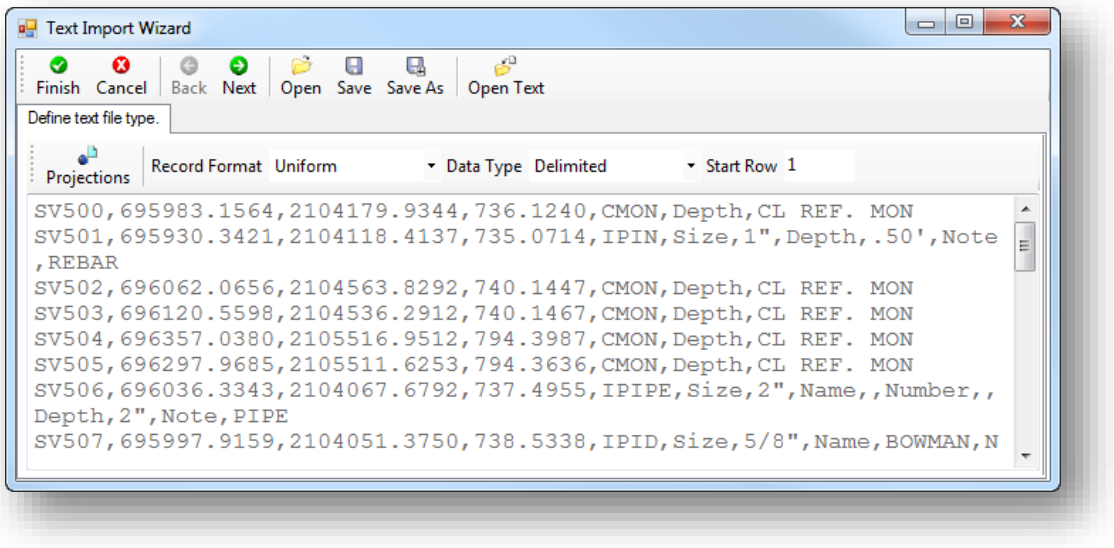
- ✓ Open MicroStation using the shortcut for the training class.
- ✓ From the MicroStation File Open dialog, select the **Project** configuration file **MUS-92256** and open the following design file:

  \Survey\RawData\92256_FB001.dgn

- ✓ Create a new **Field Book**.
- ✓ Edit the field book properties to name the field book M92256A2
- ✓ Right-click on the new field book and choose the **Load > File Using Text Import Wizard…** option. The *Select File* dialog is opened. Open the following file:

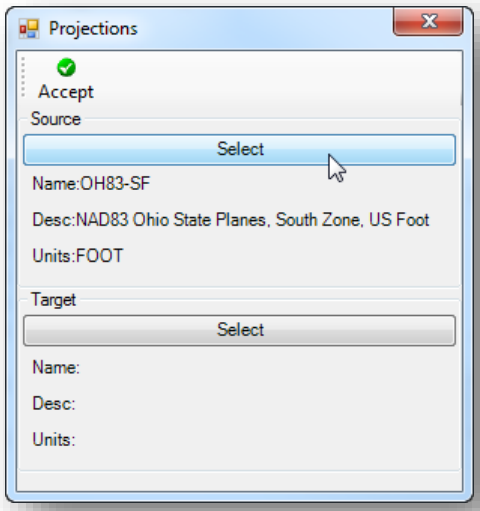
  \survey\rawdata\M92256A2.csv

  The *Text Import Wizard* dialog is opened.



The content of the selected CSV file is displayed in the dialog as shown above.

✓ Geographic Coordinate Systems can be defined as part of the TIW import process. From the *Text Import Wizard* dialog, select the **Projections** button to access the *Projections* dialog shown below.

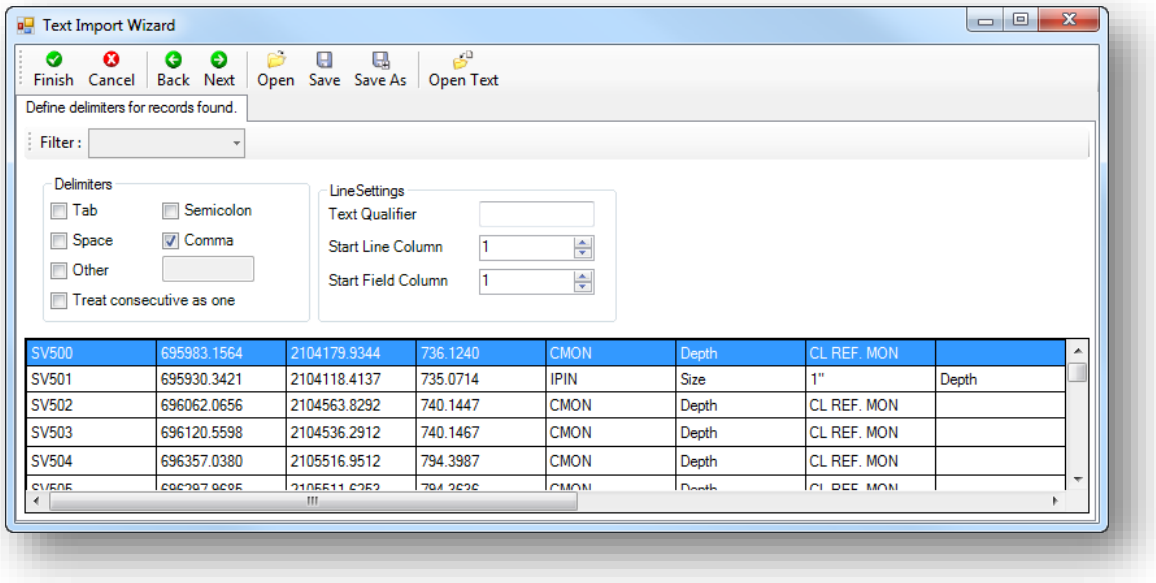


Use the **Select** button to choose the GCS for the data.

The **Target** is ignored by the software. The active GCS in MicroStation is used as the target. If the active GCS is different than the source GCS, the survey software will adjust the data on the fly.

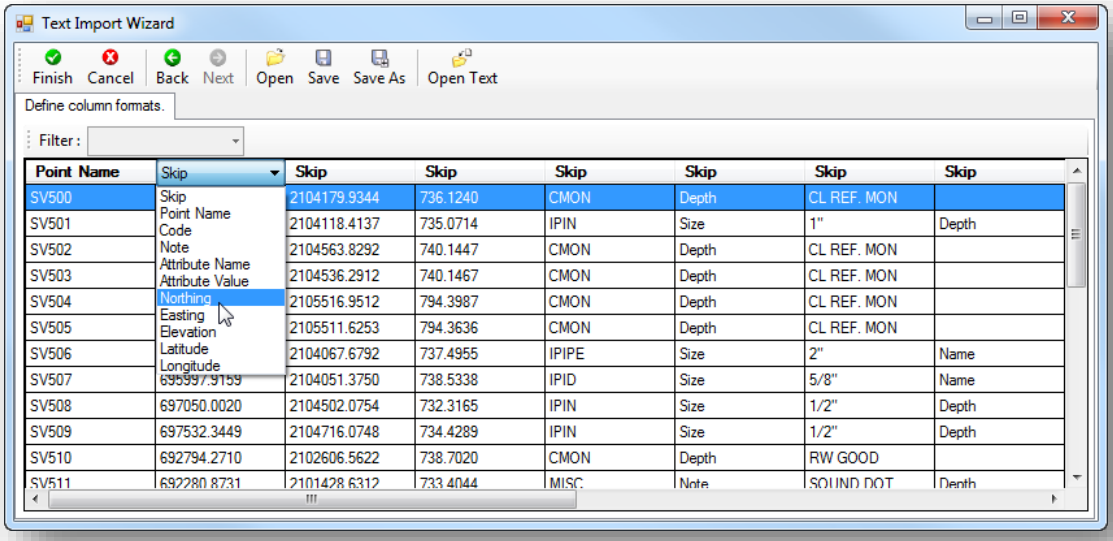
✓ Select the **Next** button on the *Text Import Wizard* dialog to move to the next step of the wizard.

Define the **Delimiter** by checking on the **Comma** option. The data is separated into columns as shown below.



Select the **Next** button to go to the next step of the wizard.

✓ The next step of the wizard will allow you to define the contents of each column. Each column has a drop down menu of options to identify the content of the columns. By default, each column is set with a value of **Skip**.



✓ Define each column appropriately before selecting the **Finish** button. For this dataset, the columns should be defined as listed below. Note that there are five attributes in this dataset.

Point Name
Northing
Easting
Elevation
Code
Attribute Name
Attribute Value
Attribute Name
Attribute Value
Attribute Name
Attribute Value
Attribute Name
Attribute Value
Attribute Name
Attribute Value

✓ Select the **Finish** button to initiate processing the data.

- ✓ You are prompted to create a new tiw file. Select **Yes** to save the tiw file in the \survey\rawdata folder for this project. Name the file using the five digit PID number for the project: 92256.tiw

- ✓ You are next prompted to save the tiw file format in the import settings. Select **Yes** to save these settings for this project.

The data is mapped to the file and the terrain model is created.

- ✓ Set the design file **Drawing Scale** to your preferred value to review the data.

- ✓ After looking over the data, select **File > Save Settings** and then **File > Save**.

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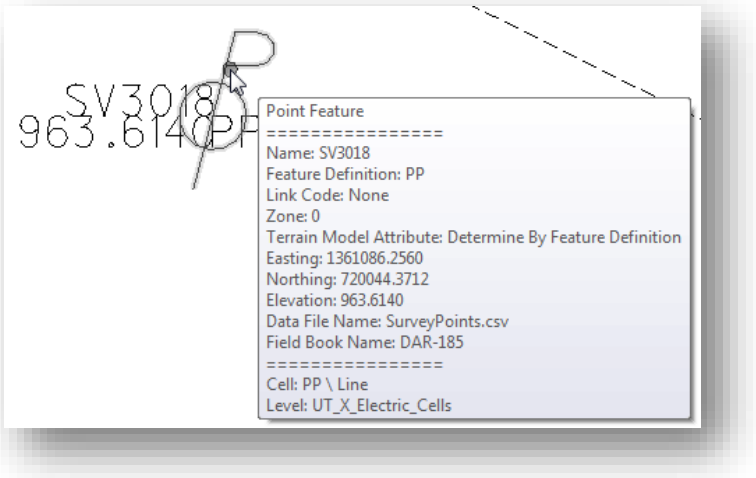
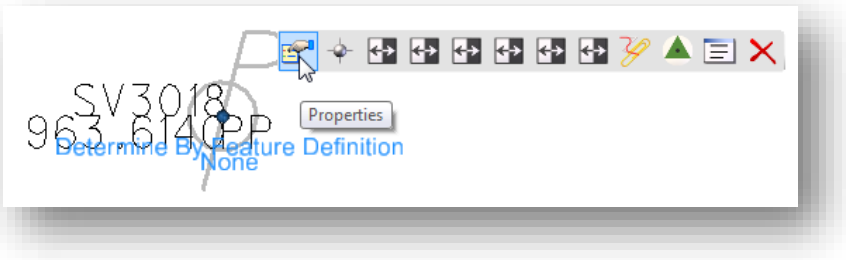
7 Reviewing and Editing Survey Data

Reviewing and Editing Points

To review a single survey point, simply float the cursor over the point. A pop-up menu with information about the point will appear similar to the example below.



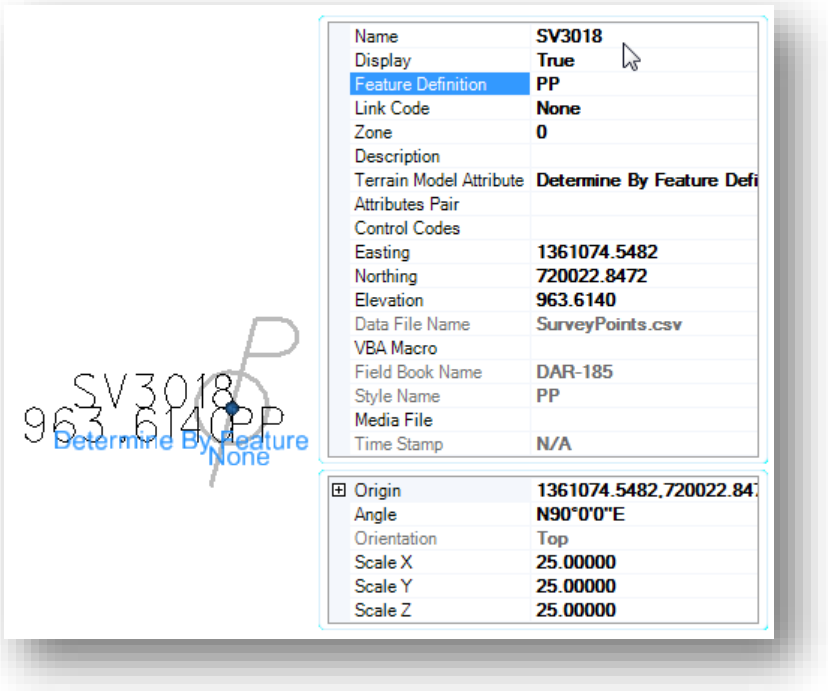
The MicroStation **Element Selection** command can be used to review or edit various properties of a selected point. When a point is selected, a menu of commands will appear onscreen as shown below.



The following commands are available:

- Properties
- New Point Feature
- Turn on/off Name
- Turn on/off Feature
- Turn on/off Description
- Turn on/off Elevation
- Turn on/off Custom Operations
- Turn on/off All annotations
- Report
- Create Control Point
- Edit Observations
- Delete

Select the **Properties** item from the pop-up menu to access the dialog shown below.

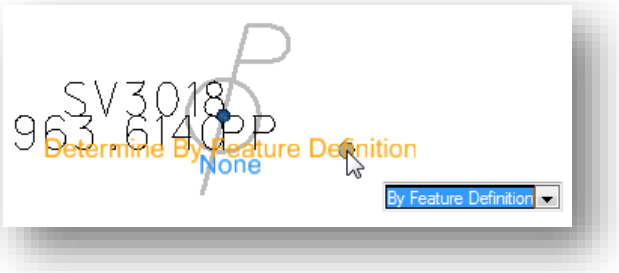


This is the easiest way to edit the attributes of a point. Nearly every field in the dialog is editable.

Note: The **Scale** fields represent the current MicroStation **Annotation Scale** setting and should not be edited.

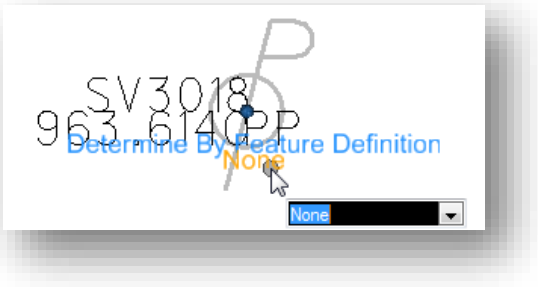
In addition to the pop-up menu options, two editable fields are displayed below the selected point.

Terrain Model Attribute
To edit the **Terrain Model Attribute**, select the point and then select the first field as shown below.



To change the value, use the up and down arrow keys on the keyboard.

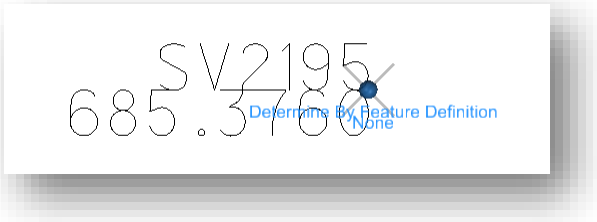
Link Code
To edit the **Link Code**, select the point and then select the second field as shown below.



To change the value, use the up and down arrow keys on the keyboard.

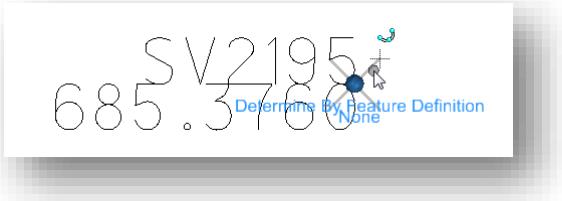
Moving Points

Occasionally it may be necessary to graphically move a point to a new location. When a survey point is selected using the MicroStation element selection tool, the origin of the point is highlighted with a circle as shown in the example below.



Using the **Element Selection** tool, the circle can be selected to move the point, however, when a point is moved by selecting the circle it will not only be moved to the X,Y position you choose but also to the current MicroStation Active Elevation.

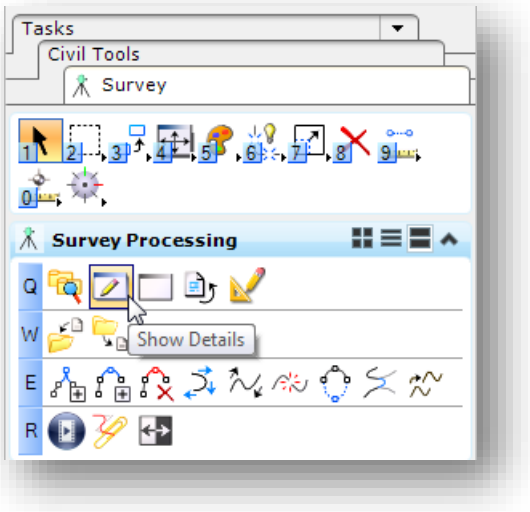
To move a point and preserve the elevation value, use the **Element Selection** tool to select the survey point at any location other than the circle at the point origin. Drag the point to the new location. The Z value will be preserved when moving a point in this manner.



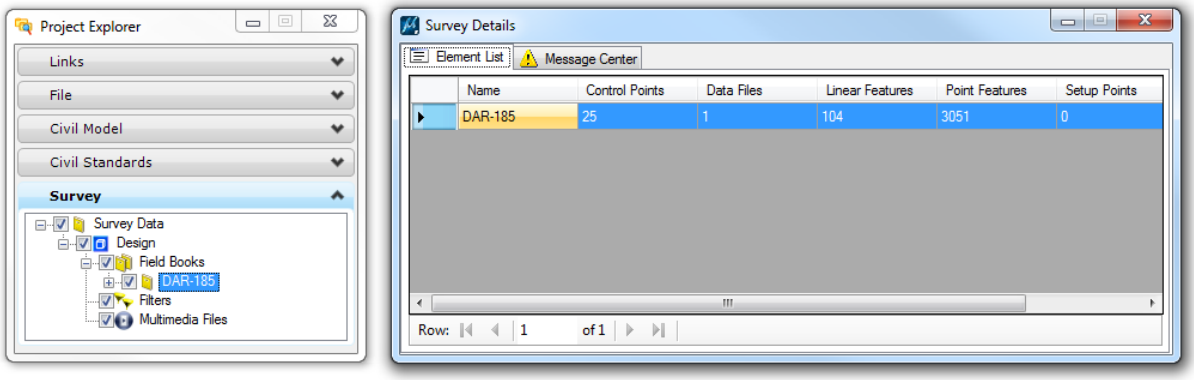
To move a point to known coordinates, edit the coordinate values in the **Point Properties** dialog shown on the previous page.

Editing Points with the Survey Details Dialog

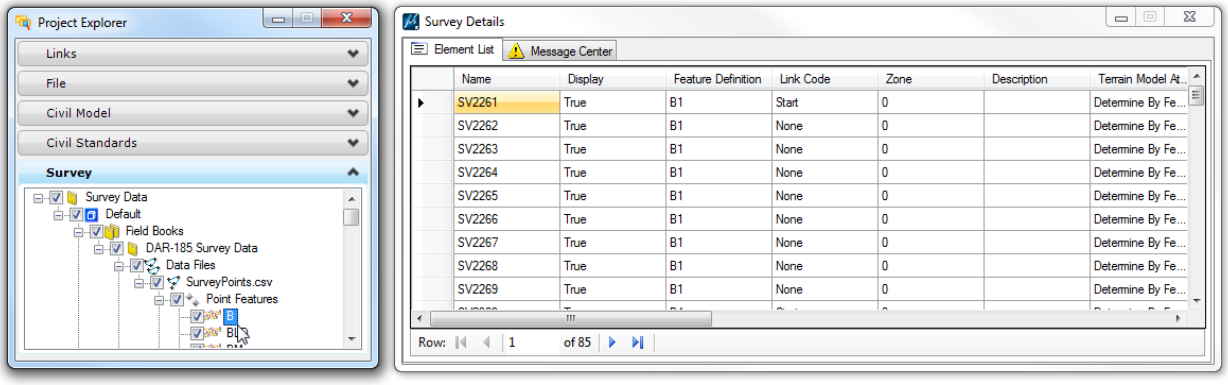
The *Survey Details* dialog is accessed by selecting the **Show Details** icon from the *Tasks* dialog as shown below.



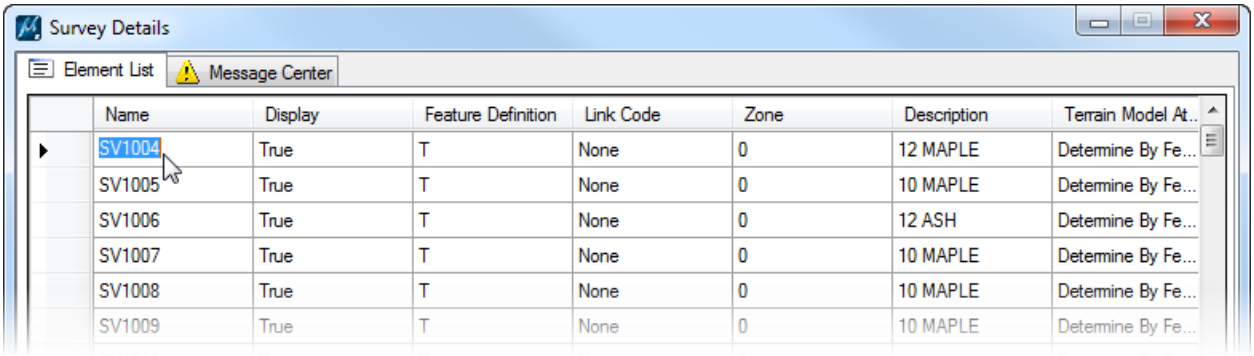
The content of the *Survey Details* dialog is determined by the selected item in the **Survey** tab of the *Project Explorer*. In the example on the following page, the **DAR-185** field book is selected. Information about the field book is displayed in the *Survey Details* dialog.



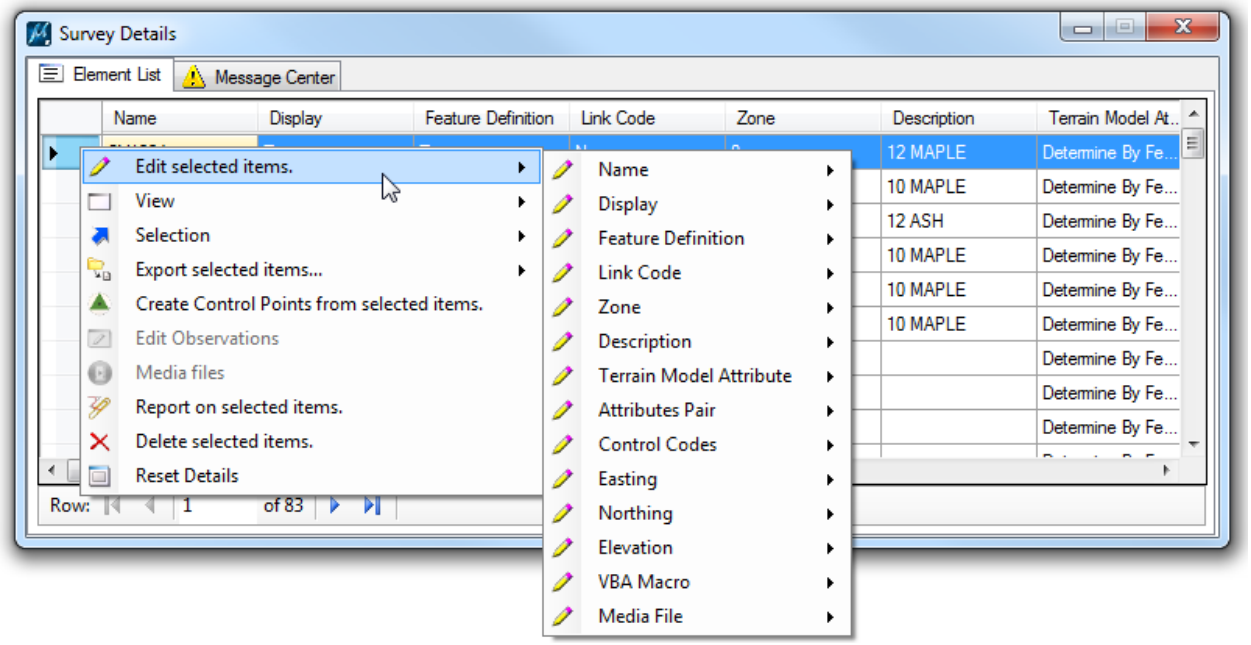
Selecting the **Point Features** item under a dataset will display all the points for the dataset in the *Survey Details* dialog. The **Point Features** item can be expanded to reveal the point features that are included in the dataset. Selecting one of the **Point Features** will display only the points that use the selected feature as shown in the example below.



Some of the fields in the **Survey Details** dialog can be edited by selecting the field, and then by clicking in the selected field. An example editing the **Name** field is shown below.



Individual points or a group of selected points can be edited in the *Survey Details* dialog by right-clicking on the area to the left of the selected point(s). The editing options shown on the following page are available.



Changes made to the data are dynamic and are applied instantly. For example, if a point is deleted the graphics are removed from the file, the terrain model is updated (if applicable) and any Linear Features that contain the point are updated.

If you make an edit that you did not intend to make, simply select the MicroStation **Undo** command. The last action is reverted.

Reviewing and Editing Linear Features

There are three types of linear feature definitions in OpenRoads Survey:

Dynamic Linear Features

- Dynamic linear features are composed of points of the same feature
- The chains are generated dynamically using the feature name and the linking codes
- These chains will dynamically update on the fly if changes are made to the linking codes or to the feature associated with a point(s) in the field book
- The order of the point list cannot be changed; points are connected in the order that they were numbered in the field

Point List Linear Features

- Point list linear features are comprised of a list of survey points
- The order of the points is used to determine the linear feature geometry
- Linking codes are also used to define the shape of the linear feature
- Points can be included in the chain list in any order
- The points that make up a point list linear feature can have different feature codes
- These linear features are just like survey chains in GEOPAK Survey

Graphic Linear Features

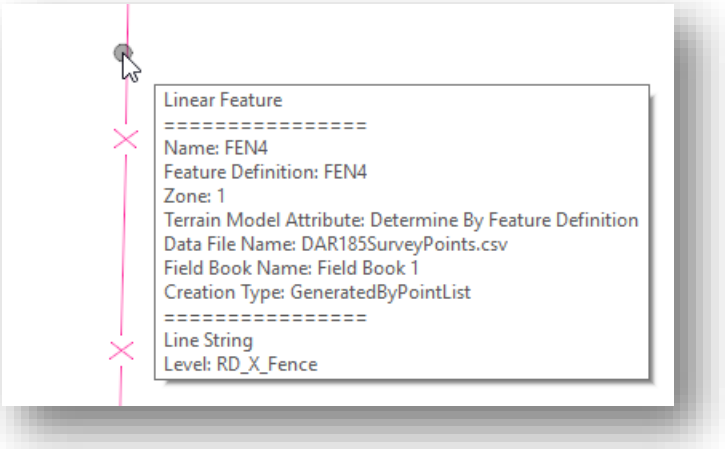
- Graphic linear features are drawn one at a time as a MicroStation graphic, ether by converting a point list linear feature to a graphic linear feature or by importing a 3D MicroStation graphic line
- If you convert a point list linear feature to a graphic linear feature any subsequent edits to the points that originally defined the chain will not update the graphic linear feature. This allows users to make edits to the graphic chain using MicroStation commands.
- Graphic linear features can be include in the terrain model

These linear feature types are hierarchical. A Dynamic Linear Feature can be converted to a Point List. A Point List type can be converted to a Graphic type.

The ODOTcadd **Survey Settings** have been configured to generate **Point List Linear Features** as the default.

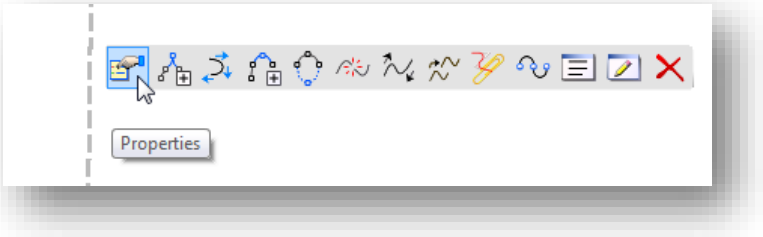
> Note: This setting was changed with the October 16, 2015 release of the ODOTcadd Standards. Previous versions of the ODOTcadd settings were configured to use the Dynamic Linear Feature as the default.

To review a single linear feature, simply float the cursor over the element to reveal a pop-up menu similar to the example below.



The MicroStation **Element Selection** command can be used to review or edit various properties of a selected linear feature.

When a **Dynamic Linear Feature** is selected, a menu of commands as shown below will appear onscreen.



The following commands are available if the selected linear feature is a **Dynamic Linear Feature**:

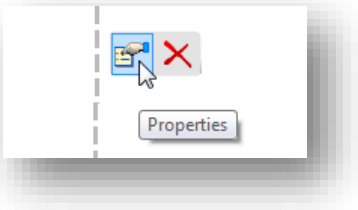
- Properties
- Append Point in Linear Feature
- Move Point Along Linear Feature
- Insert Point in Linear Feature
- Close Linear Feature
- Break Linear Feature
- Transpose Linear Feature
- Move Linear Feature
- Report
- Convert to Point List Linear Feature
- Manage Point List
- Edit Point Features
- Delete

When a **Point List Linear Feature** is selected, a menu of commands as shown below will appear onscreen.

The following commands are available if the selected linear feature is a **Point List Linear Feature**:

- Properties
- Append Point in Linear Feature
- Remove Point from Linear Feature
- Join Linear Features
- Move Point Along Linear Feature
- Insert Point in Linear Feature
- Close Linear Feature
- Break Linear Feature
- Transpose Linear Feature
- Move Linear Feature
- Report
- Convert to Graphic Linear Feature
- Manage Point List
- Edit Point Features
- Delete

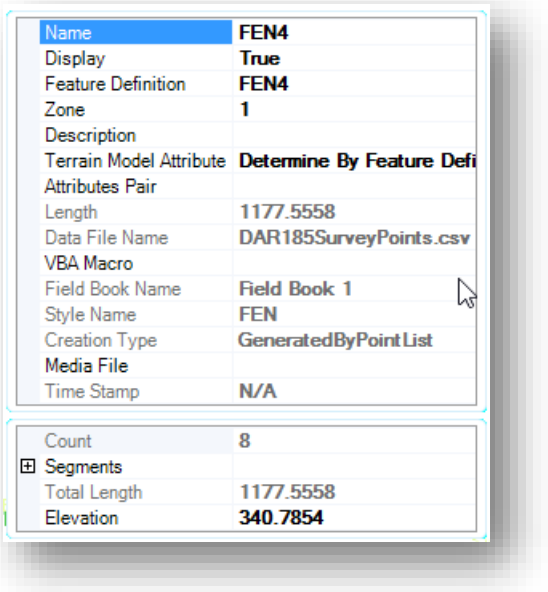
When a **Graphic Linear Feature** is selected, a menu of commands as shown below will appear onscreen.



The following commands are available if the selected linear feature is a **Graphic Linear Feature**:

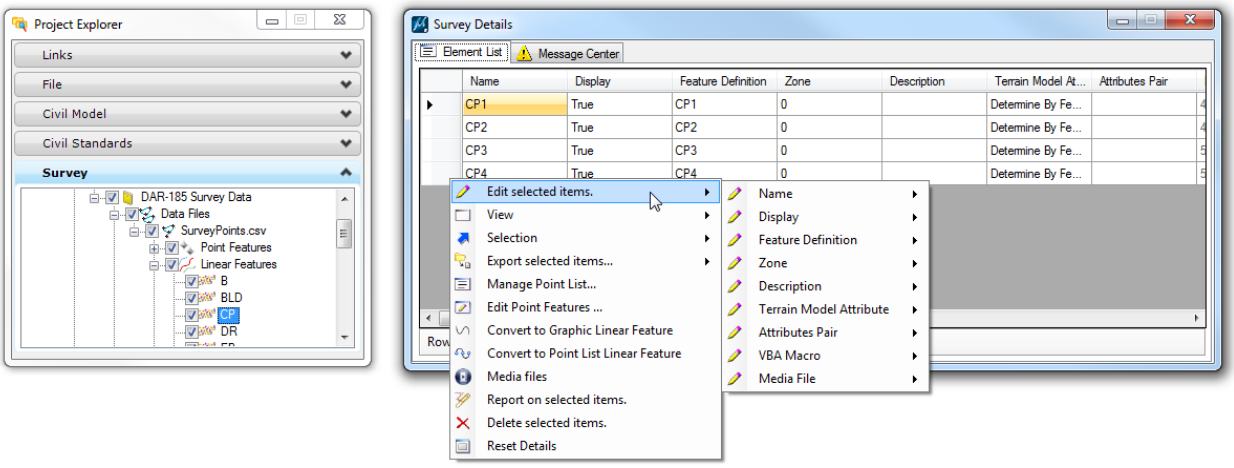
- Properties
- Delete

Select the **Properties** item to access the dialog show below. The properties of a dynamic linear feature are shown below.



Many of the fields in the *Linear Features Properties* dialog can be edited directly in this dialog.

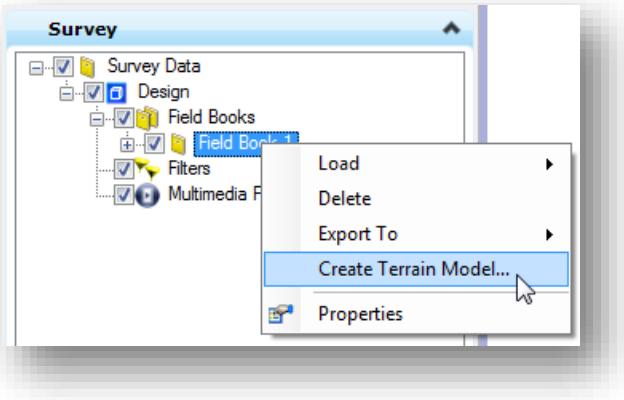
Linear features can also be edited using the *Survey Details* dialog. An example is shown below.



In the example above, the feature **CP** was selected from the **Linear Features** list in the *Project Explorer* dialog. All of the **CP** linear features for the data file are displayed in the *Survey Details* dialog. A right-click in the selection margin to the left of the **Name** field will reveal the editing options shown above.

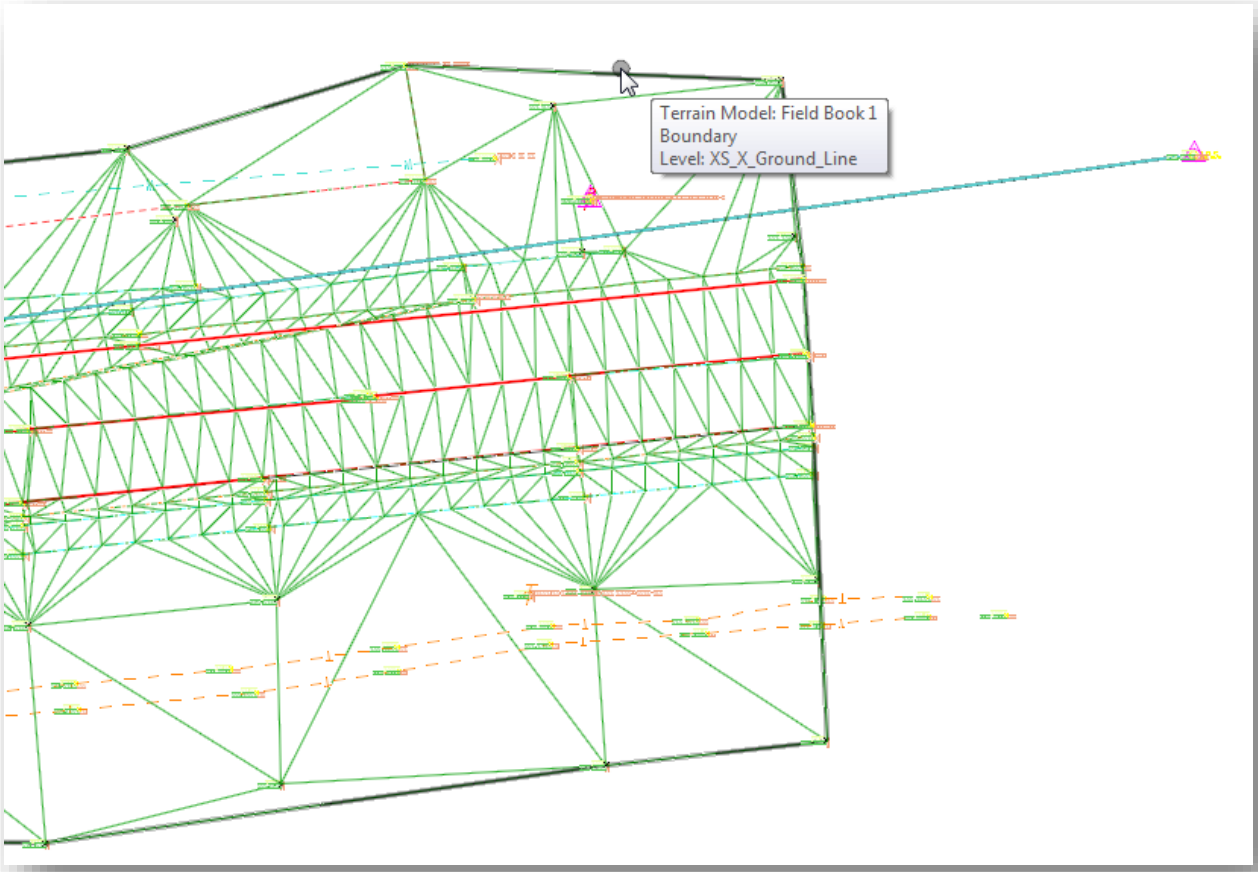
Reviewing and Editing Terrain Models

Terrain models are manually generated after the survey data is processed by right-clicking on a Field Book name and choosing the Create Terrain Model… option as shown below,

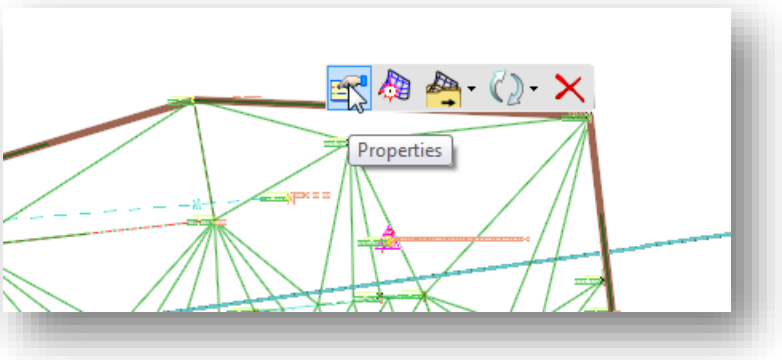


Note: Multiple datasets contained in one field book are combined to make one terrain model.

When using the ODOTcadd workspace, the triangles and the external boundary of the terrain model is visualized as shown below.



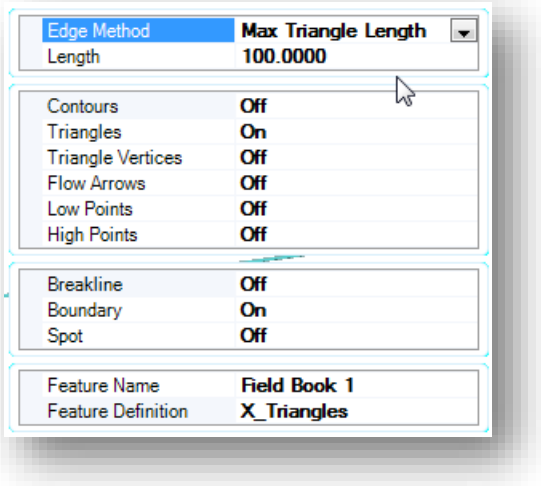
Use the MicroStation *Element Selection* tool to select a terrain model in the design file to reveal the pop-up menu shown below.



The following commands are available:

- Properties
- Set As Active Terrain Model
- Export Terrain Model
- Update From Source
- Delete

The **Properties** options are shown below.



Edge Method

In the ODOTcadd workspace, the default **Edge Method** has been set to **Max Triangle Length** with a **Length** value of 100. The following **Edge Method** options are available:

- None
- Slivers
- Max Triangle Length

The option to key in a **Length** value is only available when the **Edge Method** is set to **Max Triangle Length**.

Contours, Triangles, Triangle Vertices, Flow Arrows, Low Points, High Points
This display of each of these items can be toggled on or off using these options. Note that these options do not turn on/off the MicroStation level display for these items.

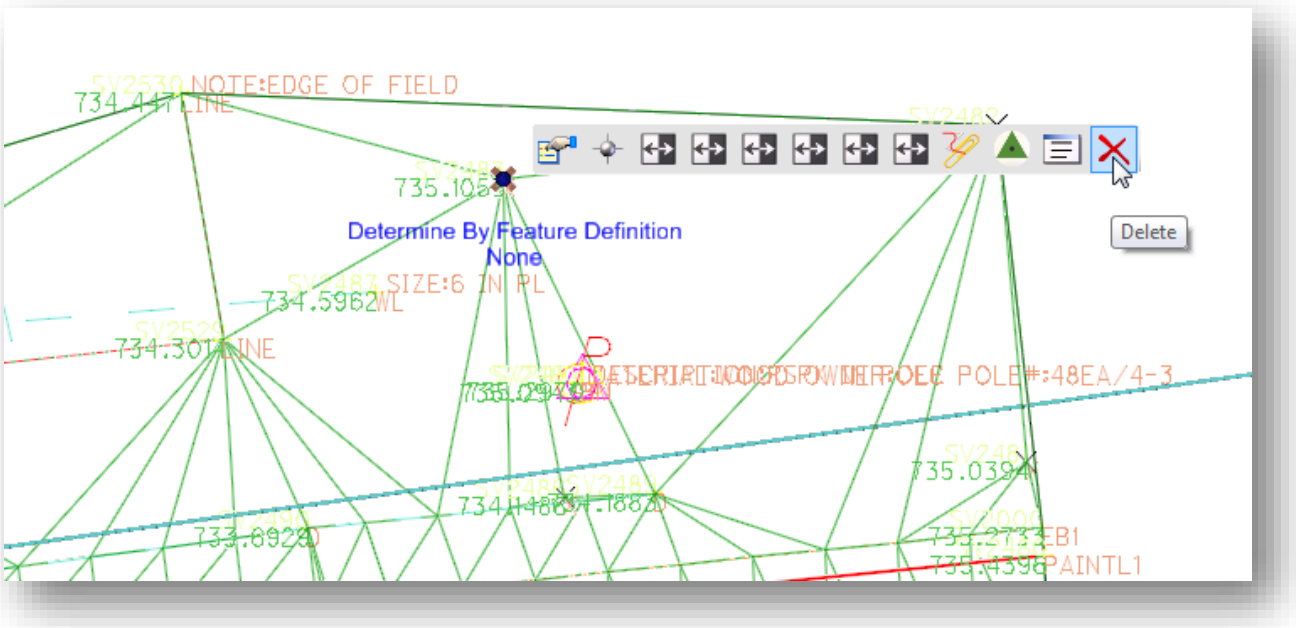
Breakline, Boundary, Void, Spot
This display of each of these items can be toggled on or off using these options.

Feature Name
The **Feature Name** is the file name that will be used when the terrain model is exported to GEOPAK format.

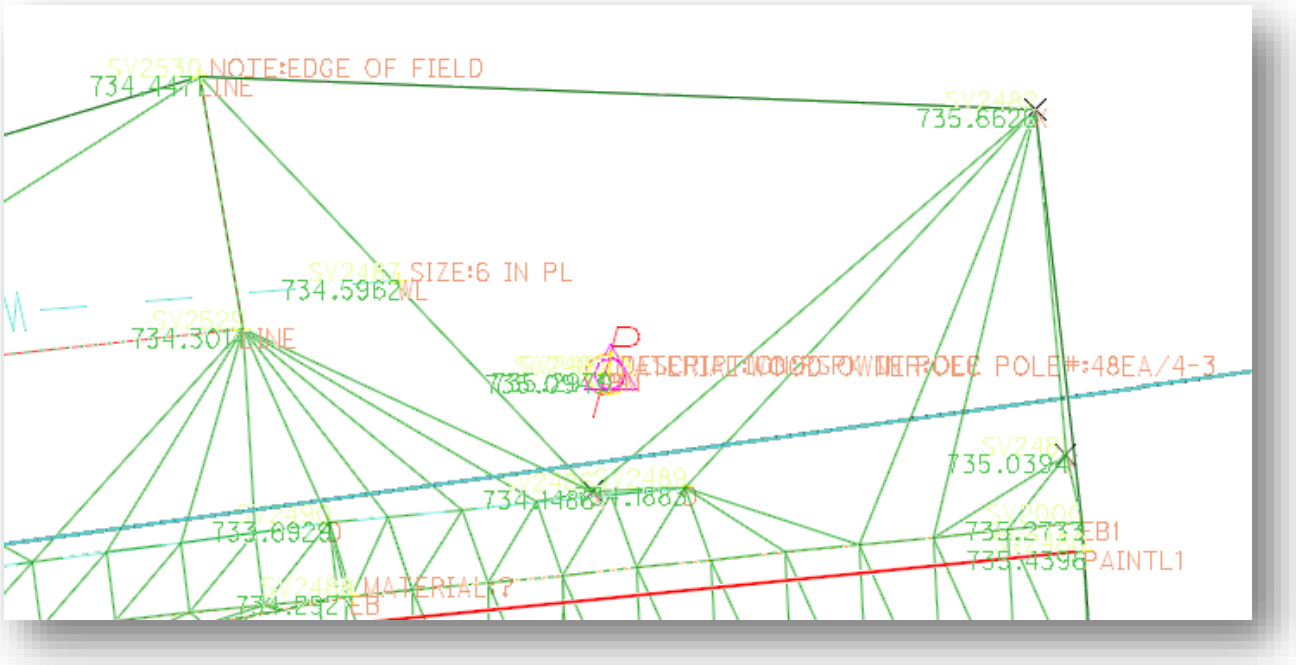
Feature Definition
The **Feature Definition** item is used to select the surface feature that will be used to control the terrain model display. Surface feature definitions are defined in **ODOT_Features_Design.dgnlib**. When using the ODOTcadd workspace, the surface feature **X_Triangles** is the default. This feature has been configured to diplay the terrain model triangles and boundary. Various surface features are available in the ODOTcadd workspace with triangles and contours toggled on.

Edits made to the points and linear features that comprise the terrain model are immediately and dynamically reflected in the terrain model.

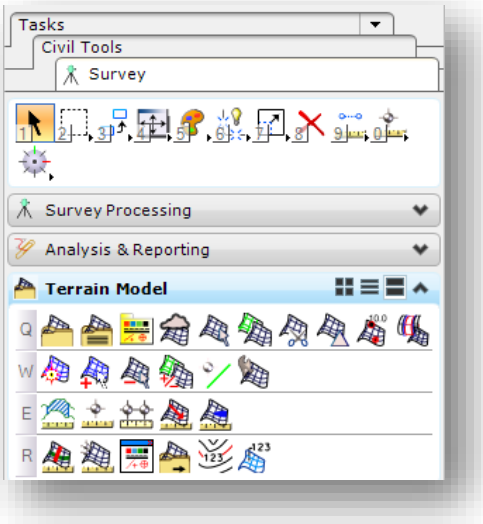
For example, deleting a point as shown below…



…is immediately and dynamically reflected in the terrain model as shown below.



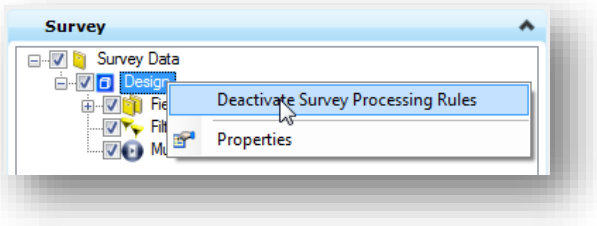
The *Task Navigation* dialog's **Survey** group contains a host of commands in the **Terrain Model** group for editing and analysis as shown below.



For a complete list of these commands, see the OpenRoads online help.

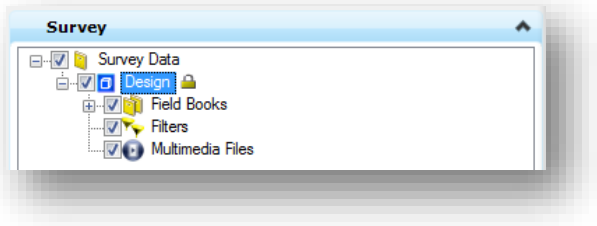
Disable Survey Processing Rules

The terrain model is dynamically updated as changes are made to the survey data. If you wish to use one of the *Terrain Model* tools to edit the terrain model (for example, to remove some unnecessary edge triangles), it is necessary to first disable the survey processing rules for the design model. Once disabled, the terrain model can be freely edited independent of the survey data. The survey processing rules can be disabled by right-clicking on the model name in the **Survey** tab of *Project Explorer* and selecting **Deactivate Survey Processing Rules** as shown below.

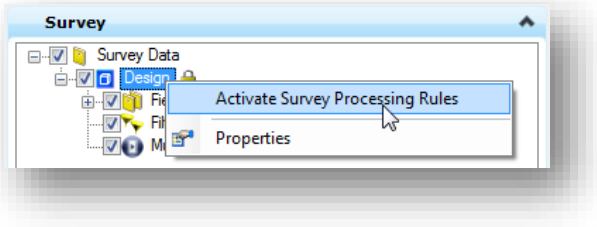


Also note that once deactivated, changes to the Survey data will no longer update the terrain model.

Once deactivated, a lock icon will be displayed next the model name in the **Survey** tab of *Project Explorer* as shown below.

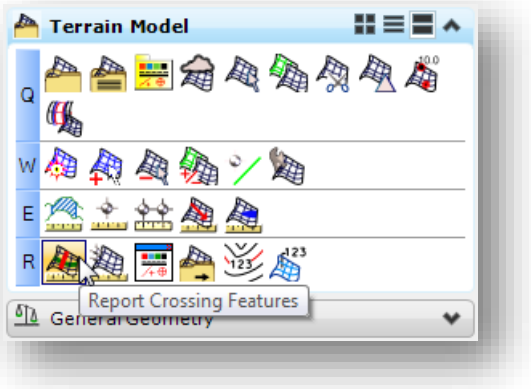


The survey processing rules can be enabled by selecting **Activate Survey Processing Rules** as shown below, however, ***reactivating the rules means that the terrain model will be updated to reflect the survey data and any edits that you may have made using the Terrain Model tools will be disregarded***.

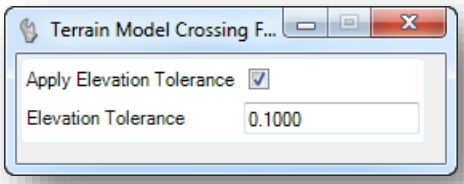


Report Crossing Features

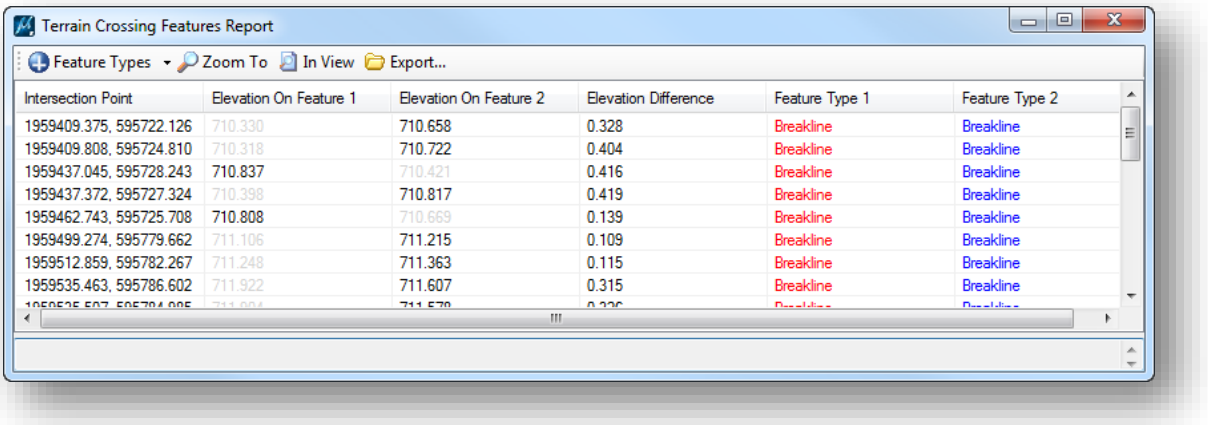
Report Crossing Features is available from the **Terrain Model** task menu as shown below. Note that the terrain model processing rules do not need to be deactivated in order to use this command.



When selected, the command will prompt you to select the terrain model and whether to apply an elevation tolerance to the results, as shown below. The elevation tolerance can be used to filter out crossings that have an elevation difference smaller than the value specified. This is useful to filter out crossings at points that are dual coded to define two separate feature lines such as a point that defined the edge of pavement and the start of a driveway.



After stepping through these two prompts, the **Terrain Crossing Features Report** shown on the following page is opened.



The following commands are available at the top of the dialog:

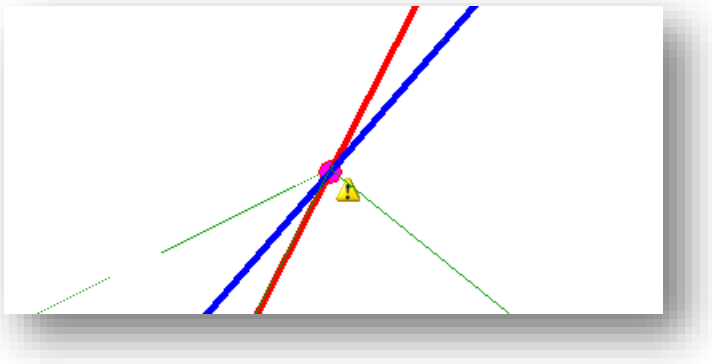
Feature Types
This drop-down menu provides a list of terrain model features types that will be considered for inclusion when crossing features are detected. Each feature type can be toggled on/off as desired.

Zoom To
This command is used to zoom to the selected crossing.

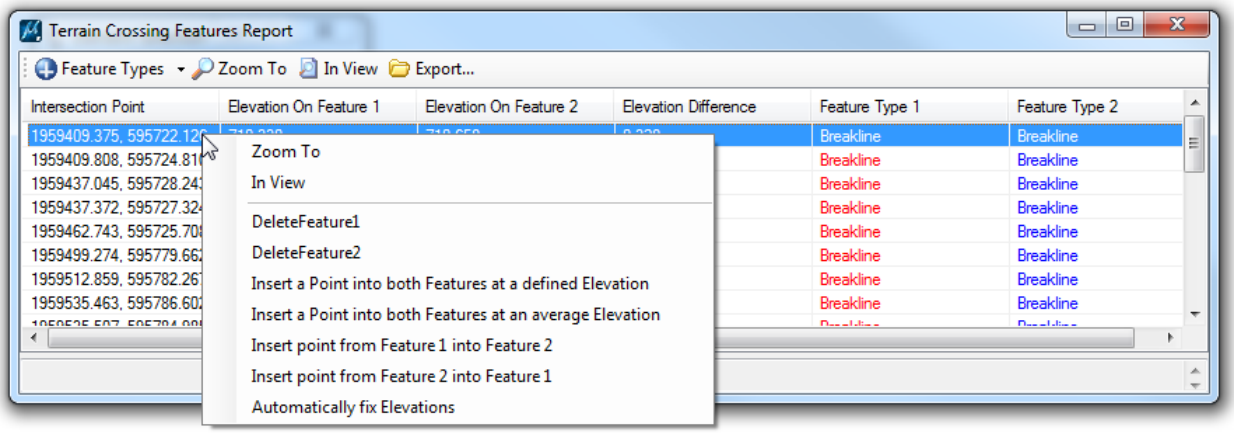
In View
Selecting the In View option filters the list of crossings to only display those that are contained within the current view extents.

Export
This command is used to generate a Terrain Crossing Features Report.

When the **Zoom To** command is selected, the current crossing is displayed in the MicroStation view window with a yellow warning icon at the crossing location.



The crossing lines are highlighted in red and blue corresponding to the red and blue text shown for **Feature Type 1** and **Feature Type 2** in the *Terrain Crossing Features Report* dialog. The crossings are rectified using point and linear feature editing commands as there are no commands in the *Terrain Crossings Feature Report* dialog to edit the crossings.
A variety of methods can be used to resolve the crossing features. Right-click on a crossing in the *Terrain Crossing Features Report* dialog to reveal the menu shown below.



As each crossing is resolved it is removed from the dialog list.

In some cases, it may be desirable to use the MicroStation **Move Element** command to slightly move one of the points; however care must be taken when moving points to ensure that the original elevation of the point is retained. When moving elements in 3D files, the default MicroStation behavior is to move the element to the Active Depth.

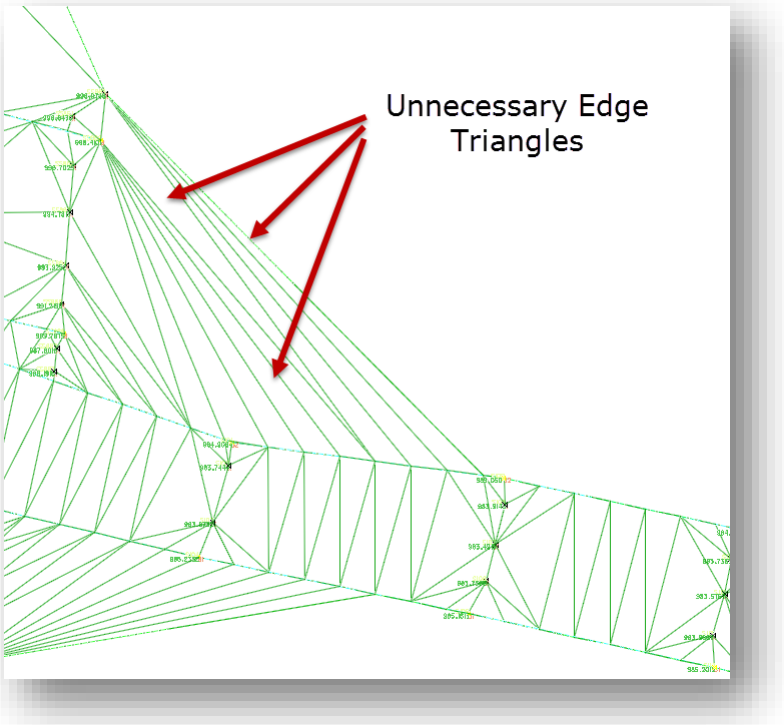
To move a point and preserve the elevation value, use the **Element Selection** tool to select the survey point at any location other than the circle at the point origin. Drag the point to the new location. The Z value will be preserved when moving a point in this manner.

.

Removing Edge Triangles

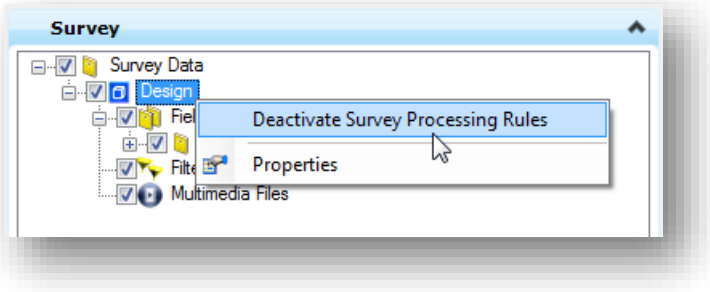
After survey processing and editing is complete, it may be necessary to delete some of the terrain model edge triangles that are formed in areas along the boundary of the terrain.

The example below shows several triangles that are formed across an area where no survey data was collected.



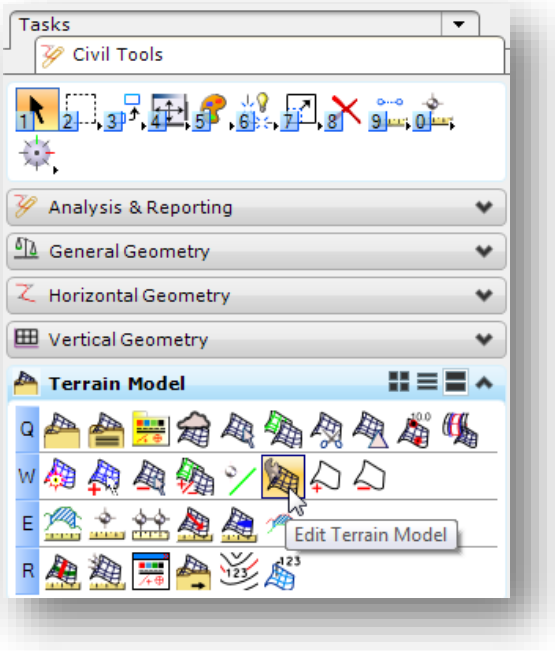
Setting the terrain model's **Edge Method** to **Max Triangle Length** with a shorter value can eliminate some of these triangles, however it may still be desirable to manually remove some of these triangles.

Terrain models are "ruled" by the survey points and chains. Changes made to the survey points and chains are dynamically reflected in the terrain model. Before editing triangles, it is necessary to turn of the survey processing rules so that the terrain model is disconnected from the survey elements. To do so, right-click in the name of the active Model in the *Project Explorer's* **Survey** group and select **Deactivate Survey Processing Rules** as shown below.



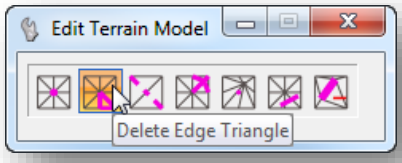
When the rules are deactivated, a lock icon will display next to the model name.

OpenRoads provides a variety of terrain model creation and editing commands in the **Civil Tools > Terrain Model** group of the *Tasks* menu group as shown below.

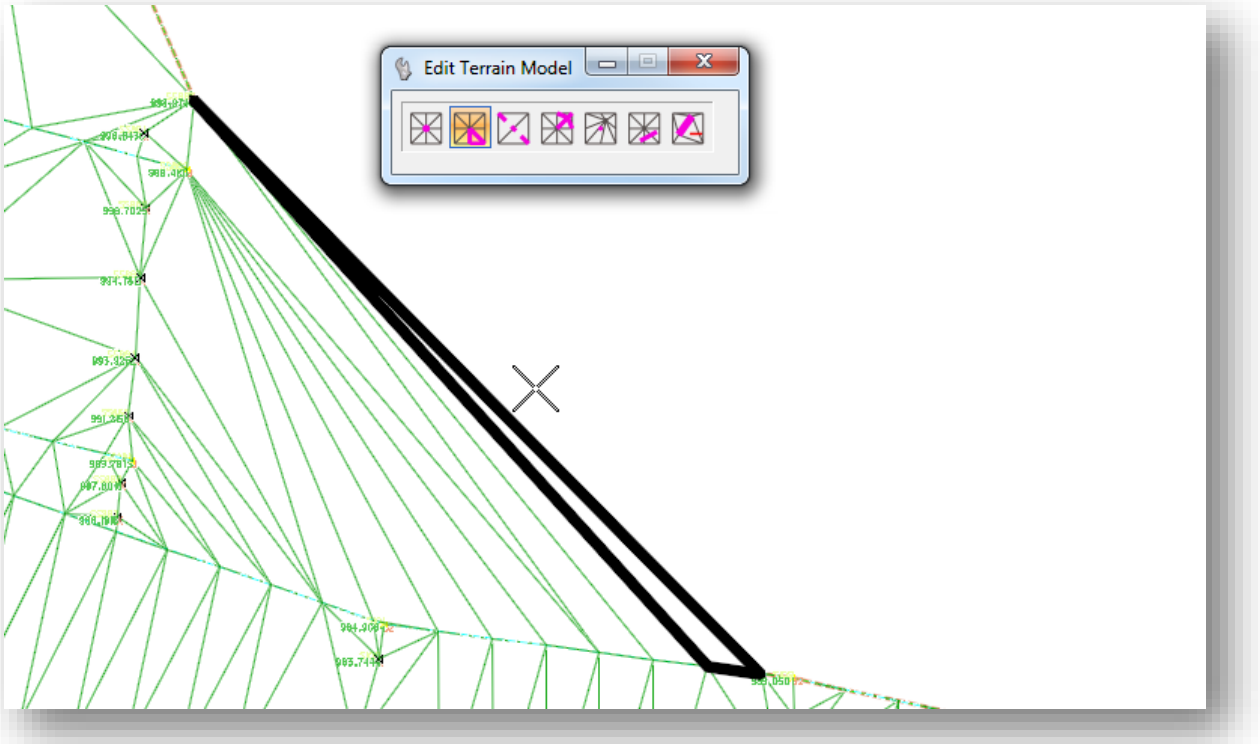


These tools are documented in the OpenRoads help.

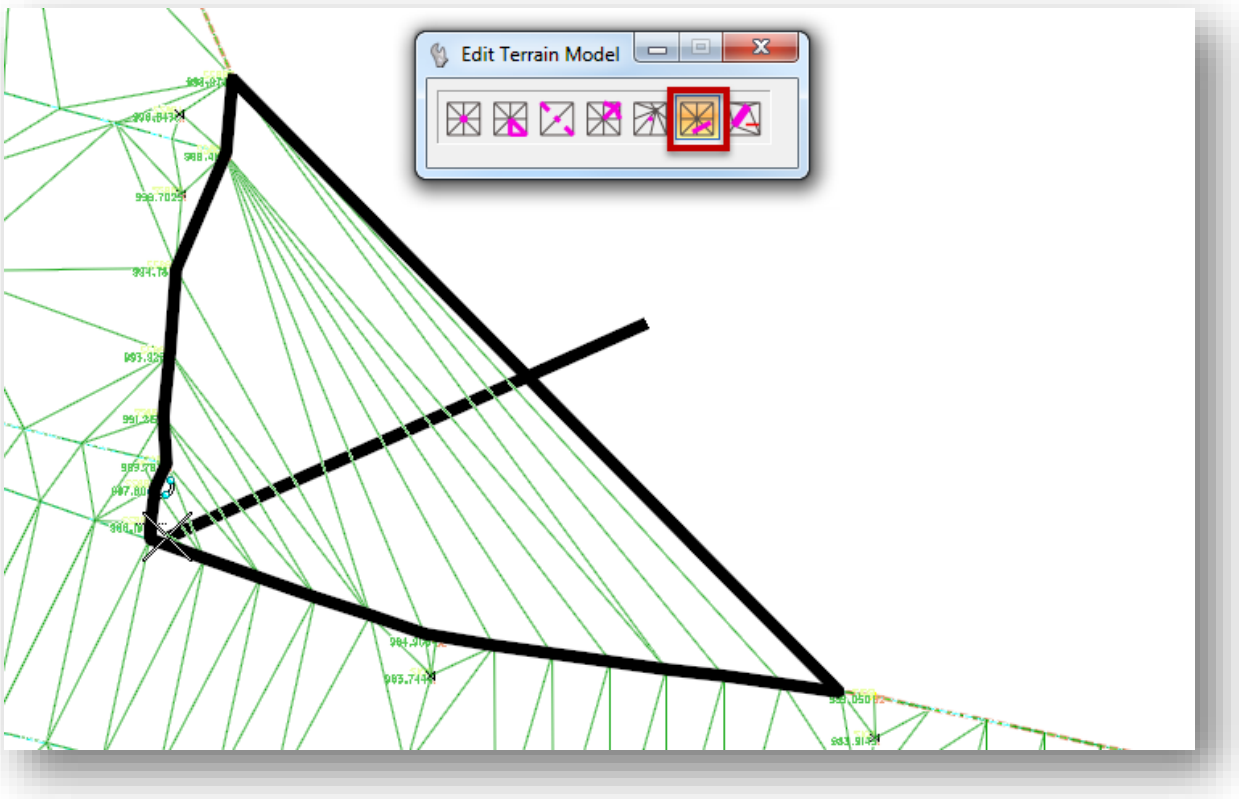
The **Edit Terrain Model** tool can be used to remove the edge triangles from a terrain model.



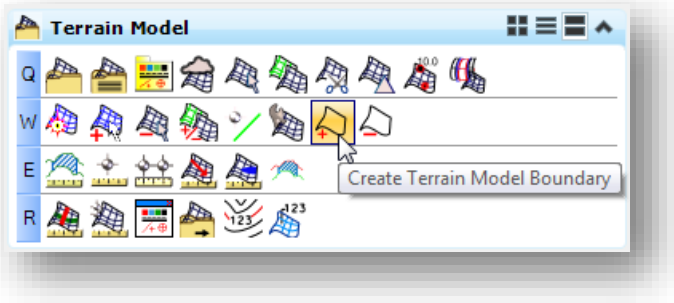
This command will allow you to remove edge triangles one at a time. Each triangles is highlighted as shown below. Issue a Data Point to remove the highlighted triangle. As each triangles is removed, the next triangle is highlighted.



Alternately, the **Delete Triangle by Line** command can be used to drag a line through several triangles to be deleted as shown below.



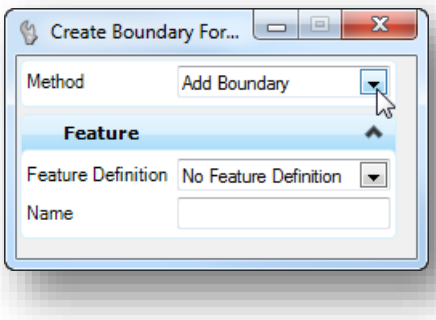
After editing the terrain model to remove any unnecessary edge triangles, the **Create Terrain Model Boundary** tool is used to assign a boundary to the terrain that will be maintained when the Survey Processing Rules are turned on. This tool is located in the **Terrain Model** group of the *Tasks* menu as shown below.



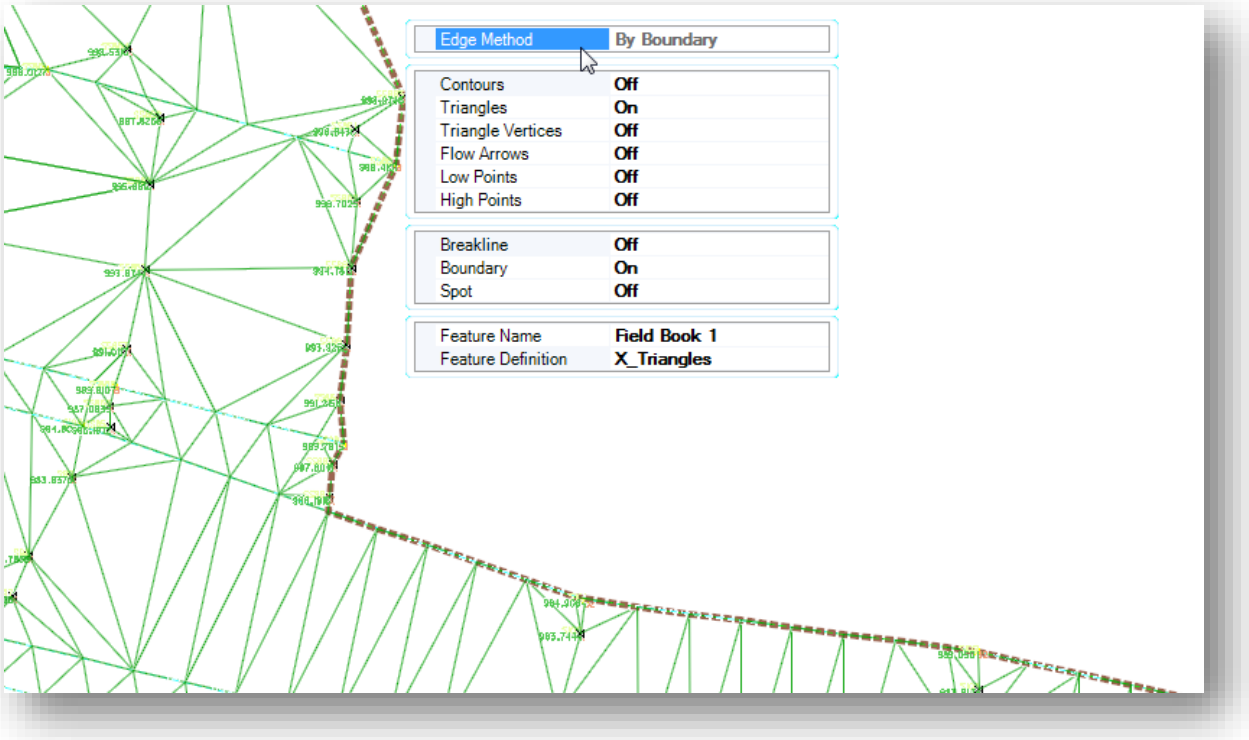
The tool has three options:

- **Extract Graphic** - extracts the current boundary for the triangulation to an editable 3D linestring.
- **Add Boundary** - extracts the current boundary for the triangulation as an explicit boundary in the terrain element - ie locked boundary.
- **Add Ruled Boundary** - extracts the current boundary for the current triangulation to an editable ruled draped boundary element. Deleting this element will remove the boundary from the terrain.

Use the **Add Boundary** method to add a fixed boundary to the selected terrain model. Don not assign a **Feature Definition** or a **Name** for the boundary.



After the boundary is added to the terrain model and the **Survey Processing Rules** are turned back on, edits to the survey information will still be applied to the terrain model, however, the **Max Side Length** and **Slivers** methods for setting the terrain boundary are no longer available. Reviewing the properties of the terrain model shows that the **Edge Method** is set to **By Boundary** as shown below.

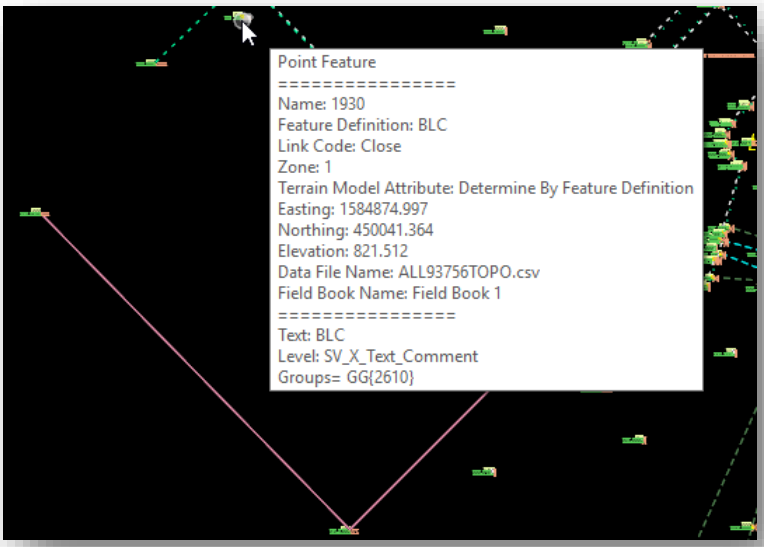


If additional survey information is added outside of the terrain model boundary, this information will not be added to the terrain model unless the boundary is deleted. The terrain model boundary can be removed using the **Remove Terrain Model Boundary** tool in the **Terrain Model** task group. Removing the boundary and enabling the Survey Processing Rules will automatically add the new survey data to the terrain model, however previous edits to the edge of the terrain will be lost.

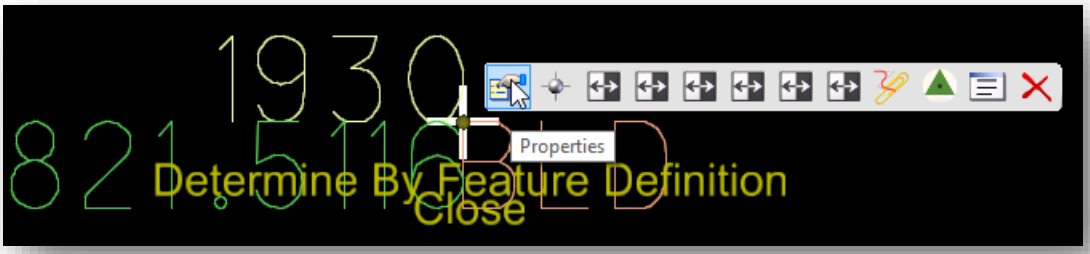
Exercise 6 – Correcting the ALL-93756 Dataset

In this exercise we'll fix a few problems with the ALL-93756 dataset.

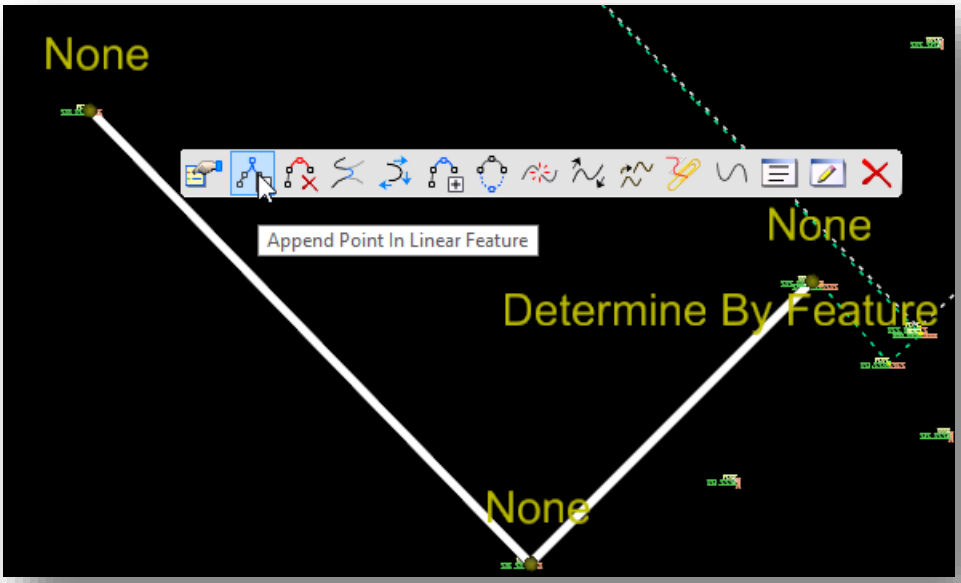
- ✓ Open MicroStation using the shortcut for the Survey Training class.
- ✓ From the MicroStation *File Open* dialog, select the **ALL-93756 Project**.
- ✓ Open the Field Book design file for the project.
- ✓ Zoom in on the building in the South-Western quadrant of the project. The fourth corner of the building was miscoded as BLC as shown below.



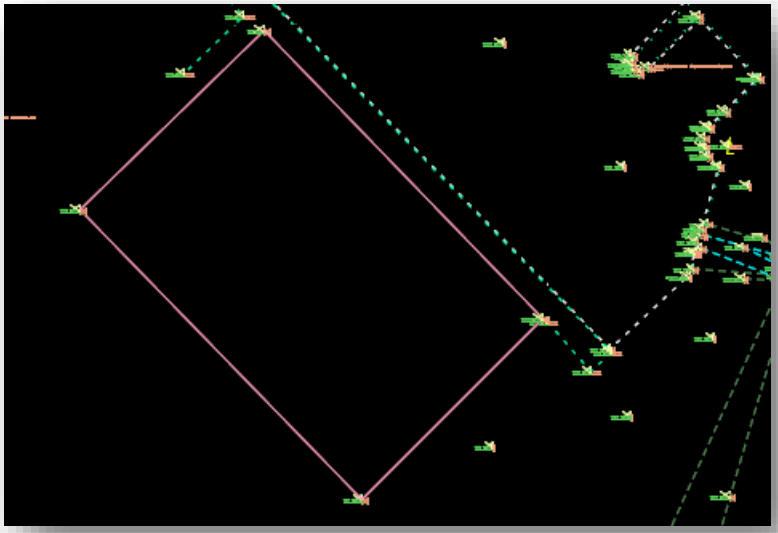
- ✓ Edit the properties of the point to change the **Feature Definition** to the correct field code of "BLD" (select the point and choose the **Properties** item from the pop-up menu).



- ✓ After changing the feature definition for the point, we can add the point to the linear feature for the building. Select the building line and choose the **Append Point in Linear Feature** option as shown below.

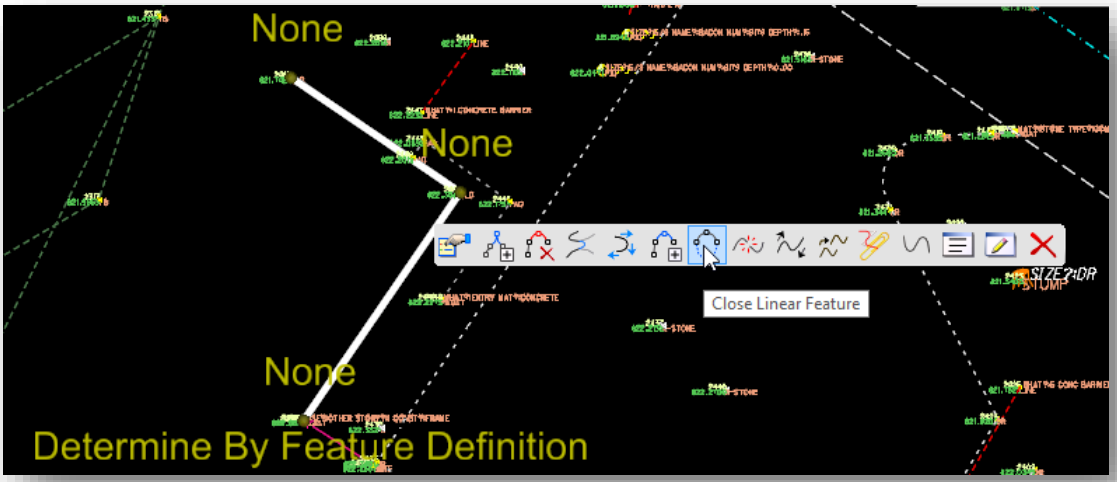


- ✓ Choose the point that you wish to append to the linear feature. Accept the solution. When complete, the linear feature for the building should appear as shown below.



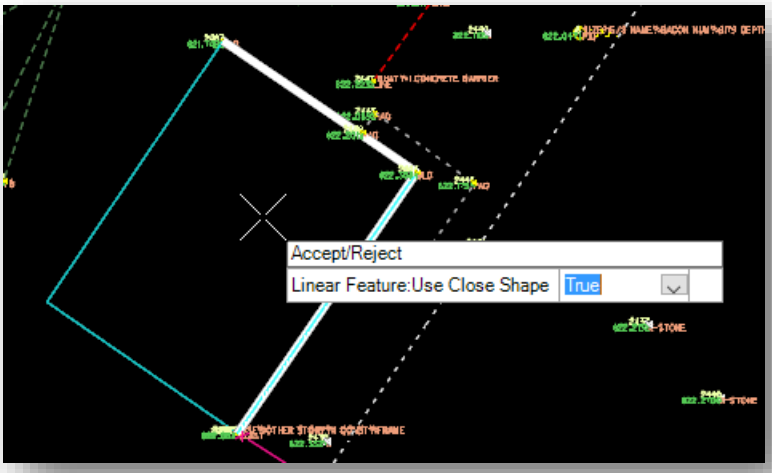
Next we'll fix a second building in the south-eastern quadrant of the project. Unlike the previous example this one does not have a surveyed point at the back corner of the building. We'll use the **Close Linear Feature** command to assume a point to close the building.

- ✓ Select the building in the south-eastern quadrant of the project and choose the **Close Linear Feature** command as shown below.

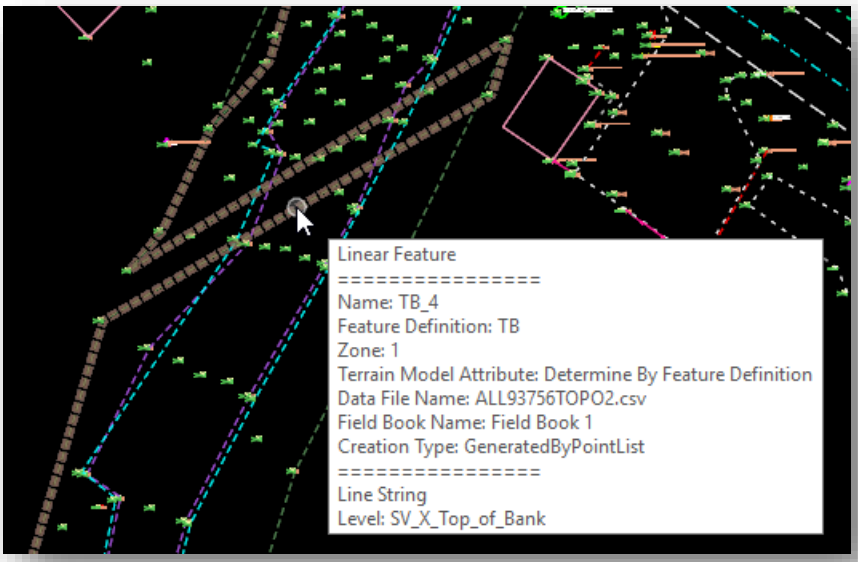


- ✓ The software has two options for closing the figure.

  Choose **True** to construct perpendicular lines as shown below to close the figure. Choose **False** to close the figure by constructing a straight line from the first and last points. For this example, choose **True**.

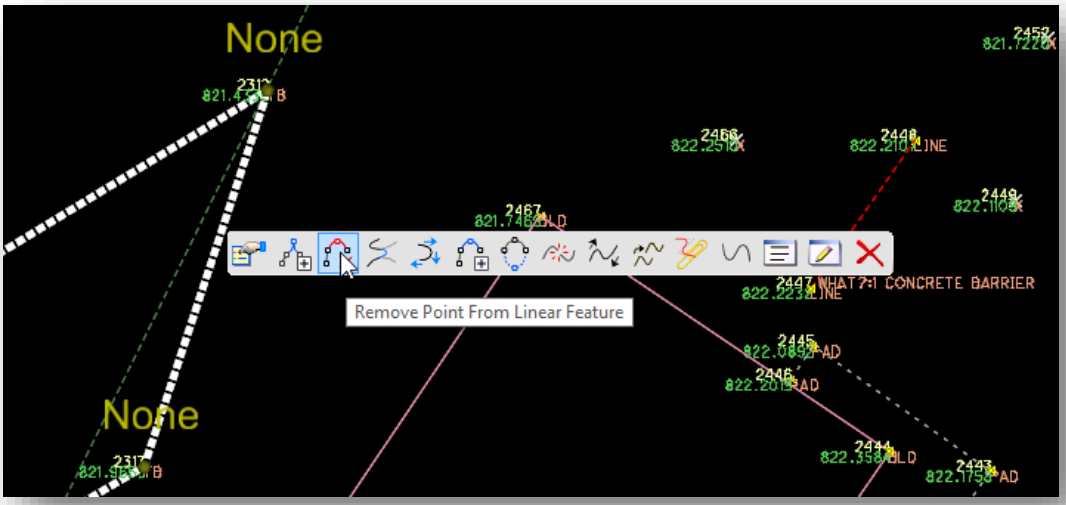


Next we'll fix a Top of Bank feature that was accidentally miscoded and crosses over the survey data as shown below.



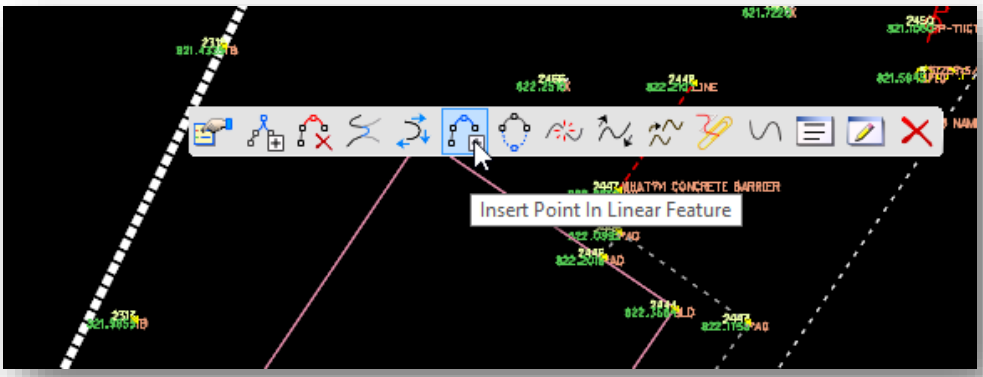
Points 2312 and 2313 should have been included in the linear feature named TB1. First we'll remove these two points from the TB_4 linear feature.

- ✓ Select the TB_4 linear feature and choose the **Remove Point From Linear Feature** option.



- ✓ Remove both points from the linear feature.

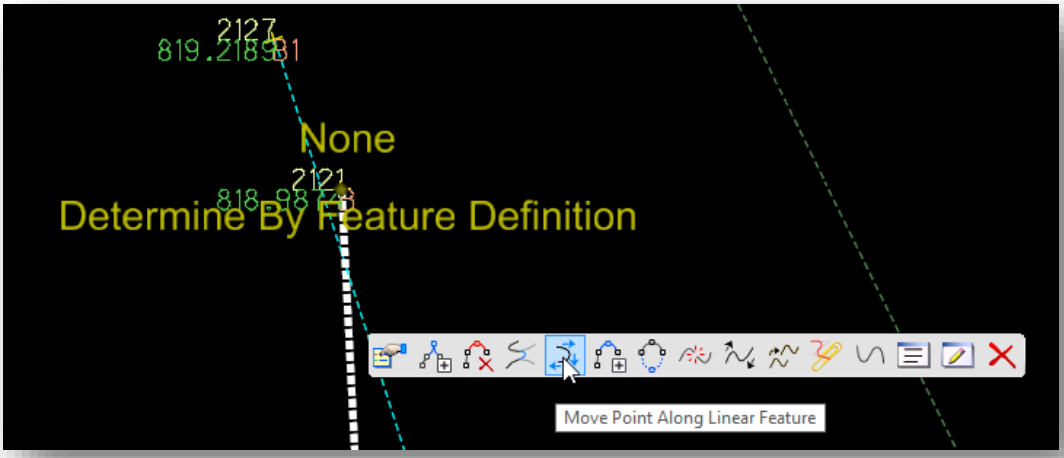
- ✓ Next we will insert both points into the linear feature TB1_5. Select the linear feature TB_5 and choose the **Insert Point In Linear Feature** option



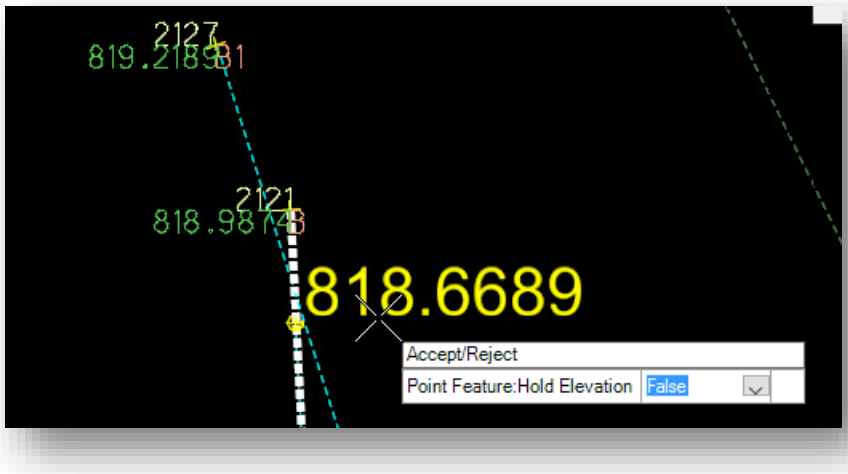
- ✓ Inset points 2313 and 2313 into the linear feature.

The last error we will fix is a crossing break line in the north-eastern quadrant of the project.

- ✓ Select the linear feature named "B" and choose the **Move Point Along Linear Feature** option as shown below. We'll use this command to slide point 2121 along the linear feature to move it so it does not overlay the other break line.



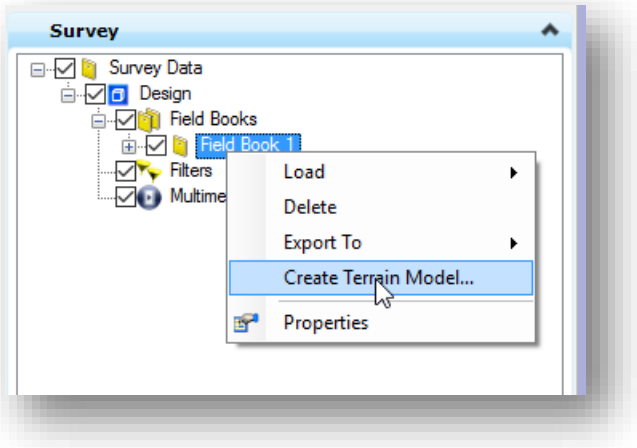
- ✓ Select point 2121. As the cursor is moved, the elevation for the point is determined by either holding the current elevation or allowing the software to compute the elevation value by sliding the point along the slope of the line. Set the **Point Feature Hold Elevation** value to **True** to retain the original elevation value.



- ✓ Issue a data point at the position that you wish to move the point to. When complete, the lines no longer overlap.

After making these edits, we will create a terrain model for the project.

- ✓ In the *Project Explorer* dialog's **Survey** group, right-click on the field book name to choose the **Create Terrain Model** option. A terrain model for the project is created from all of the datasets contained in the field book.



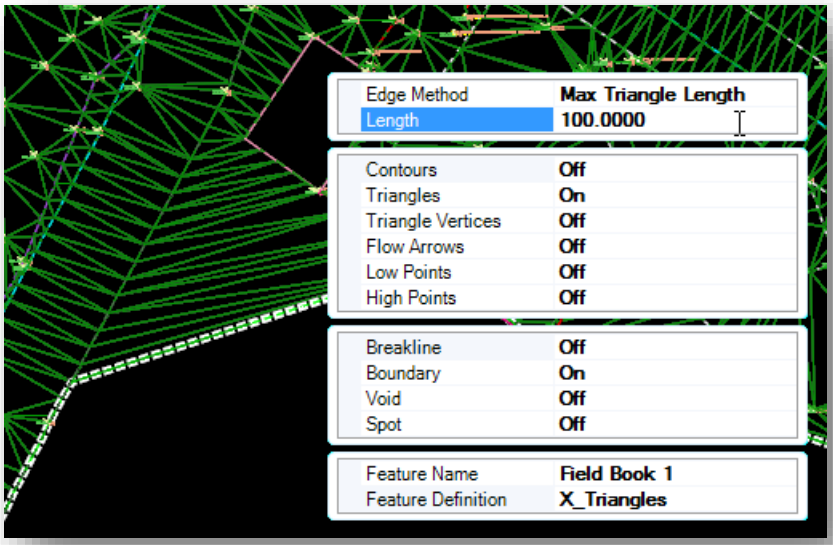
The terrain model should be reviewed for crossing break lines and also for areas where the triangles may extend across areas where no data was collected.

- ✓ Use the **Report Crossing Features** command discussed earlier in this chapter to review and edit crossing features.

After reviewing and correcting crossings, the next editing operation is to remove any edge triangles that may extend across areas where no survey data was collected.

The **Edge Method** for terrain model creation defaults to **Max Triangle Length** with a value of **100**. Before removing any extraneous edge triangles, try changing the **Length** parameter to a shorter value.

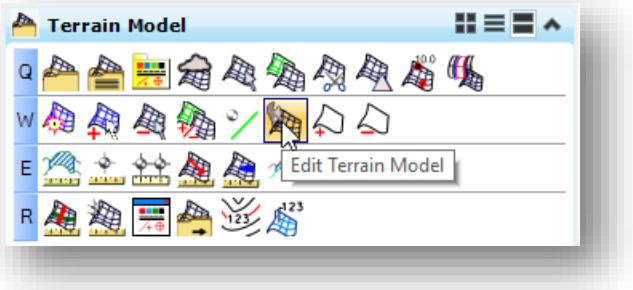
- ✓ Select the terrain model and choose the **Properties** option to access the dialog shown below. Try changing the **Length** parameter to 50 or 75 and review the results. If the Length is set too short there may be areas where triangles that you wish to maintain are removed.



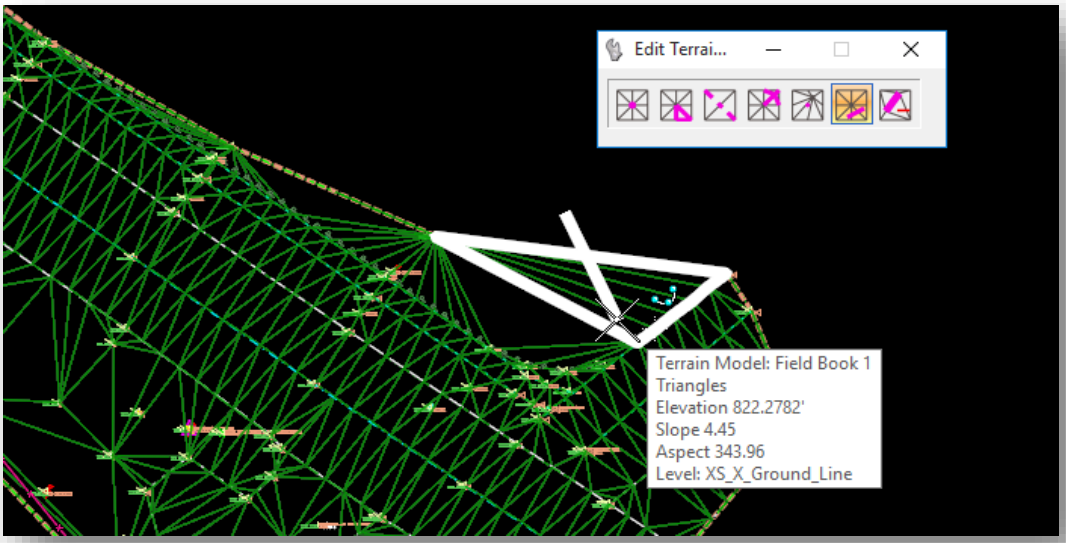
After adjusting the triangle **Length** parameter, the next step is to edit the terrain model to remove any unnecessary edge triangles.

- ✓ In order to edit the terrain model, we need to first deactivate the Survey Processing Rules as shown previously in this chapter. Once the rules are deactivated, we can make edits to the terrain model.

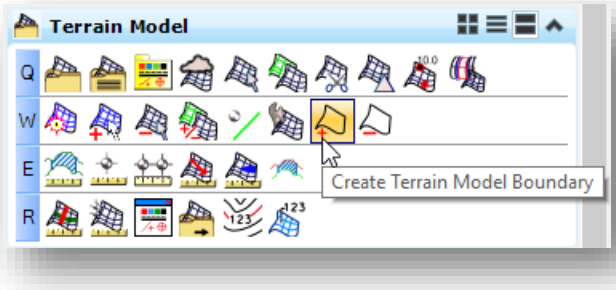
- ✓ Choose the **Edit Terrain Model** command from the *Tasks* menu as shown below.



- ✓ From the *Edit Terrain Model* tool settings, choose the **Delete Triangle By Line** command to remove any unwanted edge triangles by dragging a line through the triangles as shown in the example below.

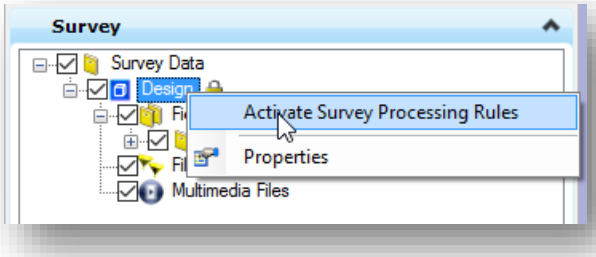


- ✓ After removing any unwanted edge triangles, the next step is to create a fixed boundary for the terrain model. Choose the **Create Terrain Model Boundary** command as shown below.



- ✓ Select the terrain model and use the **Add Boundary** option to add the boundary to the terrain model.

- ✓ After adding the fixed boundary to the terrain model, we can now reactivate the Survey Processing Rules. In the *Project Explorer* dialog, select the Model name and choose the **Activate Survey Processing Rules** option.

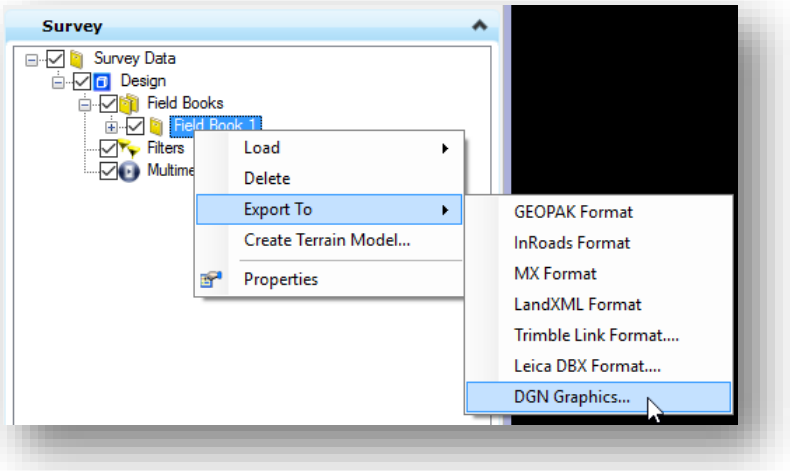


Changes to survey data within the interior of the terrain model will now update the terrain, however the boundary will remain fixed unless the boundary is removed from the terrain model by choosing the **Remove Terrain Model Boundary** command in the *Tasks* menu.

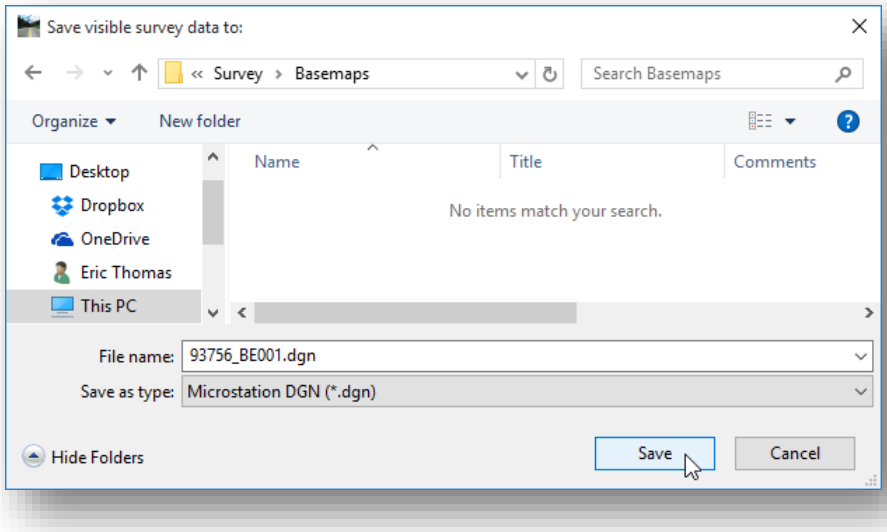
The data is now ready to be exported to a survey basemap for use by the designers on the project. Take the following steps to export the file to a survey basemap design file, removing the survey "rules".

- ✓ From the MicroStation menu, select **File > Save Settings**.

- ✓ From the **Survey** group in the *Project Explorer* dialog, right-click on the field book and choose **Export To > DGN Graphics…** as shown below.



- ✓ Save the new file to the \Design\Survey\Basemaps folder as shown below. Name the file using the PID number for the project followed by "_BE001.dgn".



- ✓ After the export is complete, the software will open the newly created file. The survey mapping and the terrain model are contained in the new file; however, the survey processing rules are removed.

- ✓ You may wish to lock the data to prevent accidental edits. To do so, use the MicroStation **Element Selection** tool to select all the elements in the file. Choose **Edit > Lock** to lock all the selected elements. After completing this task, choose **File > Save Settings** and then exit MicroStation.

8 Processing Multiple Data Sets

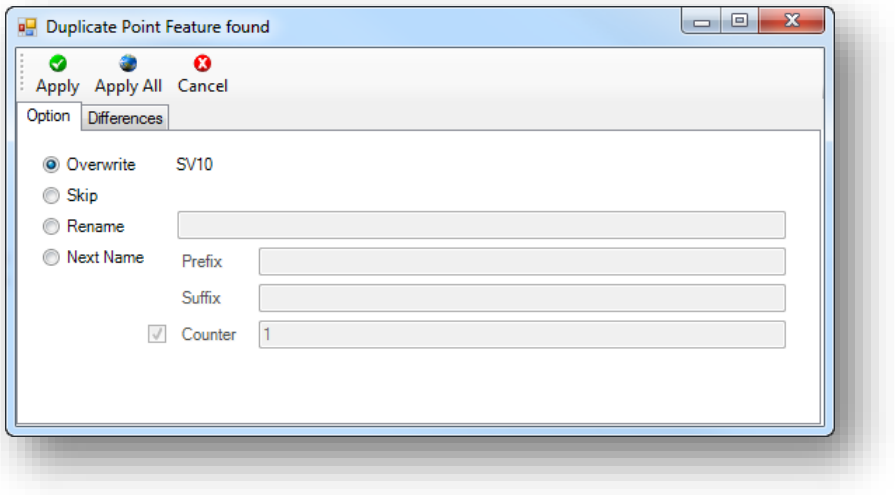
Handling Duplicate Point Names

When processing multiple datasets for the same field book it is not unusual to encounter duplicate point names. There are two cases where this typically occurs:

1. The same control points are contained in multiple datasets.

2. The field crew accidentally collected new data using the same point names as a previous dataset.

In either case, the duplicates can be handled upon import. When each dataset is imported the software will notify the user of any duplicates as shown below.



The **Prefix** and **Suffix** fields can be used to append the point names with a user defined prefix or a suffix.

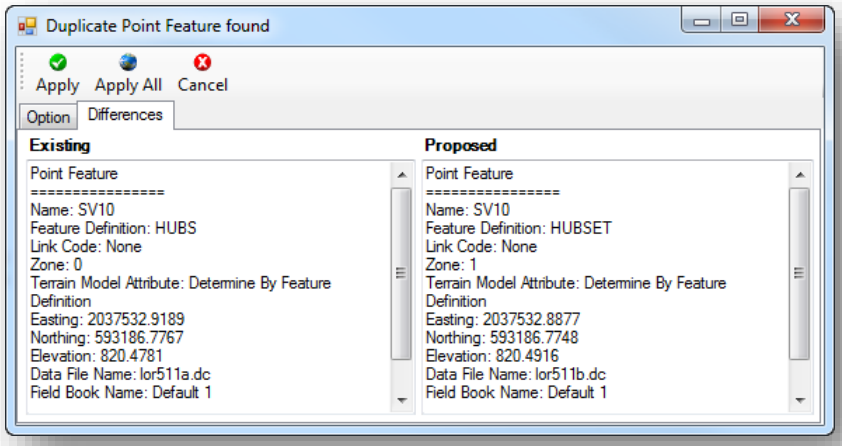
- When assigning prefixes or suffixes, care must be taken to ensure that the resulting point names will be compatible with GEOPAK COGO naming conventions if the survey points will be exported to a GEOPAK GPK file.

- See Chapter 3 for information on COGO survey point names

- See Chapter 14 for information on exporting data to GEOPAK formats.

The **Counter** field is used to add a value to the point names. The accompanying key-in field is used to specify an increment factor.

The **Differences** tab, shown on the following page, will allow you to compare the values for each point before deciding which action to take on the **Option** tab.



Exercise 7 – Processing Multiple Trimble .dc Files

In this exercise, we'll import two datasets in a raw data format and perform a few edits to correct various errors.

- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **LOR-12121** and then open the following MicroStation design file

  \Survey\RawData\12121_FB001.dgn

- ✓ Create a new **Field Book** named LOR-511
- ✓ Load the following data files:

  \Survey\RawData \lor511a.dc
  \Survey\RawData \lor511b.dc

- ✓ Four duplicated point names will be encountered. Choose the appropriate action (**Overwrite**, **Skip**, **Rename**, **Next Name**).
- ✓ After importing both datasets, change the MicroStation **Annotation Scale** to your preferred value.

  Note: You may want to turn off the level for the **Setup Lines** and the **Observation Lines** before reviewing and editing the data.

- ✓ From the MicroStation pull-down menu, select **File > Save Settings**.

9 Correcting Errors

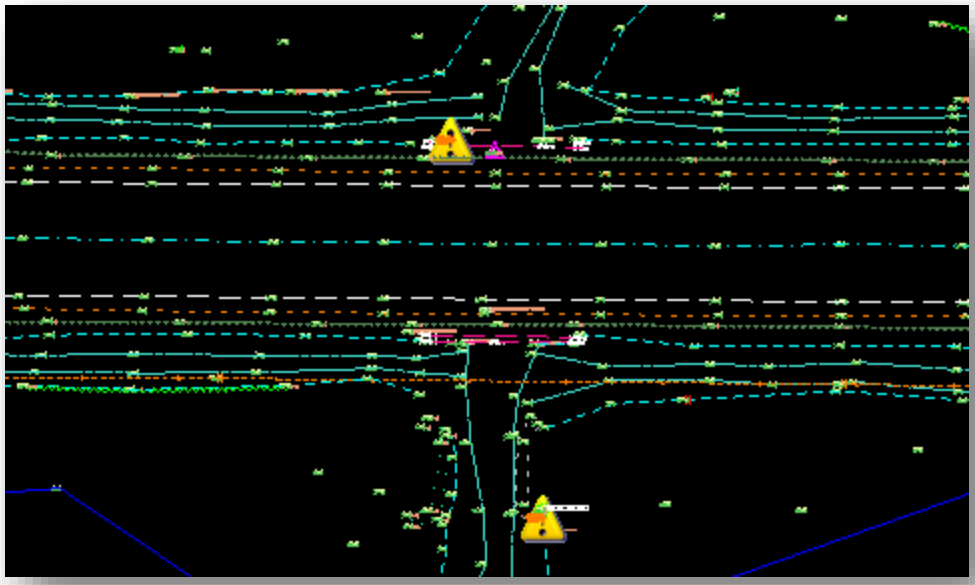
Exercise 8 – Correcting Errors

Occasionally a survey point or linear feature will be miscoded in the field. These coding errors are easy to correct in OpenRoads Survey. In this exercise, we'll correct a few code errors using the design file from a previous exercise.

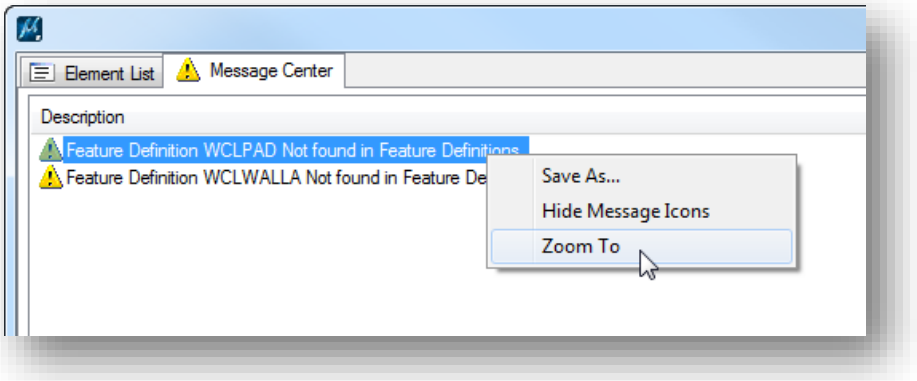
- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **LOR-12121** and then open the following MicroStation design file:

\Survey\RawData \12121_FB001.dgn

- ✓ Notice that there are two yellow warning icons displayed in the dataset as shown below.

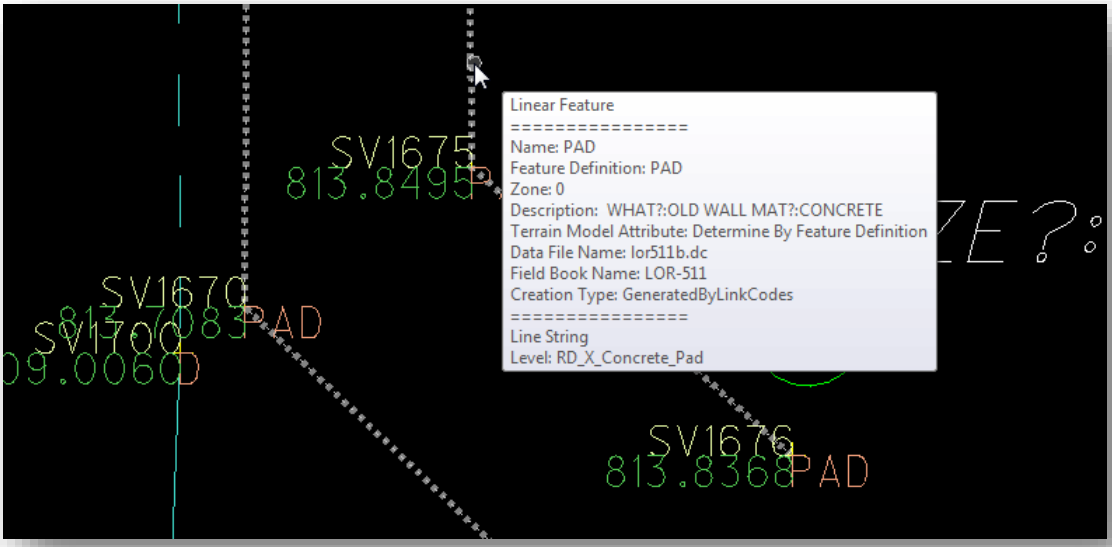


Open the *Survey Details* dialog to review the warning messages as shown below.



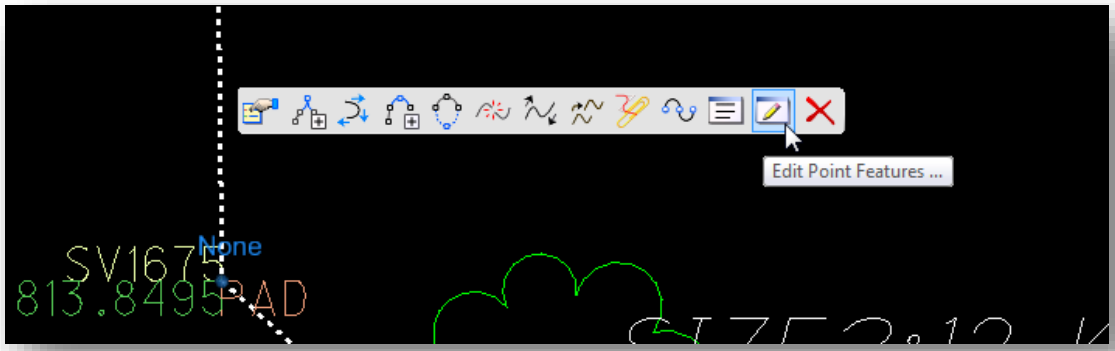
✓ Right-click on the warning message in the *Survey Details* dialog and select the **Zoom To** option to find which warning icon in the design file corresponds to the selected message. Note, that this option is really a window center operation and not a true zoom. Use the MicroStation view controls to zoom in the desired amount before selecting the **Zoom To** option.

Point SV1676 has been miscoded in the field. Edit the point to change the **Feature Definition** to **PAD** (select the point and choose the **Properties** option to edit the **Feature Definition**). The point will dynamically be included in the linear feature named PAD as shown below.

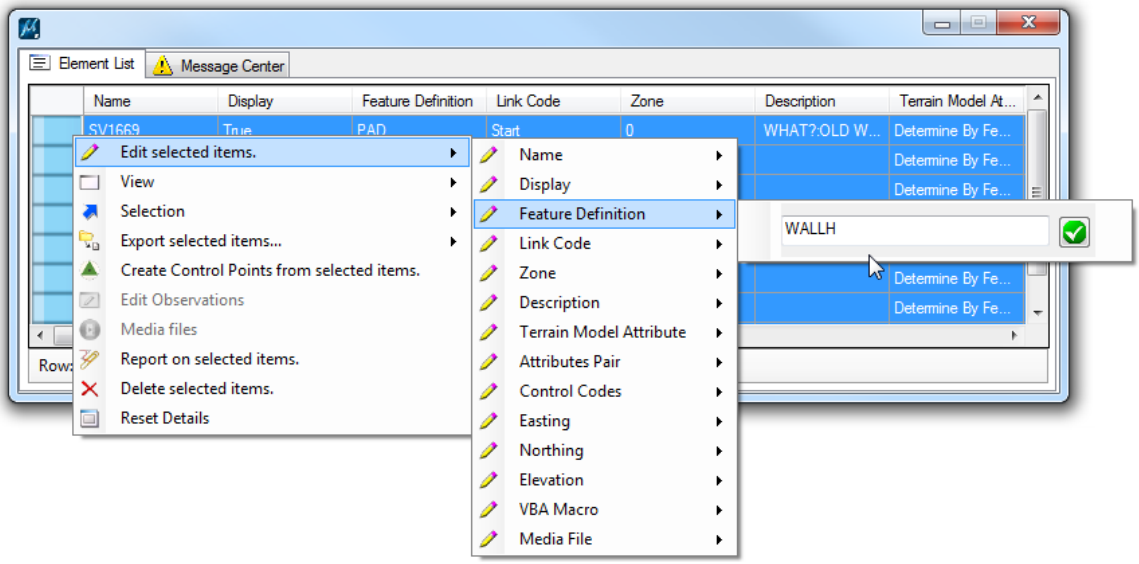


This particular linear feature represents a headwall, not a concrete pad, so we'll need to make additional edits to the data to correct the feature code for all the points in the linear feature and also to close the linear feature.

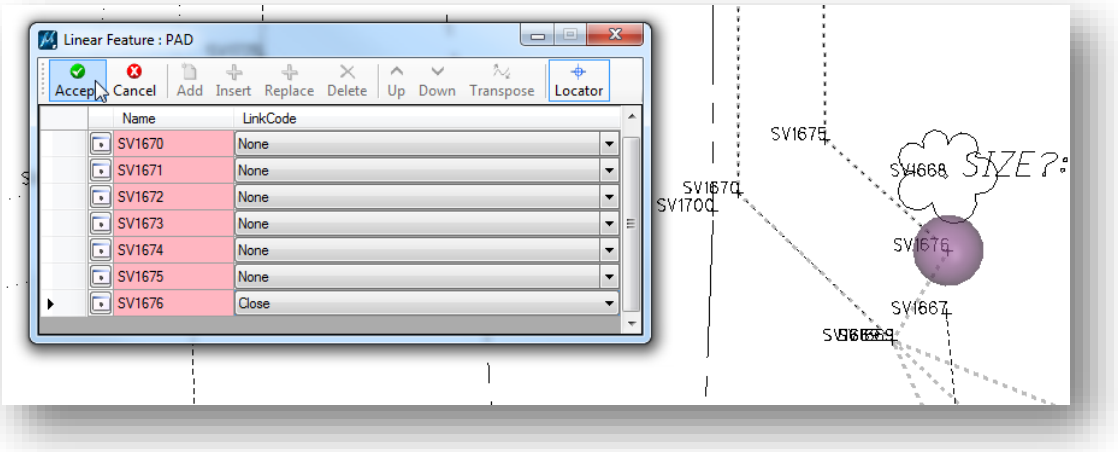
✓ To edit the **Feature Definition** for all of the points in the linear feature, use the MicroStation **Element Selection** tool to select the linear element. From the pop-up menu, select **Edit Point Features** as shown below.



The **Survey Details** dialog displays the points that make up the linear feature. Select all the points and right-click in the selection margin at the left of the **Name** column to access the menu shown below. Change the **Feature Definition** to **WALLH** for the selected points as shown below.



✓ To close the linear feature, Use the MicroStation **Element Selection** tool to select the linear feature. Choose the **Manage Point List** option from the pop-up menu. The *Linear Feature* dialog shown below is opened.



Change the **LinkCode** option for point SV1676 to **Close**. Select the **Accept** button. The linear feature is closed and dynamically updated.

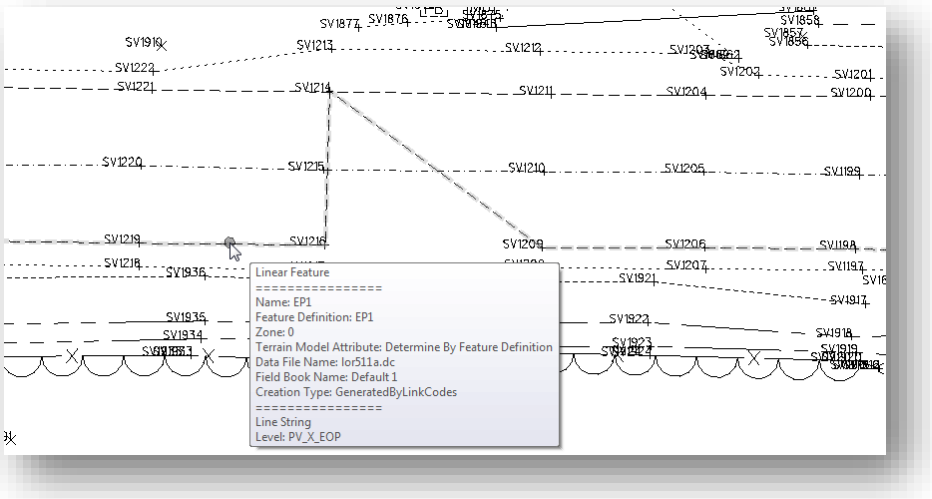
✓ Open the *Survey Details* dialog and use the **Zoom To** command to move to the next warning message. Point SV1778 should be coded as WALLA.

After changing the feature code to WALLA, the point is dynamically included in a linear feature.

Use the **Edit Point Features…** command to change the **LinkCode** for point SV1778 to **Close**.

A visually inspect of the data will reveal a few minor problems. Make the following edits:

✓ There is a problem with the edge of pavement lines crossing on the west side of the project. Point SV1214 has a feature definition of EP1. This point should have been coded as EP. Use the point **Properties** dialog to change the feature definition for point SV1214 to EP. Since the linear features are defined as dynamic link features, the point is automatically included in the linear feature EP and is removed from the linear feature EP1.



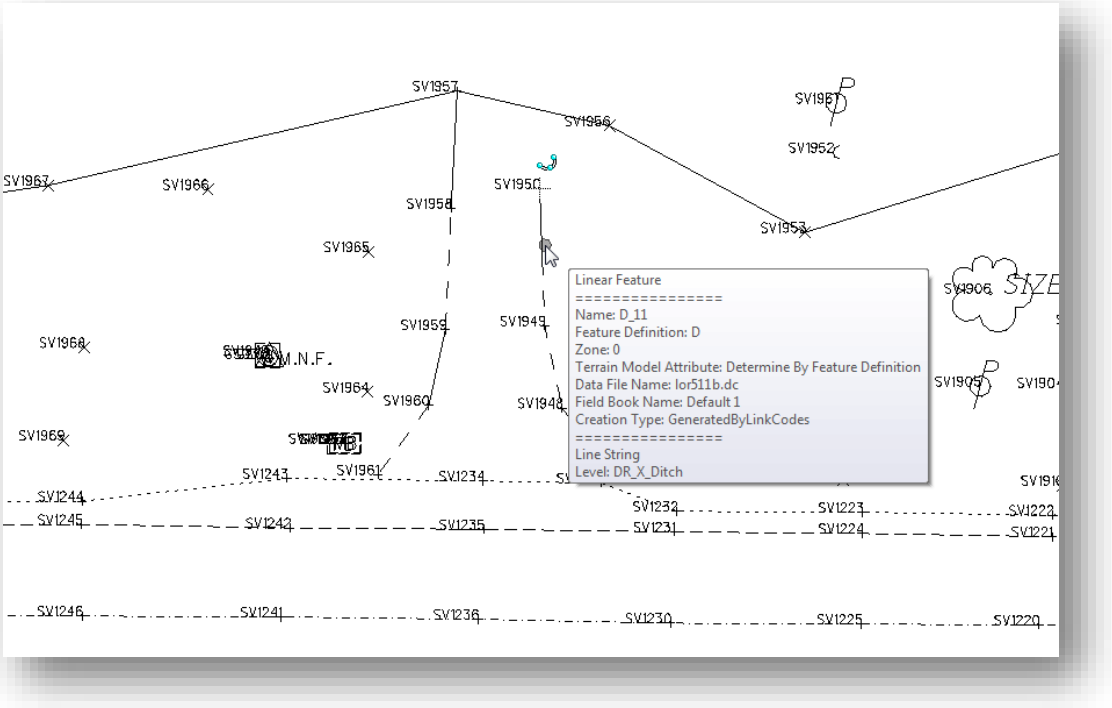
- ✓ The ODOT tree and shrub line feature definitions are defined uniquely for cases where the woods are to the surveyors left or right depending on the direction of survey. To use these codes correctly, if the woods or the shrub line are on the surveyors left the WOODSL or SHRUBL codes should be used. Conversely, if the woods or the shrub line are on the surveyors right, the WOODSR or SHRUBR codes should be used.

  There are three tree lines in the survey data. Each of them displays the arcs representing the tree line in the wrong direction. There are two ways to correct this problem:

  - Select the linear feature and choose the **Transpose Feature** command.
  - Change the feature definition for the points that make up the linear feature to use either the WOODSL or WOODSR feature definition as necessary.

  Try correcting the problem using each method described above.

- ✓ A driveway at the west side of the project has been accidentally coded as a drainage ditch. Locate the driveway shown below and edit the point list to change the feature definition from D to DR for each side of the driveway.



- ✓ From the MicroStation pull-down menu, select **File > Save Settings**.

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10 Graphic Linear Features

When collecting survey data in the field, it is not always easy to predict how the survey data will be triangulated. Occasionally, it may be necessary to append the field data by drawing some 3D graphic break lines to insert into the surface in order to provide a better triangulated model. This can be accomplished by inserting a **Graphic Linear Feature** into the surface.

A graphic linear feature can be any MicroStation graphical element. Editing consists of using MicroStation tools to draw or modify the element. The symbolization of these linear features can be controlled by the assigned feature, but assigning a specific feature is an option – not a requirement.

Exercise 9 – Graphic Linear Features

In this exercise, we will place two graphics elements in a 3D file, representing the base of a headwall, and then import these elements into the survey data as a break line.

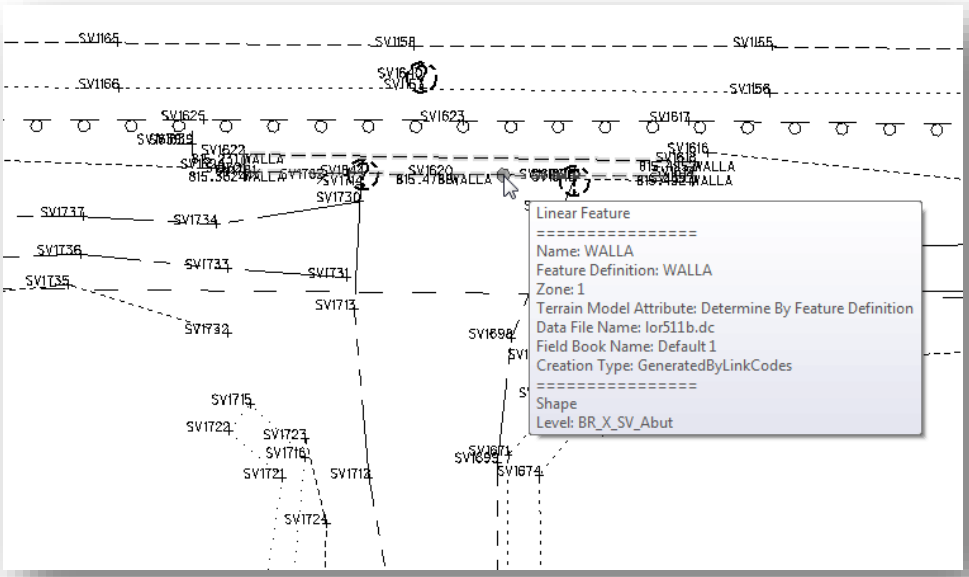
- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **LOR-12121** and then open the following MicroStation design file:

  \Survey\RawData \12121_FB001.dgn

- ✓ Optional:
  - Change the Annotation Scale to 1:5
  - Turn off the following levels:
    - SV_Observation
    - SV_X_Text_Comment
    - SV_X_Text_Description
    - SV_X_Text_Elevation

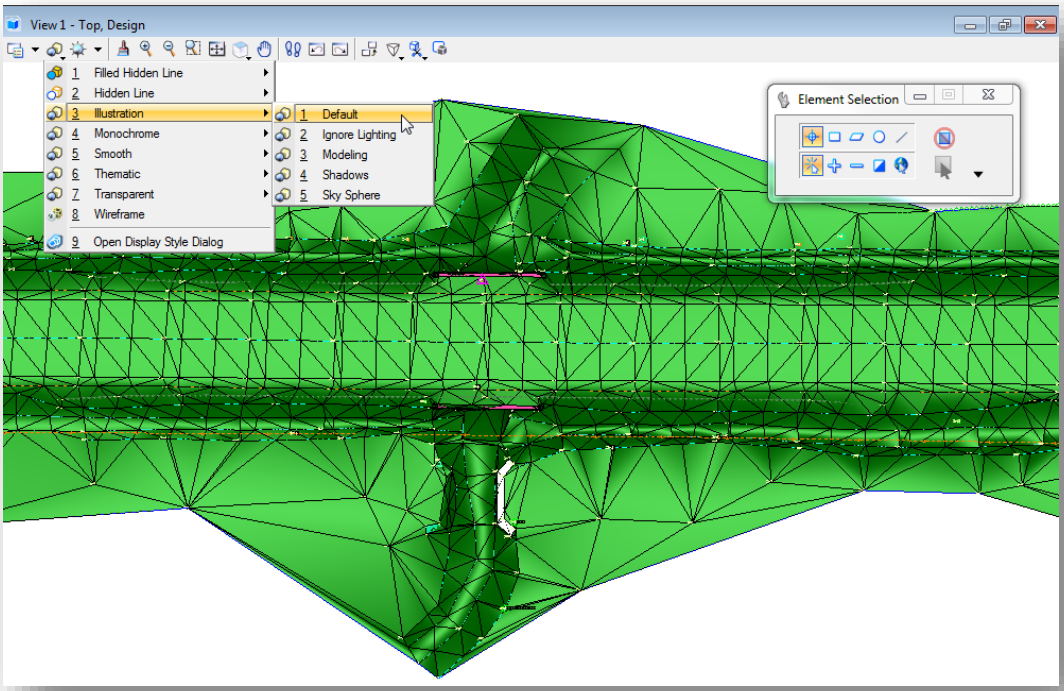
  This will reduce the overlapping text and make it easier to read the point names when zoomed in on each point.

- ✓ Zoom in on the linear feature named WALLA as shown on the following page. This feature represents the top of the headwall.

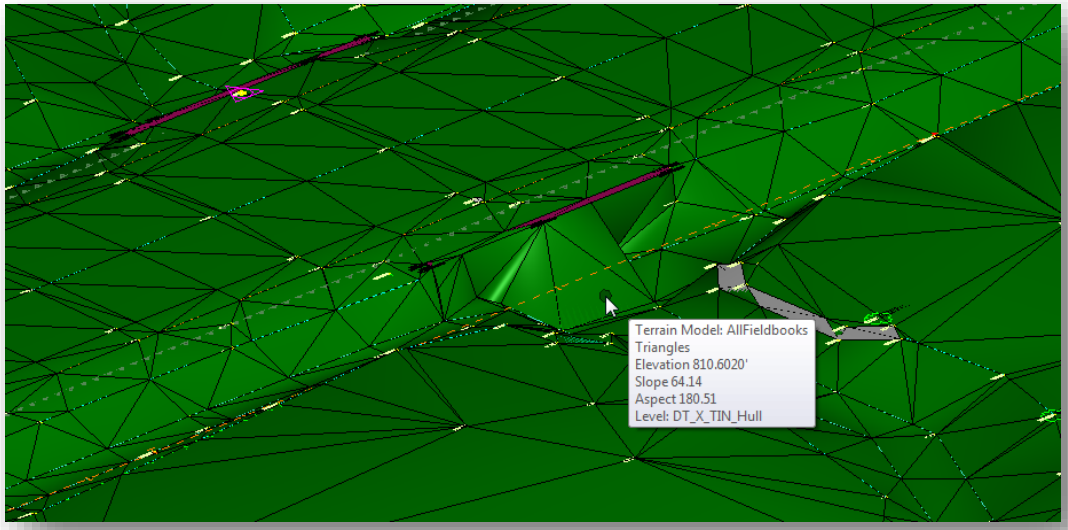


Let's take a look at how the triangles were formed for this dataset.

- ✓ Select the terrain model and choose the **Properties** command from the pop-up menu.
- ✓ Change the **Feature Definition** to **X_Triangles**
- ✓ Change the view **Display Style** to **Illustration > Default** as shown below.



Now let's rotate the view to get a better look at how the triangles are formed around the headwall on the south side of the road. Use the Rotate View command to orient the view similar to the example below.



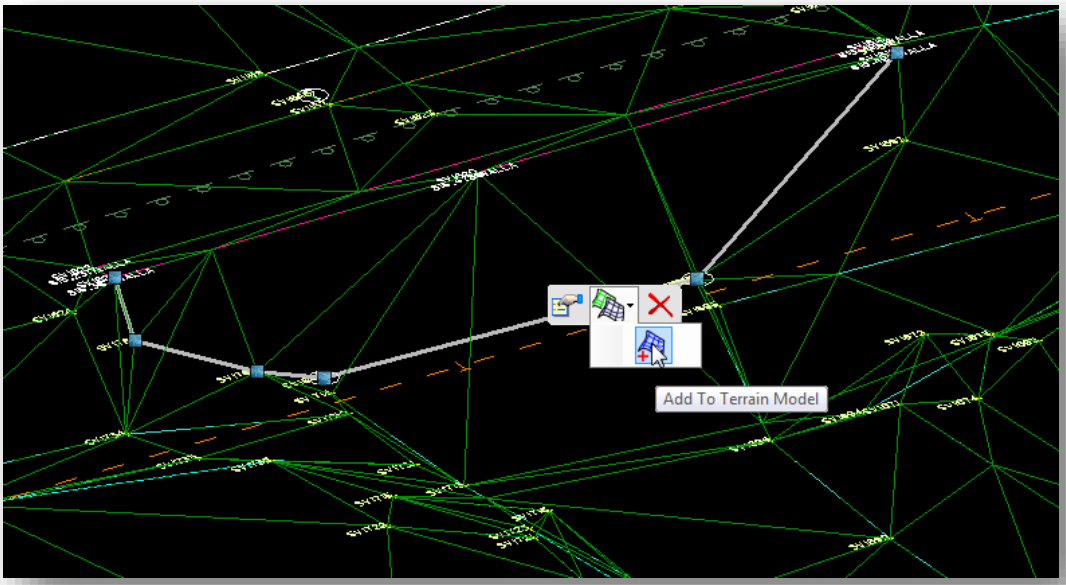
Notice that some of the triangles are formed such that they extend from the top of the headwall out into the ditch. The bottom of the headwall was not coded as a break line by the field crew. Rather than send the crew back out to pick up additional points, we'll draw a 3D MicroStation SmartLine that can be inserted into the terrain model as a graphic linear feature.

There are some surveyed points in the dataset that we can draw a 3D SmartLine through in order to better define the bottom of the headwall.

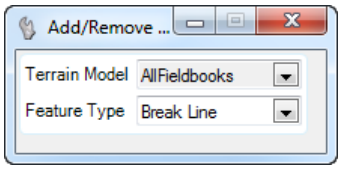
- ✓ Set the active MicroStation level to **DT_X_Break_Line**
- ✓ Change the MicroStation **Display Style** back to **Wireframe**
- ✓ Draw a MicroStation SmartLine element through the following points:

SV1621, SV1781, SV1782, SV1844, SV1845, SV1619

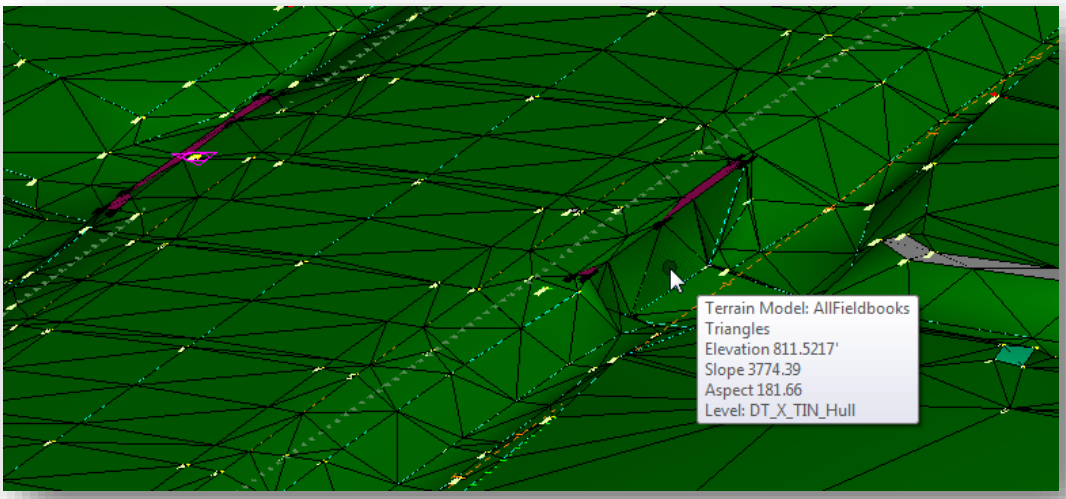
- ✓ To include the 3D SmartLine in the terrain model, use the MicroStation **Select Element** tool to select the element, and then choose the **Add To Terrain Model** icon as shown on the following page.



✓ Set the **Feature Type** as **Break Line** as shown below.

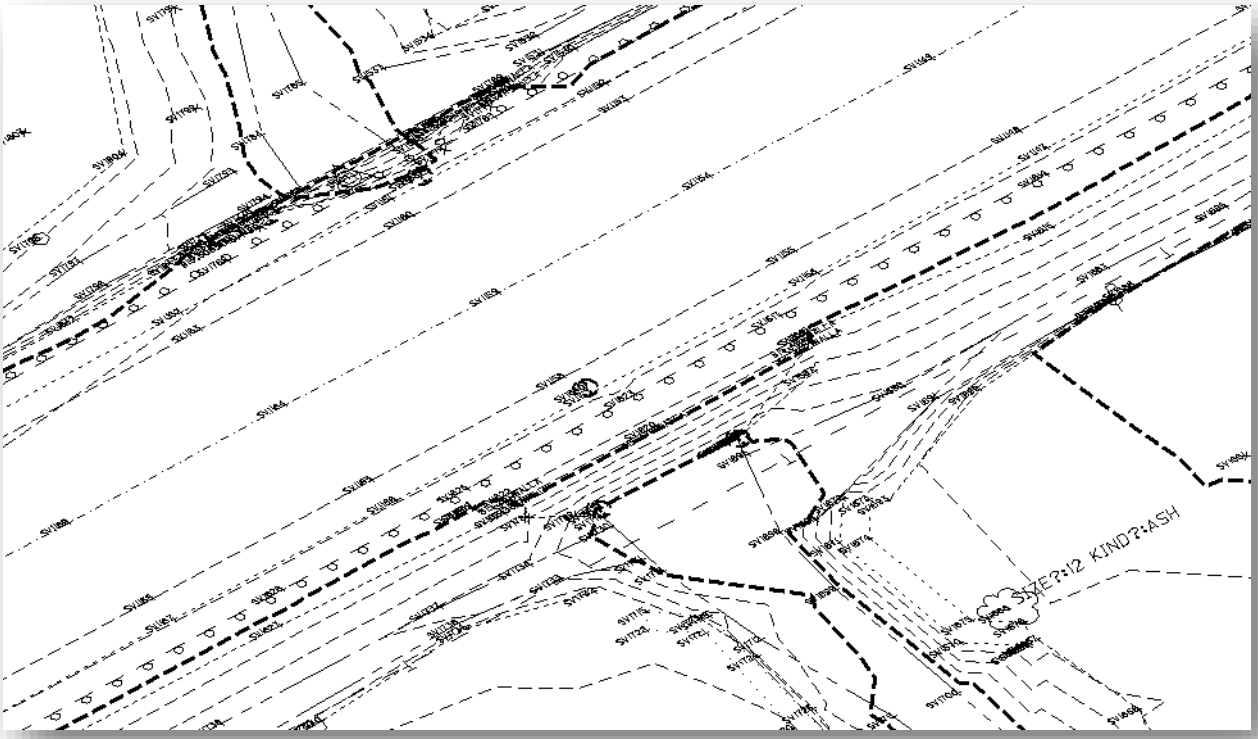


✓ Follow the prompts to accept the **Terrain Model** and the **Feature Type**. The 3D Smartline is added to the terrain model which is dynamically updated as shown below.



The headwall on the other side of the road has a similar problem. Take the following steps to better define the bottom of the headwall:

- ✓ Choose the MicroStation level **DT_X_Break_Line**
- ✓ Draw a SmartLine through points SV1769, SV1772, SV1786, SV1795, SV1780, SV1779, SV1777.
- ✓ Add the line as a new graphic linear feature.
- ✓ Set the MicroStation display mode to Illustration and rotate the view to admire your handiwork. A rotated view showing the terrain model from the south east using the **Feature Definition** of **Existing Ground 5' Contours** is shown below.



Caution!
Be careful when adding graphic break lines that you do not create an overhang situation where the graphic break line goes underneath the top of the headwall.

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11 Bridge Surveys

Field Codes

The ODOT Feature Code list includes the field codes listed below for bridges. The information in this section is provided in order to better define the codes and their intended use.

Field Code	Description	Terrain Model Attribute
BD	Bridge deck	Do Not Include
BOB	Bottom of the beams	Do Not Include
BRFLOOR	Bottom of the bridge deck	Do Not Include
BRRAIL	Top of the bridge railing or parapet	Do Not Include
BRSEAT	Beam seat elevation shots	Do Not Include
PIER	Perimeter of the pier	Do Not Include
PIERCB	The bottom of the pier cap	Do Not Include
PIERT	The outline of the pier cap	Do Not Include
WALLA	The outline of the abutment wingwall or the face of the abutment breastwall. Shoot the bottom of the wall as a break line.	Break

BD: Bridge Deck is used to determine toe to toe of parapet and perimeter of the bridge deck.

BOB: Bottom of beam is used to determine vertical clearance and location of the beams. Use judgment to determine the points of critical vertical clearance. The minimum shots for BOB are one at each bearing. If the beams might be reused, shoot the web for one exterior beam. Also shoot any changes in the bottom of the beam due to cover plates. Shoot a point on each side of the change in section. Measure the center to center spacing of the beams. This will be used to determine the location of the beams.

BRFLOOR: Bridge Floor is used to determine out to out of bridge deck and bottom of bridge deck. This is especially important for slab bridges and stage construction. If stage construction is considered, a shot should be taken where the deck will be cut for stage construction. Discuss with the project manager if this shot is necessary and exactly where the shot should be taken.

BRRAIL: Bridge Rail is used to locate the barrier. This information may be needed if the parapet is to be reused. Discuss with the project manager where the shots on the railing should be taken.

BRSEAT: will be used for the elevation of the beam seat. Take shots as close to the centerline of each beam as possible. Record where the point was taken in relation to the beam. These shots will used in conjunction with the BOB to determine the height of the bearing device.

PIER: used to determine location, and size of pier columns.

PIERCB: used to determine location, skew, and size of pier cap.

PIERT: Pier Top is used to determine location, skew, and size of pier cap. These shots are used to determine the skew of the pier cap. Take a shot at the top and bottom of each step in the pier cap. Also, take a shot on the opposite side of the pier cap. These shots will be used to determine the width of the pier cap.

WALLA: The purpose of these points is to determine the location and skew of the abutment. From these shots we would also like to be able to get the outline of the wall. For the wing walls, at a minimum get a point at all four corners and another shot along each face of the wing wall. Shoot the bottom of the wall or where the ground meets the wall as a break line. If you are collecting the bridge information as a separate job on the data collector, the WALLA feature code should be included with in the topographic data, not in the bridge data.

Terrain Model Requirements

For projects containing one or more bridges, the existing ground terrain models should not include any of the bridge information. A separate terrain model is required for the surface of each bridge.

Note that the bridge codes in the ODOT Field Code list are all configured with the terrain model attribute set to Do Not Include with the exception of the WALLA code. This will ensure that the ground terrain model for the project contains the existing ground information under the bridge and does not include the bridge itself.

Data Collection Procedures

The recommended practice for bridge surveys is to collect all of the bridge information as a separate job in the data collector. This ensures that all the necessary data for the bridge is isolated from the ground terrain survey and can be used to easily generate a terrain model for the bridge deck information. Note that the WALLA feature should be collected with the topographic information, not as part of the bridge job ib the data collector.

If the bridge information has been collected in the same job on the data collector as the topographic survey, the easiest way to generate the surface of the bridge is to use the Bentley Civil Terrain Modeling tools to create the bridge deck surface from 3D graphics rather than the OpenRoads Survey tools.

An example of each approach is provided in the following two exercises.

Exercise 10 – Creating a Bridge Terrain Model Using Separate Data Files

In this exercise we'll process survey data in which the bridge information was collected as a separate job on the data collector. Each portion of the data will be processed into separate field books.

- ✓ Open MicroStation using the shortcut for the training class

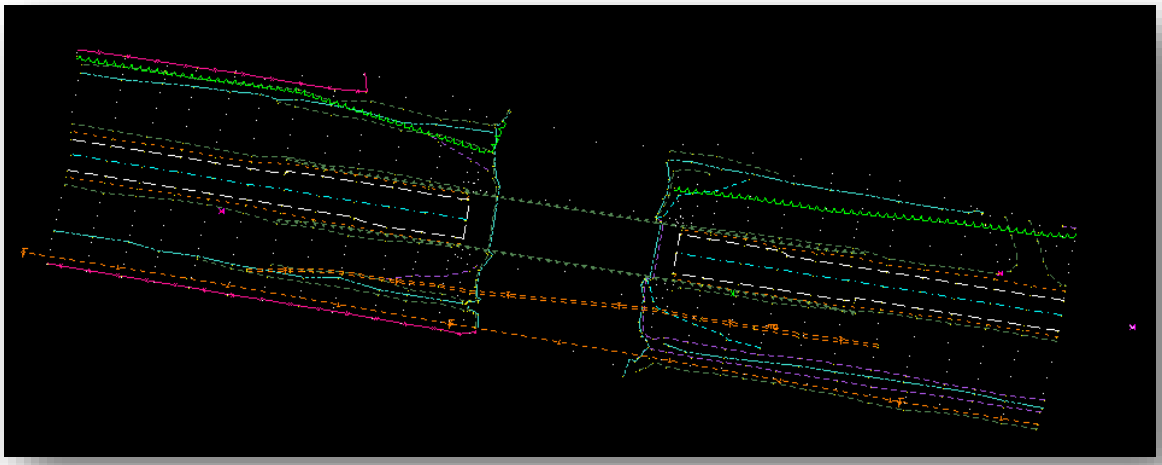
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **MAD-16653** and then open the following design file:

  \Survey\RawData\16653_FB001.dgn

- ✓ Create a new field book and name it **MAD 665-397 Topo**. Load the following data file:

  \Survey\RawData\MAD-665-397.sdr

  This data file contains the topographic survey for the project. The data is imported as shown below. Notice that a terrain model was not automatically generated for the data.

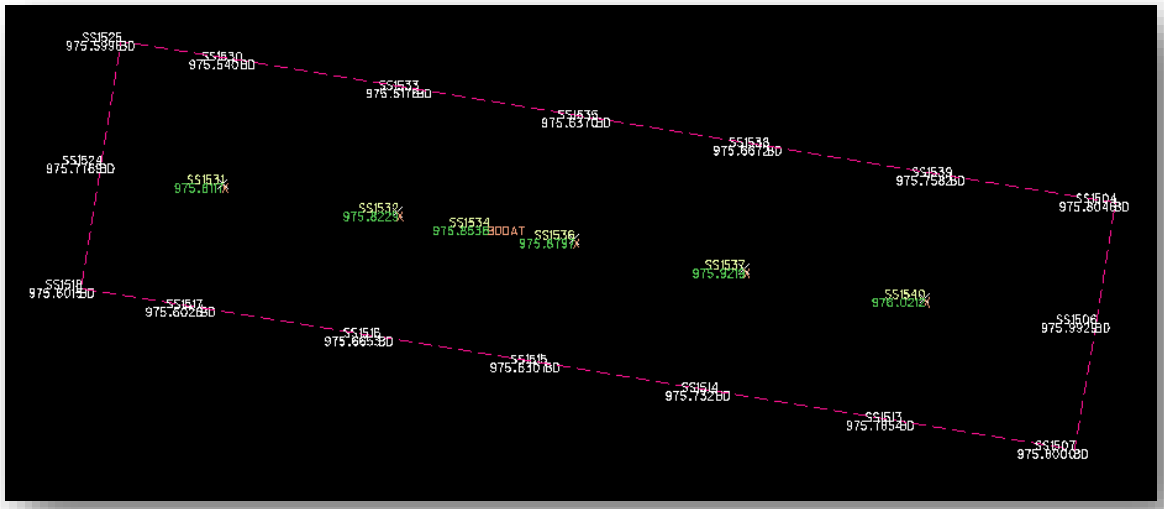


- ✓ Create a second field book for the bridge information. Rename the new field book to: **MAD-665-397 Bridge**

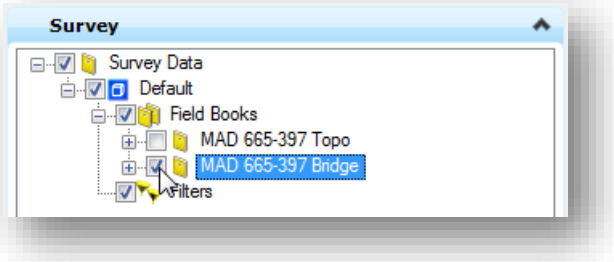
- ✓ Load the following data file:

  \Survey\RawData\MAD-665-397BRID.sdr

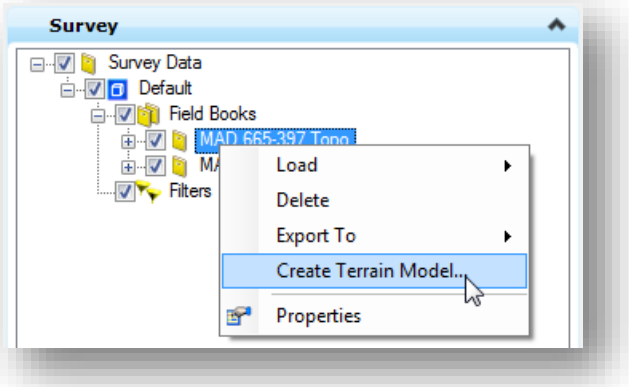
  The data is imported as shown on the following page. A terrain model is not generated for this field book either.



Note: In the *Project Explorer* dialog, you can turn on/off the display of the data for each field book using the check boxes next to the field book name as shown below.



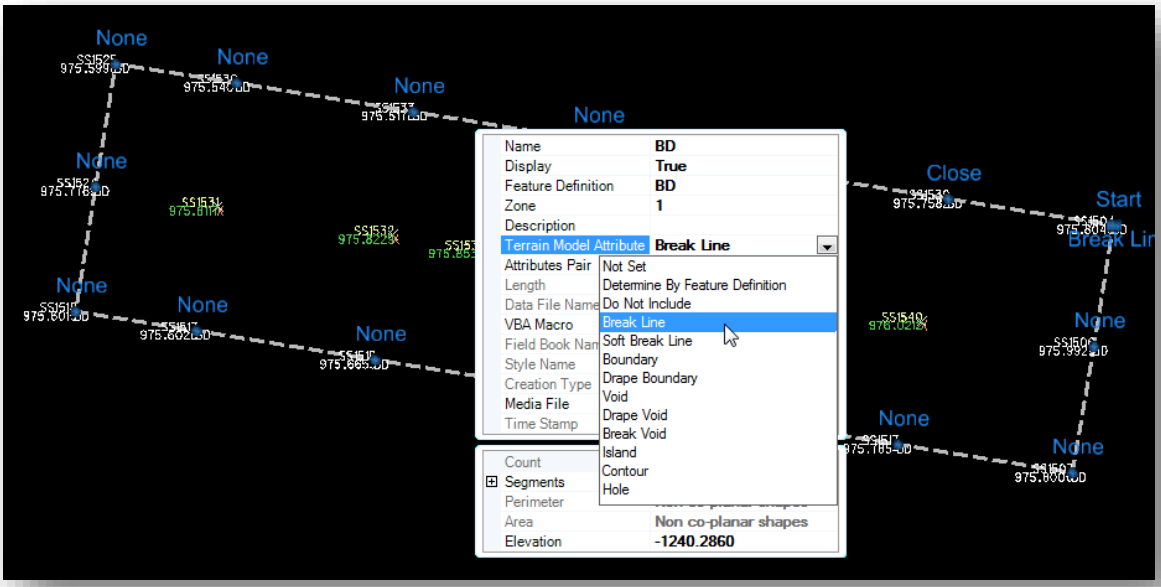
✓ To create a terrain model for the topo data, right-click on the field book name and choose the **Create Terrain Model…** option as shown below.



A terrain model is created using the name of the field book.

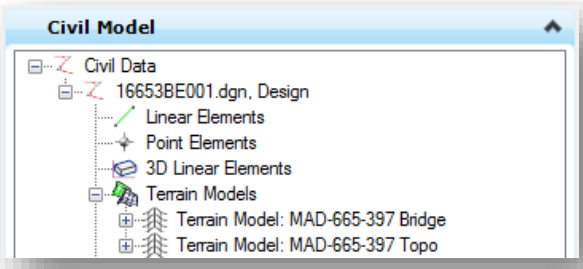
The field book containing the bridge deck information will be used to create a second terrain model for the bridge deck. This data file includes some features that are will be included in a terrain model (X) as well as the bridge deck feature (BD) that is not included in the terrain model.

- ✓ To include the bridge deck in the terrain model, select the bridge deck element and choose the Properties option from the pop-up menu. Change the **Terrain Model Attribute** item to **Break Line** as shown below.



Note: Any other features, such as the LINE2D feature code, that are not normally included in the terrain model can be added to the bridge deck terrain model by changing the Terrain Model Attribute to the appropriate value.

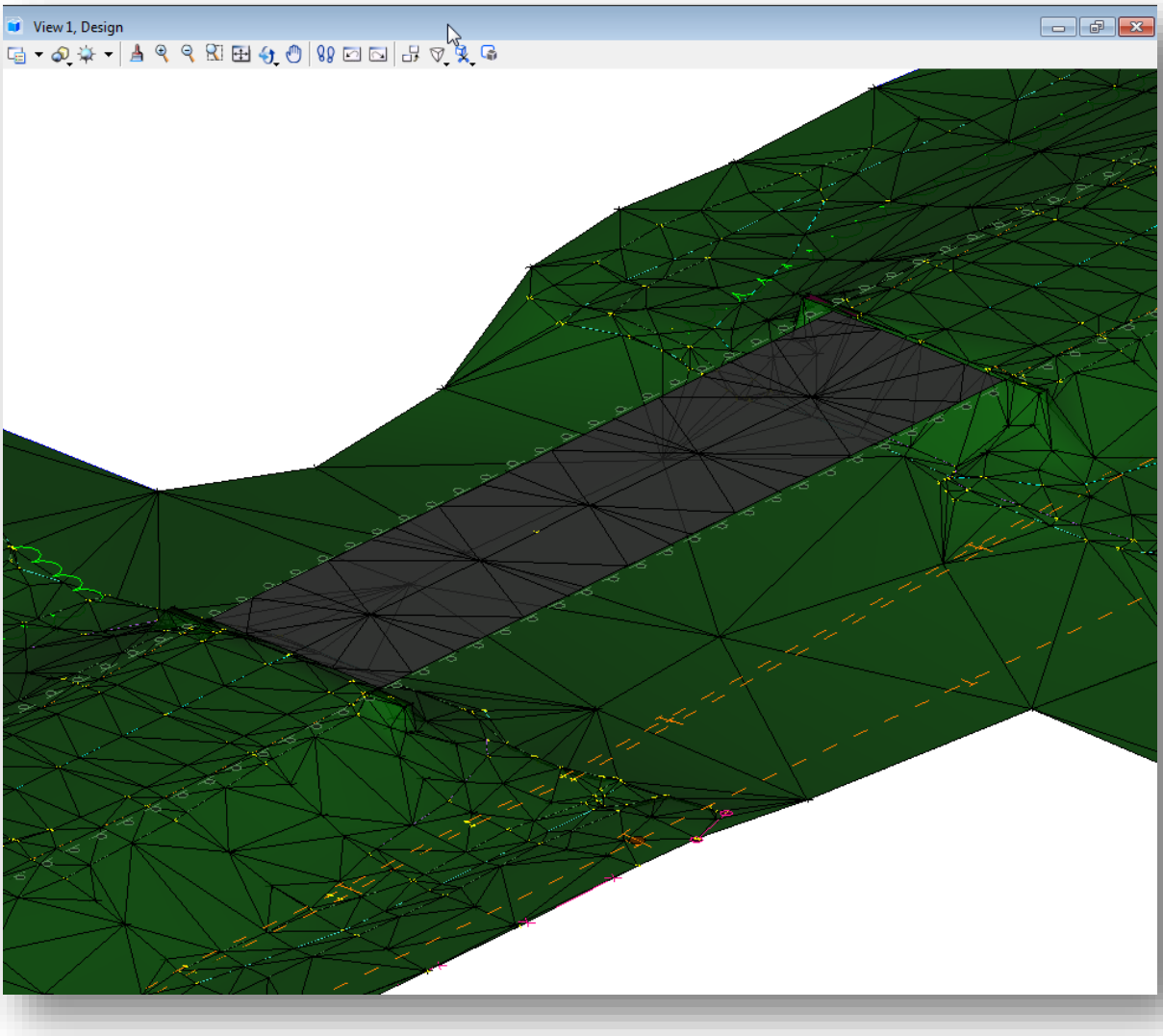
- ✓ Create the terrain model for the bridge deck by right-clicking on the field book name and choosing the **Create Terrain Model…** option. A second terrain model is created for the project as shown in the *Project Explorer* dialog's **Civil Model** tab below.



Take the following steps to display the terrain models:

- ✓ Change the Feature Definition for the Topo terrain model to Existing Ground Triangles
- ✓ Change the **Feature Definition** for the Bridge terrain model to **Existing Bridge Deck**
- ✓ Set the **Edge Method** for the bridge deck terrain model to **Maximum Triangle Length** with a value of **1** foot.
- ✓ Change the View Display Style to Illustration

An example of the completed terrain models for the project is shown in a rotated view below.



Exercise 11 – Creating a Bridge Deck Terrain Model from 3D Graphics

In this exercise we'll import multiple datasets to define the existing ground terrain as well as generate a separate terrain model for a bridge deck.

The survey data for this project includes both ground terrain information as well as the bridge deck information in the same survey dataset. The bridge was not collected as a separate job on the data collector.

- ✓ Open MicroStation using the shortcut for the training class

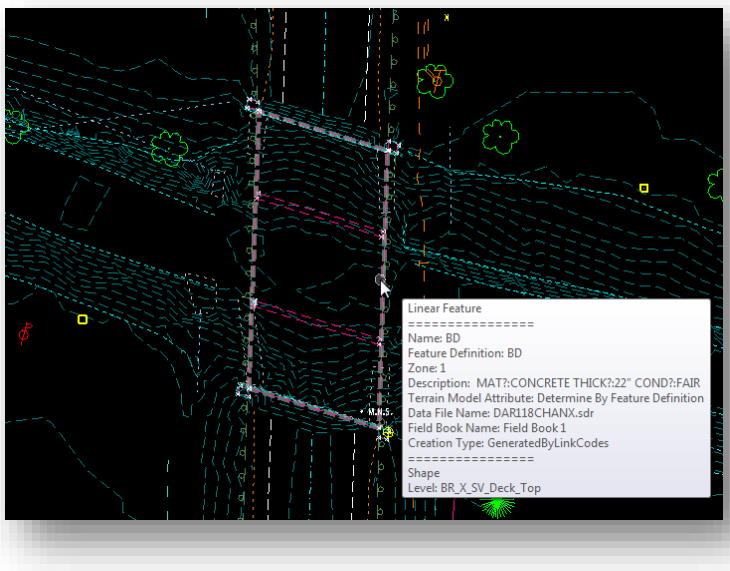
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **DAR-11222** and then open the following design file:

  \Survey\RawData\11222_FB001.dgn

- ✓ Create a new **Field Book** and import the following datasets:

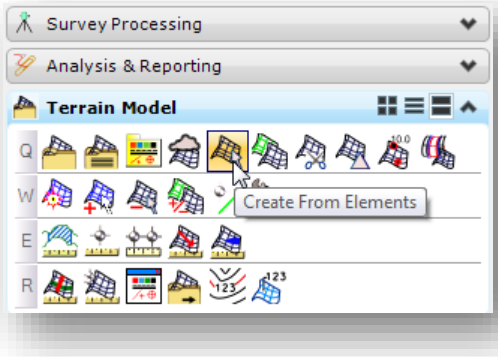
  \ Survey\RawData \DAR118CHANX.sdr
  \ Survey\RawData \DAR1180849.sdr
  \ Survey\RawData \DAR1180849B.sdr
  \ Survey\RawData \DAR118WL.sdr
  \ Survey\RawData \DAR118VRS.sdr

- ✓ After the datasets have been imported a new terrain model is automatically created. Edit the terrain model properties to set the **Display Feature** to **X_Contours 05' Major**. Notice that the edge of pavement and the center of pavement lines stop short of the bridge deck. This causes the contour lines to drop off before the terrain surface reaches the bridge deck.



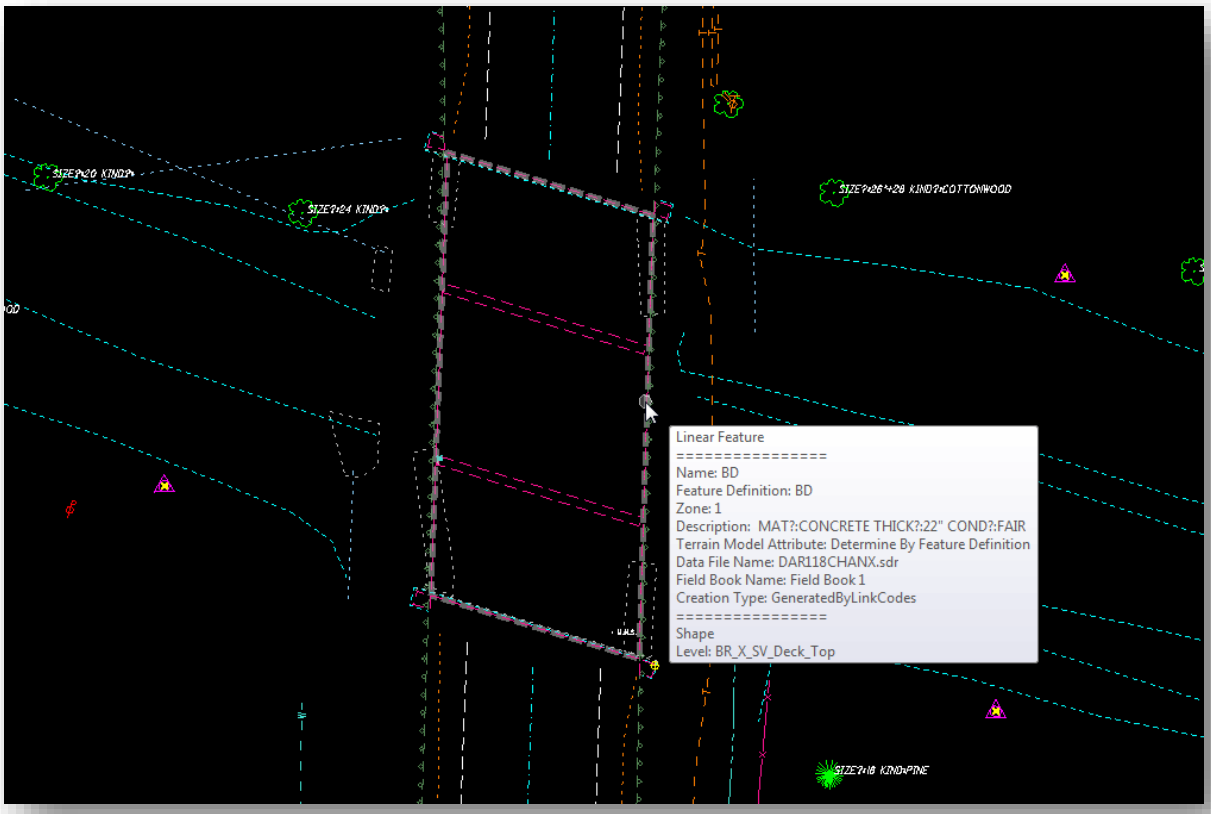
- ✓ Turn off the levels **DT_X_Contour_Major DT_X_Contour_Minor**, and any other unnecessary levels to clean up the screen display before moving to the next step.

The **Create From Elements** tool, located in the *Task Navigation* dialog's **Terrain Model** group, is used to create a new terrain model from selected 3D MicroStation graphics.



Depending on how the survey data was collected, creating a terrain model for the bridge deck can be as simple as selecting the bridge deck element(s) or can involve edge of pavement and a centerline lines that were collected across the surface of the bridge deck using the **LINE2D** feature code.

In this dataset, the perimeter of the bridge deck was collected as one closed element and the edge of pavement and center of pavement lines were stopped short of the bridge as shown below.

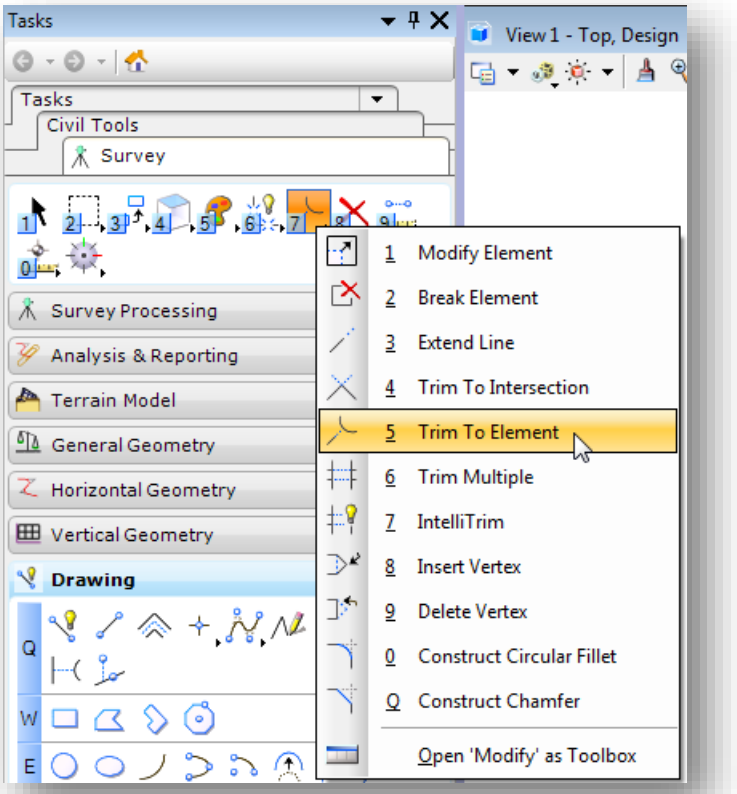


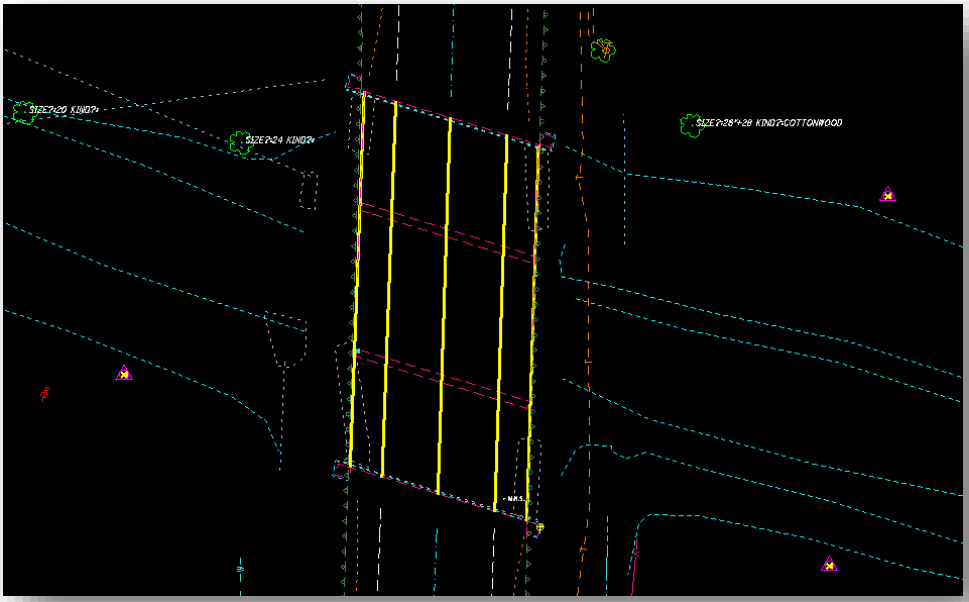
- ✓ It may be desirable to connect the edge and center of pavement lines by drawing 3D lines across the bridge in order to generate a crowned surface for the bridge deck. Before we generate the terrain model, draw lines across the bridge as shown below. Use the level **DT_X_Break_Line** for these graphics.

The next step is to trim the lines so that they meet the bridge deck limits. We'll also draw two lines along the edges of the bridge deck as shown on the following page.

Note: This method assumes that the profile of the bridge deck surface is on a continuous slope and is not in a vertical curve.

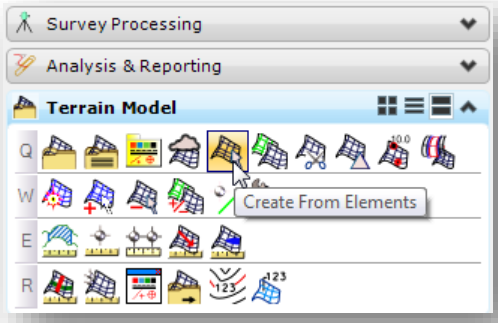
✓ Use the MicroStation **Trim To Element** tool to trim the lines to intersect the bridge deck as shown below.





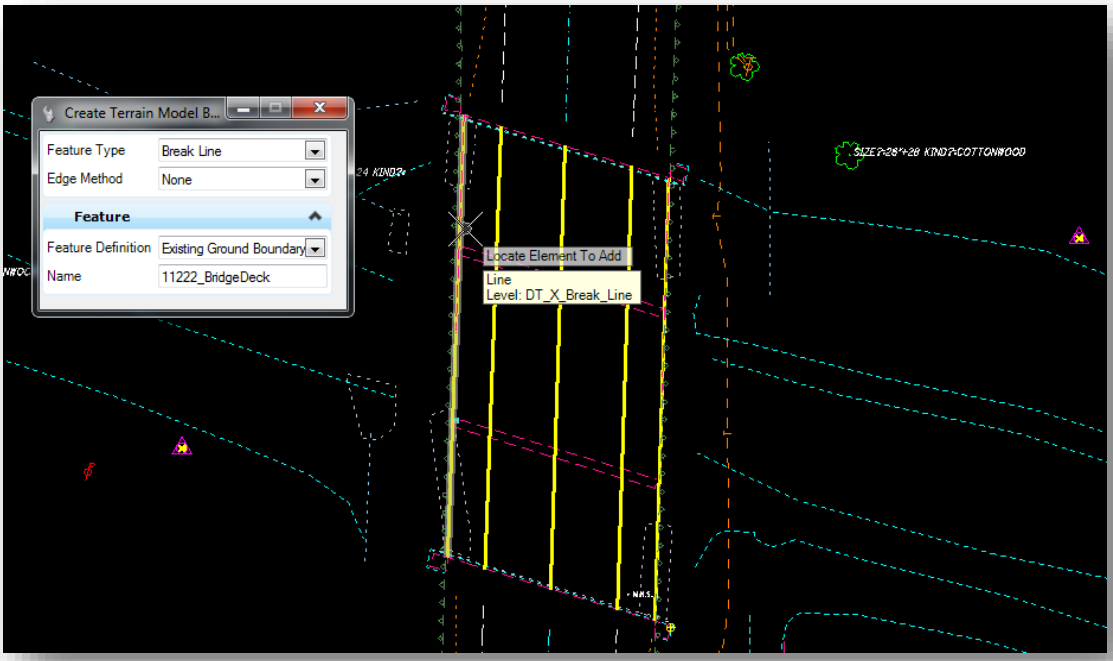
We will use these 5 lines to generate the bride deck terrain model.

✓ Select the **Create From Elements** tool from the **Terrain Model** group in the Task Navigator.



- Set the **Feature Type** to **Break Line**
- Set the **Edge Method** to **None**
- Set the **Feature Definition** to **X_Bridge Deck**
- Name the terrain model using the PID number for the project as follows: **11222_BridgeDeck**

Select each of the lines when prompted to **Locate Element to Add** as shown below. Each line will be included as a **Break Line** in this terrain model and is hilighted as you select the elements.

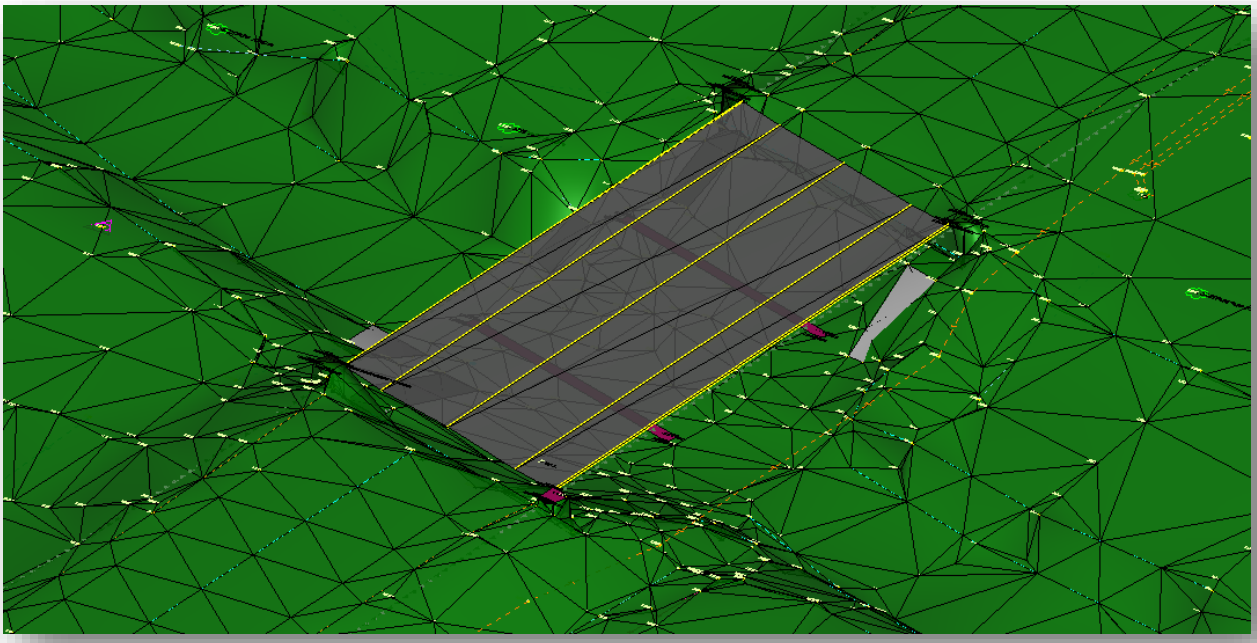


Reset when you have finished selecting the lines.

You are now prompted to accept the settings. Issuse a data point to accept the **Feature Type** and **Edge Option** paramaters. Upon completion, the terrain model is created.

✓ Now it's time to examine your handiwork. Take the following steps to view the terrain models.

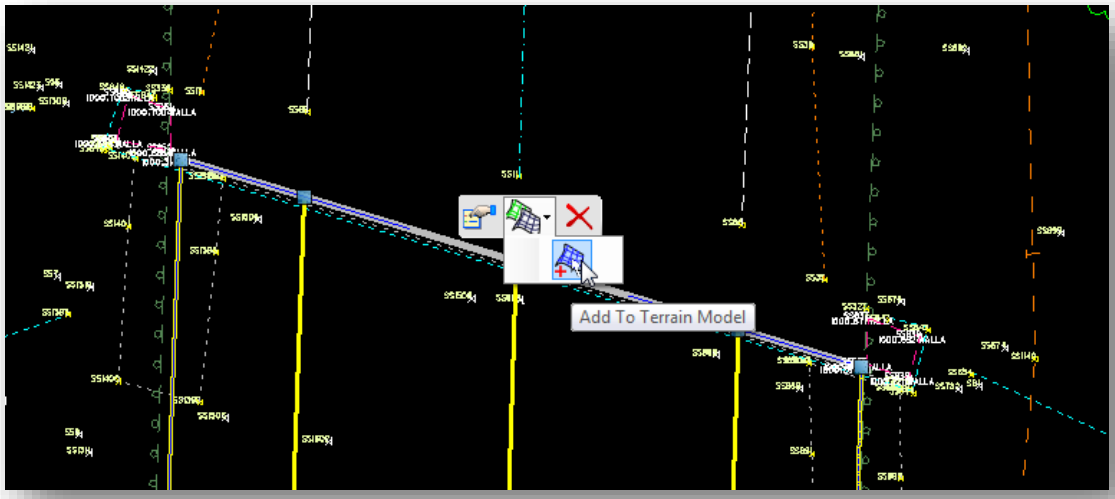
- Select the AllFieldBooks terrain model and change the **Feature Definition** to **X_Triangles**
- Turn on the level **DT_X_Triangles** if it is not on
- Turn off the level **BR_X_SV_Deck_Top**
- Change the MicroStation **Display Style** to **Illustration**
- Rotate the view to review the terrain model triangulation



With this dataset there is a drop-off between the pavement and the bridge deck surface at each end of the bridge. Additional editing to the existing ground terrain model is necessary to eliminate the drop off. This can be facilitated by drawing a 3D line string at each end of the bridge deck to be inserted into the existing ground terrain model.

- ✓ Use the **Place SmartLine** command to draw a 3D line string each end of the bridge deck. When drawing the SmartLines, be sure to snap to the ends the lines that were used to make the bridge deck surface.

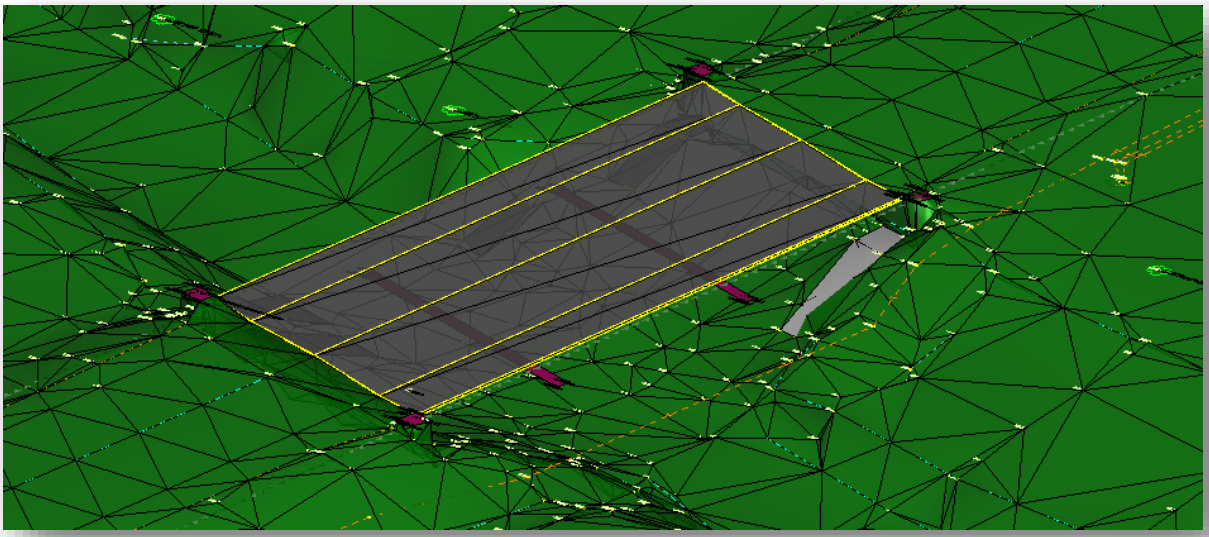
- ✓ Select the 3D Smartline and choose the **Add to Terrain Model** command as shown below.



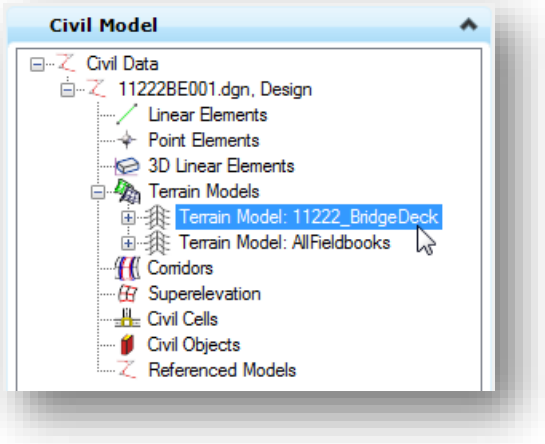
- ✓ When prompted, identify the **AllFieldBooks** terrain model to add the element. Set the **Feature Type** to the **Break Line**

- ✓ Repeat these steps to add the Smartline at the other end of the bridge deck to the AllFieldBooks terrain model

The completed terrain models for the bridge deck and the ground survey are shown below.



The bridge deck terrain model is added the **Civil Model** tab in the *Project Explorer* dialog as shown below:



Notes about this example and data collection procedures
In this example, the edge of pavement and pavement crown lines for the bridge deck was not collected in the field. Instead, 3D lines were drawn across the bridge deck limits in order to generate the surface of the bridge deck. This data could have been further enhanced in the field collection process as detailed below:

- Use the EP and CP field codes to collect the edge of pavement and center of pavement lines up to the bridge deck limits
- Collect the perimeter of the bridge deck using the BD field code, including points at the edge of pavement and center of pavement locations.
- Use the LINE2D field code to collect the edge of pavement and center of pavement lines across the surface of the bridge deck. The LINE2D code will draw 3D lines in a 3D MicroStation model, but the lines are not included in the terrain surface.
- Create the bridge deck terrain model using the 3D lines drawn for the BD and LINE2D features.

The goal is to create a seamless transition from the existing ground terrain model and the bridge deck terrain model. There may be other methods to achieve these results.

12 Ground Survey and LiDAR Data

Occasionally it is necessary to merge ground survey information with LiDAR generated terrain models in order to deliver a combined terrain model. LiDAR based terrain information can come from a variety of sources including the ODOT Office of CADD and Mapping Services and the Ohio Statewide Imagery Program (OSIP). Regardless of the data source, the procedure to merge the terrain information is similar. This chapter will detail the process to generate an OpenRoads terrain model from OSIP XYZ data and merge the data with ground survey information.

Exercise 12 – Merging OSIP Data with Ground Survey

In this exercise we will merge ground survey information for a slip project with OSIP data for the area.

Part 1 – Import the Survey Data

- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **TUS-77777** and then open the following design file:

  \Survey\basemaps\77777_BC001.dgn

- ✓ The file was created using the ODOTSeed3d_OH83-NF.dgn seed file. Before proceeding, verify that the Ohio North Zone GCS is active.
- ✓ Create a new Field Book to import the Survey data. Import the following file:

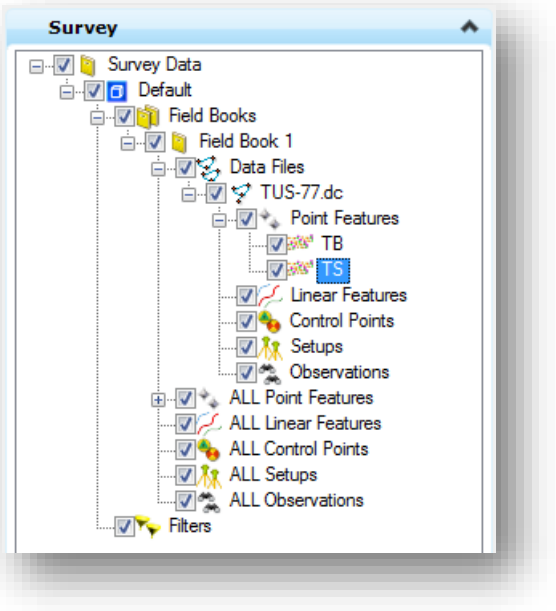
  \Survey\RawData\TUS-77.dc

- ✓ After importing the data, create a terrain model for the field book.

There are a few problems with the data that must be corrected before we merge the data with the OSIP information. The field code for the Toe of Slope was miscoded as TS instead of TSL. Additionally, there are not any mapping codes in the data to define the start and end of the linear features.

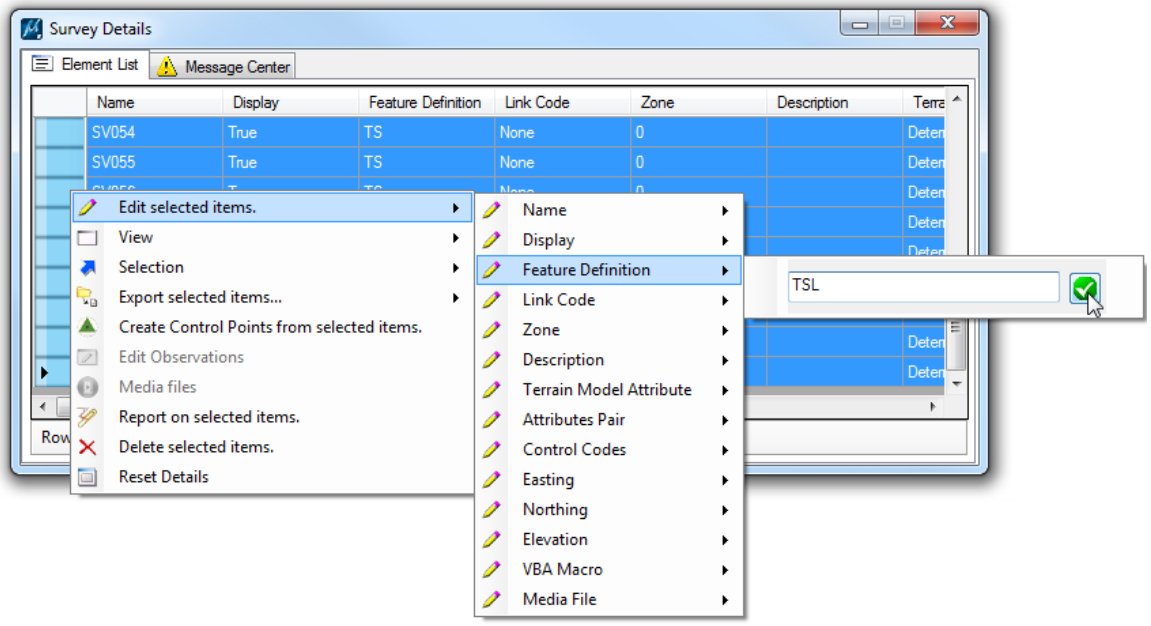
Take the following steps to change the TS field code to TSL:

- ✓ In the *Project Explorer* dialog, select the TS point features from the data tree as shown on the following page.

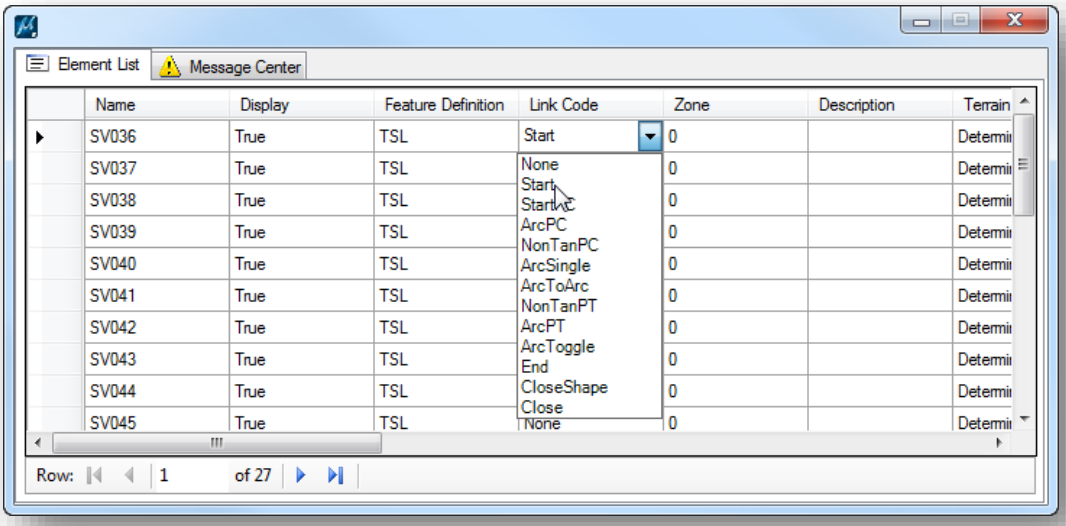


Once selected, all of the points defined with feature TS are displayed in the *Survey Details* dialog.

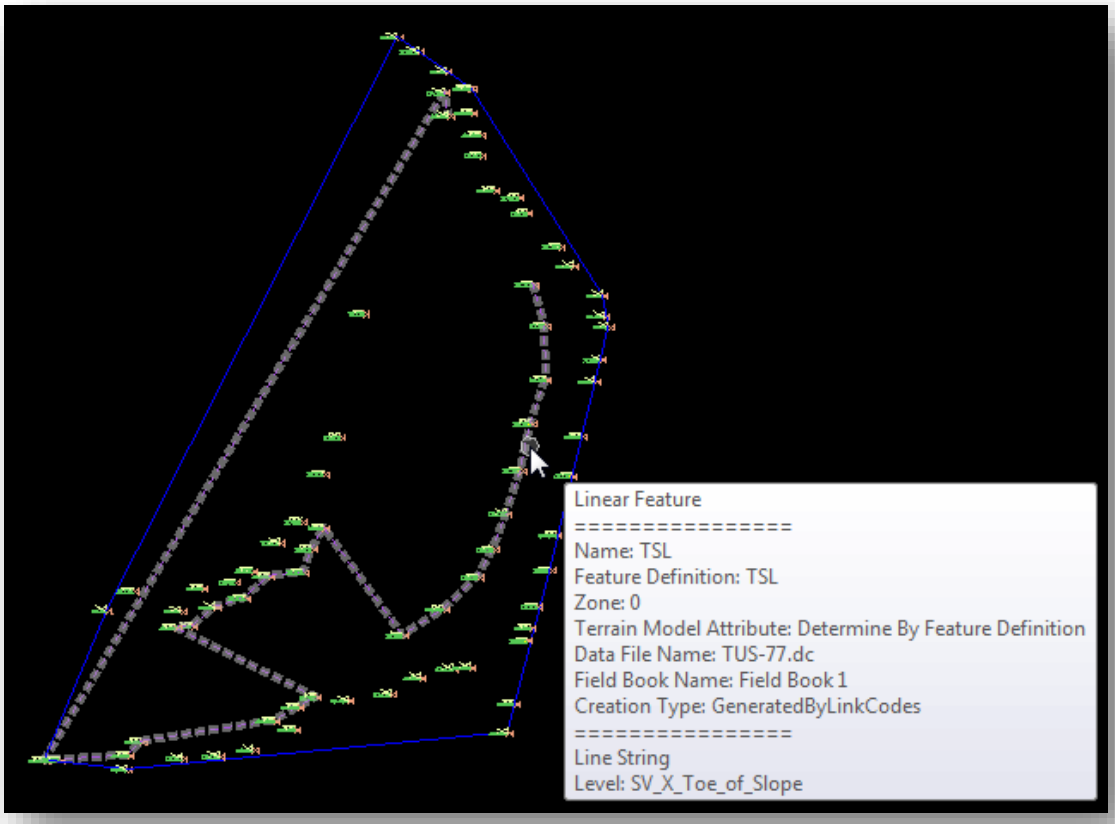
- ✓ Open the Survey Details dialog, select all the points, and right-click in the margin to reveal the editing options shown below. Change the **Feature Definition** to **TSL** and apply the change.



✓ The linking codes for the linear feature have not been defined. In the *Survey Details* dialog, change the **Link Code** parameter to **Start** for point SV036 as shown below.



This will dynamically link all the points with the TSL feature definition in numerical order as shown below. Next we need to break this up into a few different linear features.



- ✓ Insert the following Link Codes for the points listed below:

Point Name	Link Code
SV045	End
SV046	Start
SV053	End
SV054	Start
SV056	End
SV057	Start
SV060	End
SV074	Start
SV075	End

- ✓ All of the Top of Bank features were coded as TB1 in this dataset. These also need to be connected using linking codes to define the proper linear features. Make the following edits to the Link Code for the TB1 features:

Point Name	Link Code
SV001	Start
SV014	End
SV015	Start
SV024	End
SV025	Start
SV035	End
SV061	Start
SV073	End

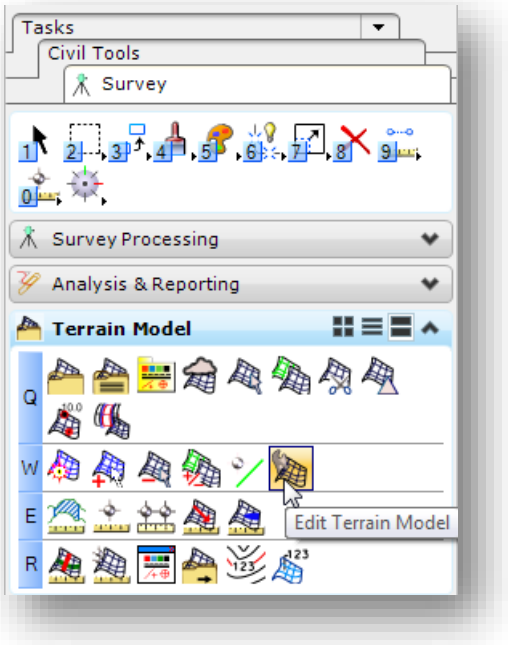
Next we'll review the triangulation of the slip data and remove any unnecessary triangles.

- ✓ Change the feature of the terrain model to **X_Triangles** (select the terrain boundary and choose the **Properties** option to set the **Display Feature** option).

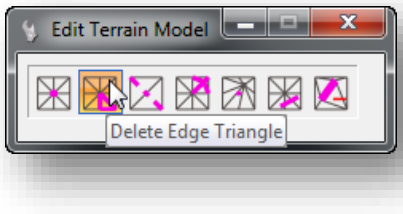
There are several triangles that connect across areas where no information was collected. This can be minimized by setting the **Maximum Side Length** parameter and then further refined by removing any undesired triangles.

- ✓ Select the terrain model and choose the **Properties** option. Change the **Edge Method** to **Max. Triangle Length** with a **Length** value of **25**. This will remove most of the unnecessary triangles.

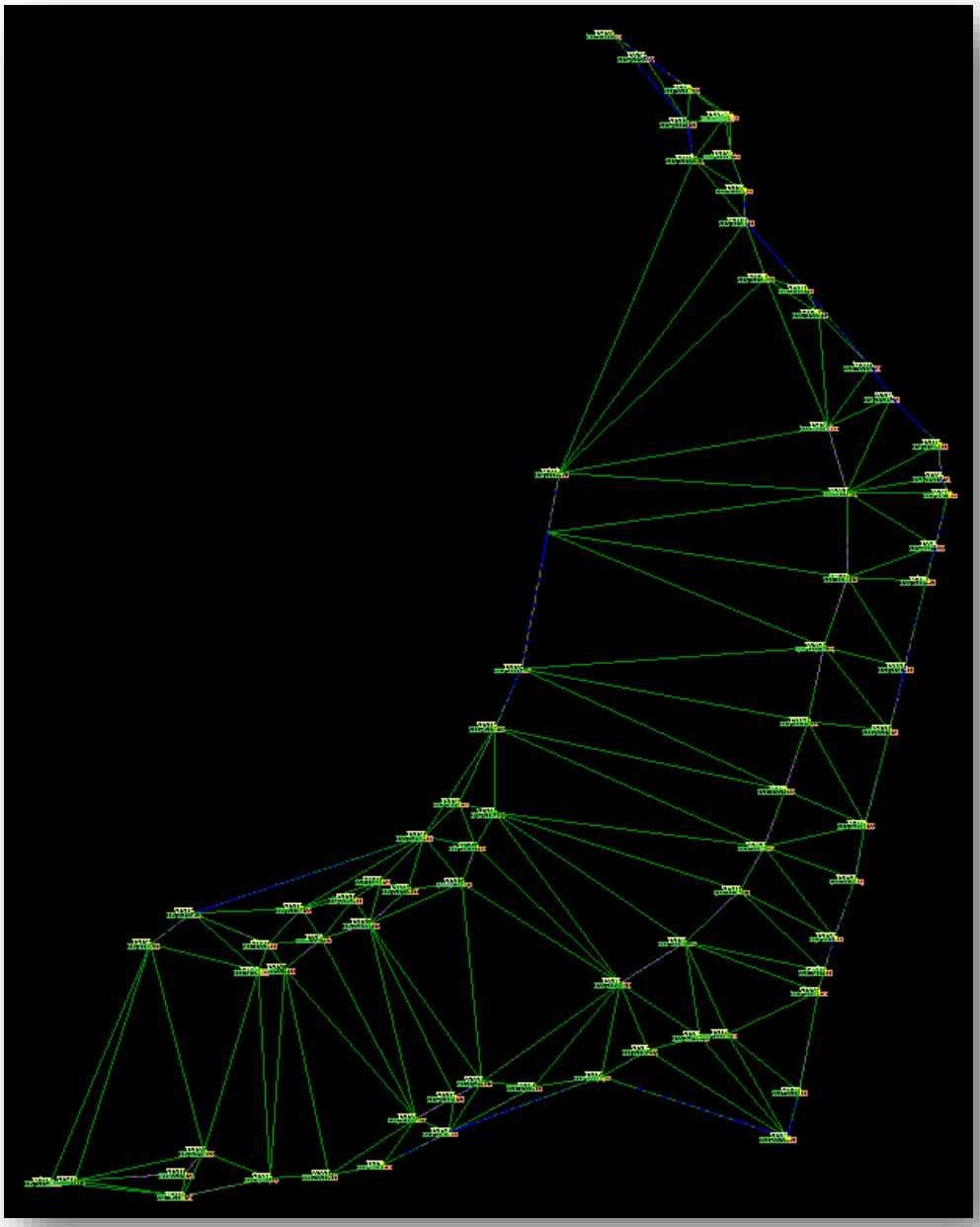
- ✓ From the *Tasks* menu, select the **Edit Terrain Model** command from the **Terrain Model** tab as shown on the following page.



The *Edit Terrain Model* tools shown below are available. These tools are documented in the online help.



- ✓ Use the **Delete Edge Triangle** command to remove any slivers or undesired triangles from the terrain model. When complete, the terrain model should appear similar to the example on the following page.



Part 2 – Create a Terrain Model from the OSIP data

OSIP data is available to ODOT employees in XYZ format in the following location:

G:\GEOMEDIA\warehouses\images\osip\lidar

The data is in State Plane coordinates and has been separated into numerous files called "Tiles". In order to determine which tile you need, two design files containing the tile information are available for the north and south zones that can be attached to your design file. These files are located in the following folder:

\ODOTcadd\Standards\data\OSIPTile_OH83-NF.dgn
\ODOTcadd\Standards\data\OSIPTile_OH83-SF.dgn

- ✓ Attach the North Zone tile file, OSIPTile_OH83-NF.dgn as a reference attachment.

  When attaching the reference, be sure to select the **Orientation** option **Geographic – Reprojected**.

- ✓ The tile information is displayed in the file as a series of squares with the tile number.

  Make note of the tile number that overlaps the survey area: _____.

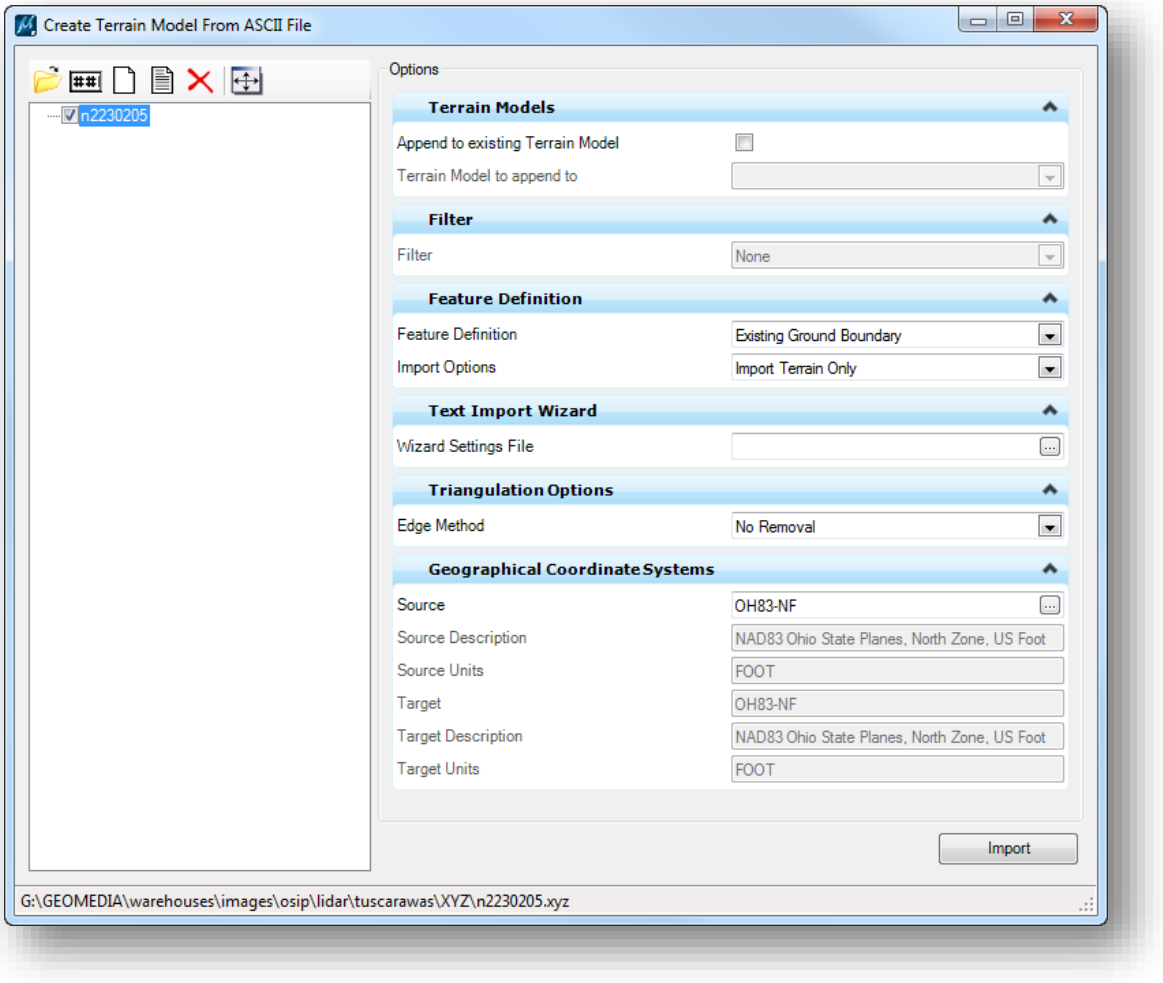
To create a terrain model for the tile, take the following steps:

- ✓ From the **Terrain Model** tab of the *Tasks* dialog, select the **Create Terrain Model From ASCII File** command. Open the appropriate OSIP .xyz file, using the tile number you located in the previous step, from the GEOMEDIA folder. This project is in Tuscarawas County.

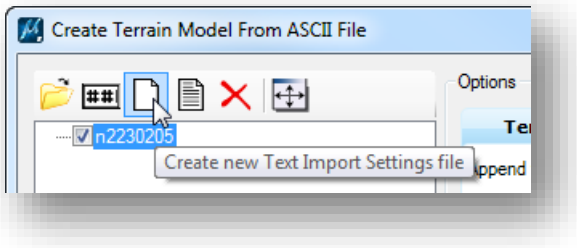
  Use the following settings in the *Create Terrain Model From ASCII File* dialog:

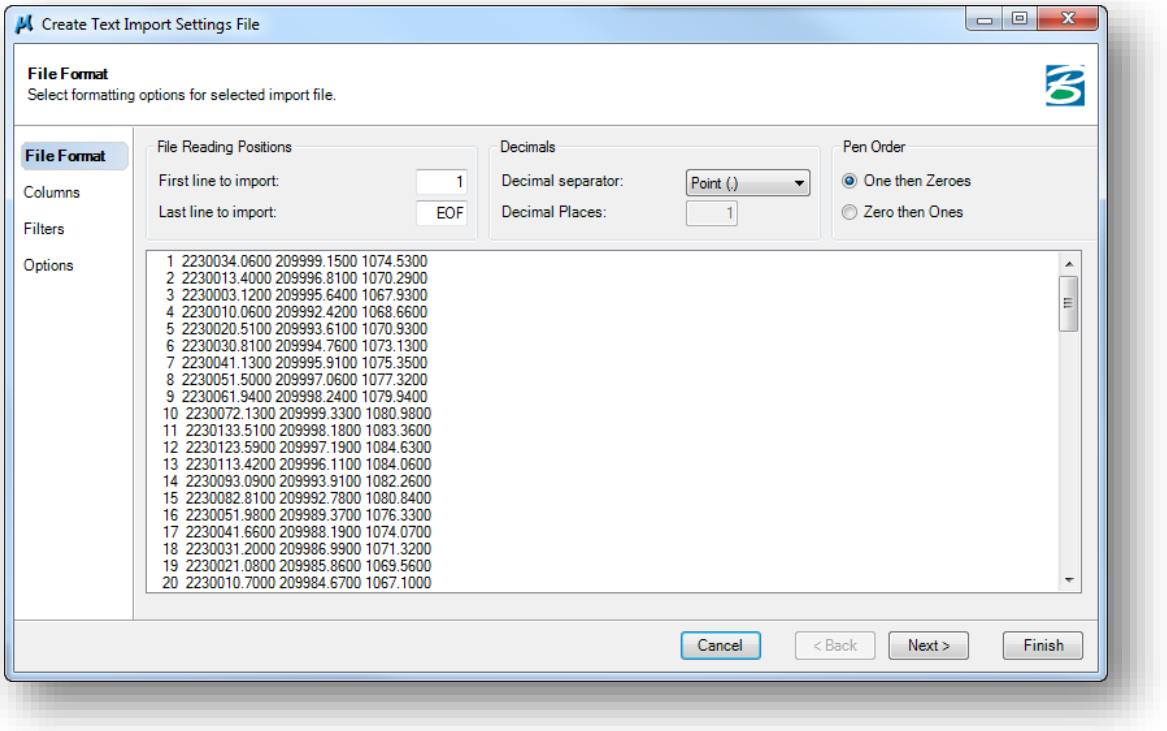
Feature Definition	X_Boundary
Import Options	Import Terrain Only
Edge Method	Max Triangle Length
Maximum Side Length	100
Geographic Coordinate System	OH83-NF

  Use the default value for all other settings as shown on the following page.



✓ Select the **Create New Text Import Settings File** icon which will allow you to define the format of the .xyz file that you are importing. The *Create Text Import Settings File* dialog shown on the following page is opened.





The dialog contains four tabs on the left: **File Format**, **Columns**, **Filters**, and **Options**.

- ✓ Use the default options on the **File Format** tab as shown above.
- ✓ On the **Columns** tab, change the settings as follows:

  Feature Type Spot
  Feature Definition X

  Change the headings for the columns in the file from **Skip** to the following:

  Column 1 **Easting**
  Column 2 **Northing**
  Column 3 **Elevation**

- ✓ Select the **Options** tab on the left side of the dialog to set the Geographic Coordinate System **Source** to OH83-NF
- ✓ Select the **Finish** button to save a Text Import Wizard for the process.

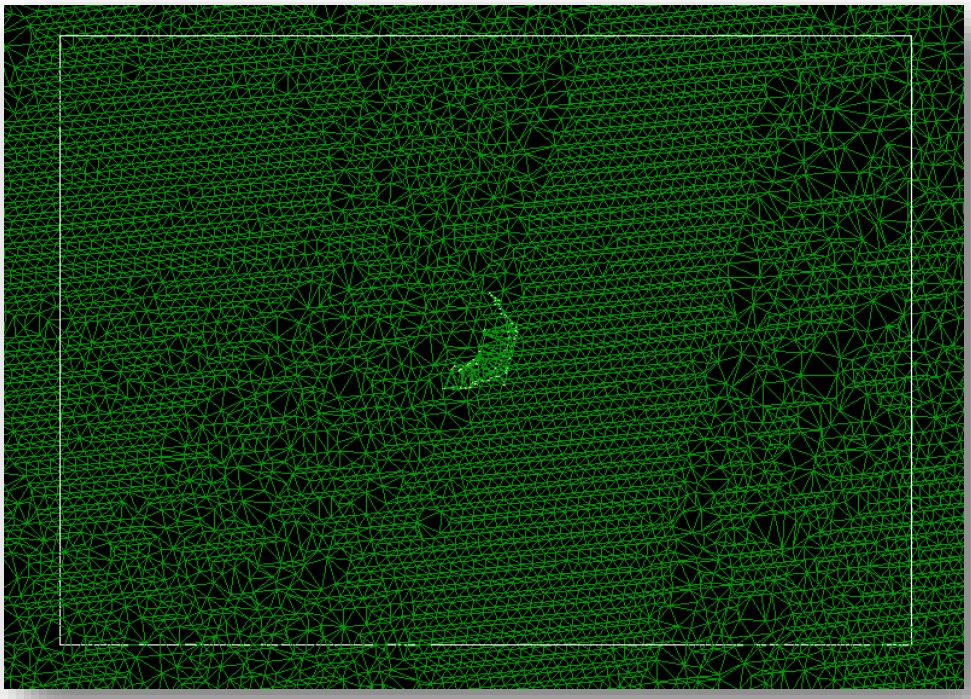
  From the *Create Terrain Model From ASCII File* dialog, select the **Import** command button to initiate the process. A terrain model for the selected tile is created.

Part 3 – Merging the Terrain Information

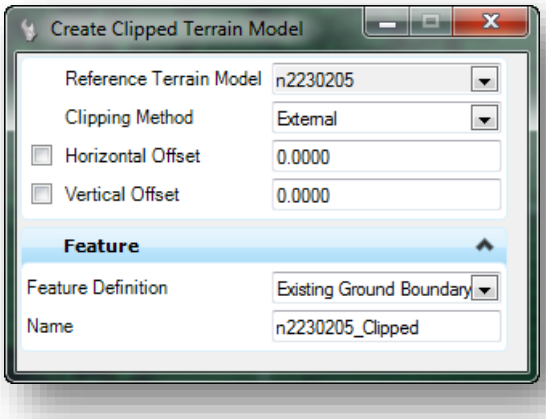
The terrain model for the OSIP tile is much larger than needed. Take the following steps to clip the terrain model to include a smaller area:

✓ Draw a rectangle similar to the one shown below to define the clipping limits.

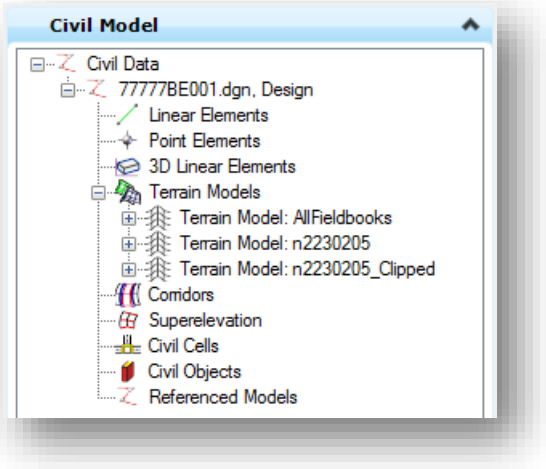
Note: the **Display Feature** was changed to **Existing Ground Triangles** for the OSIP terrain model in the example below.



✓ From the **Terrain Model** tab in the *Tasks* dialog, select the **Create Clipped Terrain Model** icon. Use the settings shown below to clip the terrain model. Follow the prompts to select the clipping element and initiate the process.

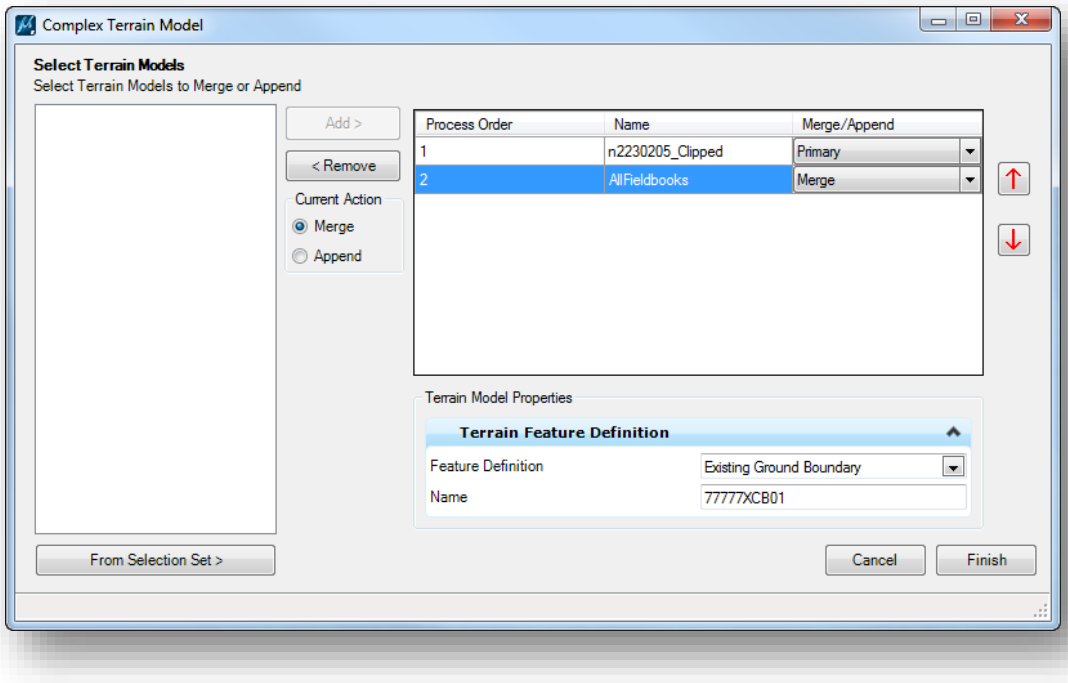


A new terrain model for the clipped area is created as shown below in the *Project Explorer* dialog under the **Civil Model** tab.



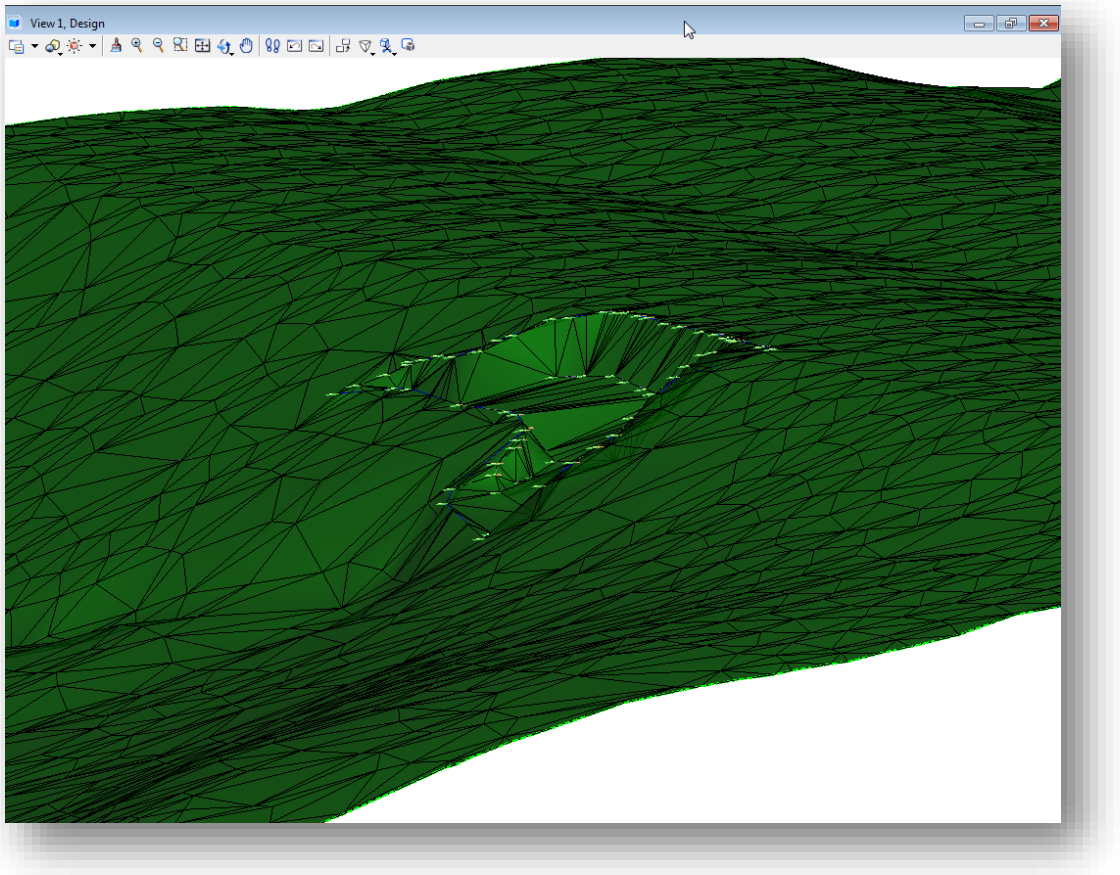
- ✓ The terrain model for the entire OSIP tile is no longer needed. In the **Civil Model** tab, right-click the n2230205 terrain model and select the **Delete** option to remove it from the file. The shape that was used to define the clipping area can also be deleted.

- ✓ To merge the terrain information, select the **Create Complex Terrain Model** icon from the **Terrain Model** tab in the *Tasks* menu. The *Complex Terrain Model* dialog is opened.

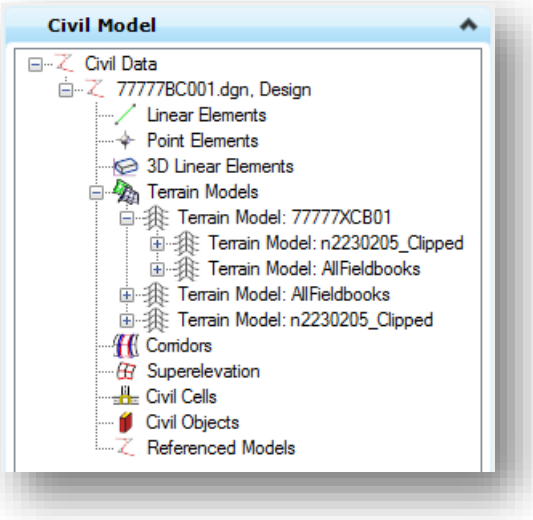


Name the new terrain model appropriately for the project using the naming convention specified in the **ODOT CADD Engineering Standards Manual**, Section 305.1.

✓ Using the settings shown above, select the **Finish** button to initiate the process.
A rotated view of the merged terrain model is shown below.



Note that the new terrain model, 77777XCB01, is composed from the AllFieldBooks terrain model and the n2230205_Clipped terrain model. Even though the n2230205_Clipped model is not specifically needed it cannot be deleted from the Civil Model.



13 Reports

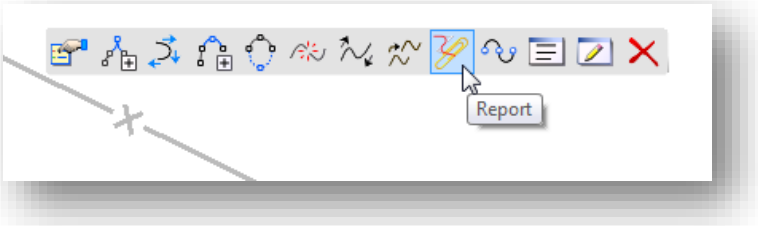
The **Civil Report Browser** is used to generate and print various reports. There are several default reports delivered with the software. This section will detail the process to generate a few commonly used reports.

This chapter does not contain a specific lab exercise. The following **Project** and design file, which was processed earlier in the training, can be used to test the reports detailed in this chapter:

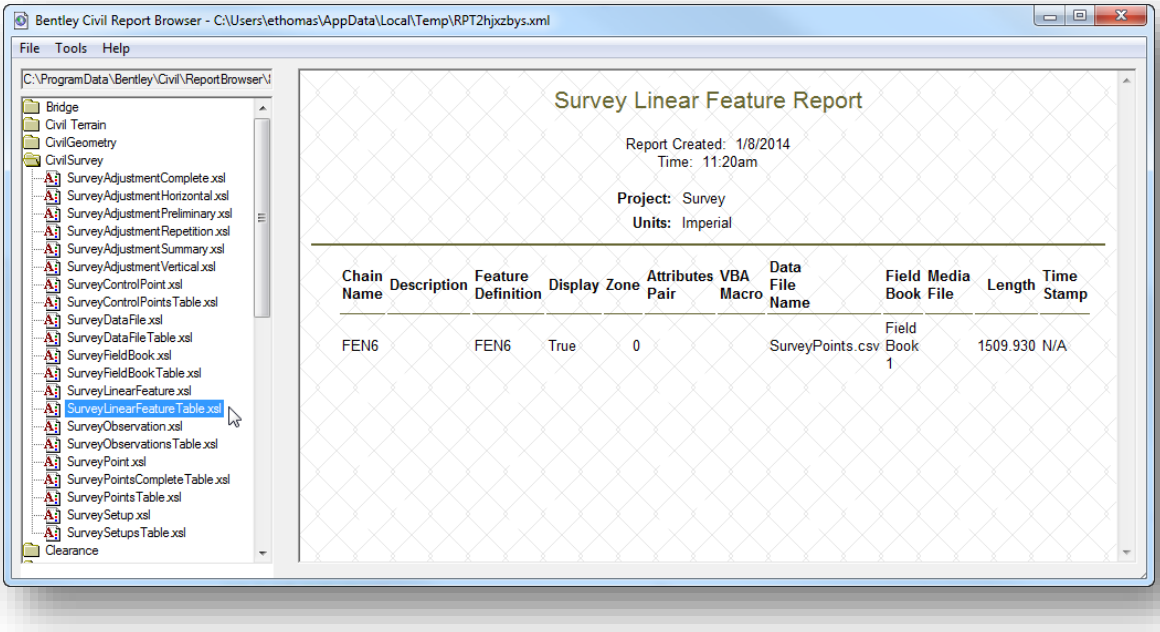
Project: LOR-12121
Design File: \Survey\RawData\12121_FB001.dgn

Generating a Report for a Single Element

When a point or linear feature is selected, the pop-up menu contains a **Report** option. In the example below, a fence line is selected.



Selecting the **Report** icon will open the *Bentley Civil Report Browser* dialog as shown below.



Two report formats are available for linear features: **SurveyLinearFeature.xsl** or **SurveyLibearfeatureTable.xsl** as shown above.

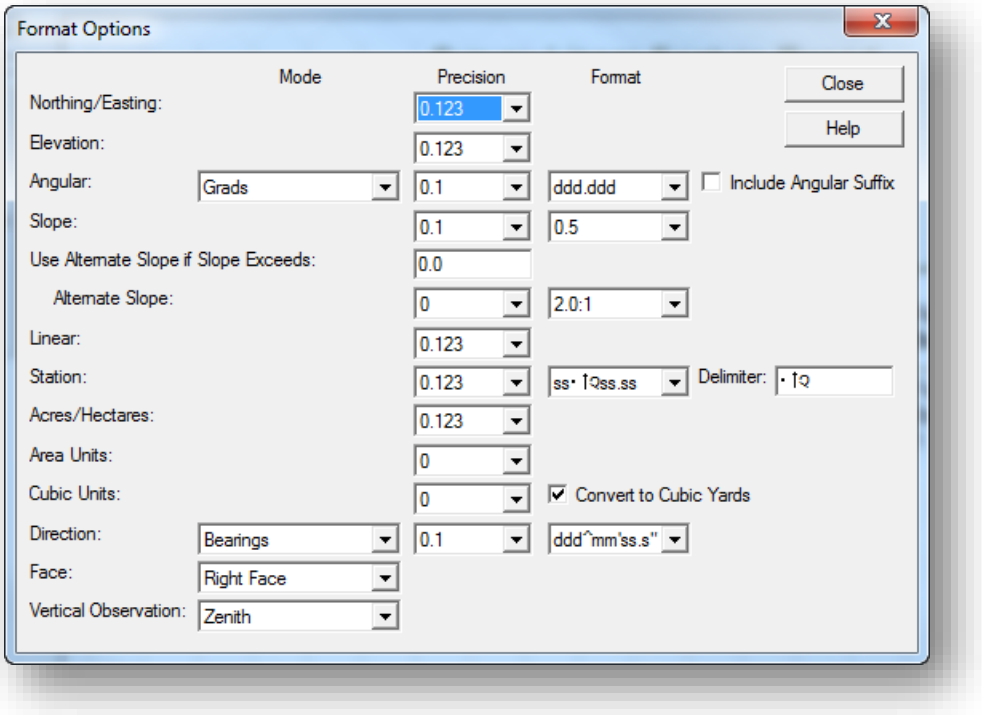
Civil Report Browser Menu Options

The *Civil Report Browser* menu has the following options:

- File
- Tools
- Help

The **File** menu contains the usual commands for opening and saving reports. The **Save As…** option can be used to save the report into an HTML file, an XML file, a DOC file, XLS file or a text file.

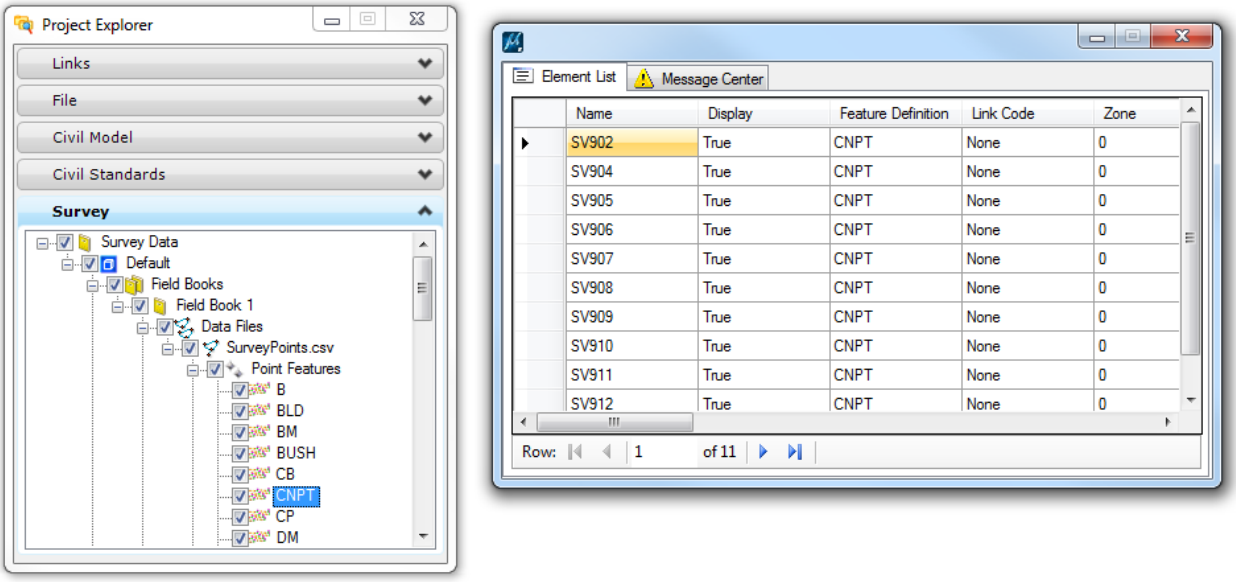
Select **Tools > Format Options…** to open the *Format Options* dialog shown below. This dialog is used to set the precision and format for displaying a variety of types of data in the report.



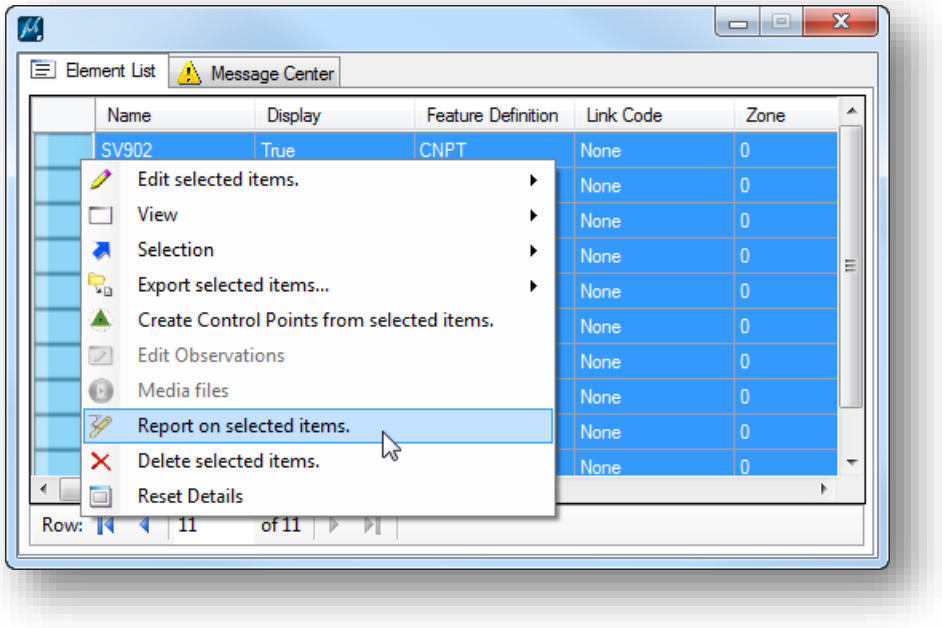
Generating Reports for Multiple Elements

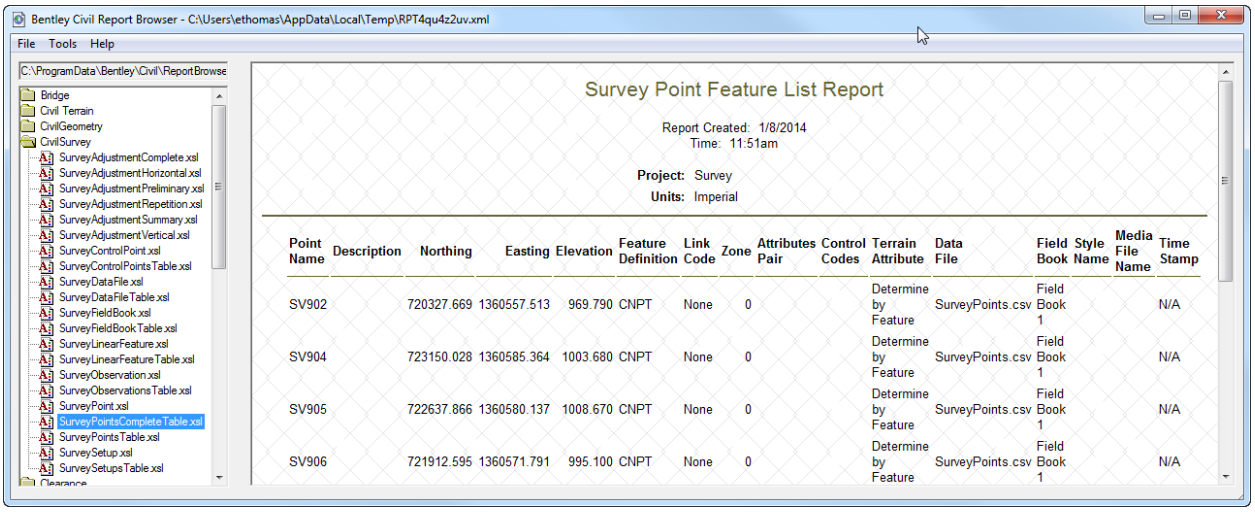
Multiple elements can be included in a report by selecting the desired element in the **Survey** tab of the *Project Explorer* dialog, and then accessing the **Report** command from the *Survey Details* dialog.

For example, selecting the **CNPT** feature in the **Point Features** list as shown below will display data for all the point features in the data file that use the CNPT feature code.



Select the points that you wish to include in the report. Right-click in the selection margin to select the **Report on selected items** option as shown below. The report is shown on the following page.



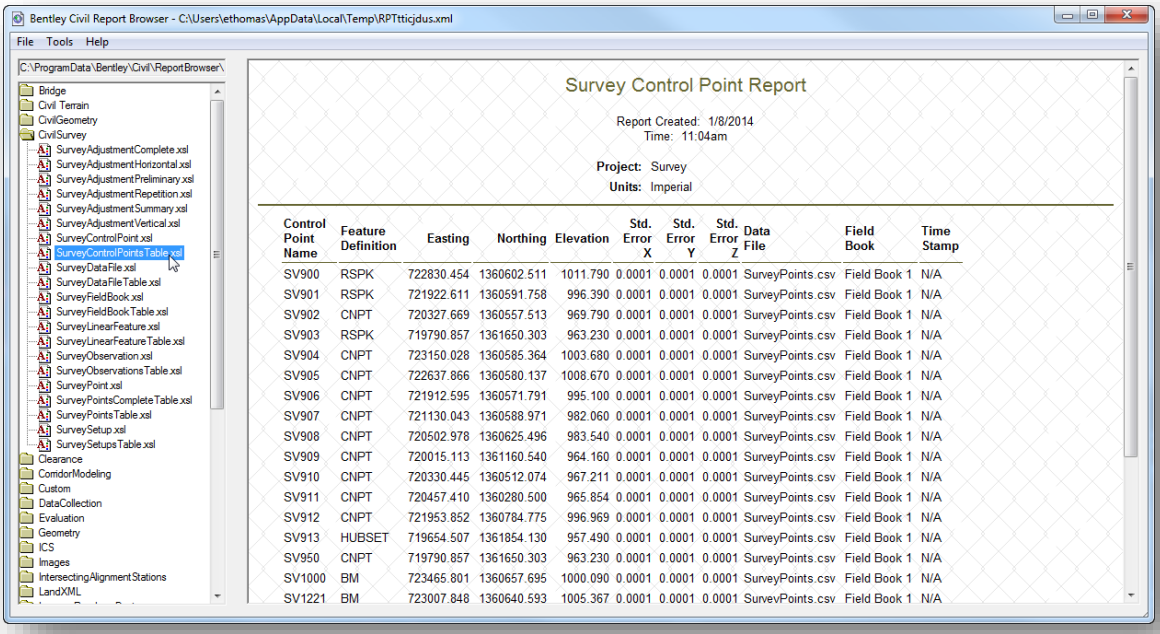


Generating a Control Point Report

A control point report can be generated with the following steps:

- Select the **All Control Points** item under the **Survey** tab in the *Project Explorer* dialog.
- Open the *Survey Details* dialog and select all of the control points listed.
- In the *Survey Details* dialog, right-click in the selection margin and select the **Report On selected items** option.

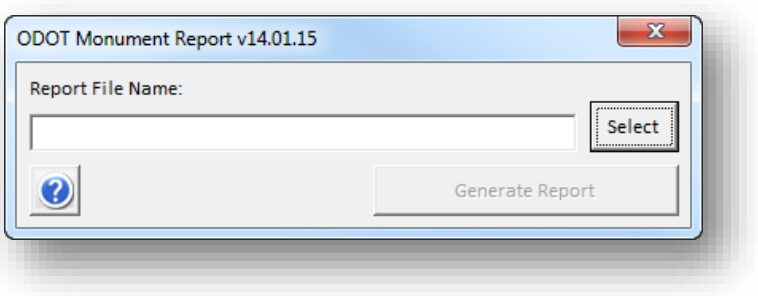
A report is generated similar to the example below.



ODOT Monument Report

The **ODOT CADD Engineering Standards Manual**, Section 504.6 Monument Reports, details the requirements for a monument report to be included with the digital submission of a project. The information in the CADD Manual documents the GEOPAK version of this application which is used to generate an ODOT Monument Report from the GPK file for the project. A new application has been written to generate a monument report from the OpenRoads Survey information.

The VBA application ODOT_MonumentReport_OpenRoads.mvba can be accessed from the ODOT pull-down menu in MicroStation by selecting **ODOT > Survey > Monument Report (OpenRoads)**. The dialog shown below is opened.



Report File Name:
This key-in field is used to enter the full path and the name for the report file. The **Select** button may be also be used to specify the path and name for the report file.

The report file naming convention is defined in the **ODOT CADD Engineering Standards Manual**, Section 504.6 Monument Reports. The OpenRoads Survey version of this application does not include the functionality to extract station and offset information from a selected chain; therefore the chain name shall be omitted from the CSV file name as detailed below.

Monumentation reports shall be stored in the \survey\docs director using the following naming convention:

*nnnnn*_Monuments.csv
nnnnn = Five digit PID Number for the project

Example: 12121_Monuments.csv

Generate Report
Select this button to initiate report generation. The report is an ASCII text file in Comma Separated Value (CSV) format. The CSV file generated by this Visual Basic application contains the following information:

Point Name, Feature Name, Northing, Easting, Elevation, Geographic Coordinate System

An example of the CSV file, opened in Microsoft Excel is shown on the following page.

	A	B	C	D	E	F
1	Point Name	Feature Name	Northing	Easting	Elevation	Geographic Coordinate System
2	MN16	GOVCON	593148.2483	2036908.351	815.71	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
3	SV10	HUBSET	593186.7748	2037532.888	820.4916	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
4	GS01	HUBSET	593188.6825	2036713.871	815.9845	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
5	GS02	MAG	593202.9569	2036515.389	815.9402	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
6	GS03	MAG	593206.7235	2036319.212	817.4116	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
7	MN15	GOVCON	593218.5434	2035055.579	822.18	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
8	GS02_1	CONDAT	593202.9569	2036515.389	815.9402	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot
9	GS03_1	CONDAT	593206.7235	2036319.212	817.4116	OH83-NF NAD83 Ohio State Planes, North Zone, US Foot

All of the control points found in all of the Field Books are included in the report.

The feature codes that are considered monuments are defined in the Section 504.6 of the **ODOT CADD Engineering Standards Manual**. These field codes are defined in the Survey Settings in the file ODOT_Features_Survey.dgnlib when using the ODOTcadd configuration. To review the list of feature codes that are defined in the Survey Settings, take the following steps in MicroStation:

- From the MicroStation *Project Explorer* dialog select the **Civil Standards** Tab
- Under the Libraries item, select Project Settings, ODOT_ProjectSettings.dgnlib, Design > Survey > Settings.
- Right-Click on **Settings** and select the **Properties** option. The *Element Information* dialog is opened containing the settings parameters.
- From the *Element Information* dialog, select the **Points** tab. The **Control Point Features** item defines the feature codes to be included as monument points.

14 Importing and Exporting Data

All data generated by the OpenRoads Survey software is stored in the active DGN Model. The existing GEOPAK software cannot use the data stored directly in the design file. The necessary data must be exported to the appropriate format in order to be used by ODOT's design personnel.

The following file formats are required for design use:

- GEOPAK Tin Model (.tin) for the existing ground surface
- GEOPAK COGO Database (.gpk) containing the necessary points and linear features

Note that it may not be necessary or even desirable to export all the survey points and linear features for topographic features to a GPK file. The designer may only need the control points and any geometric centerlines or right-of-way features in the GPK file. In this exercise well export all of the data to the GPK file.

Important!
It is important to remember that any changes made to the survey data after the GPK and TIN models have been exported are not dynamically reflected in the GPK and TIN file contents. It is necessary to manually export the data to generate new files containing the modifications. This can lead to problems if the design personnel have begun to store COGO Chains and Profiles for the proposed work on the project. Always coordinate with the design team before updating files.

It is also important to recognize that the position of the survey information is relative to the currently selected Geographic Coordinate System. If the data is to be provided to the designer in ground coordinates, take the necessary steps to transpose the data to the appropriate coordinate system before exporting the data.

Exercise 13 - Exporting Survey Points and Chains to a GEOPAK GPK File

In this exercise, we'll export the survey points and linear features to a GEOPAK COGO database (.gpk file). The GEOPAK Road functions will be used to create the GPK file and access the COGO dialog. This can also be done through GEOPAK Survey but to do so would require creating a GEOPAK Survey project which is unnecessary for this task. There is less overhead going through the GEOPAK Road menu.

- ✓ Open MicroStation using the shortcut for the training class

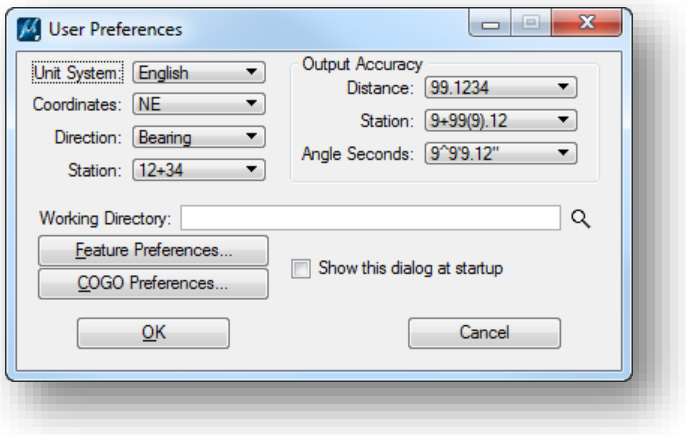
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **ERI-11311** and then open the following design file:

  \Survey\RawData\11311_FB001.dgn

- ✓ GEOPAK must be active with a GPK file open.

- ✓ Before creating a new GPK file, we must select the folder for the GEOPAK **Working Directory**.

  From the MicroStation pull-down menu, select **Applications > GEOPAK > Road > User Preferences** to access the *User Preferences* dialog shown below.

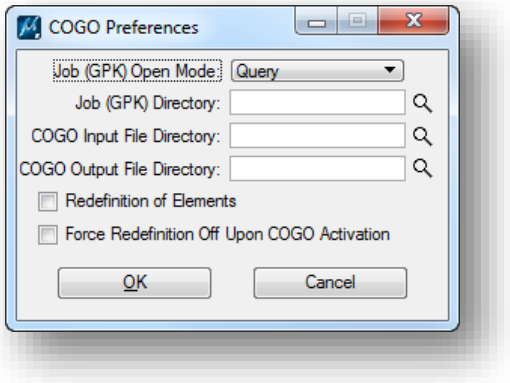


  The **Working Directory** is used to specify the default location where GEOPAK will save or open files. In the ODOT project directory structure, the \geopak folder is used to store the GPK file.

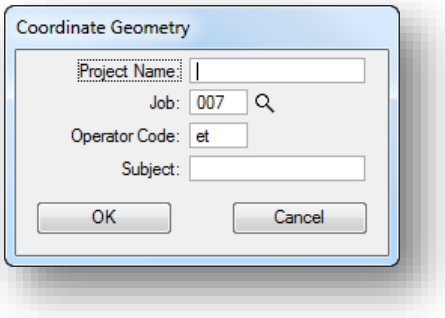
- ✓ Set the **Working Directory** as follows:

  \ODOT_Training\OpenRoadsSurvey\ProjectData\ERI\11311\geopak

  It is good practice to always review the **COGO Preferences** before proceeding. From the *GEOPAK User Preferences* dialog, select the **COGO Preferences…** option to access the *COGO Preferences* dialog shown on the following page.

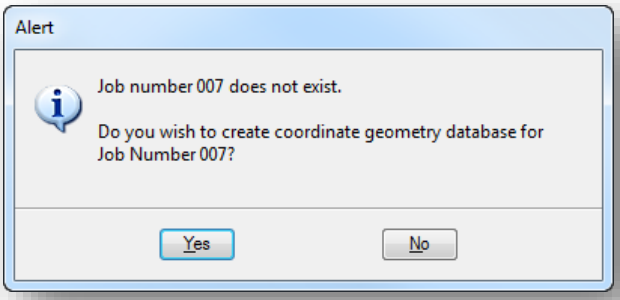


- ✓ Set the dialog as shown above. If there is anything defined in the **Job (GPK) Directory** be sure to remove it or set it to the same value as the **Working Directory**.
- ✓ Select **OK** to close the *COGO Preferences* dialog.
- ✓ Select **OK** to close the *User Preferences* dialog.
- ✓ Once GEOPAK is activated and the **Working Directory** has been set, you can create or open a GPK file by selecting **Applications > GEOPAK > Road > Geometry > Coordinate Geometry**. The *Coordinate Geometry* dialog shown below is opened.



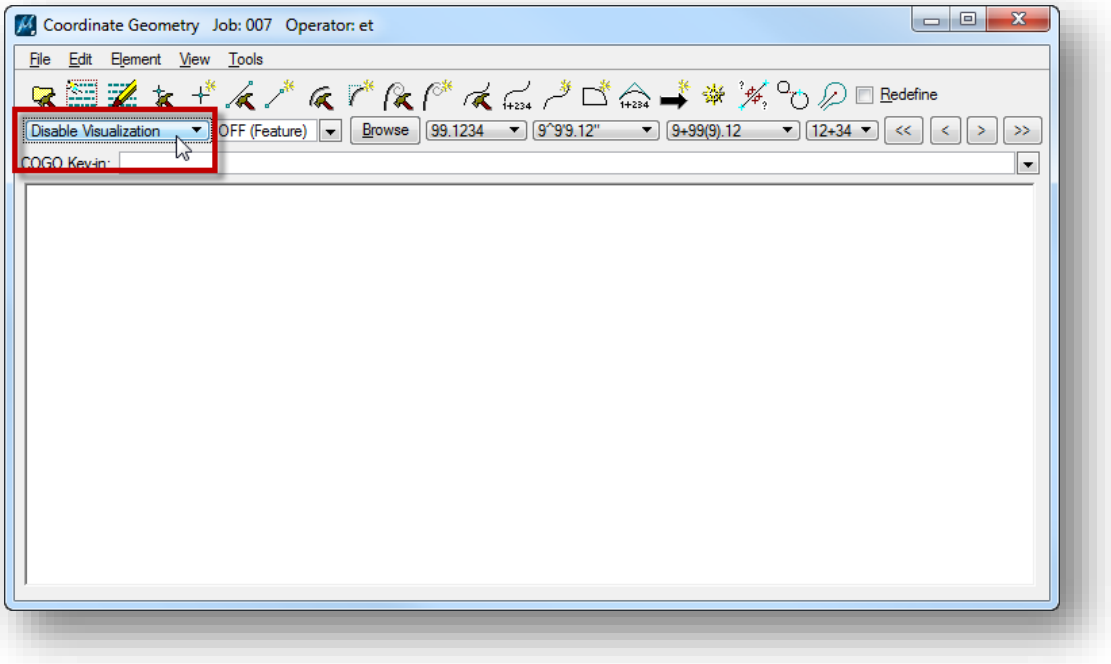
- The **Project Name** is optional
- Key in the 3-character **Job** number for the GPK file
- Key in your initials for the **Operator Code**
- The **Subject** is optional

✓ Select **OK**. If the GPK file does not exist, the software will prompt you to create the file.



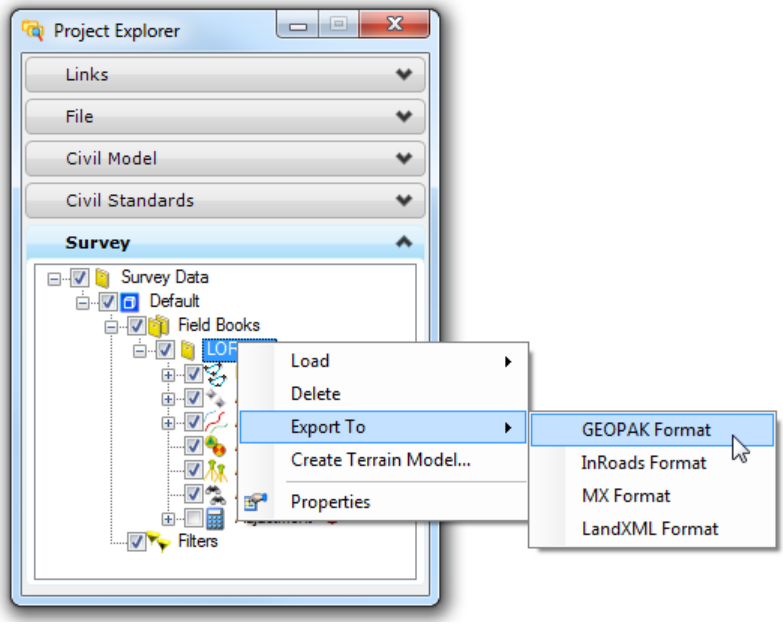
Select **Yes**. A file named job###.gpk is created in the current GEOPAK Working directory where ### represents the three characters that you have keyed in for the **Job**.

The *Coordinate Geometry* dialog shown below is opened. Be sure to set the visualization mode to **Disable Visualization** as shown below. This is necessary to ensure that the coordinate geometry software does not visualize the data in the current design file which will result in duplicate graphics for the survey information.

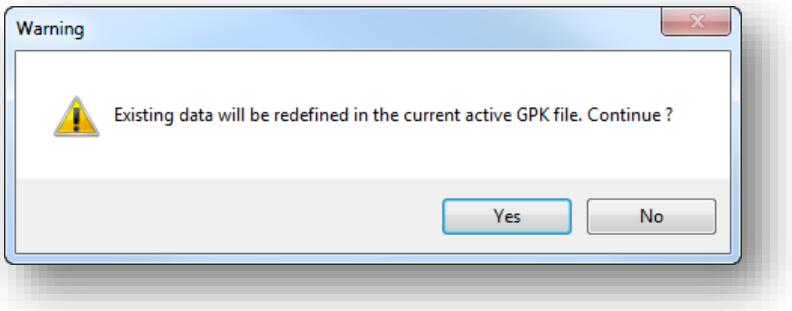


After the Working Directory has been defined and the GPK file has been created, we are ready to export the survey data to the GPK file.

✓ In the *Project Explorer* dialog, right click on the desired field book to access the **Export To > GEOPAK Format** option as shown below.



This option is used to export all the survey data in the selected Field Book to the GPK file. The software will issue the following warning message. Select **Yes** to proceed; however, it is not recommended that you export all of the topographic information to a GPK file. Typically it is desirable only to export specific information to the GPK file such as Control Points.



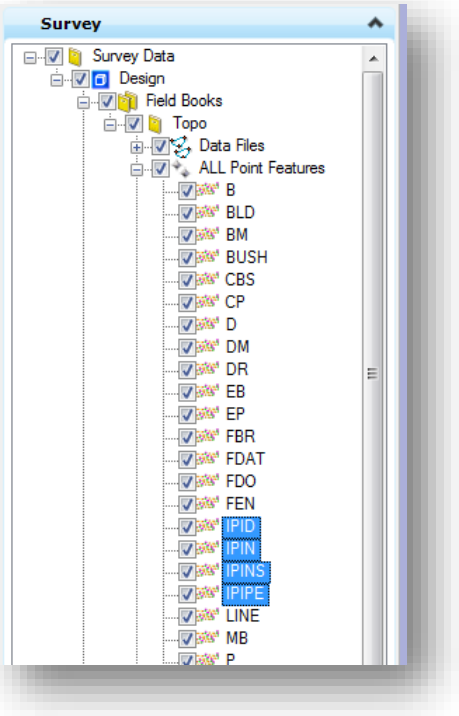
✓ To export specific information to the GPK file, select the Point or Linear Features that you wish to export in the **Survey** group of the *Project Explorer* dialog as shown in the example on the following page.

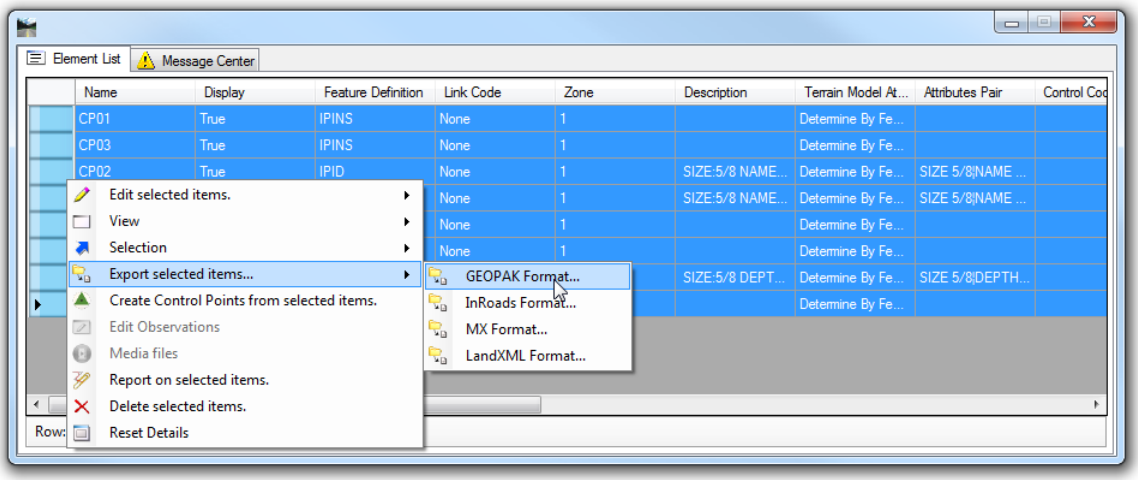
- ✓ After selecting the desired features, from the **Survey** group in the *Tasks* menu, choose the **Survey Details** dialog to display the details for the selected items.

- ✓ The *Survey Details* dialog displays the individual elements from the selected features. You can individually choose which items to export or choose them all as shown in the example below.

  Right-click in the selection margin to the left of the listed elements and choose Ex**port Selected Items > GEOPAK Format** as shown below.

  If any elements exist in the GPK with the same point numbers as defined in the survey data, the existing elements in the GPK file will be overwritten. The software will prompt you whether to write the elements to the GPK before completing the export process.





Important!
It is important to follow the standard COGO point naming guidelines specified in Section 306.2 of the **ODOT CADD Engineering Standards Manual**. Also, see Chapter 3 of this training guide for information on standard COGO element names.

Important!
As stated previously, it is important to remember that if changes are made to the survey data a new GPK must be exported for design use. Check with the designers before overwriting any existing GPK file information.

Exercise 14 - Exporting Terrain Model Data to GEOPAK and LandXML

OpenRoads Survey provides the ability to export the terrain model to the following formats:

- MXRoads
- Inroads DTM
- GEOPAK TIN
- LandXML

The GEOPAK TIN model is required by ODOT's designers using GEOPAK Road. Occasionally, you may be asked by a consultant or contractor to provide a LandXML version of the terrain model that can be imported into other software programs. This exercise will cover the steps to export the terrain model in both GEOPAK TIN and LandXML formats.

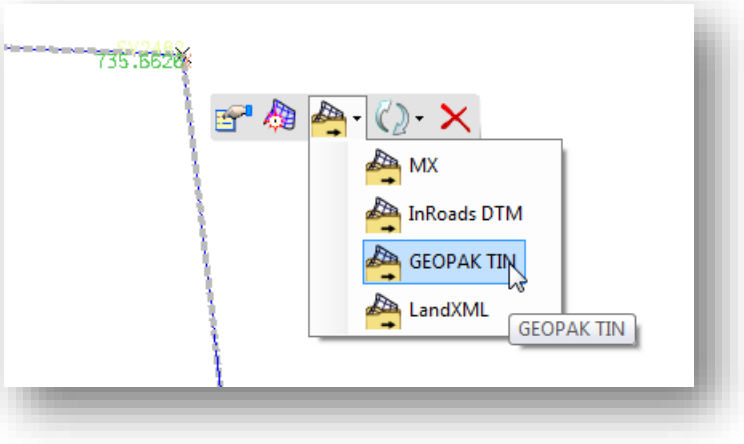
Exporting the Terrain Model for GEOPAK

A GEOPAK TIN model must be provided for ODOT's designers using GEOPAK Road.

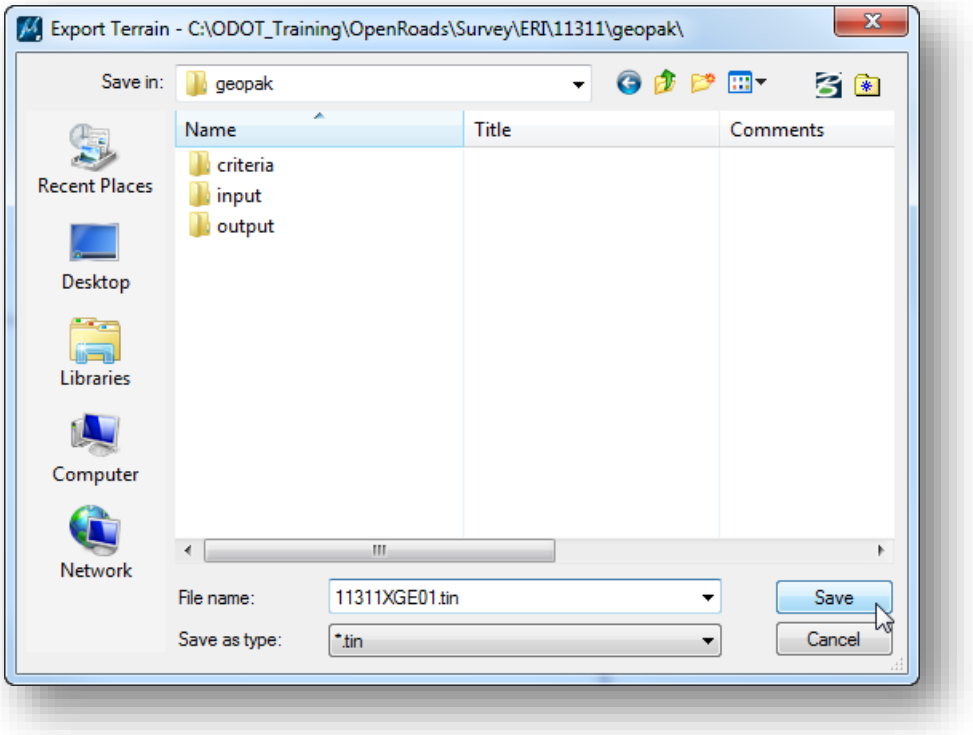
- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **ERI-11311** and then open the following design file:

  \Survey\RawData\11311_FB001.dgn

- ✓ Does the designer require the terrain model on the grid, or on the ground? Select the appropriate Geographic Coordinate System before exporting the data. Make sure the same GCS settings are used for the TIN file export that were used for the GPK export.
- ✓ Using the MicroStation **Element Selection** tool, select the terrain model to reveal the pop-up menu shown below. Choose the **Export GEOPAK TIN** option.



The **Export Terrain** dialog shown on the following page is opened.



- Section 305.1 of the **ODOT CADD Engineering Standards Manual** defines standard file names for GEOPAK TIN files.

- The file should be saved in the \geopak folder for the project as shown above.

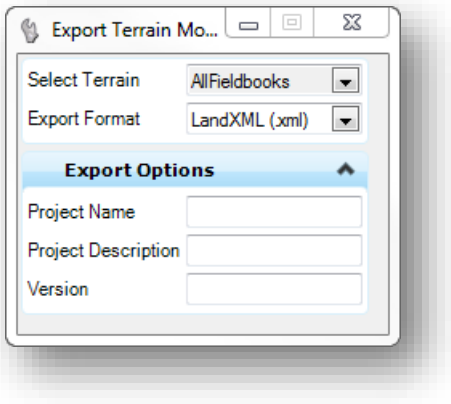
Exporting a LandXML File

Take the following steps to export a LandSML file:

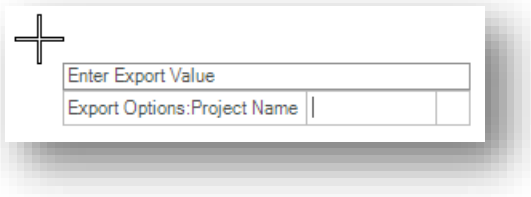
- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **ERI-11311** and then open the following design file:

  \Survey\RawData\11311_FB001.dgn

- ✓ Does the client require the terrain model on the grid, or on the ground? Select the appropriate Geographic Coordinate System before exporting the data.
- ✓ Using the MicroStation **Element Selection** tool, select the terrain model to reveal the pop-up menu with the export options. Choose the **Export LandXML** option. The Export Terrain Model dialog shown below is opened.



- ✓ Use the **Select Terrain** menu to select the terrain model to export. The **Project Name**, **Project Description**, and **Version** items are optional.
- ✓ The software will step you though each of these key-in fields with floating dialogs on the cursor as shown in the example below. Accept each option with a data point.



After stepping through the options, the **Export Terrain** dialog opens for you to select the folder where you would like to save the XML file. By default, the file will be named using the name of the terrain model with a .xml file extension. This file should normally be saved in the \geopak folder for the project.

Exercise 15 - Importing Terrain Models

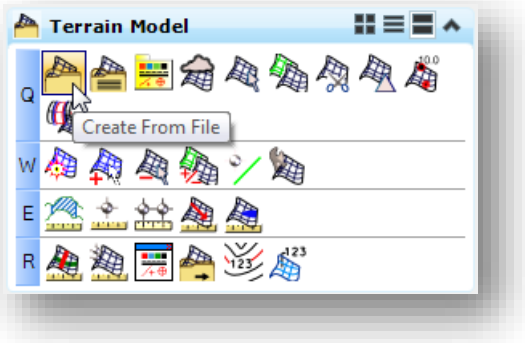
Terrain models can be imported from a variety of sources including GEOPAK TIN models and LandXML format. In this exercise, we'll import a GEOPAK TIN model for use with OpenRoads.

- ✓ Open MicroStation using the shortcut for the training class
- ✓ From the MicroStation *File Open* dialog, select the **Project** configuration file **DAR-12345** and then open the following design file:

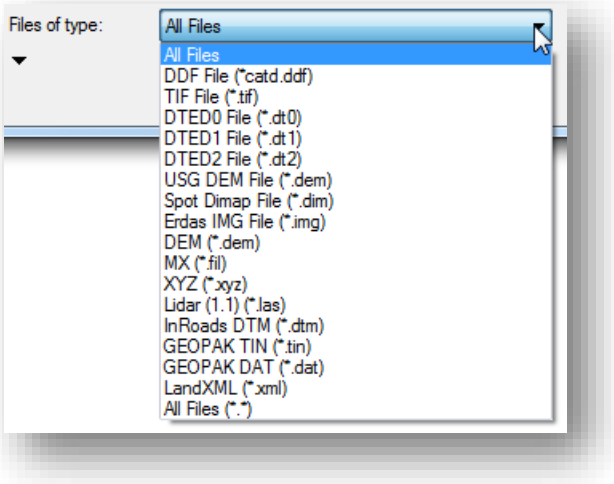
  \Design\Geopak\basemaps\12345_KD001.dgn

  The *Task Navigation* menu **Terrain Model** group contains commands to import surfaces from anther file, from ASCII files, or from graphics.

- ✓ Select the **Create from File** option to import a surface from another file type.



When the command is selected, the *Select Files to Import* dialog is opened. The following file types are supported:

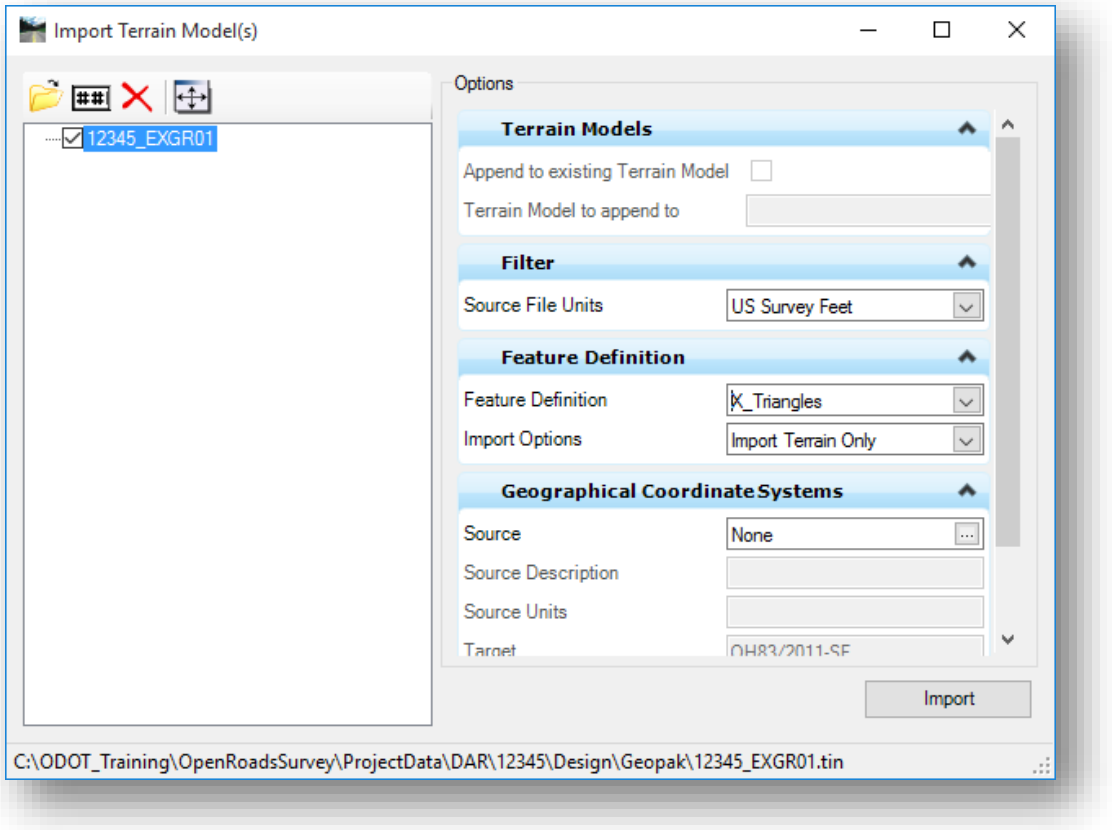


- ✓ Select the **GEOPAK TIN (*.tin)** option.

✓ Open the following file:

\12345\Design\Geopak\12345_EXGR01.tin

The *Import Terrain Model(s)* dialog shown below is opened.

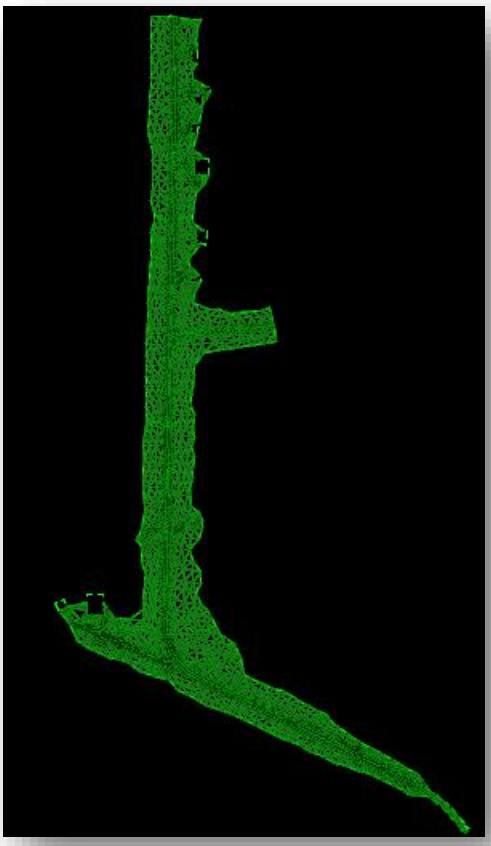


For this file, make the following settings:

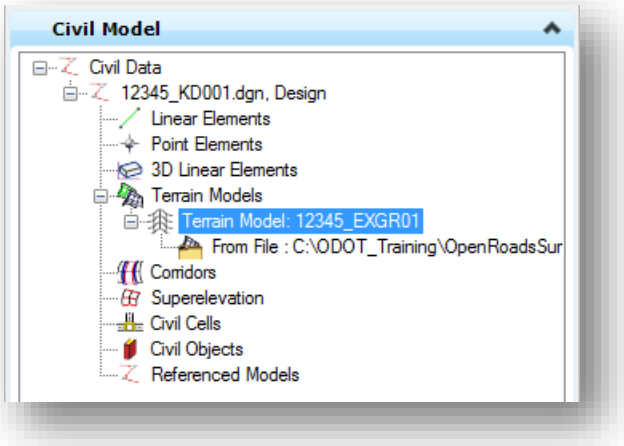
- ✓ Set the **Source File Units** to **US Survey Foot**
- ✓ Set the **Feature Definition** to **Terrain Models > X_Triangles**

Note that the **Geographic Coordinate Systems** can be defined for the **Source** data. The **Target** data is set to the current design file value.

✓ After setting the dialog parameters appropriately for the terrain model import, select the **Import** option to initiate the process. The TIN model is imported and the triangles are displayed as shown on the following page.



The terrain model is not imported as a part of the Survey data. Rather, it is imported as part of the **Civil Model** as shown in the *Project Explorer* dialog below.

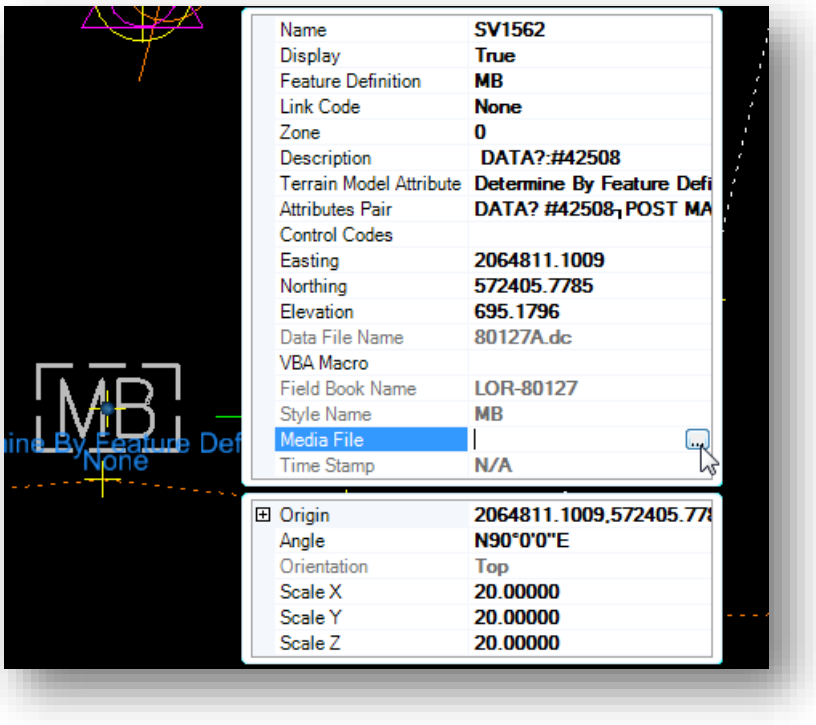


15 Media Files

Media files, such as pictures, sounds, and movies, can be associated with Survey points or Linear Features in the OpenRoads Survey data. The media files can be manually attached to the selected element, or attached as part of the survey data processing from a dataset that includes photo attributes

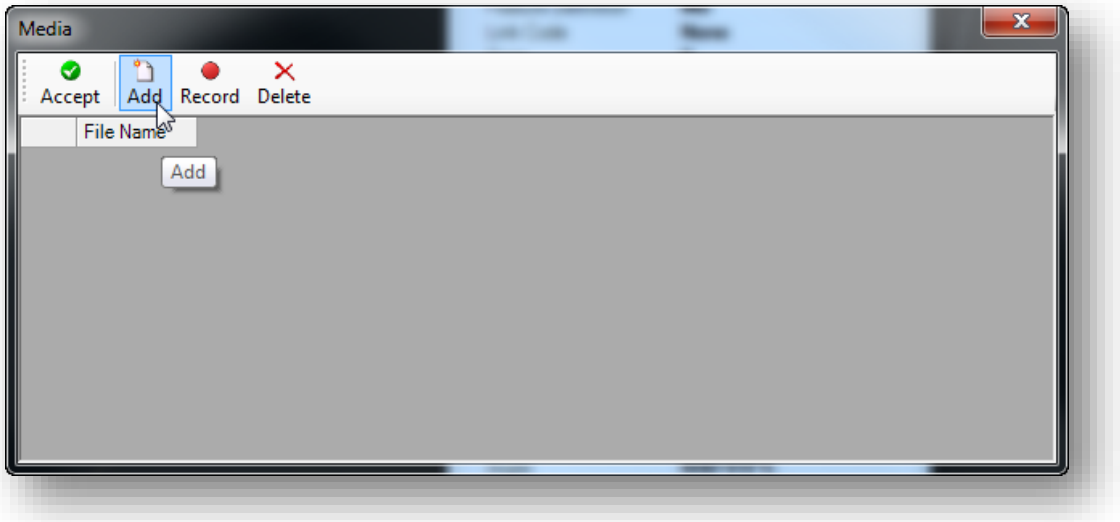
Manually Attaching Media Files

To manually attach a media file, use the MicroStation **Element Selection** tool to select a survey element. Open the **Properties** dialog as shown below.



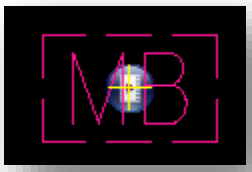
The **Media Files** option is used to attach a media file to the selected point. Choose the **…** icon to browse for the media file.

The *Media* dialog is opened to which allows you to select media files to associate with the point.

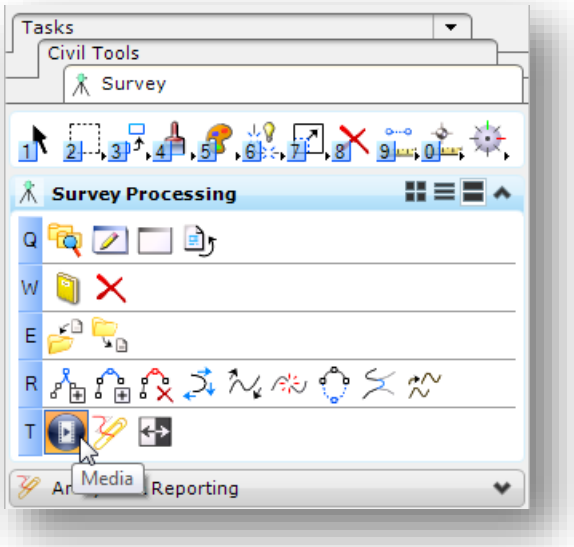


Choose the **Add** button to browse for the media file to attach.

After the file has been attached, a media file icon is displayed on the point in MicroStation as shown in the example below.



To review the media attachment, select the **Media** icon in the Survey Processing task list.



You are prompted to select a survey point or linear feature that has a media file attached. When selected, the media is opened. In the example below, a jpg image of a mail box was attached to a point in the survey data.

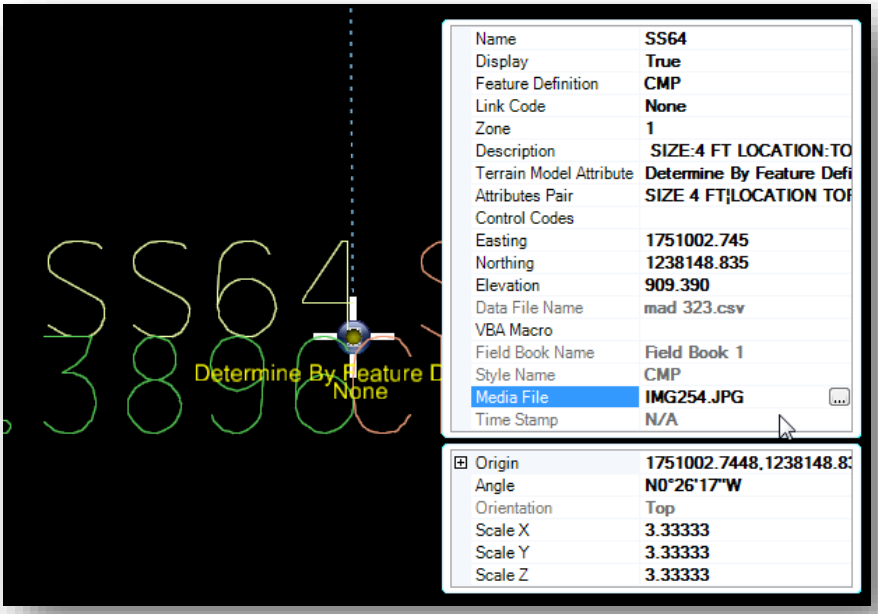
Processing Datasets with Media Files

The photos from data collectors with a camera can be attached as a photo attribute to a survey point. With the ODOT configuration, Trimble data collectors will prompt the surveyor to take a photo. If the data collector does not prompt for a photo, after taking a photo with the data collector the photo can be assigned to a specific point.

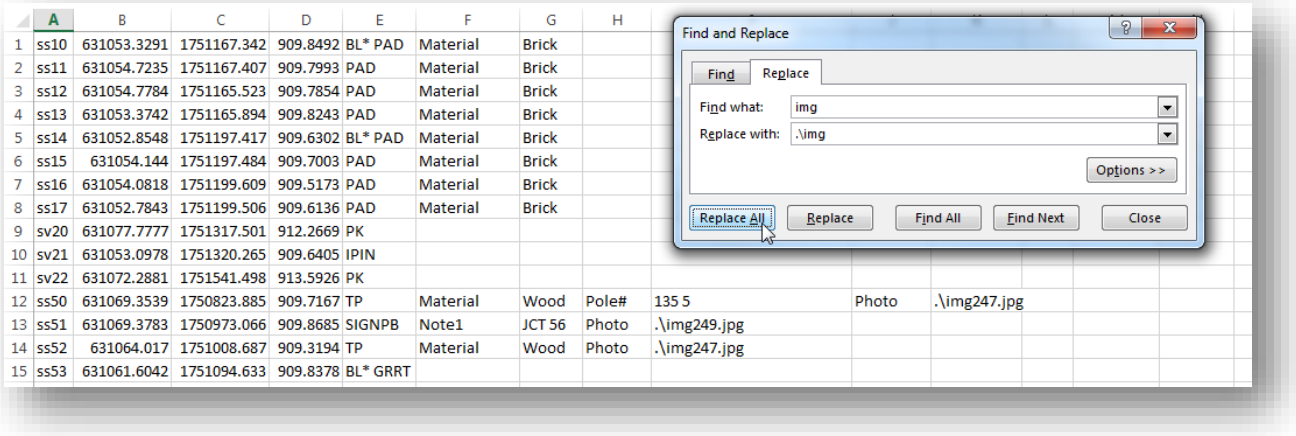
The example below shows a portion of a .csv file with photo attributes.

	A	B	C	D	E	F	G	H	I	J	K	L
1	ss10	631053.3291	1751167.342	909.8492	BL* PAD	Material	Brick					
2	ss11	631054.7235	1751167.407	909.7993	PAD	Material	Brick					
3	ss12	631054.7784	1751165.523	909.7854	PAD	Material	Brick					
4	ss13	631053.3742	1751165.894	909.8243	PAD	Material	Brick					
5	ss14	631052.8548	1751197.417	909.6302	BL* PAD	Material	Brick					
6	ss15	631054.144	1751197.484	909.7003	PAD	Material	Brick					
7	ss16	631054.0818	1751199.609	909.5173	PAD	Material	Brick					
8	ss17	631052.7843	1751199.506	909.6136	PAD	Material	Brick					
9	sv20	631077.7777	1751317.501	912.2669	PK							
10	sv21	631053.0978	1751320.265	909.6405	IPIN							
11	sv22	631072.2881	1751541.498	913.5926	PK							
12	ss50	631069.3539	1750823.885	909.7167	TP	Material	Wood	Pole#	135 5	Photo	img247.jpg	
13	ss51	631069.3783	1750973.066	909.8685	SIGNPB	Note1	JCT 56	Photo	img249.jpg			
14	ss52	631064.017	1751008.687	909.3194	TP	Material	Wood	Photo	img247.jpg			
15	ss53	631061.6042	1751094.633	909.8378	BL* GRRT							
16	ss54	631065.231	1751095.096	910.1248	GRRT							

By default, the software assumes all photos are in the same folder as the Field Book design file. Reviewing the point properties will list the name of the attached **Media File** as shown below.

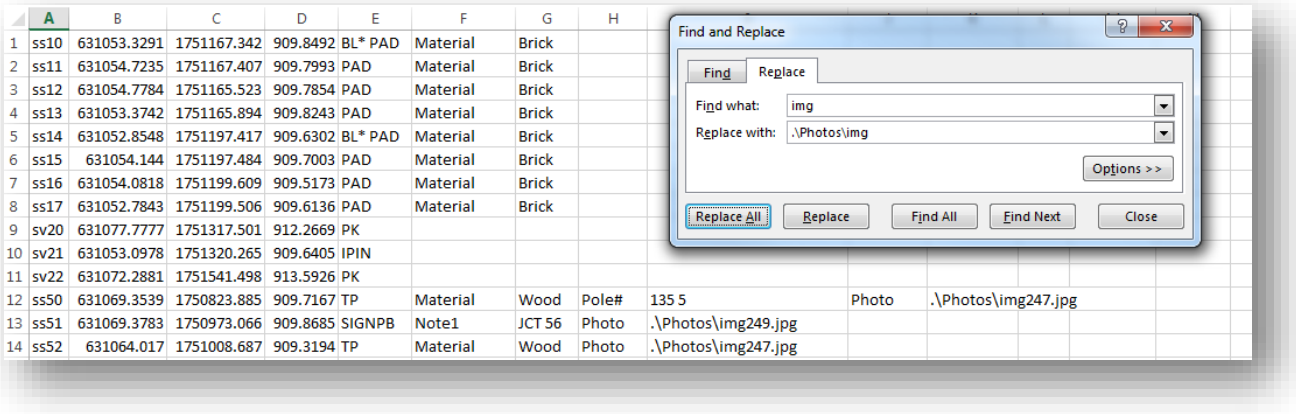


We have seen cases where the survey processing has failed to attach the images. If this occurs, it may be necessary to append the path to the image file in the survey data. In the example below, the .csv file is edited to assign a relative path using the **Find and Replace** command in Excel. The prefix "**.**" is added to each image file.



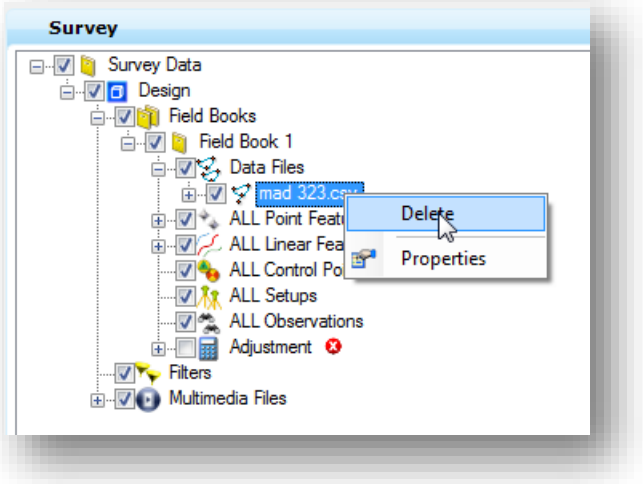
	A	B	C	D	E	F	G	H			
1	ss10	631053.3291	1751167.342	909.8492	BL* PAD	Material	Brick				
2	ss11	631054.7235	1751167.407	909.7993	PAD	Material	Brick				
3	ss12	631054.7784	1751165.523	909.7854	PAD	Material	Brick				
4	ss13	631053.3742	1751165.894	909.8243	PAD	Material	Brick				
5	ss14	631052.8548	1751197.417	909.6302	BL* PAD	Material	Brick				
6	ss15	631054.144	1751197.484	909.7003	PAD	Material	Brick				
7	ss16	631054.0818	1751199.609	909.5173	PAD	Material	Brick				
8	ss17	631052.7843	1751199.506	909.6136	PAD	Material	Brick				
9	sv20	631077.7777	1751317.501	912.2669	PK						
10	sv21	631053.0978	1751320.265	909.6405	IPIN						
11	sv22	631072.2881	1751541.498	913.5926	PK						
12	ss50	631069.3539	1750823.885	909.7167	TP	Material	Wood	Pole#	135 5	Photo	.\img247.jpg
13	ss51	631069.3783	1750973.066	909.8685	SIGNPB	Note1	JCT 56	Photo	.\img249.jpg		
14	ss52	631064.017	1751008.687	909.3194	TP	Material	Wood	Photo	.\img247.jpg		
15	ss53	631061.6042	1751094.633	909.8378	BL* GRRT						

For projects with a large number of photos, it may be desirable to save the phots in a sub-directory of the RawData folder. In the example below, the photos were stored in a Photos sub-directory. The path is prefixed to the image file names in the .csv file as shown below.

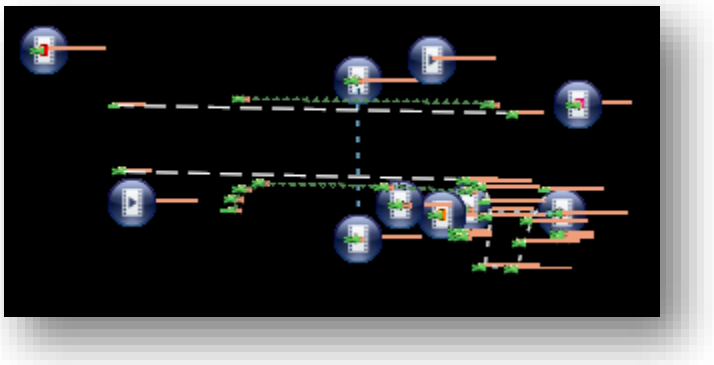


	A	B	C	D	E	F	G	H			
1	ss10	631053.3291	1751167.342	909.8492	BL* PAD	Material	Brick				
2	ss11	631054.7235	1751167.407	909.7993	PAD	Material	Brick				
3	ss12	631054.7784	1751165.523	909.7854	PAD	Material	Brick				
4	ss13	631053.3742	1751165.894	909.8243	PAD	Material	Brick				
5	ss14	631052.8548	1751197.417	909.6302	BL* PAD	Material	Brick				
6	ss15	631054.144	1751197.484	909.7003	PAD	Material	Brick				
7	ss16	631054.0818	1751199.609	909.5173	PAD	Material	Brick				
8	ss17	631052.7843	1751199.506	909.6136	PAD	Material	Brick				
9	sv20	631077.7777	1751317.501	912.2669	PK						
10	sv21	631053.0978	1751320.265	909.6405	IPIN						
11	sv22	631072.2881	1751541.498	913.5926	PK						
12	ss50	631069.3539	1750823.885	909.7167	TP	Material	Wood	Pole#	135 5	Photo	.\Photos\img247.jpg
13	ss51	631069.3783	1750973.066	909.8685	SIGNPB	Note1	JCT 56	Photo	.\Photos\img249.jpg		
14	ss52	631064.017	1751008.687	909.3194	TP	Material	Wood	Photo	.\Photos\img247.jpg		

If edits are made to the .csv file after it was initially processed, it is necessary to delete and re-load the data in order to reprocess the changes made to the .csv file. Right-click on the data file and select the **Delete** option as shown below.



After processing the data, survey points with images assigned will be displayed with the Media icon similar to the example below.



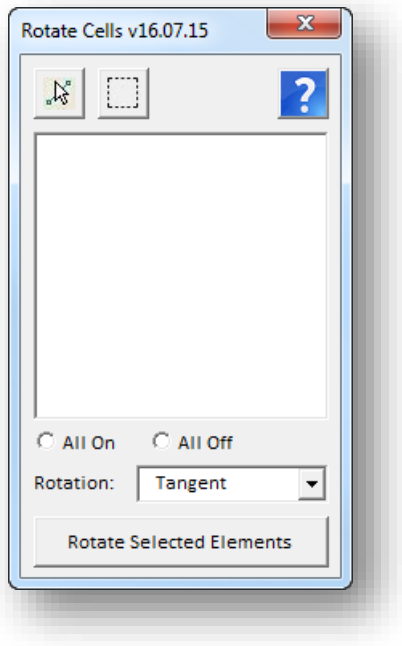
The **Media** command is used to view the images as described previously in this chapter.

Note:
In the SELECTseries 4 release of the software, media files can only be viewed from the original design file containing the survey data. Image files are not available from reference attachments or exported design files.

16 Rotating Survey Symbols

When survey data is drawn into a MicroStation design file, all of the symbol cells are placed at a zero degree rotation. This can often lead to symbols being displayed at odd angles on the construction plans. Many users like to rotate the symbols relative to a selected curvilinear element. The **ODOTcadd_RotateSurveyElements.mvba** application can be used for this task.

The application is accessed by selecting **ODOT > Survey > Rotate Symbols (OpenRoads)**. The dialog shown below is opened.

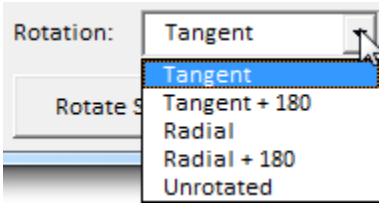


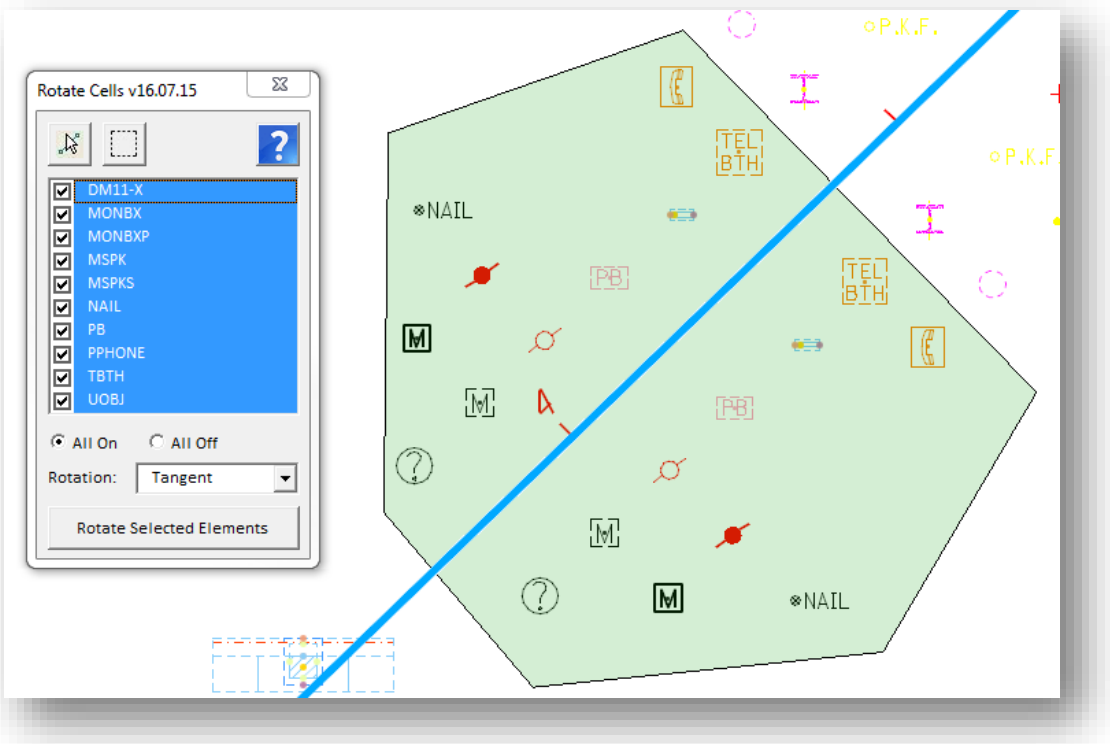
Select Reference Element
Select the element that will be used as the reference element that selected cells will be rotated relative to. The selected element can be a MicroStation line, linestring, arc, or curvestring element. The selected element is displayed as a weight 5 line, color 170.

Place Fence Shape
After the reference element is selected, this command is used to place a shape around the elements that you wish to rotate relative to the selected reference element.

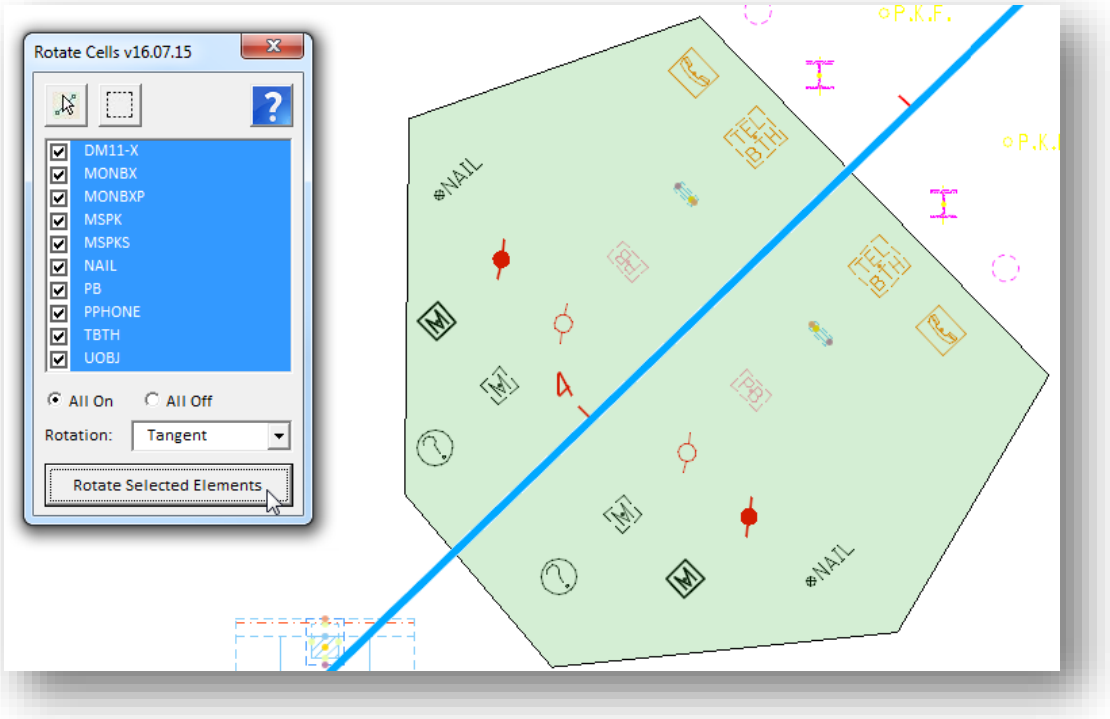
After the fence shape is placed, the program scans the design file for any cells enclosed within the fence shape. The list of cells is populated in the dialog as shown in the example on the following page.

The **Rotation** option is used to select how the cells are rotated relative to the selected reference element. The default option, **Tangent**, is used in most cases.



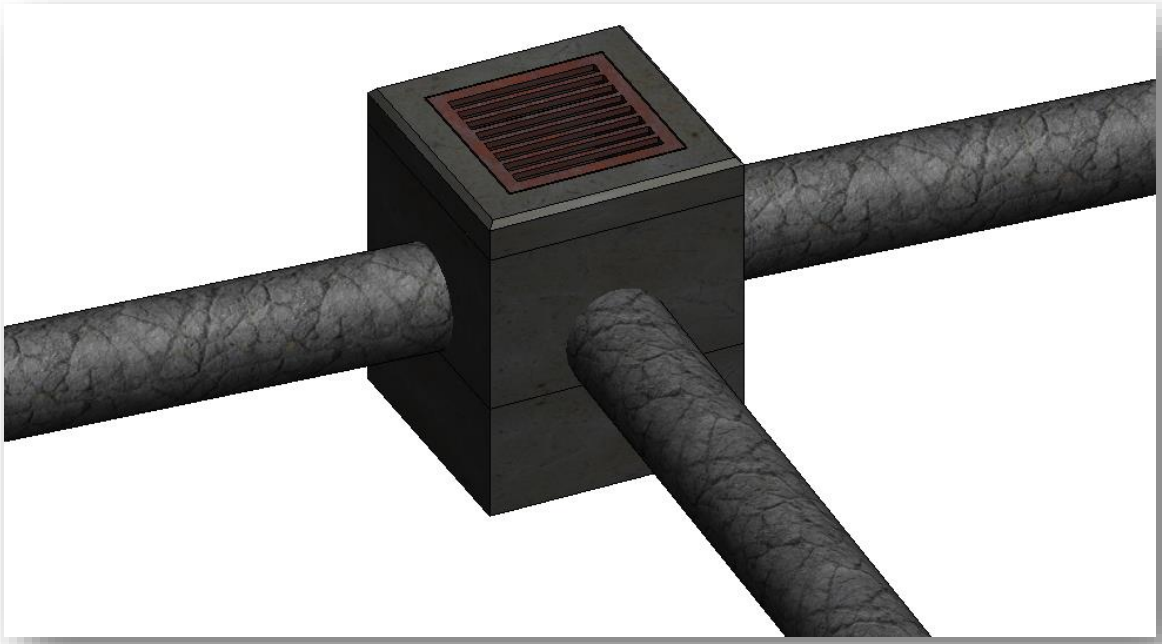


The check list can be used to turn on/off the rotation of selected cells. When the **Rotate Selected Elements** button is selected, the cells within the fence are rotated relative to the selected reference element as shown in the example below.



17 Existing Utilities and Storm Sewers

For OpenRoads corridor modeling, ODOT's design personnel will require the existing storm sewer and other utility information in a 3D model. An example of a 3D catch basin is shown below.



Not every project will be developed using a 3D model. For projects that do not require a model, the legacy GEOPAK tools, and ODOT's VBA applications for existing storm sewers, are used to show the storm sewer information on the plan, profile, and cross sections.

This chapter documents the workflow to provide survey information using the following processes:

- The legacy process, using ODOT's Drainage VBA Applications, is used for projects that do not require a 3D model. This process uses ODOT's legacy field codes for the drainage structures. Attributes assigned to the survey points for each drainage structure that define the pipes terminating within each structure. A GEOPAK GPK file is required for this process. Survey data processed with OpenRoads Survey tools can be used for this workflow as detailed in this chapter.

- The second workflow uses a new set of field codes for the drainage structures. The new process does not require attributes for the pipe information, nor does it require a GEOPAK GPK file.

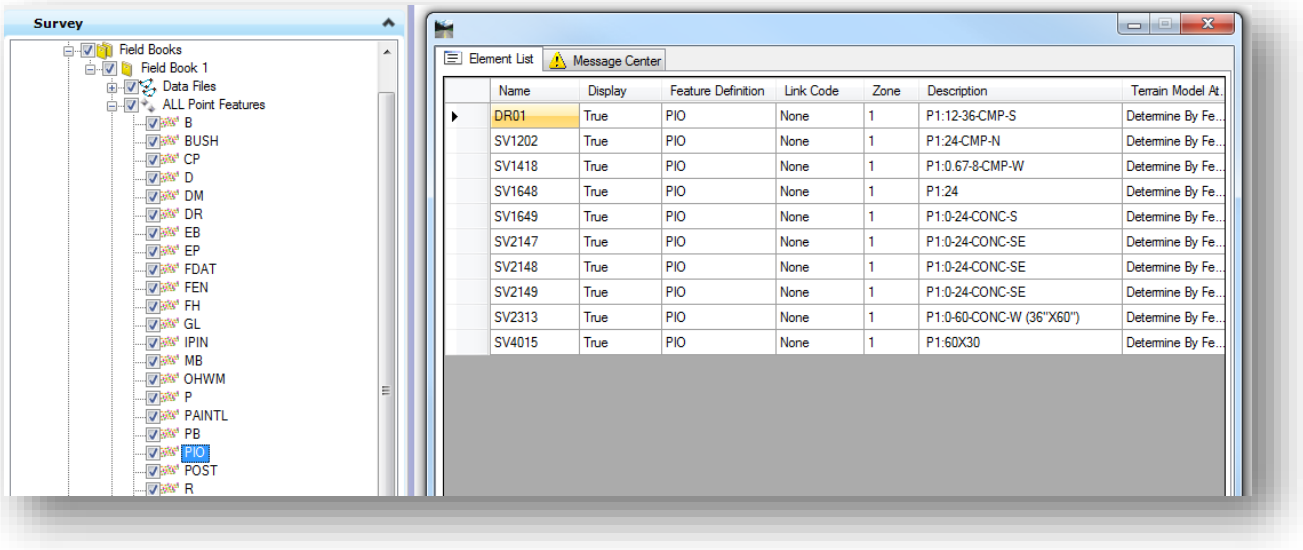
The Surveyor should review this chapter with the design personnel before beginning the field survey to determining which method is required.

Using OpenRoads Survey Data with the Legacy ODOT VBA Applications

If the design personnel for the project will use the legacy ODOT VBA Applications to draw the storm sewer information on the plan, profile, and cross sections, the legacy process to assign attributes to the catch basins, manholes, and inlets is documented in the following PDF file:

..\ODOTcadd\Standards\vba\Doc\ODOT_DrainageVBA.pdf

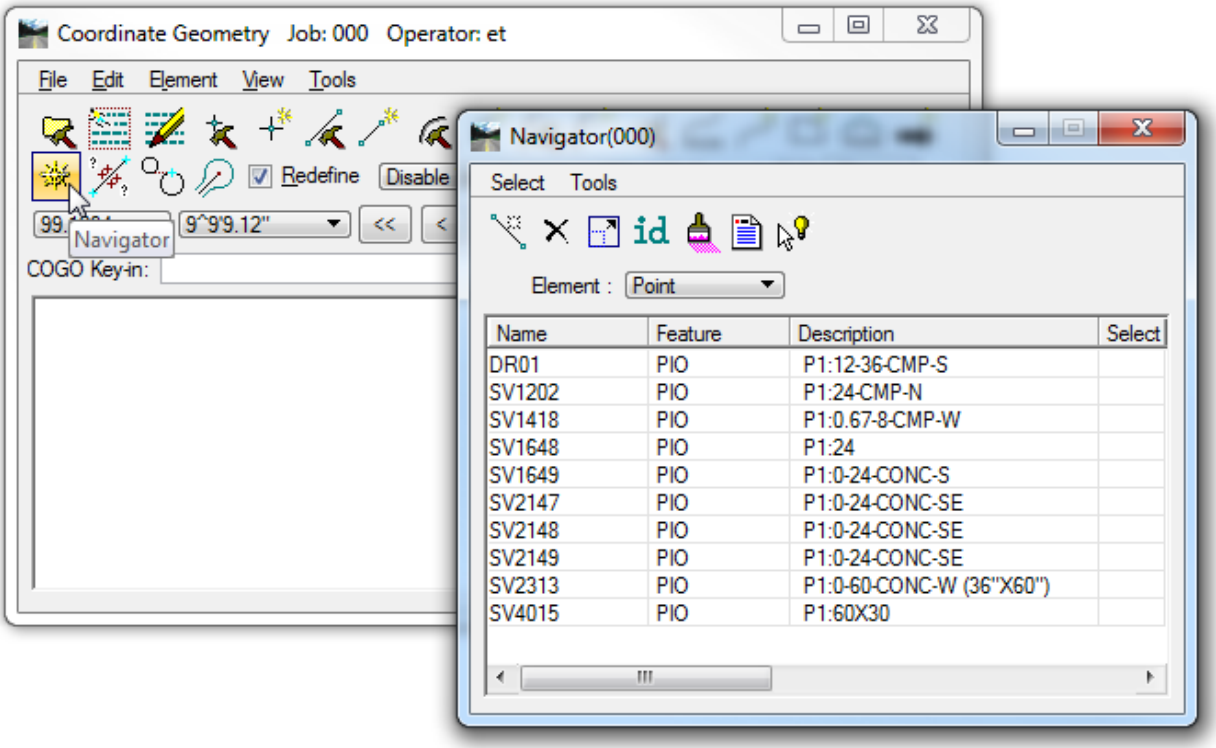
The legacy field codes using the drainage attributes are required for this process. When the data is collected using the drainage attributes documented in the above PDF file, the pipe information for the drainage field codes can be reviewed using the *Project Explorer* and the *Survey Details* dialog. In the example below, the point feature **PIO** is selected in the **Survey** group of the *Project Explorer* dialog. All of the points in the Field Book with the PIO field code are displayed in the *Survey Details* dialog.



The **Description** column lists the attributes for each surveyed PIO point. In the example above, note that OpenRoads uses a colon character for the separator between the attribute name P1 and the attribute value. The ODOT VBA applications assume an equal sign is used to separate the attribute name from the value.

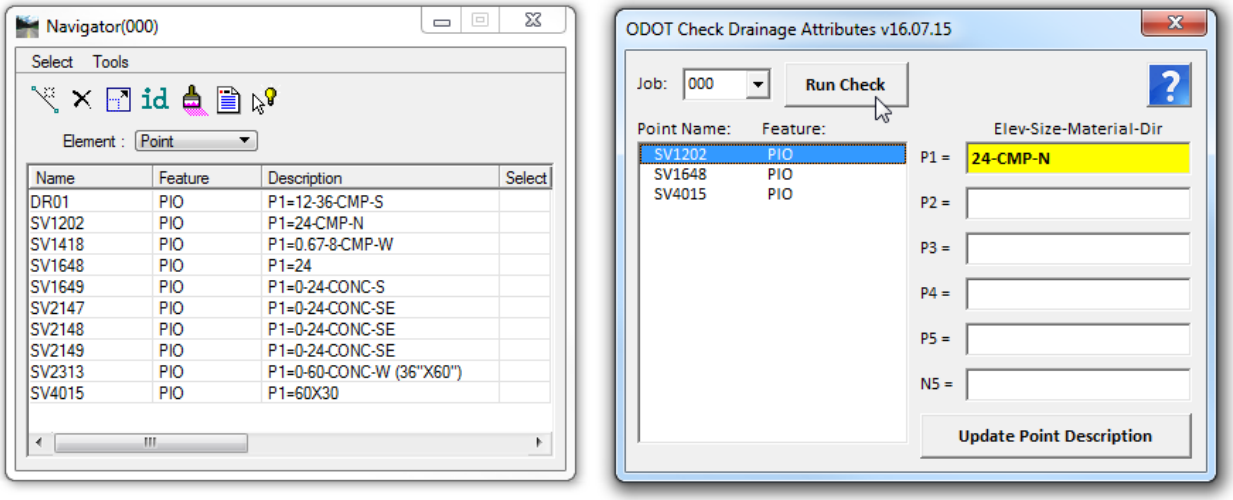
The ODOT VBA applications read the surveyed drainage information from a GEOPAK GPK file. The drainage points must be exported to a GPK file as detailed in chapter 14 of this training guide.

Once the points have been saved in the GPK file, the **GEOPAK COGO Navigator** can be used to review the points as shown on the following page.

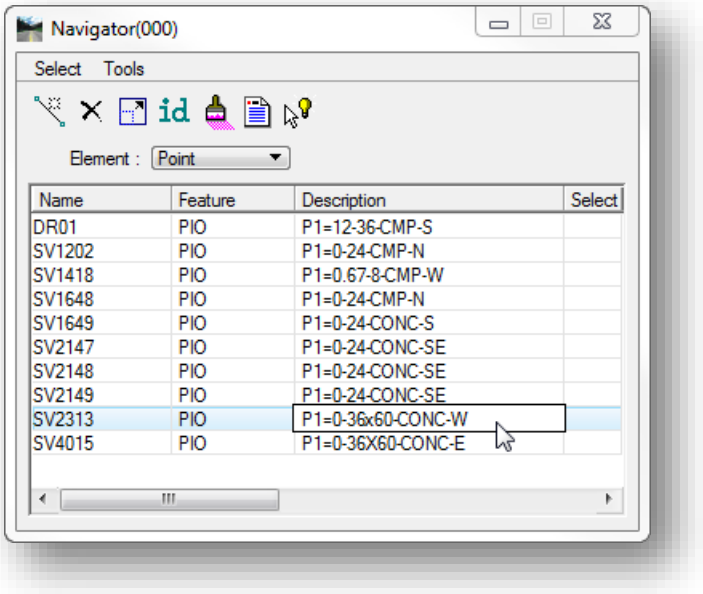


Before the data can be used with the legacy ODOT Storm Sewer VBA applications, the format of the description must be changed to replace the colon with an equal sign. Select **ODOT > Hydraulics > Existing > Plan View – Attribute Checker** to run the **ODOT_EXDrainageAttributeChecker.mvba** application that is used to review and edit the attributes.

When the **Run Check** button is selected, the application will replace the colon character with the equal character as well as check each point to ensure that the attribute format is correct. In the example below, three points were found that do not have the proper format. The attribute checker is used to enter the correct value and update the point description in the GPK file.



Note that the attribute checker may not catch all errors. After editing the attributes, review the point description in the *Navigator* dialog to ensure that there are not any other errors. In the example below, the **Description** for point **SV2313** will be edited in the Navigator dialog to remove the **(36"X60")** text at the surveyor appended to the end of the P1 attribute, which is not needed (as shown on the previous page), to correct the entry for the culvert size which should be entered in rise by span format as **36X60**.



Notes:

- Editing must be enabled by selecting **Tools > Settings** from the *Navigator* dialog, and then checking on the **Single Click Enables List Cell Editing** option.
- The **Redefine** option must be toggled on in the main COGO window to allow editing.
- This section assumes knowledge of the GEOPAK COGO functions. See the online help of ODOT's GEOPAK Road 1 training guide for information not covered here.
- The cells placed by the legacy field codes can be used to extract a 3D utility model using the processes detained in the following sections.

Using OpenRoads Survey Data to Generate a 3D Model

This section documents the field surveying process to collect the storm sewer information in a format suitable to generate the 3D model. The process described here replaces the process described in the previous section using the drainage attributes.

ODOT's previous procedure relied on the storm sewer points being stored in a GEOPAK GPK file. Since the survey points are no longer stored in a GPK file, and the GPK file will be removed from the OpenRoads software in a future release, a new process is necessary.

- For OpenRoads projects using a 3D model, ODOT will no longer use the attributes P1, P2, P3, P4, and P5 to store the storm sewer pipe information with the survey points. These attributes are still in the feature definition library, but will most likely be removed at a future date.

- ODOT's VBA applications for drafting the existing storm sewer pipes will eventually be retired and replaced by the process documented in this section.

- New field codes, which were previously defined in the "Office Use" category of ODOT's GEOPAK Survey Manager Database file (ODOT.smd) will be added the code list in the data collectors. These field codes are used to more accurately represent the actual drainage structure types.

The recommended process for the data collection of existing storm sewer information for OpenRoads 3D modeling is summarized below:

- Shoot the storm sewer structures using the new ODOT field codes for drainage items.

- Shoot the invert of the drainage structure using the **FLINE** field code. If you are unable to shoot the invert, measure the depth and take a shot on the grate adding the depth to the rod height.

- Pipe information will be recorded in a Microsoft Excel file in the format defined in this training manual. The pipe information contained in the Excel file can be collected at the time each drainage structure is surveyed, or at a later date.

- Rotate the cells placed by OpenRoads Survey to represent the actual position of the drainage structures. The ODOT VBA Application **ODOTcadd_RotateSurveyElements.mvba** is used for this purpose.

- A new ODOT VBA application, **ODOTcadd_ExistingStormSewer.mvba**, will be used to read the drainage pipe information from a CSV file to draw the pipes in the 3D survey Field Book design file.

- The 3D model for the drainage network can be generated by either the surveyor or the designer. Bentley's Subsurface Utility (SUDA) software is used to generate the 3D model of the drainage information. This 3D model of the storm sewers will be generated in a separate drainage basemap design file contained in the design\Roadway\Basemaps folder. The file is named using the "BD" file name code.

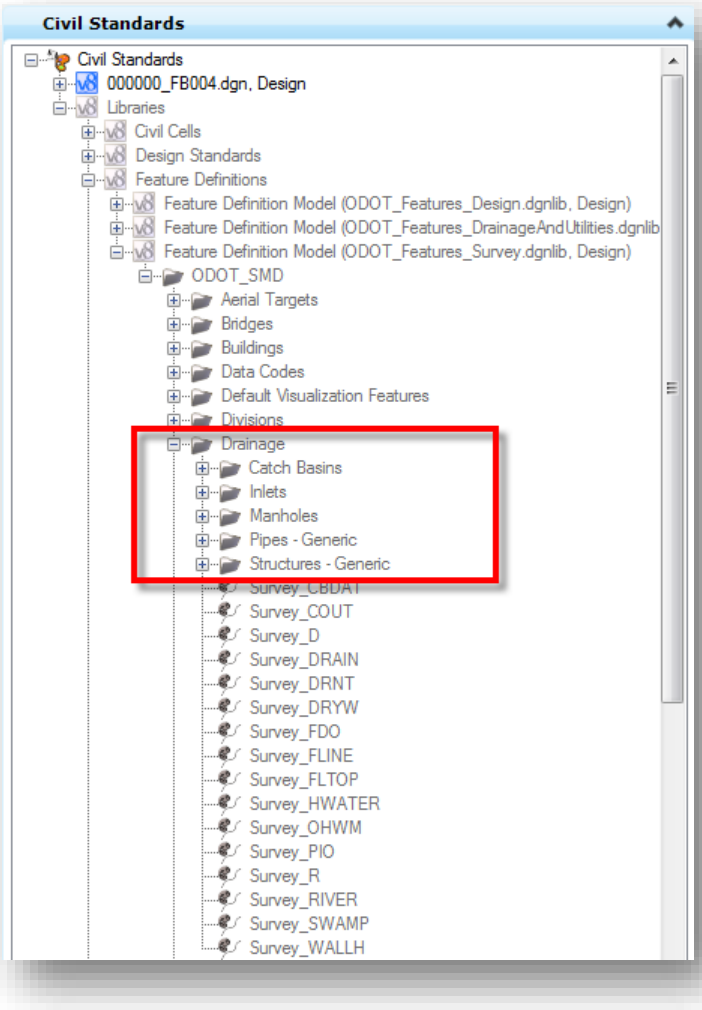
Field Codes for 3D Modeling

ODOT's field code list provides field codes for various storm sewer catch basins, manholes, and inlets. The complete code list can in PDF format can be found in the ODOTcadd Standards in the following folder:

..\ODOTcadd\Standards\GEOPAK\Survey\Field_Codes

ODOT has traditionally used generic field codes for the data collection of storm and sanitary structures. As ODOT continues to move towards and increased use of 3D modeling, it will become increasingly more important to generate models with storm sewer information that more accurately represents the size and location of the drainage structures found in the field.

The generic field codes are supplemented with specific codes that can be used to change the field code on specific survey points in order to draw a catch basin, inlet, or manhole type that more accurately represents the actual structure in the field. The supplementary codes for specific structure types have not been included in the data collector code list up to this point. These codes are defined in the GEOPAK Survey SMD file, and also in the OpenRoads Survey feature definition library. The available features can be reviewed in the *Project Explorer* dialog by accessing the **Civil Standards** group as shown below.



The **Catch Basins**, **Inlets**, and **Manholes** categories contain the supplemental codes.

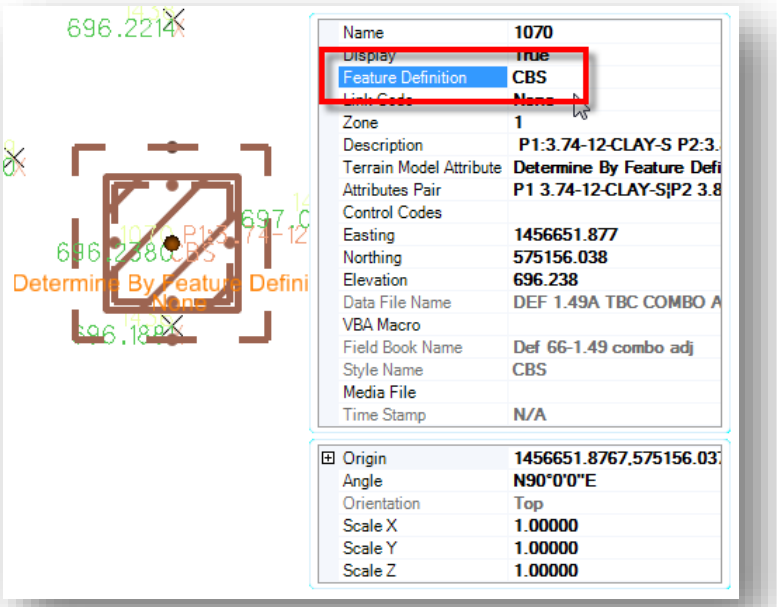
The legacy generic codes are contained in the **Structures - Generic category**.

The **Pipes - Generic** category contains the legacy drainage pipe codes that should no longer be used. All pipe information should be collected using the procedures documented in this chapter.

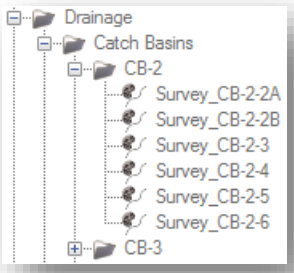
The name of the actual field code is prefixed with "Survey_" in the feature definition library as shown at left.

The specific feature types for catch basins, inlets, and manholes can be used after the data has been processed to edit a specific survey point and change its feature definition in order to draw the appropriate plan view cell.

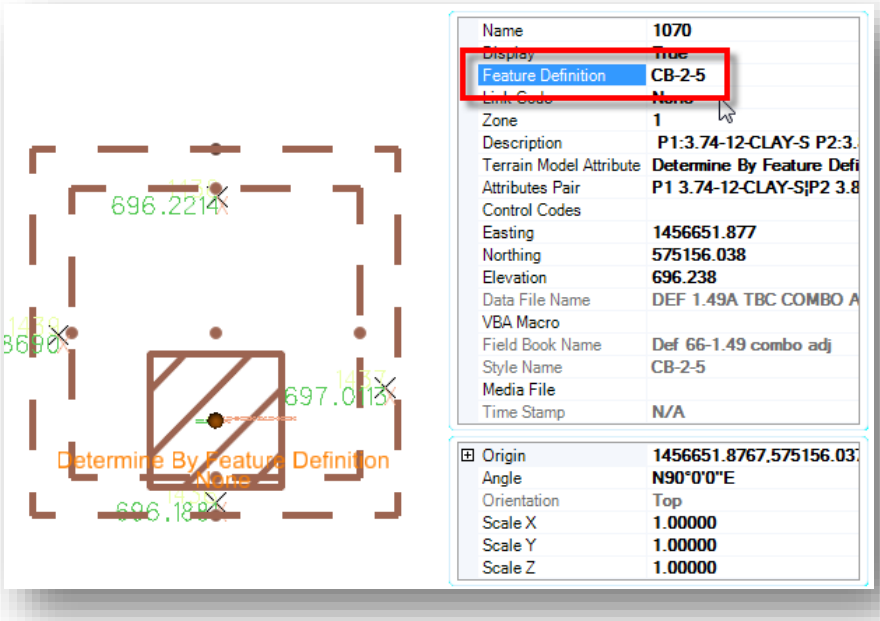
To change the feature definition for a survey point to one of the specific field codes, select the point and choose the **Properties** icon. Key in the new **Feature Definition** name, omitting the "Survey_" prefix.



The generic field code CBS was used in the field for this survey point. The point is drawn using the cell for a No. 2-2B catch basin. The available catch basin field codes can be reviewed in the *Project Explorer* dialog In the **Civil Standards** group as shown on the previous page. The CB-2 category is shown below.



Changing the code to CB-2-5 results in the appropriate plan view cell being drawn for the structure as shown below.



As ODOT moves into 3D modeling, the generic field codes will be replaced with field codes representing the basic catch basin, inlet, and manhole types. The following table summarizes the codes that should be used in place of the generic codes:

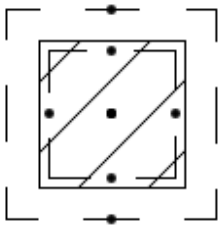
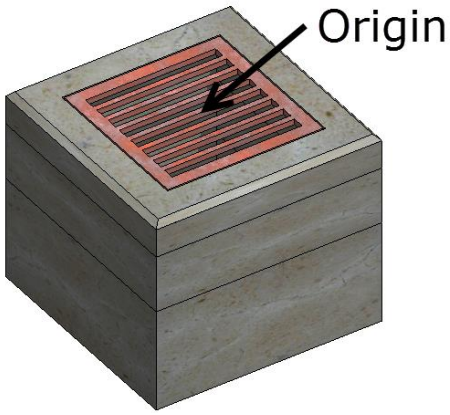
New Code	Old Code	Description
CB-2-2B	CBS	Catch Basin No. 2-2B Use the code for catch basin No. 2-2A, 2-2B, 2-3, 2-4, 2-5, and 2-6
CB-3	CI	Catch Basin No. 3 Use the code for catch basin No. 3 and 3A
CB-4		Catch Basin No. 4 Use the code for catch basin No. 4 and 4A
CB-5		Catch Basin No. 5 Use this code for catch basin No. 5, 5A, 8, and 8A.
CB-6		Catch Basin No. 6
CB-7	CBR	Catch Basin No. 7
I-2-6		Median Inlet No. 2-6 Use this code for all No. 2 and 2A inlets
I-3B	MI	Median Inlet No. 3
I-4B		Median Inlet No. 4
MH-3	STMH	This code places a cell for a Manhole No. 3 but should be used for all storm sewer manholes
MH-3-SAN	SSMH	Manhole No. 3 Use this code for all sanitary sewer manholes

While the new codes listed above are more specific than the old field codes, they are still somewhat generic as they do not take into account the size of the vault for each structure type.

The following two codes are provided for the flow line at the top and bottom of drainage structures.

Code	Description
FLINE	Flow line at the bottom of the drainage structure
FLTOP	Low point elevation of the inlet or catch basin grate/top.

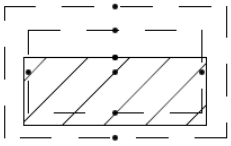
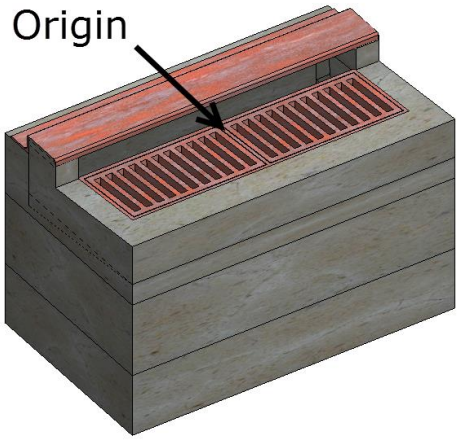
Further instructions for editing the code for each of the above field codes are provided in the following pages.

Code	Description	Plan View Cell	3D View
CB-2-2B	Catch Basin No. 2-2B Use this code for all square catch basins with a note designating the size of the vault and whether the structure has a side inlet.	CB22B-X 	

Notes:
Shoot the center of the grate.

Edit the field code in the office to use one of the other square catch basin types:

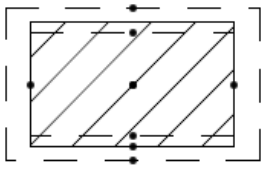
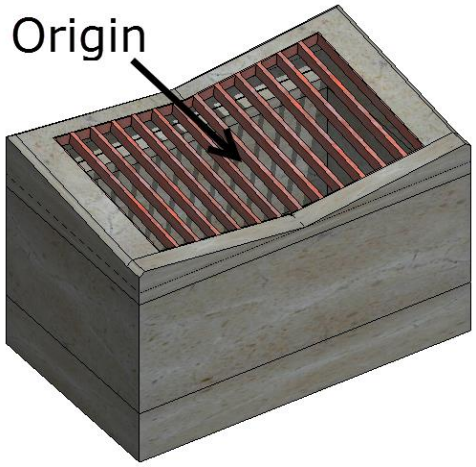
- CB-2-2A
- CB-2-3, CB-2-3SI
- CB-2-4, CB-2-4SI
- CB-2-5, CB-2-5SI
- CB-2-6, CB-2-6SI

Code	Description	Plan View Cell	3D View
CB-3	Curb Inlet No. 3. Also used for No. 3A which has one grate.	CB3-X 	

Notes:
Shoot the low spot of the grate, at the face of curb in the center of the structure.

Edit the field code in the office to use one of the other types:

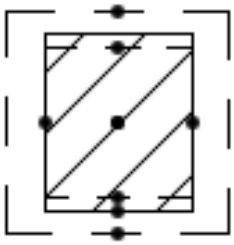
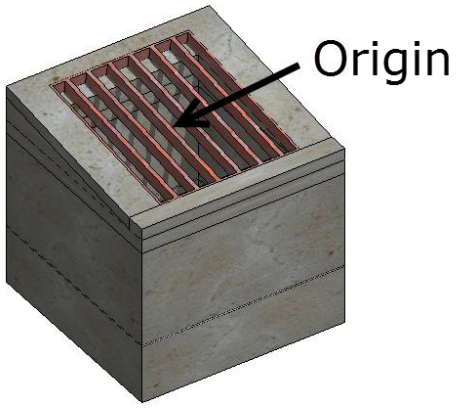
- CB-3A

Code	Description	Plan View Cell	3D View
CB-4	Catch Basin No. 4 Use this code for catch basin No. 4 and 4A. The vault size varies for the 4A structures.	CB4-X 	

Notes:
Shoot the center of the grate. If the grate is slanted, take a second shot at the low point using the **FLTOP** field code.

Edit the field code in the office to use one of the CB4A types:

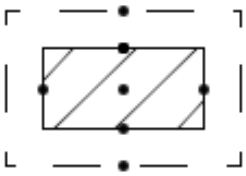
- CB-4A-42, CB-4A-48, CB-4A-54, CB-4A-60, CB-4A-66, CB-4A-72

Code	Description	Plan View Cell	3D View
CB-5	Catch Basin No. 5 Use this code for catch basin No. 5, 5A, 8, and 8A. The vault size varies for the 5A and 8A structures. The 8 and 8A structures have a v-shaped grate.	CB5-X 	

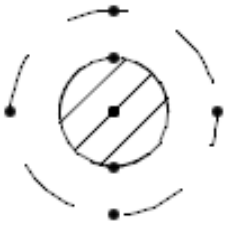
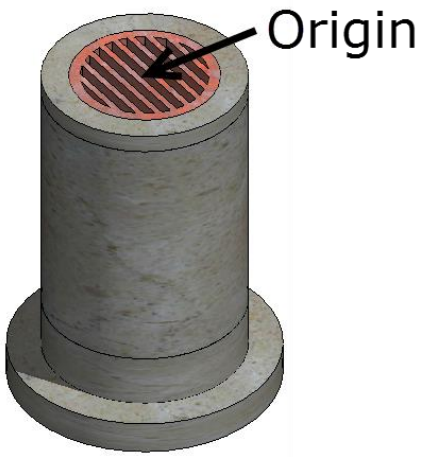
Notes:
Shoot the center of the grate. If the grate is slanted, take a second shot at the low point using the **FLTOP** field code.

Edit the field code in the office to use one of the CB-5A or CB-8A types:

- CB-5A-42, CB-5A-48, CB-5A-54, CB-5A-60, CB-5A-66, CB-5A-72
- CB-8A-42, CB-8A-48, CB-8A-54, CB-8A-60, CB-8A-66, CB-8A-72

Code	Description	Plan View Cell	3D View
CB-6	Catch Basin No. 6	CB6-X 	

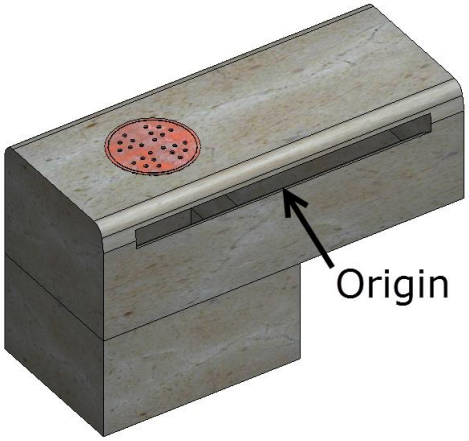
Notes:
Shoot the back of the grate.

Code	Description	Plan View Cell	3D View
CB-7	Catch Basin No. 7	CB7-X 	

Notes:
Shoot the center of the grate. For domed grates, add the height of the dome (approximately 4”) to the rod height. A flat grate is used for the 3D model.

Code	Description	Plan View Cell	3D View
FLINE	Flow line at the bottom of the drainage structure	GTM	NA

Code	Description	Plan View Cell	3D View
FLTOP	Low point elevation of the inlet or catch basin grate/top.	GTM	NA

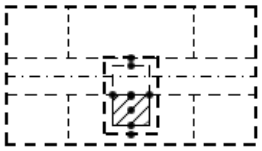
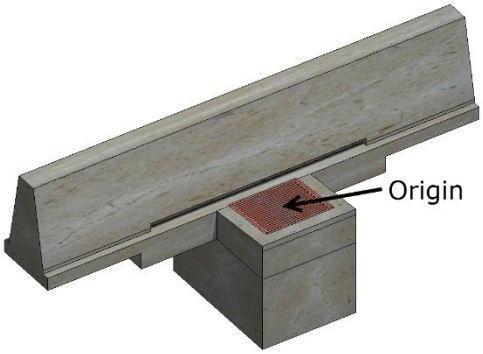
Code	Description	Plan View Cell	3D View
I-2-6	Median Inlet No. 2	I26-X	

Notes:
Shoot the flow line elevation at the center of the opening. These inlets come in various sizes from 6’ to 20’ in length, in 2’ increments.

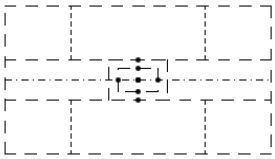
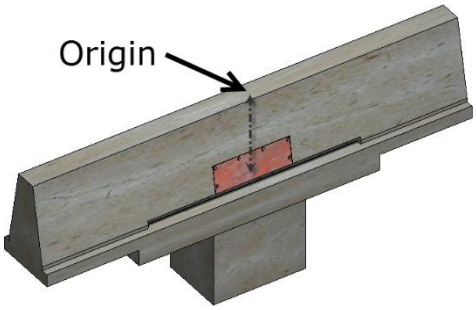
I-2 median cells are 3.0’ wide. I-2A median cells are 3’-4” wide.

Edit the field code in the office to use one of the I-2 or I-2A types:

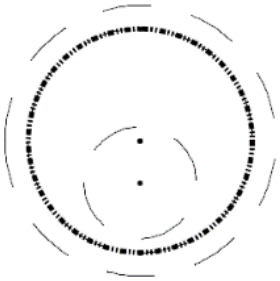
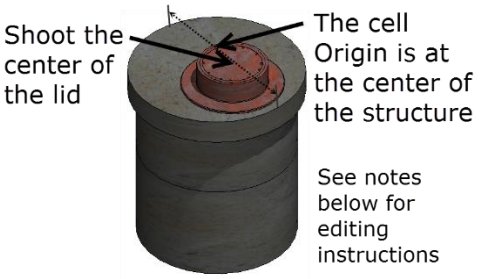
- 1-2-6, 1-2-8, 1-2-10, 1-2-12, 1-2-14, 1-2-16, 1-2-18, 1-2-20
- 1-2A-6, 1-2A-8, 1-2A-10, 1-2A-12, 1-2A-14, 1-2A-16, 1-2A-18, 1-2A-20

Code	Description	Plan View Cell	3D View
I-3B	Median Inlet No. 3	I-3B-SS-X 	

Notes:
Shoot the center of the grate.

Code	Description	Plan View Cell	3D View
I-4B	Median Inlet No. 4	I-4B-SS-X 	

Notes:
Shoot the approximate center of the structure on top of the barrier. Measure the barrier height and add that value to the rod height to set the elevation for the grate.

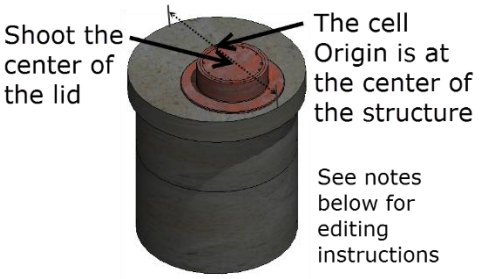
Code	Description	Plan View Cell	3D View
MH-3	Storm Manhole Use this code for all storm sewer manhole types.	MH3-48D-X 	

Notes:
Shoot the center of the lid.

The plan view cell origin is at the center of the base, not at the center of the lid. As a result, the manhole position will be shifted in relation to the survey shot at the center of the lid. The bigger the vault, the more the shift. Take a second shot at the approximate center of the base on the surface of the ground. Code this shot using the **X2D** feature code with a note to designate this as the actual center of the structure. In the office, edit the survey point to use the Northing and Easting coordinate of the X2D shot with the elevation from the shot on the lid.

Edit the field code in the office to change the manhole type appropriately

- MH-1
- MH-2-12, etc…
- MH-3-48, etc...
- MH-4-72, etc…
- MH-5-30, etc…

Code	Description	Plan View Cell	3D View
MH-3-SAN	Sanitary Manhole	MH1D-X-SAN	

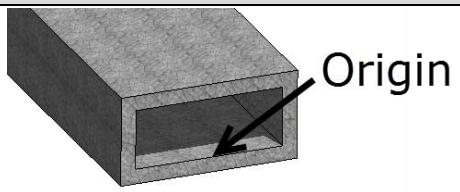
Notes:
Shoot the center of the lid.

The plan view cell origin is at the center of the base, not at the center of the lid. As a result, the manhole position will be shifted in relation to the survey shot at the center of the lid. The bigger the vault, the more the shift. Take a second shot at the approximate center of the base on the surface of the ground. Code this shot using the **X2D** feature code with a note to designate this as the actual center of the structure. In the office, edit the survey point to use the Northing and Easting coordinate of the X2D shot with the elevation from the shot on the lid.

Field Codes for Storm Sewer Pipes

The ODOT field code list provides several legacy field codes for various pipe types. The pipe material will be defined in the Excel file with the drainage pipe information, therefore it is not necessary to code the pipes with a specific field code for the pipe material. These legacy codes are retained in the data collector list, but are no longer required and may be removed at a future date.

The following field codes are typically used for all drainage pipes, drive pipes, and culverts on a typical ODOT survey:

Code	Description	Plan View Cell	3D View
CULV	Flow line at each end of a box culvert.	GTM	
Notes: Shoot a point at each end of the culvert. Note the span and rise of the interior of the box. Use the Visual Basic program **ODOTcadd_ExistingStormSewer.mvba** to draw box culverts between two OpenRoads survey points			

Code	Description	Plan View Cell	3D View
FDO	For Direction Only Used to show the direction of a pipe when the other end cannot be located	GTM	NA
PIO	Pipe Inlet/Outlet. Shoot the invert of the pipe	GTM	NA

For open pipes and box culverts, it is not necessary to collect the pipes as linear features by use of the BL* and EL* mapping codes. For example, both ends of an open pipe should be collected using the PIO field code and later connected using an ODOT visual basic application.

It is not necessary to shoot the pipes in a drainage structure. These will be drawn using a CSV file containing the pipe information and an ODOT Visual Basic application.

Field Collecting Drainage Pipe Information

The pipes will be drawn using a custom VBA application with the drainage pipe information contained in a CSV file. The pipe can be field collected as the drainage structures are surveyed, or collected at a later date. In either case, it is necessary to define the pipe information in a CSV file for processing with the VBA application.

ODOT provides a template Excel file used to collect the pipe information. The template Excel files is located in the ODOTcadd Standards.

..\ODOTcadd\Standards\Geopak\Survey\ODOT_ExistingStormSewers.xlsx

Note that the data must be exported from the Excel file to a CSV file for processing. Custom Excel files can also be used as long as the required information is saved to a CSV file using the format documented below. The first few lines of an example CSV file are shown below:

	A	B	C	D	E	F
1	First Point Name	Depth or Elevation	Size	Material	Second Point Name	Depth or Elevation
2	DR118	0	15	RCP	DR100	3.25
3	DR100	491.5	12	RCP	DR102	492.1
4	DR102	2.5	12	RCP	DR104	2.75
5	DR102	2.9	12	RCP	DR112	2.5

The First Point and Second point values can be a drainage structure, and PIO, or an FDO point. Pipes can be drawn from drainage structure to drainage structure, from pipe end to pipe end (two PIO points), or from a drainage structure to a PIO or FDO point.

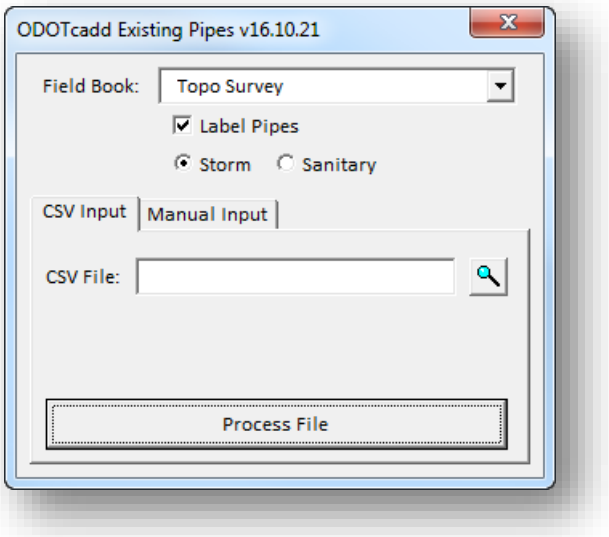
The order of the fields is fixed and cannot be modified. Each field is described below:

Field	Description
First Point Name	The point name for the drainage structure, PIO, or FDO point
Depth or Elevation	The measured depth to the pipe invert, or the actual elevation of the pipe invert. Notes: - If the value is greater than 200 it is assumed to be an elevation - Values less than 200 are subtracted from the First Point elevation when the CSV file is processed - Use a value of 0 for PIO and FDO points
Size	The pipe size, in inches - Use numbers only, do not append a double quote character to designate inches - Elliptical pipes are entered in rise by span format without any spaces or other characters. Example: 14x23
Material	The pipe material. Use only the abbreviations defined in the ODOT Excel file
Second Point Name	The point name for the other end of the pipe, a structure, PIO, or FDO point
Depth or Elevation	The measured depth to the pipe invert, or the actual elevation of the pipe invert. Notes: - If the value is greater than 200 it is assumed to be an elevation - Values less than 200 are subtracted from the First Point elevation when the CSV file is processed - Use a value of 0 for PIO and FDO points

Processing Pipes with ODOTcadd_ExistingStormSewer.mvba

The MicroStation Visual Basic program **ODOTcadd_ExistingStormSewer.mvba** is used to draw drainage pipes and box culverts between two OpenRoads survey points. The application has two modes:

- CSV Input
- Manual Input



The application is accessed from the ODOT pull-down menu by selecting **ODOT > Survey > Existing Pipes (OpenRoads)**. When the program is selected, the dialog shown at right is opened.

This **CSV Input** and **Manual Input** modes are used in the survey Field Book (FB) design file to draw pipes and culverts between drainage structures, PIO shots, and FDO shots.

Box culverts are placed using the **Subsurface Utilities** software functions as described later in this document.

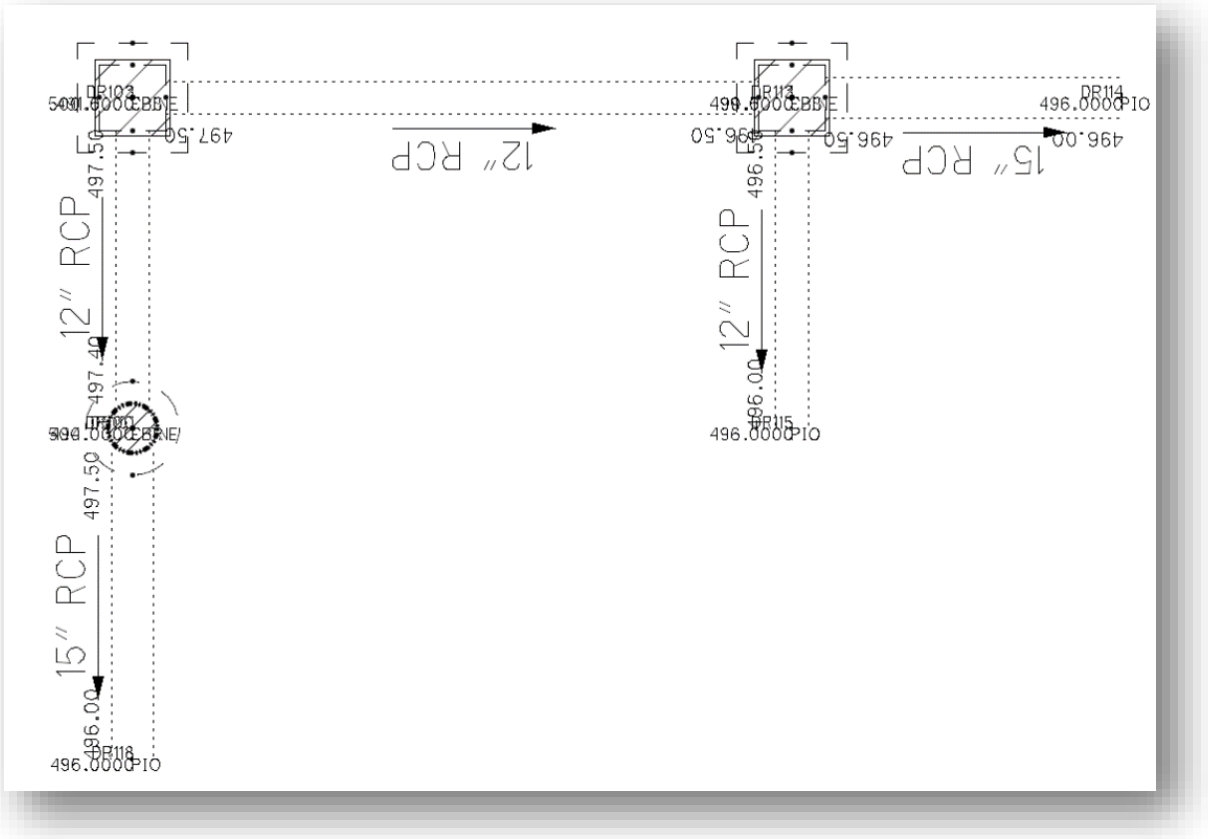
The operation of each mode is described below.

CSV Input

This mode is used to read a CSV file containing existing pipe information and draw storm sewer and sanitary sewer pipes and culverts into the survey field book design file. The lines that are drawn for the pipes are drawn in 3D at the correct elevations, however these lines are just “flat” lines using the ODOT line style for drainage pipes.

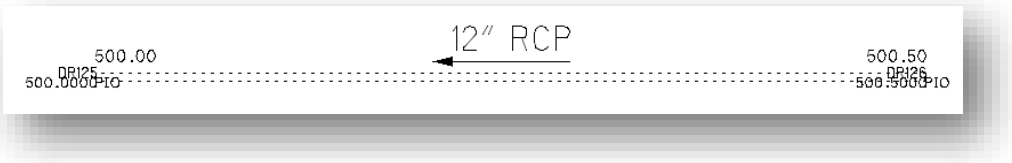
The lines for the pipes are drawn between a pair of OpenRoads survey points by reading a CSV File containing the pipe information. The format of the CSV file is defined in the previous section. The application requires a 3D model.

Select the **CSV file** and the **Field Book**. Choose the **Process File** option to initiate processing. An example of the plan graphics for the pipes drawn in the field book design file is shown below.

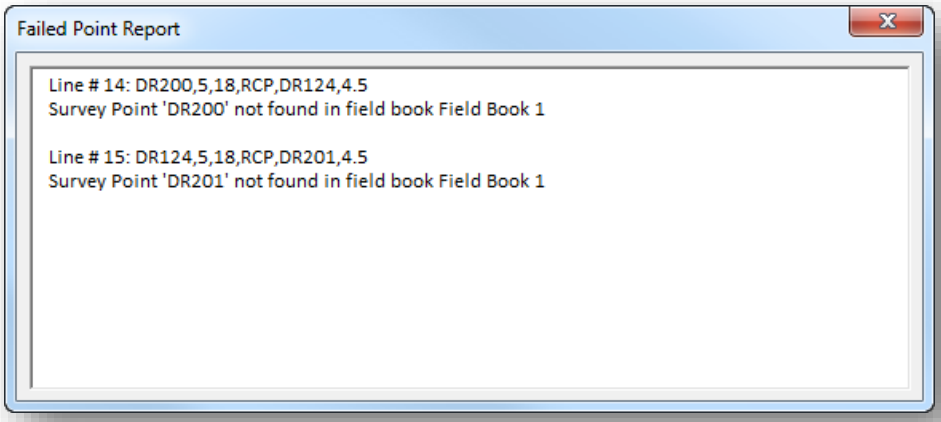


The pipe labels and flow arrows are placed using the active annotation scale and the active MicroStation text style. Changing the annotation scale after the CSV file has been processed will scale the text size, but not the flow arrow.

In addition to the size and type, the elevation at each end of the pipe is plotted for information on the level **SC_Scratch1** as shown in the example below.



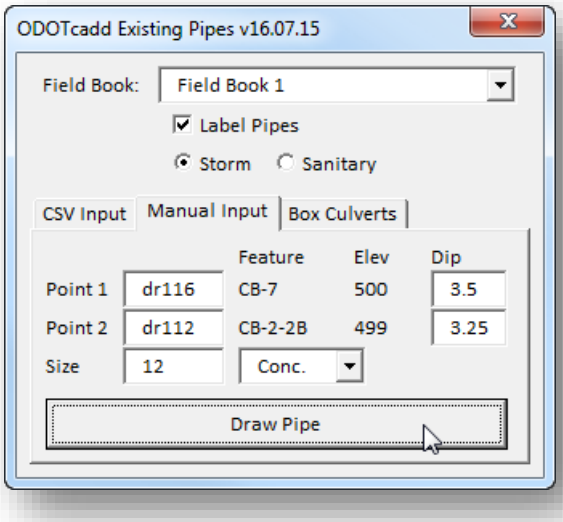
As the CSV file is processed, the selected field book is searched for survey points matching the point names defined in the CSV file. If a point in the CSV file is not found in the selected field book, it is reported in a separate dialog as shown in the example below.



CSV Input Notes:
The graphics drawn by the VBA application are drawn at the actual elevations defined by the CSV file processing.

The graphics in the survey basemap design file are intended for plan production purposes, not for 3D modeling. The 3D pipe information can be extracted from these graphics to generate a 3D model of the drainage features as described later in this document.

Manual Input
Manual input mode is used to enter the information for pipes and culverts, one at a time. This mode is useful for projects with only a few pipes when a CSV file will not be used.



The **Point 1** and **Point 2** fields are used to enter the name of the points that will be used to draw a pipe or culvert. The point names must be contained in the selected **Field Book**.

When a point name is entered, the feature name and elevation of the point is reported in the **Feature** and **Elev** fields.

The **Dip** fields are used to enter the depth for the pipe or culvert at the **Point 1** and **Point 2** location.

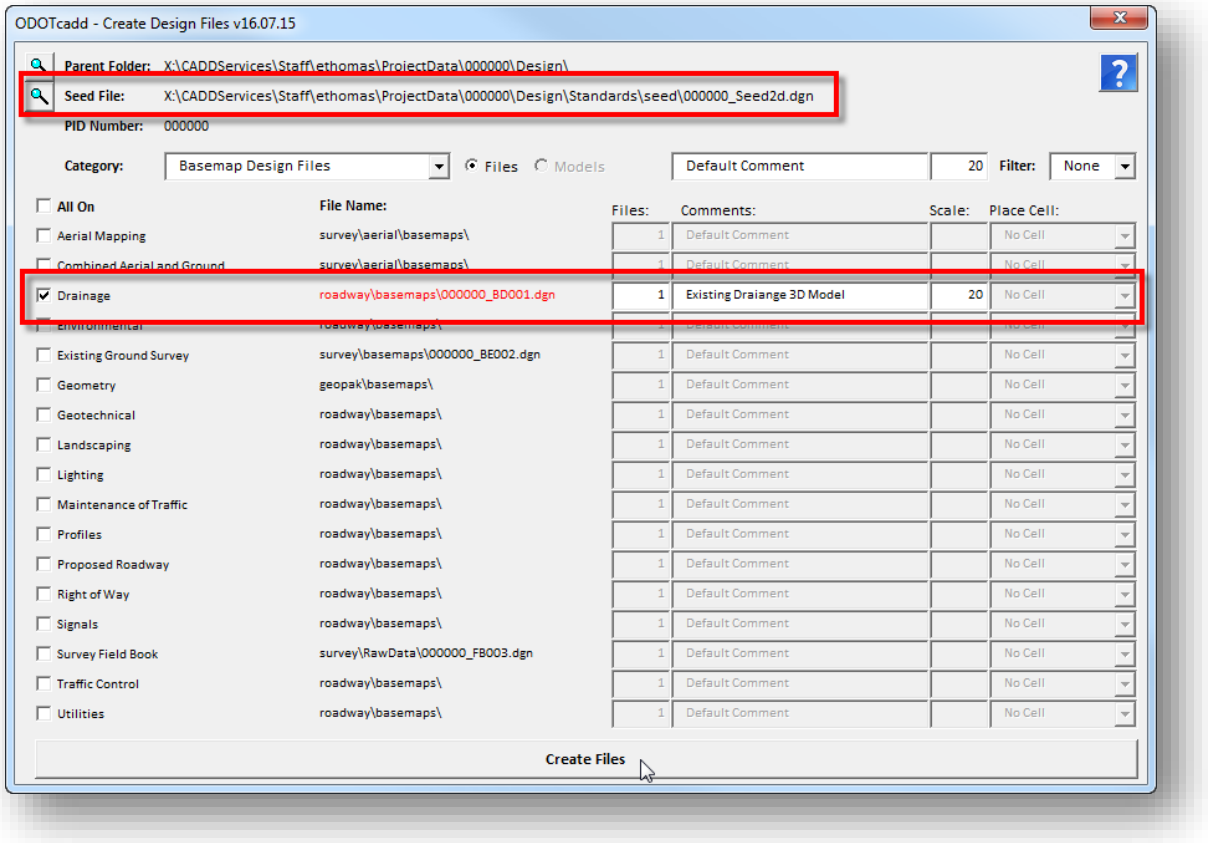
Like the CSV mode, the graphics drawn are placed at the computed elevation for the end points of the pipe, however the graphics are “flat” lines intended for plan sheets. These lines can use used to extract 3D pipes as described later in this document.

Drainage Basemap Design Files

The 3D model of the existing drainage information is typically generated in a separate drainage basemap. The drainage basemap is created using the **ODOT_Files.mvba** application. The survey data is referenced to the drainage basemap. The drainage structures and the pipes are extracted from the survey file using the **Subsurface Utility** commands to generate the 3D model.

Use the **ODOT_Files.mvba** application to create a new drainage basemap for the 3D model.

From the MicroStation pull-down menu, **select ODOT > File Management > Create Design Files** to access the program as shown below.



Notes:

- Use the 2D seed file to create the drainage basemap. The **Subsurface Utilities** software will generate a separate 3D model in the drainage basemap design file for the 3D drainage information
- The file is created in the roadway\basemaps folder
- The two-character file code is “BD”.

Extracting the 3D Drainage Nodes

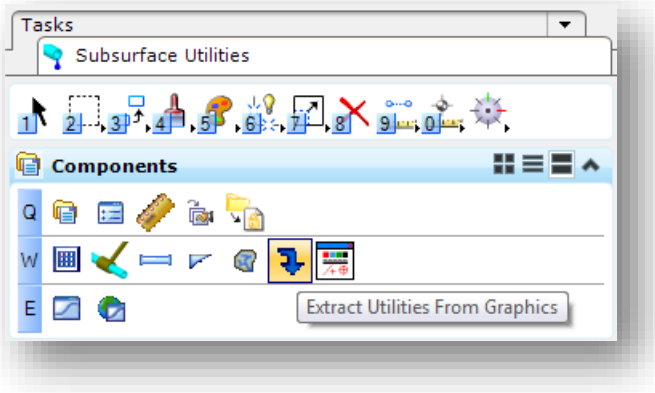
Bentley's **Subsurface Utility** tools are used to generate the 3D model of the existing drainage information. Catch basins, manholes, and inlets are referred to as a "node" by the subsurface utility software.

Take the following actions to create a 3D model of the existing drainage information. It is assumed the catch basin, manhole, and inlet cells have been rotated into place in the survey basemap before starting this process.

1. Open the newly created drainage basemap design file.

2. Attach the survey basemap as a reference.

3. From the MicroStation **Tasks** menu, select the **Extract Utilities from Graphics** command as shown below.



Note:
If this is the first time you have selected the command, you are prompted to create a utility model. Select **Yes** to create the utility model.

After the utility model is created, you must select the icon again to access the **Extract Utilities from Graphics** dialog shown below.

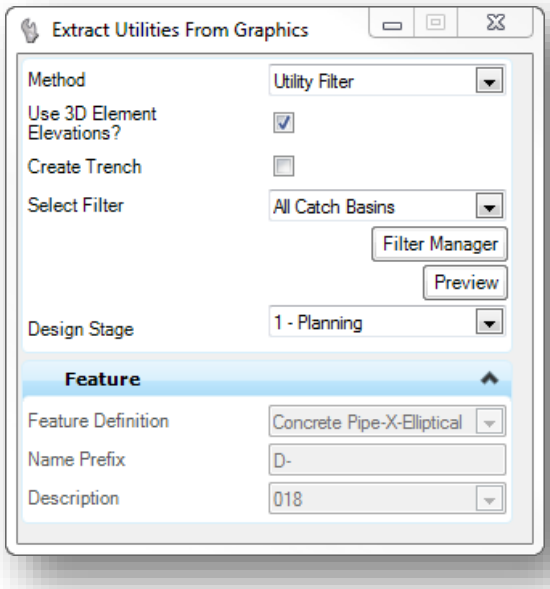
4. Set the **Method** to **Utility Filter**. Several filters are provided in the ODOTcadd Standards for individual drainage items as well as groups of items.

5. Use the **Select Filter** item to choose **All Catch Basins** filter. This filter is configured to extract only the drainage cells for the catch basins and not the pipes. The pipes will be extracted individually as a separate process.

6. Toggle on the **Use 3D Element Elevations** option.

   The **Design Stage** item is not relevant.

   The options can also be selected by use of the menu prompts floating on the cursor.



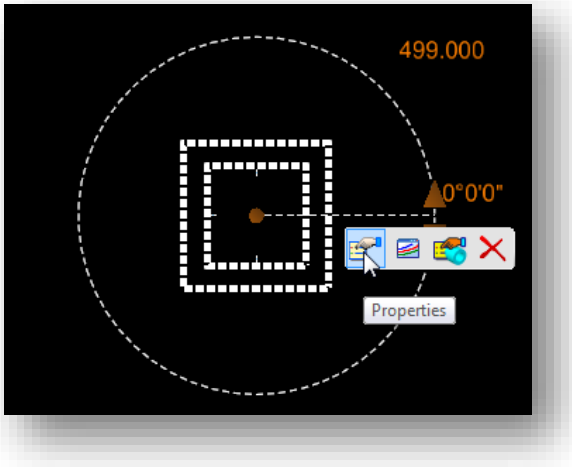
7. Accept the options as you are prompted on the cursor to initiate the extraction process.

The 3D drainage structures are extracted using the elevation of the cells mapped by the Survey process. As each drainage structure is processed, the extraction process will search for a **FLINE** feature to establish the depth of the drainage structure. If a **FLINE** feature is not found, the depth is set using at a default value.

If the drainage basemap was created with a 2D seed file, which is the recommended best practice, **the Extract Utilities from Graphics** process will create a new model named **Design-3D** containing the 3D drainage structures. This new model is automatically attached as a reference to the current 2D model.

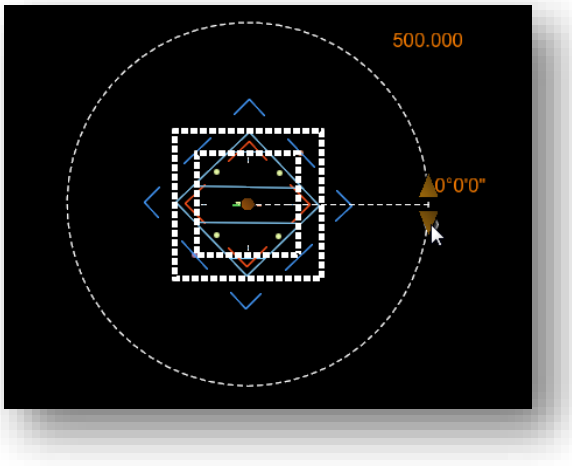
In addition to the 3D model, a 2D graphic is placed in the current 2D model for each extracted drainage structure nodes. This graphic is linked to the 3D model and can be used to make edits to the drainage structure.

In the example below, the reference file display of the survey basemap and the Design-3D model has been turned off to show the 2D graphic that is placed for one of the drainage structures.



Selecting the graphic reveals a pop-up menu that can be used to make edits to the drainage structure as well as two rules (**Node Top Elevation**, and **Node Rotation**) that can be edited by selecting the displayed text.

The extracted drainage structures do not take into account the rotation angle of the original cells and are placed at a zero degree rotation. The example at left below shows the original cell as referenced from the Survey basemap, and the 2D cell that was placed as part of the utility extraction process. It is necessary to rotate each structure manually.

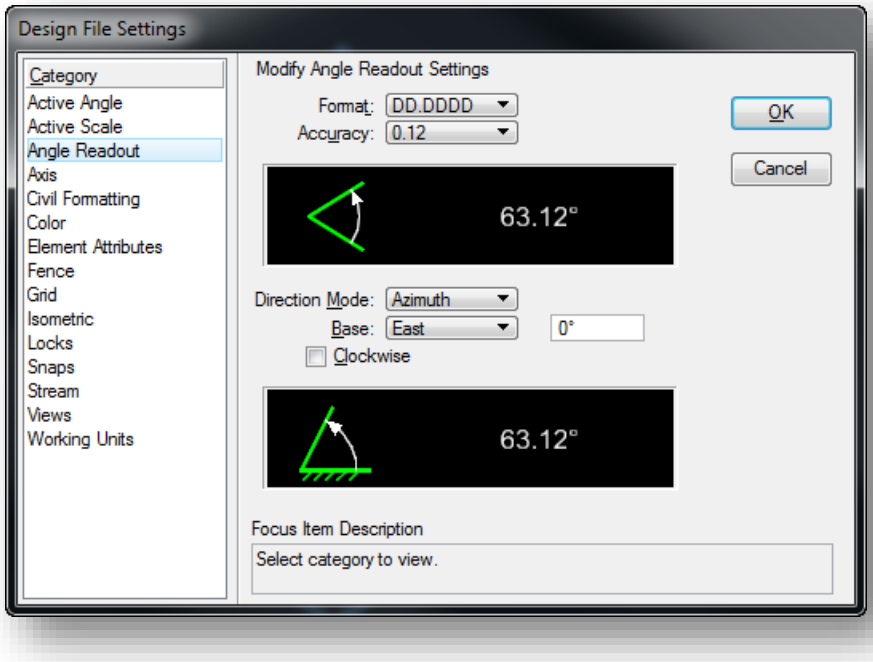


Once the 2D node is selected, parameters for the rotation of the 3D structure are displayed as shown at left. The angle can be keyed-in by selecting the angle text, or the 3D structure can be rotated by selecting one of the rotation arrows.

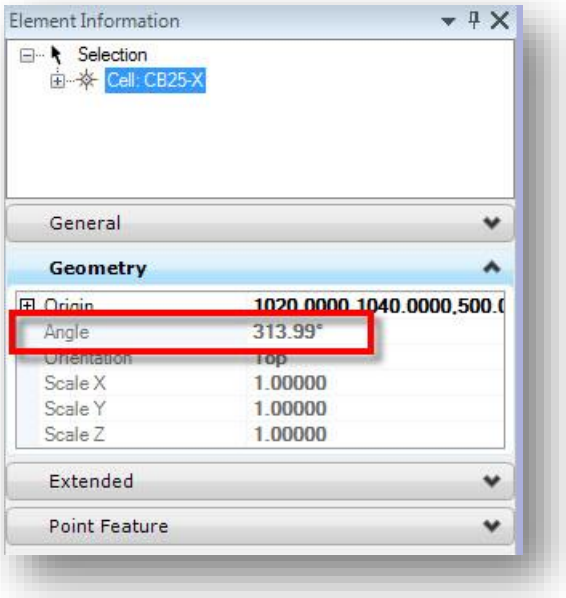
Typically, it is best to get the rotation angle of the original cell and use that value to key-in the rotation angle for the drainage node as described on the following page.

Take the following steps to key-in the rotation angle for the drainage structure:

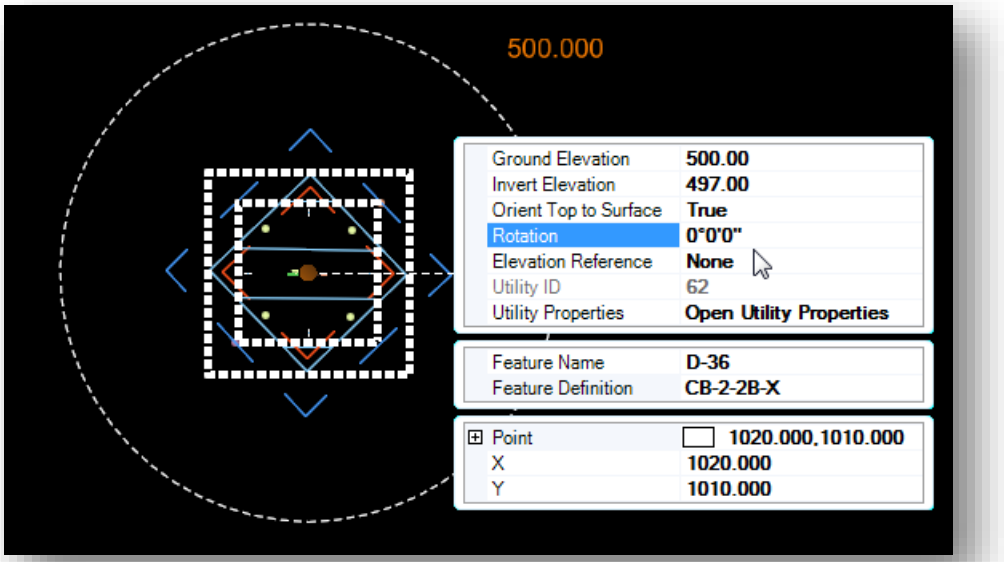
- ✓ Change the **Angle Readout** as shown below by selecting **Settings > Design File** from the MicroStation pull-down menu.



- ✓ Use the MicroStation **Element Information** command to get the rotation angle of the original cell as shown below.



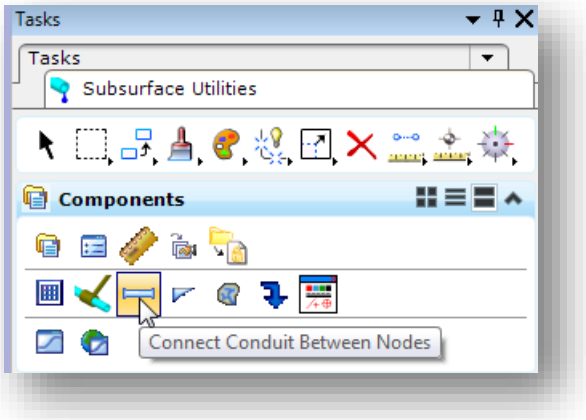
- ✓ Select the drainage node graphic and choose the **Properties** command from the pop-up menu. The **Rotation** can be modified as shown below. The graphics for the node in the 3D model are updated as changes are made to the properties.



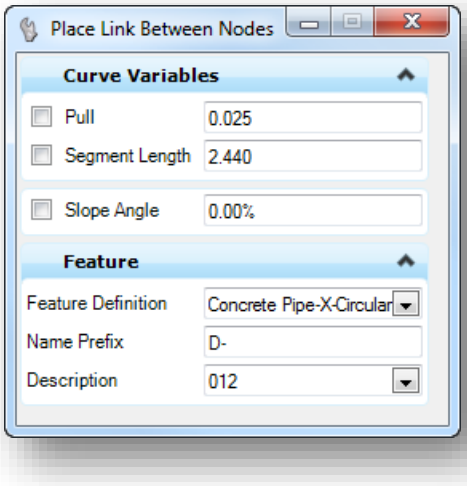
After extracting the drainage structures and rotating them into place we are ready to extract the pipes.

Extracting Drainage Links

The **Extract Utilities from Graphics** command can be used to extract pipe information; however, as of this writing the current release of the software will not connect the extracted pipes to the previously extracted nodes. Even though it is more cumbersome, with the current software, it is better to place each pipe manually as a "link" using the **Connect Conduit Link Between Nodes** command, shown below.



The dialog shown below is opened.



General information for the command can be found by selecting **Subsurface Utility > Help > Subsurface Utilities Help** from the MicroStation pull-down menu.

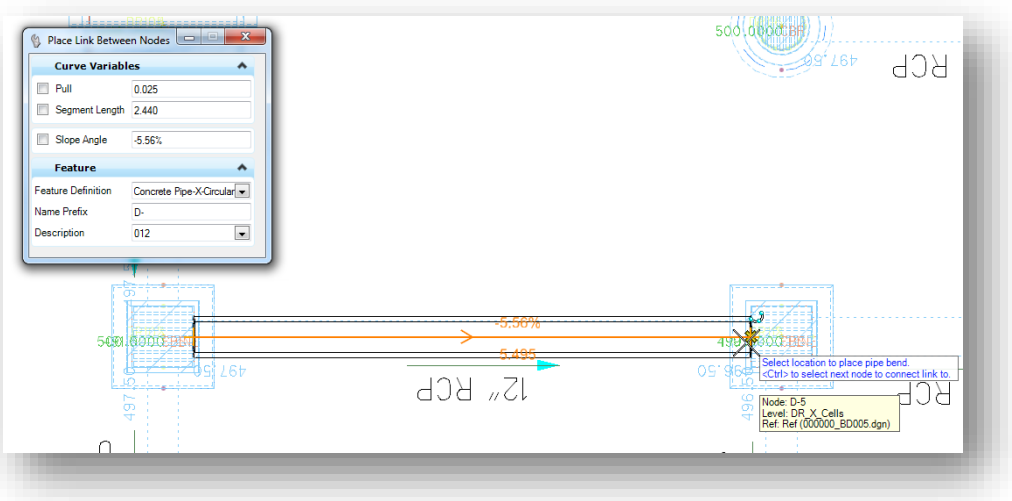
The **Feature Definition** is used to select the pipe type.

The **Description** item is used to select the pipe size.

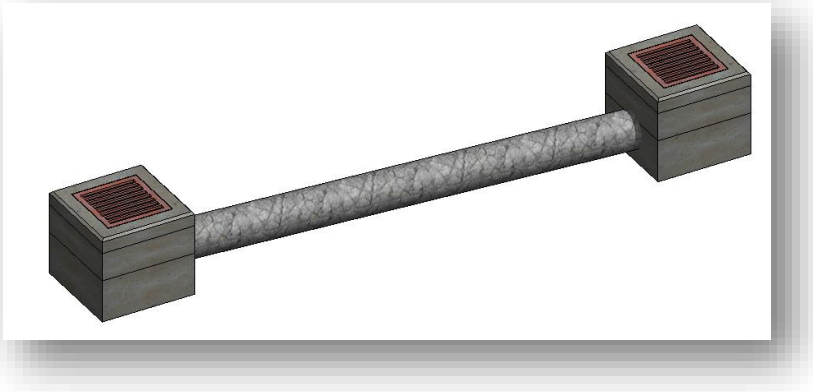
The **Name Prefix** is used to name each pipe and is incremented as you extract the pipes.

When the command is selected, you are prompted to **Select Start Node**.

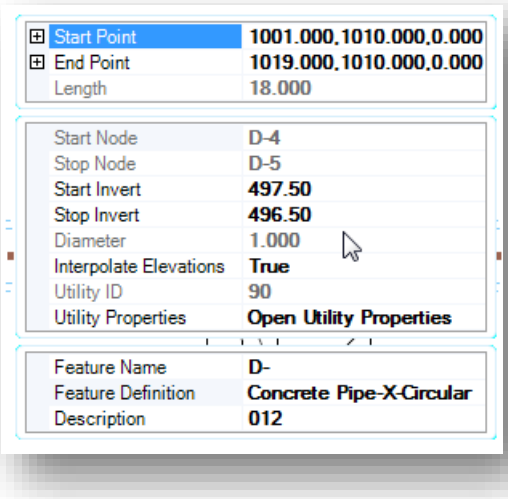
The ODOT 3D drainage items have specific connection regions on each side of rectangular structures. Circular structures have a circular connection region. When the first node is selected, the link starts from one of the connection regions. Follow the prompts to select the second node. An example is shown on the following page.



A line is placed in the current 3D model that can be used to modify he link. The extruded 3D link is placed in the 3D model as shown below.



The link is placed at the lowest elevation of the selected nodes. The elevation values can be edited by selecting the link in either the 2D or the 3D model, and then choosing the **Properties** icon from the pop-up menu.

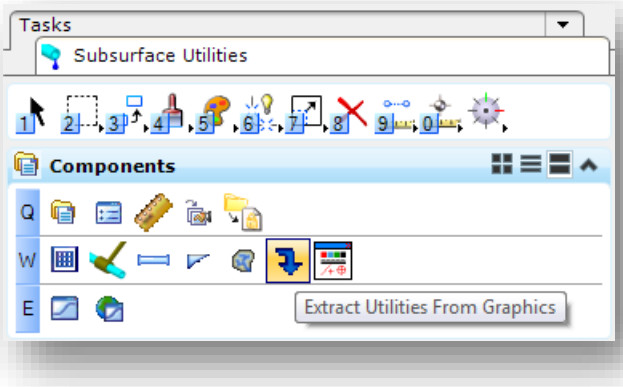


From the *Properties* menu, shown at left, the **Start Invert** and **Stop Invert** values can be edited if necessary to set the correct elevations for the pipe.

Connecting Links to a FDO or PIO Point

The field codes PIO and FDO can both be used to designate the end of a pipe. PIO is used to designate an inlet or outlet point for an open pipe of culvert. FDO (for direction only), is used to designate the direction of a pipe when the other end cannot be located.

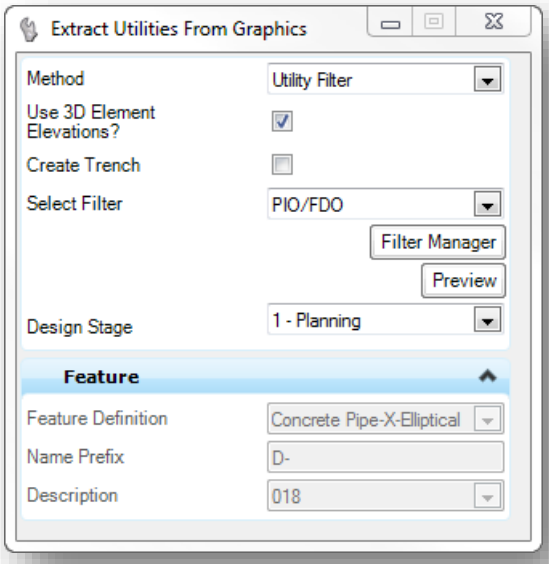
There must be a node defined at the PIO and FDO locations in order to place a link in the design file using the PIO and FDO points. The **Extract Utilities From Graphics** command is used to extract nodes at the PIO and FDO locations,



The command is selected from the task menu as shown at left.

Take the following steps to extract nodes for the PIO and FDO points:

- Set the **Method** to the **Utility Filter** option.
- Use the **Select Filter** option to choose the **PIO/FDO** filter.
- Toggle on the **Use 3D Element Elevations** option.
- Accept these options as prompted.



The extracted node for the PIO and FDO points is placed as a triangle at each point on the level SC_Scratch1 as shown at right.

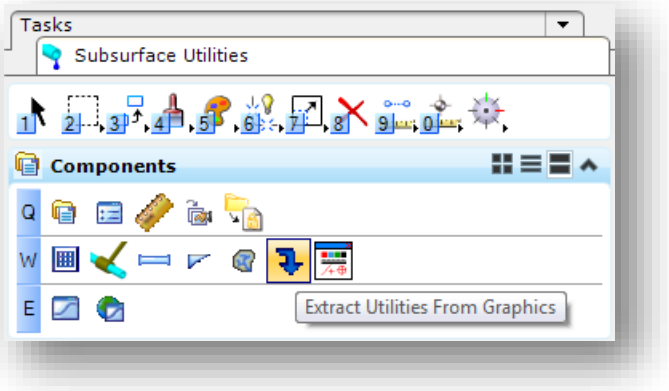
The **Connect Conduit Between Nodes** command described in the previous section is used to place the pipes between the nodes.

Extracting Multiple Links

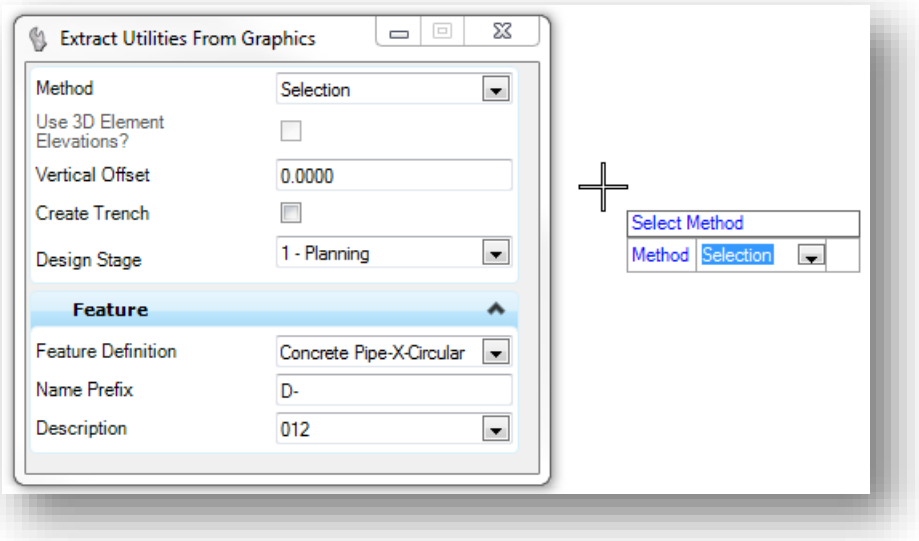
Multiple pipes of the same type and size can be extracted simultaneously using the **Extract Utilities From Graphics** command. This method has one advantage over placing each link manually using the **Connect Conduit Between Nodes** command. When the pipes are extracted, the actual 3D elevations of the graphics can be used for the created links. The **Connect Conduit Between Nodes** command uses the flow elevation for the structure as the default elevation for newly placed links. However, there is one significant disadvantage that prevents us from recommending this command. The extracted links are not connected to the previously extracted nodes. New nodes are placed at each end of the pipe using a default symbol. Since new nodes are created, this method is not the preferred method to generate the links.

ODOT has submitted several change requests to Bentley in relation to the utility extraction process. While not recommended at this time, this procedure is documented here for future reference.

To extract multiple links from the pipe graphics, select the **Extract Utilities from Graphics** command.



The dialog shown below is opened.



✓ Set the **Method** to **Selection** to select the surveyed pipe lines to extract.

- ✓ The **Create Trench** and **Design Stage** items are not relevant.
- ✓ Set the appropriate **Feature Definition** for the type of pipe that you will be extracting.

- ✓ The **Name Prefix** is used to name each pipe and is incremented as you extract the pipes.

- ✓ The **Description** field is used to select the size of the pipe

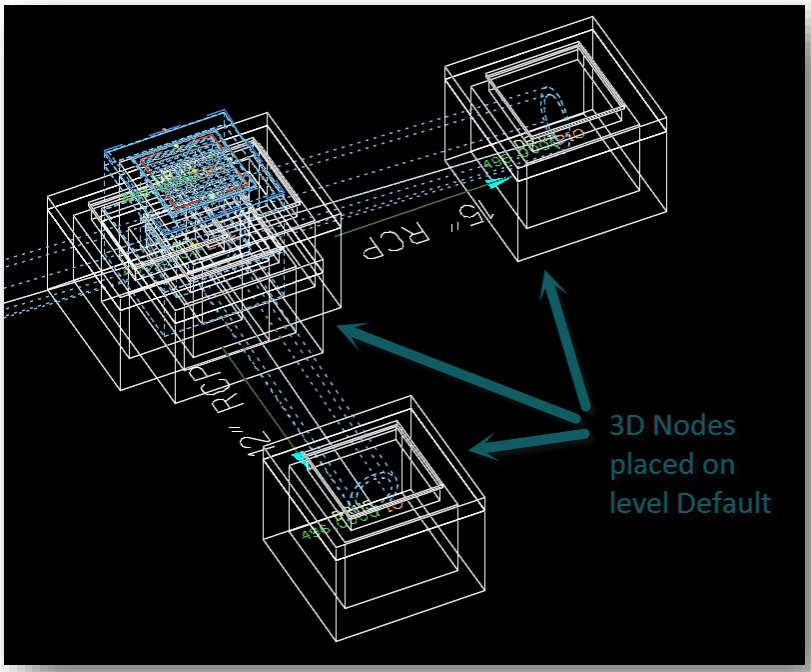
- ✓ Issue a data point to accept the **Select Method** prompt. You are prompted to **Locate Elements – Reset to Complete** for the pipe extraction process.

- ✓ Choose all of the pipe elements that are the same type and size corresponding to the **Feature Definition** and **Description** that you have selected in the *Extract Utilities from Graphics* dialog.

- ✓ After you have selected all of the desired pipe elements, issue a **Reset** to complete the selection process.

- ✓ As you step through the process, you are prompted as follows:
  - **Use 3D Element Elevations?** Select **Yes**.
  - **Create Trench**. Select **No**

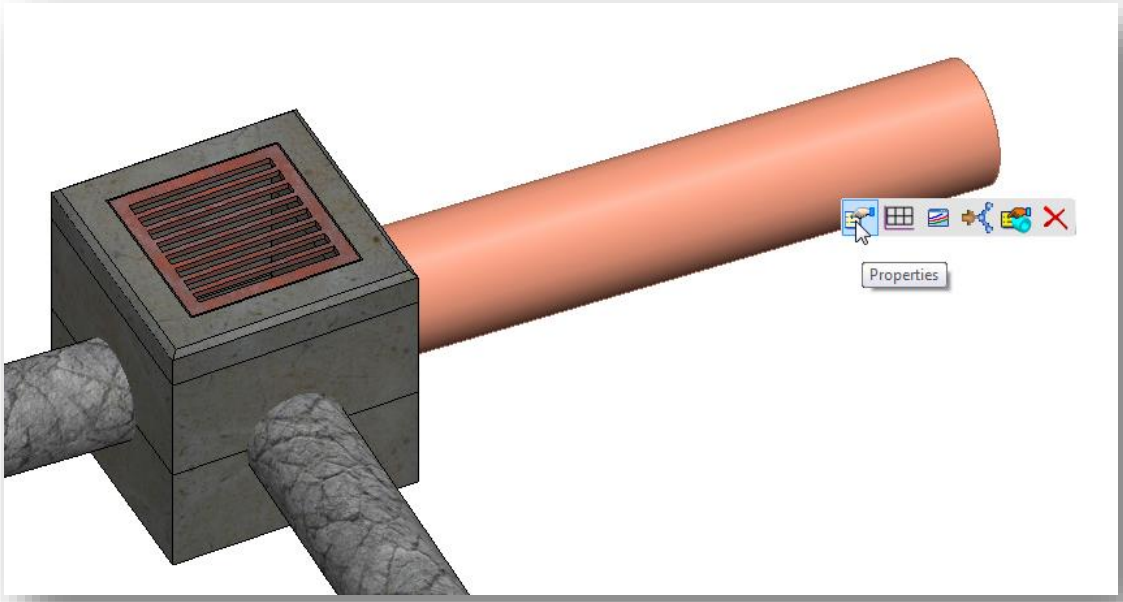
As each pipe is extracted, a 3D Node is placed on the level Default at the end of each pipe as shown below. This 3D block is required and must not be deleted. Turn off the level **Default** to turn off the display of these nodes.



As stated previously, this method is not the preferred method since new nodes are placed at the ends of the pipes.

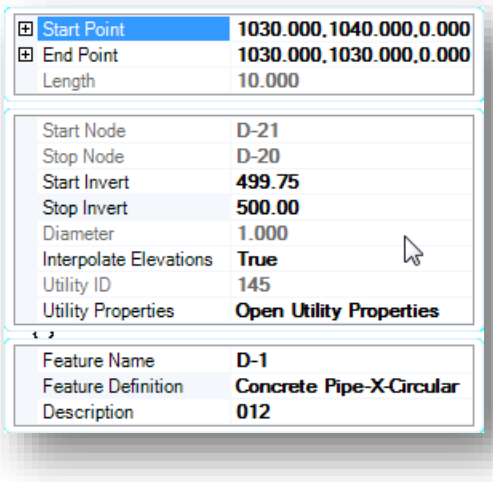
Reviewing and Editing Nodes and Links

After the nodes and links have been created, it is good practice to review the values for accuracy. The parameters of the 3D drainage information can be edited by using the MicroStation **Element Selection** tool to select a node or link, and then choosing the **Properties** icon from the pop-up menu as shown below.

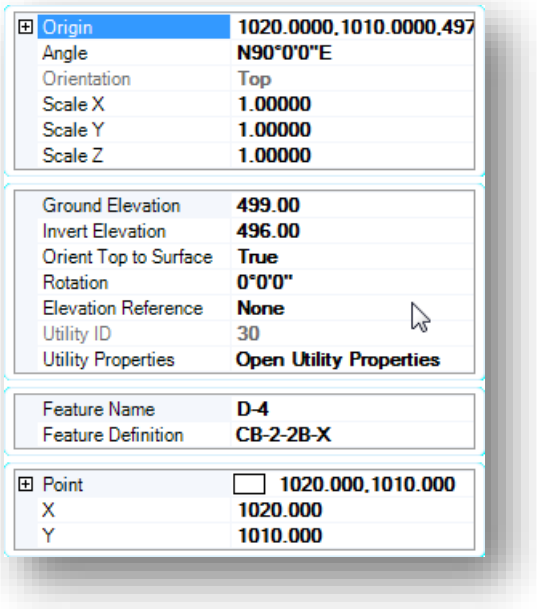


The parameters are shown below. Note that the invert values for a link cannot be edited if the link was extracted from graphics.

Link Properties



Node Properties



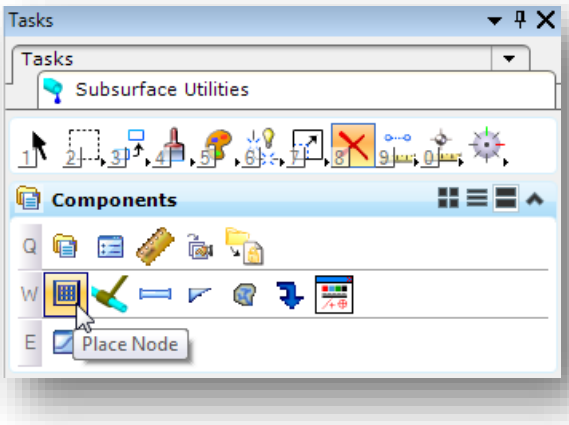
Box Culverts

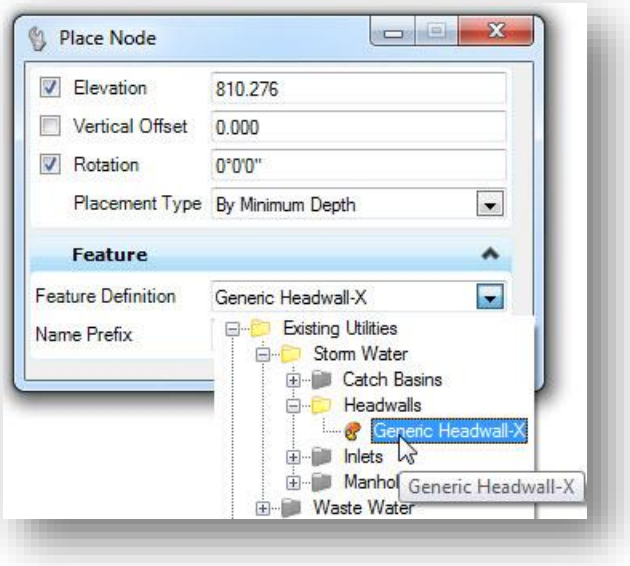
The graphics for existing storm water utilities are normally placed in a 2D model in the drainage (BD) basemap design file. The **Subsurface Utility** software is used to place the box culvert in a 2D model. The software will automatically generate the 3D model for the box culvert.

After creating a drainage basemap design file, attach the survey basemap as a reference file in order to view the culvert shots. Box culverts are surveyed using the **CULV** field code to take a shot at the invert elevation at each end of the culvert.

Box culverts are placed as a link by the **Subsurface Utility** software by use of the **Connect Conduit Between Nodes** command. A node must first be placed at each end of the proposed box culvert in the design file by use of the **Place Node** command. The generic headwall feature definition is used to defile the location of each end of the box culvert.

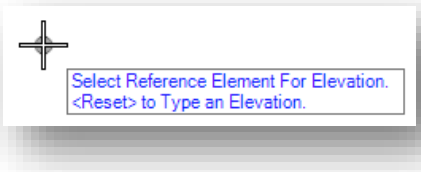
Select the **Place Node** command from the task list as shown below.





Place a node at each end of the proposed box culvert using the **Generic Headwall-X** feature definition as shown above.

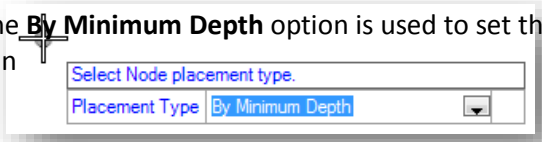
The user is prompted to select a reference element for the node elevation as shown below.



Nodes can be placed at a specific elevation, or relative to the selected surface or a corridor model. Issue a **Reset** to type an elevation.

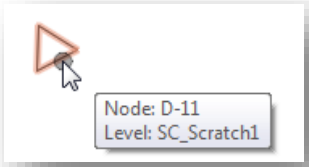
After the elevation reference is defined, the user is prompted to set the **Placement Type**.

The **By Minimum Depth** option is used to set the initial depth using a default value. The invert elevation can be edited after placement if necessary.

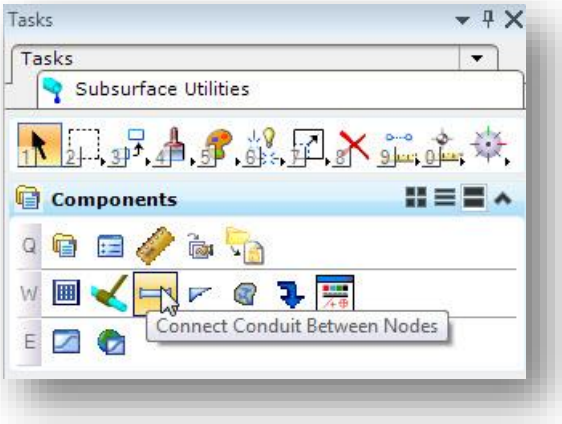


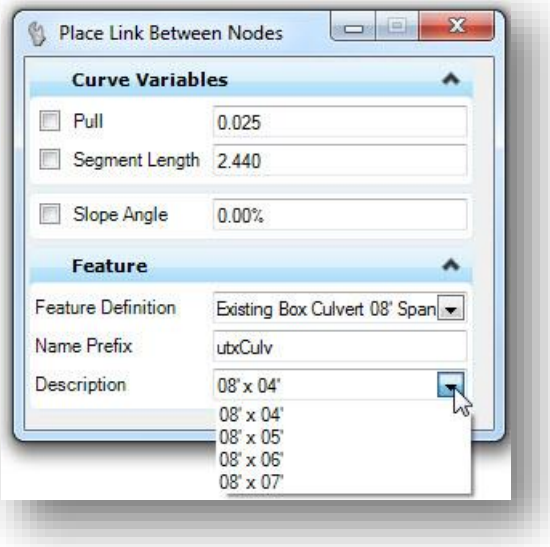
Next the user is prompted to set the location of the node. Place the node at the location of the CULV survey point.

The generic headwall node is placed using a triangle symbol on the level SC_Scratch1 as shown at right. The direction of the triangle, defined by the **Rotation** parameter, is irrelevant to the flow direction of any links connected to the node.



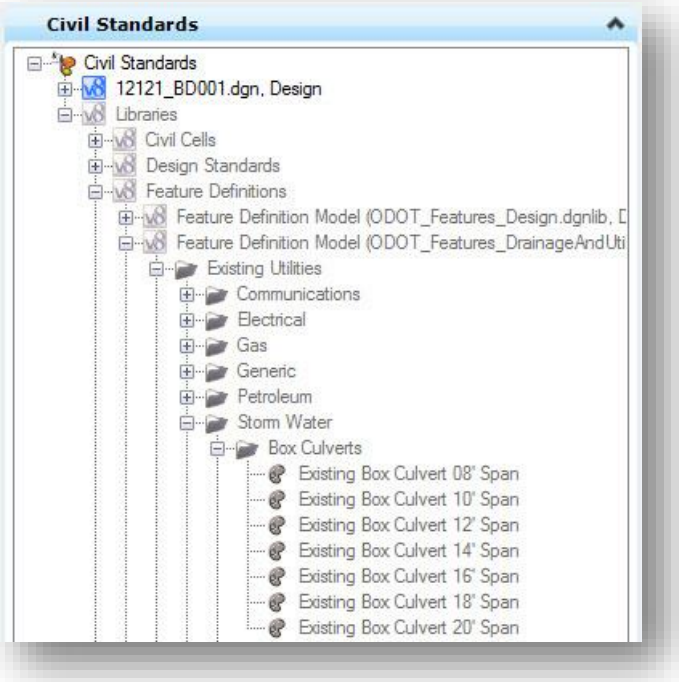
After the headwall points have been placed at each end of the culvert, the box culvert is placed using the **Connect Conduit Between Nodes** command shown below.





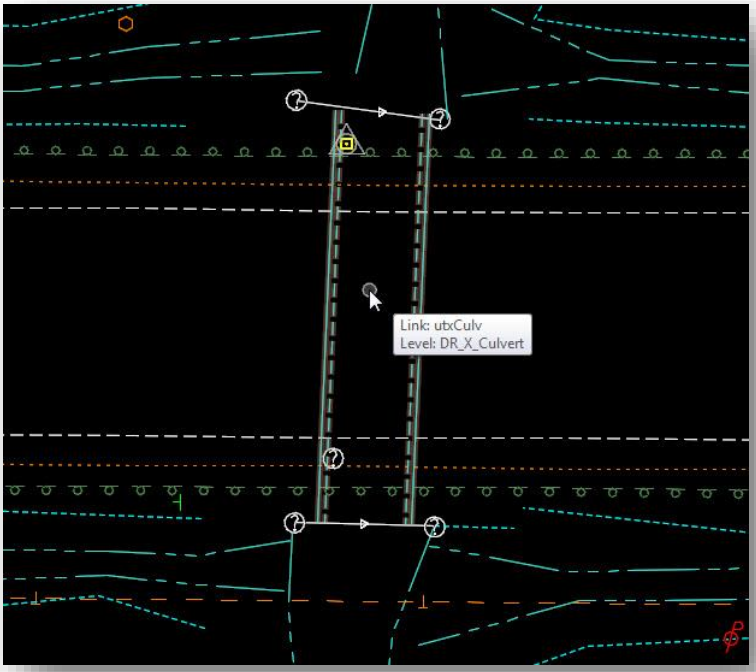
Feature definitions for existing and proposed box culverts are provided in the ODOT standards. The available features for existing box culverts are shown on the following page. The span and rise for each available culvert feature is defined by the **Description** field as shown at right above.

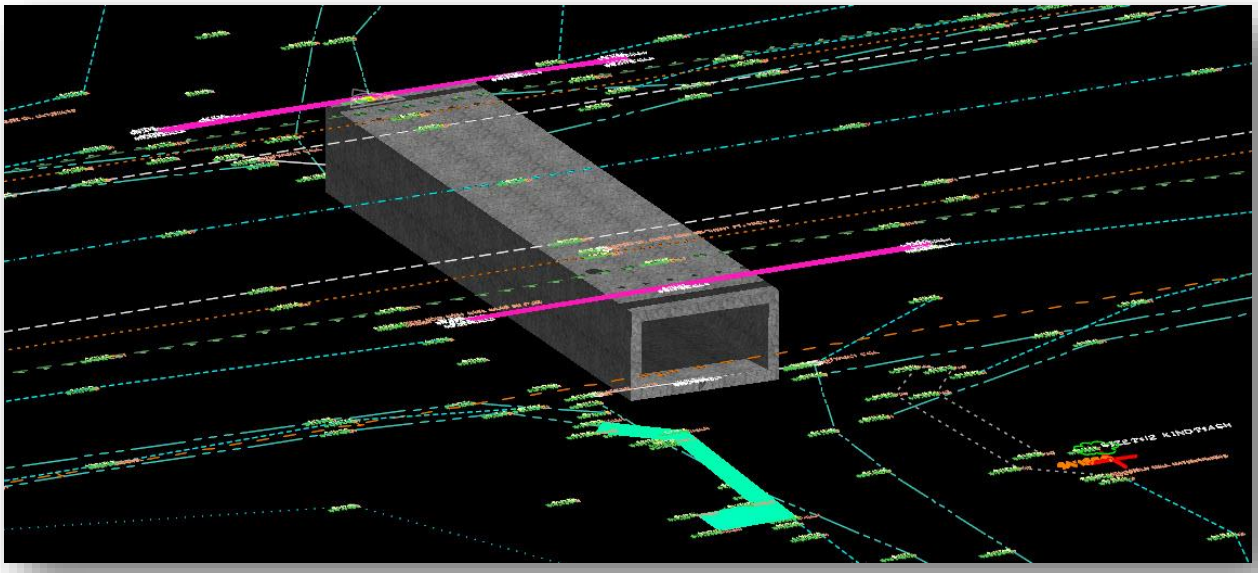
Available culvert sizes are based on the **Figure 1008-14** of the **ODOT Location and Design Manual – Volume 2, Drainage Design**.



The culvert is placed by selecting each node as shown below.

Two sets of graphics are drawn for the box culvert as shown below.



The culvert is drawn as a custom line style in the 2D model as shown at left. The 2D model can be referenced back to the survey basemap (BE file) if desired, or attached as a reference by the design personnel.

The Subsurface Utility software also creates a 3D model in the drainage basemap named “design-3d” containing the 3D model of the box culvert as shown below.