

# Using InRoads Survey for Data Reduction

*Colorado Department of Transportation*

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**CADD and Engineering Innovation**  
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**Version DRAFT**



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This manual may be freely copied or distributed for the purpose of providing the Colorado Department of Transportation and Colorado customers a consistent guide to using the Bentley suite of products to meet CDOT's design and drafting standards.

**Software Versions**

The software products referred to in this publication are furnished under a license and may only be used in accordance with the terms of such license. This document intended for use with the following software versions:

MicroStation® version 08.09.04.88  
InRoads® version 08.09.02.16  
0209 – Version 04.00 CDOT Configuration

## Document Conventions

There are several conventions that are used throughout this document to indicate actions to be taken or to highlight important information. The conventions are as follows:

<b><u>Item</u></b>	<b><u>Meaning</u></b>
<b>View Perimeter</b>	a command name or a file that you are to select
<b>Tools &gt; Options</b>	a command path that you are to select – usually from the pull-down menus
<i>Document Name</i>	the name of a document that is not hyperlinked
<i>Emphasis</i>	style used when referring to important word or phrases
<a href="#">Hyperlink</a>	style used when you have a direct link to another document on the web
<b><i>Key in</i></b>	entering data with the keyboard
<i>Quote</i>	style used to indicate an external source quotation
<b>Note:</b> text	information about a command or process that you should pay particular attention to
1. Numbered Steps	actions that you are to perform as part of the lab activities
<b>&lt;D&gt;</b> or Data	press the data button on the mouse
<b>&lt;R&gt;</b> or Reset	press the reset button on the mouse
<b>&lt;T&gt;</b> or Tentative	press the tentative button on the mouse

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# Chapter 1 - Introduction to CDOT

## An Introduction to CDOT XM Configuration

This document outlines the Colorado Department of Transportation's (CDOT) standardized CADD procedures. Topics are covered in detail and curriculum has been developed providing a foundation for CDOT users to effectively learn. The material covered is structured as a project motivated learning experience modeled after CDOT engineering workflows.

The remaining sections of this document present the reference material for each subject with supporting lab work for the student.

### **Chapter Objectives:**

- Identify the Training Directory Structure
- Where to find MicroStation XM and InRoads XM reference material
- Where to find MicroStation XM and InRoads XM lab material
- Where to look for help

## Reference Material

CDOT has developed a reference material library for the CDOT user working with the Bentley MicroStation XM and InRoads XM software.

- A Practical Guide for Using MicroStation XM
- A Practical Guide for Using InRoads XM

### **A Practical Guide for Using MicroStation XM**

This guide breaks down the use of MicroStation XM into manageable modules placing emphasis on the CDOT workflow.

- ◆ Getting Started in MicroStation
- ◆ Levels
- ◆ Working in a CDOT 3D Design Model
- ◆ Creating a CDOT Project
- ◆ Creating Your Design Graphics
- ◆ Manipulating and Modifying Design Graphics
- ◆ Cells and Patterns
- ◆ Grouping Design Graphics
- ◆ Creating Sheets
- ◆ Annotating and Plotting Sheets

### **A Practical Guide for Using InRoads XM**

This guide breaks down the use of InRoads XM into manageable modules placing emphasis on the CDOT design workflows.

- ◆ Getting Started in InRoads
- ◆ Reports
- ◆ Typical Sections
- ◆ Roadway Modeling
- ◆ Surface Editing]
- ◆ Initial Geometry Procedures
- ◆ Cross Sections
- ◆ Volumes
- ◆ Initial Surface Procedures
- ◆ Defining Vertical Geometry
- ◆ Profiles
- ◆ InRoads Options
- ◆ Hydraulics
- ◆ Creating Plan Sheets
- ◆ Surface Fundamentals
- ◆ Other Helpful Tools
- ◆ Defining Geometry

## Lab Material

CDOT has developed a lab material library for CDOT user's working with the Bentley MicroStation XM and InRoads XM software.

- Labs for Using MicroStation XM
- Labs for Using InRoads XM

### Labs for Using MicroStation XM

Labs have been created for MicroStation XM placing emphasis on the CDOT workflows.

- Getting Started In MicroStation XM
- Levels
- 3D View Controls
- Creating the Project and Design Model
- Drawing Basics using the CDOT Menu
- Draw the Median Island Nose Section
- Place Guardrail Lines
- Create 3D Utility Graphics
- Create Landscape Graphics
- Create Hydraulics Graphics
- Draw a Bridge Typical Section

- Create Plan/Profile Sheet for the Intersection
- Create a Project Specific Border
- Create a 40-Scale Plan Sheet
- Create a Bridge General Layout Sheet at Different Scales
- Create a General Notes Sheets
- Create the Standard Plans List Sheets
- Create a Title Sheet
- Annotate the Intersection Plan/Profile Sheet
- Annotate the Bridge General Layout Sheet
- Printing to a Printer
- Batch Printing to PDF

## **Labs for Using InRoads XM**

Labs have been created for MicroStation XM placing emphasis on the CDOT workflows.

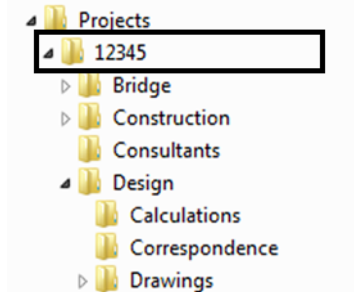
- Building Components
- Building Sections
- Modifying Templates
- Corridors & Template Drops
- Superelevation Wizard
- Point Controls, Secondary Alignments and Parametric Constraints
- Modifying Single Template Drops and Target Aliasing
- Creating Design Surfaces
- Cross Sections, Volumes and Reports
- Creating Plan Sheets

## **Training Directory Structure**

CDOT has developed a training directory structure replicating a CDOT project directory structure for use in all training. The directory has been designed so the top level (project) directory is used to designate the job project code. During training, the project code will be 12345. Sub-directories for each CDOT specialty group are included under the project directory.

## Training Directory Structure

All of the files for class are located in the **C:\Projects\12345** directory. This directory structure, as well as the file names used, conforms to the CDOT standards. More information on the CDOT directory structure and file naming convention is found in the **Creating a CDOT Project** chapter.



## How To Get Help

There are many resources available to assist you when working on your CDOT CADD project. These resources can be found on the **CDOT CADD & Engineering Innovation** website. See the **CADD Resources** chapter for detailed information on each of these options.

### **CDOT CADD & Engineering Innovation Website**

The CDOT CADD & Engineering Innovation Website is available at: <http://internal/cadd/>. It can also be found on the internet **CDOT website: Organizations > Projects Development > CADD and Engineering Innovation**.

The website provides CDOT users with up to date information, tools, and resources related to CADD.

This website is a valuable resource for CADD users and includes:

#### **CADD Library**

The **CADD Library** page provides links to manuals, newsletters, standard details, etc. One extremely useful link is to the **Tips and Tricks** section for MicroStation and InRoads.

#### **CADD Manual**

The **CDOT Computer Aided Design and Drafting (CADD) Manual** outlines CDOT's use of Bentley's MicroStation and InRoads software. It can be accessed several different ways including:

- ◆ From the Windows Start menu  
(**Start > All Programs > \_CDOT\_CADD\_Information > V09.08.XX-XM > Workflows**)
- ◆ From the CDOT Menu (**CDOT Help > Workflows**)

#### **Request & Support**

This page provides CADD help solutions where you can help, submit questions and requests, and obtain InRoads Survey and MicroStation support.

There is also a link to **IT Services** for hardware support, “how to” instructions, installation, training files, and dual monitor and work space setup.

## **CADD & Engineering Processes**

The CDOT CADD & Engineering Processes Website is available at: <http://www.dot.state.co.us/DesignSupport/CADD%20and%20Engineering%20Innovation/CADD%20Index.htm>. The website provides CDOT consultants with the latest MicroStation/InRoads configurations, CADD Workflows, manuals, training materials, resources, CADD detail library, CDOT Standards and Design Guides, and more.



### **Manuals, Training Materials, and Resources**

#### **CDOT CADD Manual**

#### **Training Materials**

##### **MicroStation 2004**

[CDOT MicroStation Essentials](#)

##### **MicroStation XM**

[Migrating CDOT Projects & MicroStation XM Update Guide](#)

##### **Redline**

[CDOT Redline Essentials](#)

##### **InRoads 2004**

[Roadway Design Using InRoads](#)

[InRoads Geometry Fundamentals](#)

[Advanced Roadway Modeling](#)

##### **InRoads XM**

[A Practical Guide for Using InRoads XM \(Draft Copy\)](#)

##### **InRoads ROW/Survey**

[InRoads Geometry for ROW and Row Plan Development Using MicroStation \(Document 1 of 2\)](#)

[InRoads Geometry for ROW and Row Plan Development Using MicroStation \(Document 2 of 2\)](#)

[InRoads Survey Date Reduction](#)

#### **ProjectWise XM**

[CDOT ProjectWise User Guide](#)

#### **CADD Training Curriculum**

[MicroStation Essentials](#)

[Traffic Workflow Using MicroStation](#)

[Roadway Design Using InRoads](#)

[InRoads Geometry Fundamentals](#)

[InRoads Geometry for ROW and ROW Plan Development Using MicroStation](#)

[InRoads Survey Data Reduction](#)

[Advance Roadway Modeling](#)

[Redline Essentials](#)

## **CADD Manager**

Contact the CDOT CADD Manager at [CADDManager@dot.state.co.us](mailto:CADDManager@dot.state.co.us) for additional help or questions.

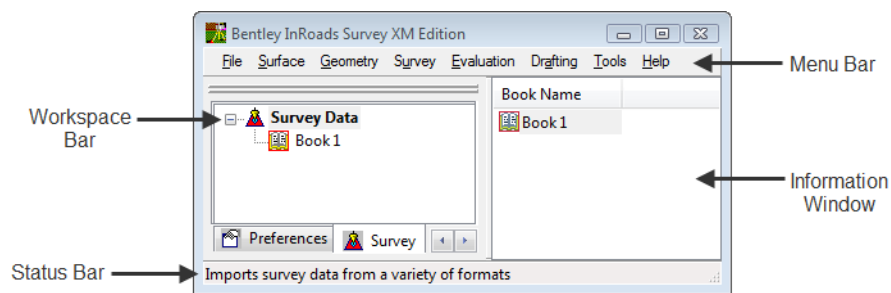


# Chapter 2 - Getting Started with InRoads Survey

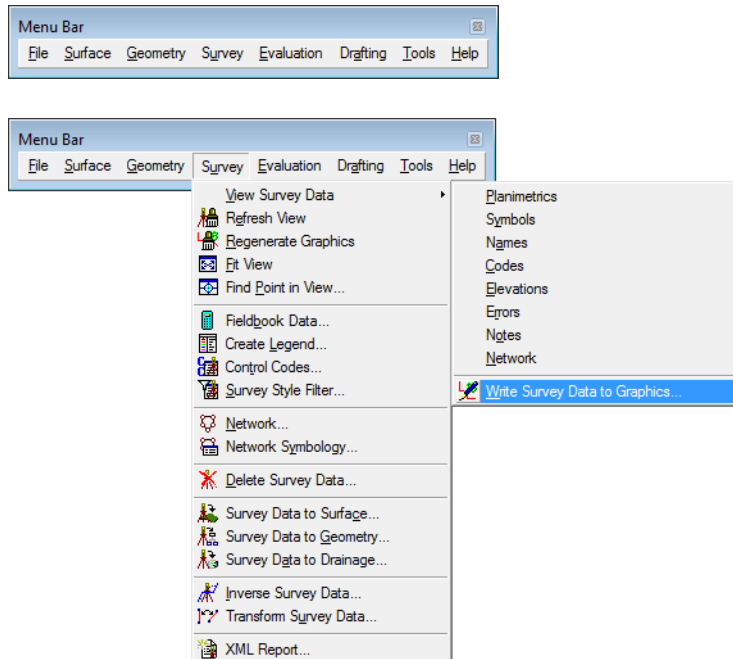
## InRoads Survey Interface

Remember, InRoads Survey is running on top of MicroStation. That means the InRoads interface can be moved outside the MicroStation environment to another screen and that the InRoads interface may hide MicroStation dialog boxes.

There are four main parts to the InRoads Survey Interface, the **Menu Bar**, **Workspace Bar**, **Information Window** and **Status Bar**.

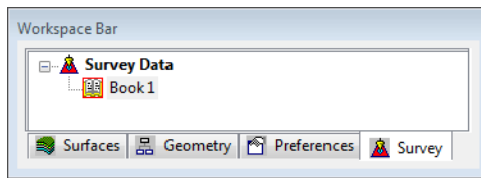


## Menu Bar



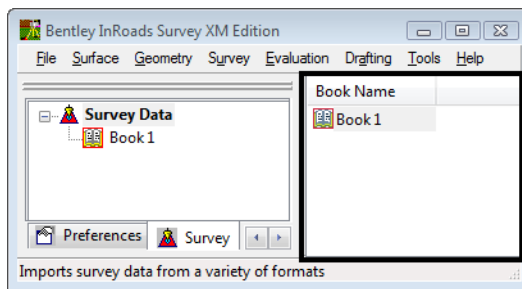
- The Menu Bar pull-down menus are used to access commands, settings, and toolbars.
- An arrow > in the pull down will expand to a submenu.
- ... In the pull down will open a dialog by that name.
- The pull-down menus will vary with the application add-ins that are loaded.

## Workspace Bar



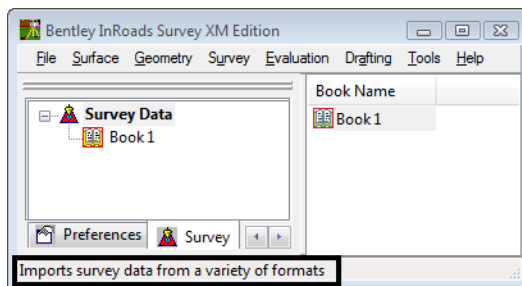
- The Workspace Bar is used to manage and separate the different file formats of the program.
- Right clicking is allowed in the Workspace Bar. The active shortcut menu will vary depending on which Tab is selected.
- The Workspace Bar can be undocked as shown here but it is not recommended.
- To switch between tabs use the scroll arrows or right click to open a short cut menu.

## Information Window



- The Information Window varies depending on which Workspace Bar tab is selected.
- Right clicking is allowed in the Information Window. The active shortcut menu will vary depending on what feature was selected.

## Status Bar



- Located in the lower left hand corner of the InRoads Survey Interface, the status bar is used for file processing feedback and tool descriptions.



## Project Defaults

Setting project defaults prior to working on any project will save time navigating to directories and will ensure the correct InRoads resources are loaded.

## Dialog Items

- Configuration Name – Select from the drop down to change the current project directories and resources.
- Default Preferences

In this section the user enters specific file names with extension names (types) InRoads will be using. The different file types and their uses are as follows:

- ◆ Preferences (\*.xin) – The main file used to define the symbology and dialog preferences.
- ◆ \*Turnouts (\*.txt) – File used to define turnouts.
- ◆ \*Drainage Structures (\*.dat) – File used by Storm and Sanitary software.
- ◆ \*Rainfall Data (\*.idf) (\*.rtc) - File used to calculate rainfall.
- ◆ \*Bridge Sections (\*.txt) - File used to define bridge sections.
- ◆ \*Drafting Notes (\*.dft) – File used by InRoads drafting tools.
- ◆ \*Pay Items (\*.mdb) – File used to calculate pay items and quantities.

- Default Directory Paths.

This section defines directory paths for loading and saving files inside InRoads.

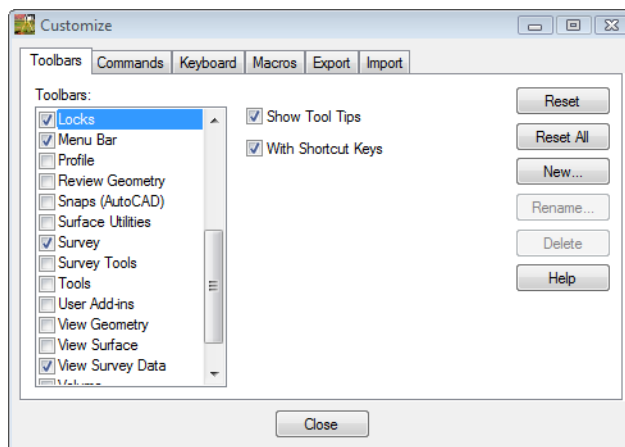
- ◆ Project Default Directory: - default location for opening, saving, importing, and exporting general files.
- ◆ Report Directory - default location where report files such as TXT and XML are generated by the report browser.
- ◆ Projects (\*.rwk) – default location of Project’s files.
- ◆ Surfaces (\*.dtm) – default location of Surface files.
- ◆ Geometry Projects (\*.alg) – default location of Geometry Project files.
- ◆ \*Template Libraries (\*.itl) – default location of Typical Sections Library files.
- ◆ \*Roadway Design (\*.ird) – default location of Roadway Library files.
- ◆ Survey Data (\*.fwd) – default location of Survey Data files.
- ◆ \*Drainage (\*.sdb) – default location of Drainage files.
- ◆ Sheet Style (\*.xsl) – default location of Sheet Style files for XML reports.
- ◆ \*Quantity Manager (\*.mdb) – default location of Quantity Manager Files.

\* Files and directories that do not impact survey applications.

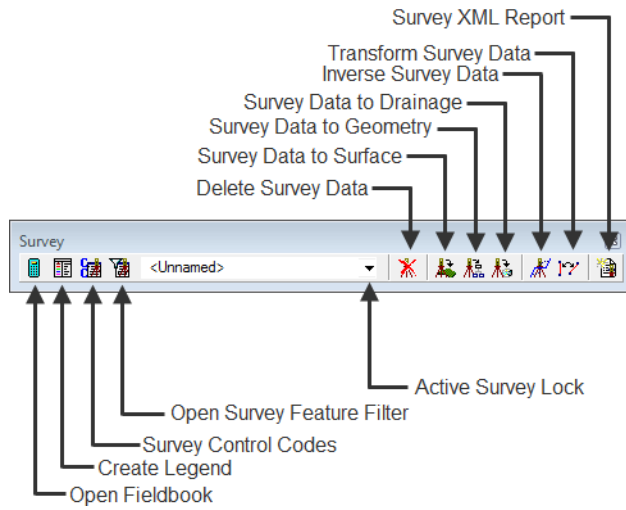
## Toolbars

Toolbars can be opened and docked in the InRoads interface. Toolbars in InRoads Survey can be customized to fit the users workflow or personal preference.

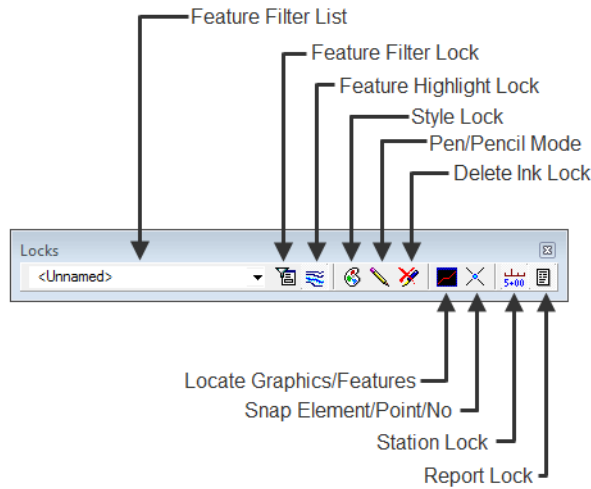
- From the pull-down menu, select **Tools > Customize**. The **Customize** dialog will appear.



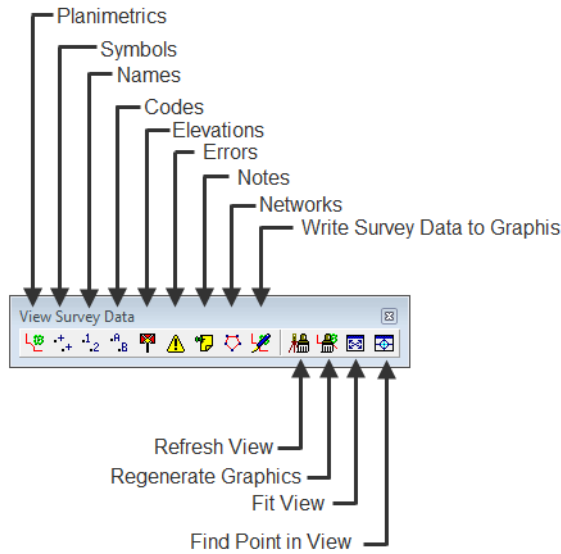
### Survey Toolbar



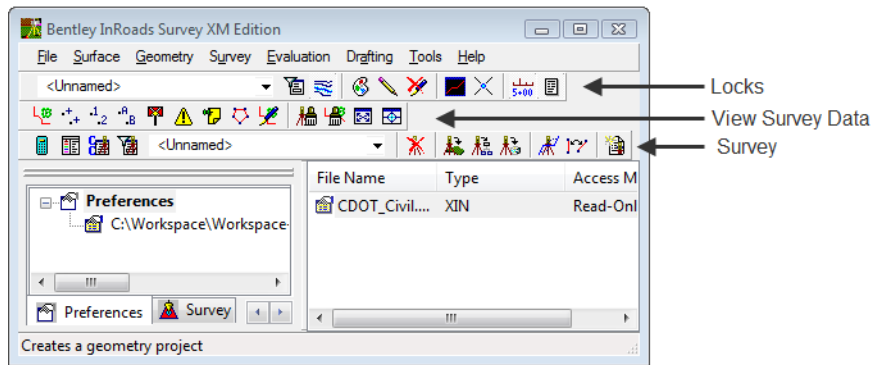
### View Survey Data Toolbar



### Locks Toolbar



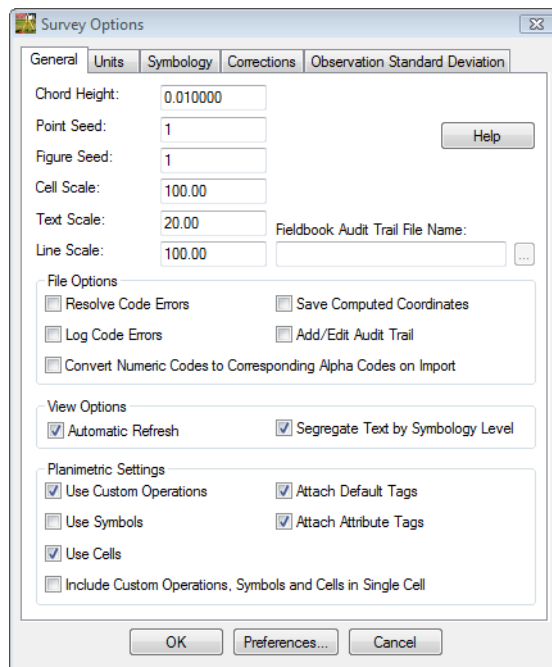
### Docked Toolbars



## Survey Options - General Tab

Survey Options dialog controls additional settings required by Survey. The Survey options can be modified by the user and are stored as an FXP file. Some of the main aspects of this dialog are the control of planimetric scale and the Fieldbook Audit Trail file which tracks changes to the fieldbook and features table.

- From the pull-down menu, select **Tools > Survey Options [General]**.



### Dialog Items

- ◆ **Chord Height:** Controls the curve stroking of elements when saved to graphics, surfaces, and alignments. The smaller the value, the greater number of vertices generated.
- ◆ **Point Seed:** Seed number used when adding points to the survey fieldbook.
- ◆ **Figure Seed:** Seed number used when saving linear planimetrics to a geometry project.
- ◆ **Cell Scale:** Scale factor used when writing survey feature Cells to graphics.
- ◆ **Text Scale:** Scale factor used when writing survey feature Text to graphics.
- ◆ **Line Scale:** Scale factor used when writing survey feature Line Styles to graphics.
- ◆ **Fieldbook Audit Trail File Name:** Text file that saves all edits from the fieldbook and feature table. The file will show the edits Before and After.

**◆ File Options**

- **Resolve Code Errors** – If checked, all code errors found while importing will be taken care of by the **Resolve Code Error** dialog.
- **Log Code Errors** – Will open the **Results** dialog at the end of the import allowing the errors to be saved to a text file.
- **Save Computed Coordinates** – If checked, any computed coordinates will be saved to the fieldbook as individual points.
- **Add/Edit Audit Trail** – If checked, displays the **Results** dialog after each edit is made. Even with it unchecked the file will still keep track of edits.
- **Convert Numeric Codes to Corresponding Alpha Codes on Import** - If checked the numeric codes used in the field will be converted to alpha codes in the fieldbook.

**◆ View Options**

- **Automatic Refresh** – If checked, will regenerate the displayed graphics after each edit.
- **Segregate Text by Feature Level** – If checked, will save the symbols, point names, codes, notes, errors, and elevations to the same level as the survey feature.

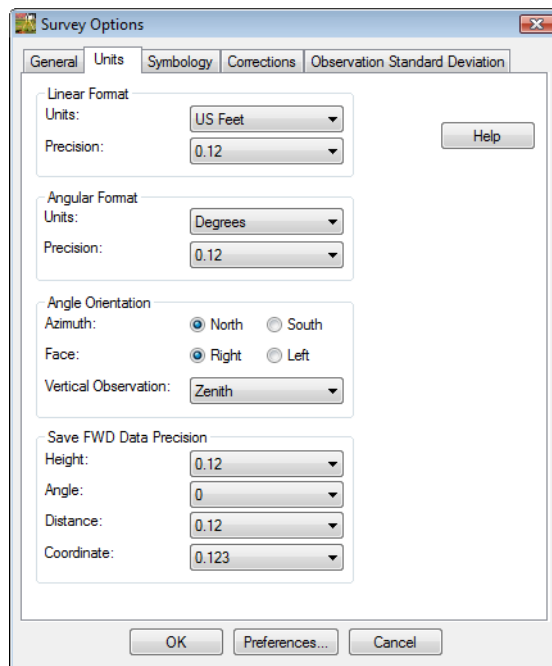
**◆ Planimetric Settings**

- **Use Custom Operations** – If checked, all Custom Operations from the Survey Feature Table will be displayed.
- **Use Symbols** – If checked, all symbols from the Survey Feature table will be displayed.
- **Use Cells** – If checked, all Cells from the Survey Feature table will be displayed.
- **Include Custom Operations, Symbols and Cells in Single Cell** – If checked, all items will be combined into a single cell called NULL.
- **Attach Default Tags** – If checked, a default InRoads tag will be defined and attached to the MicroStation graphic when written to a design file.
- **Attach Attribute Tags** – If checked, a tag, with attribute information and values will be attached to the MicroStation graphic when written to a design file.

## Survey Options - Units Tab

Survey Options *Units* tab controls how raw, linear, and angular, survey data is read by the Fieldbook. The Survey units set in this dialog box have priority over InRoads units options set elsewhere when processing or manipulating Survey data.

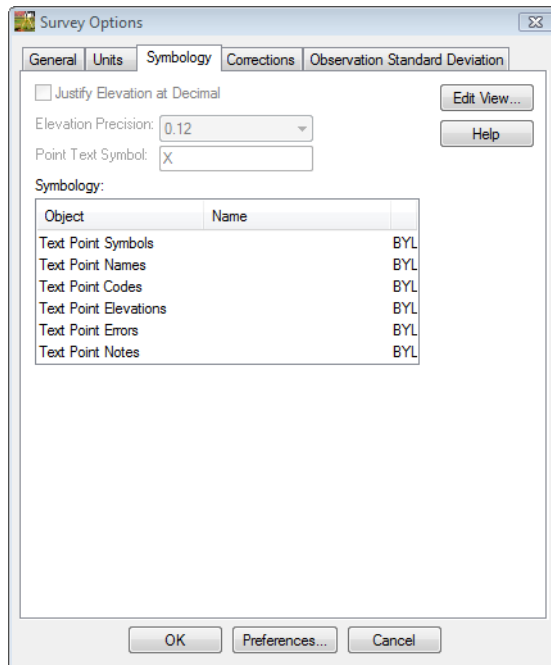
- From the pull-down menu, select **Tools > Survey Options > [Units]**.



## Survey Options - Symbology Tab

Survey Options *Symbology* tab controls view planimetrics such as Symbols, Point Names, Codes, Elevations, Errors, and Notes. There are two types of settings for each planimetric display. For the dynamic display of graphics the settings are opened with the **Edit View** button. For the design graphics written to the file the settings are opened with the **Edit** button.

- From the pull-down menu, select **Tools > Survey Options > (Symbology)**



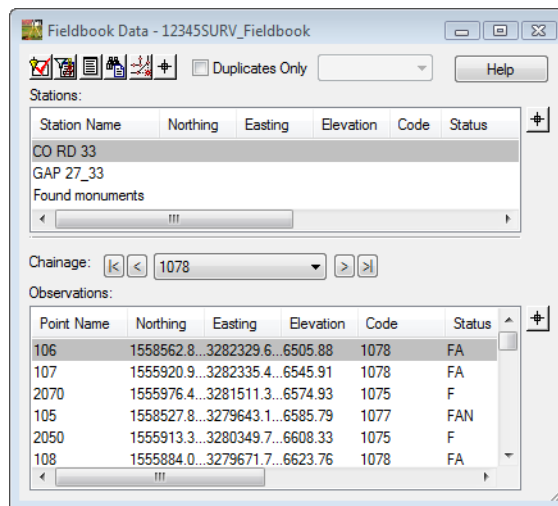


# Chapter 3 - Working with InRoads Survey – Overview


## Fieldbook Data dialog

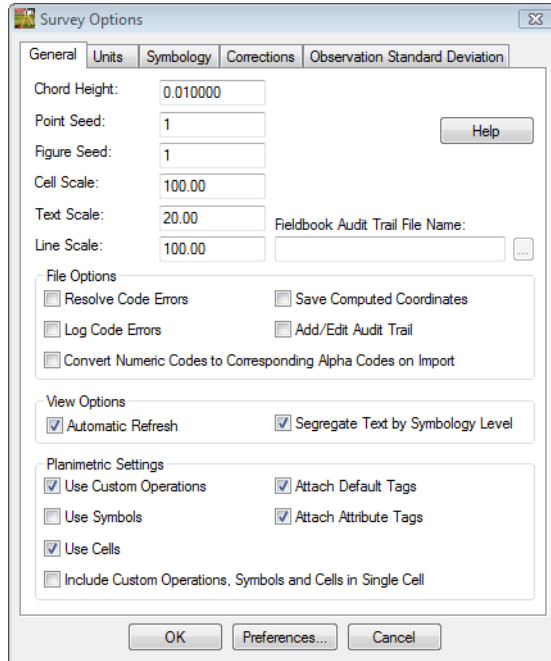
The **Fieldbook Data** dialog in InRoads Survey allows the user to manage survey data. In addition to viewing the station and observations, the dialog allows editing and adding points to the fieldbook.


- From the pull-down menu, select **Survey > Fieldbook Data...**

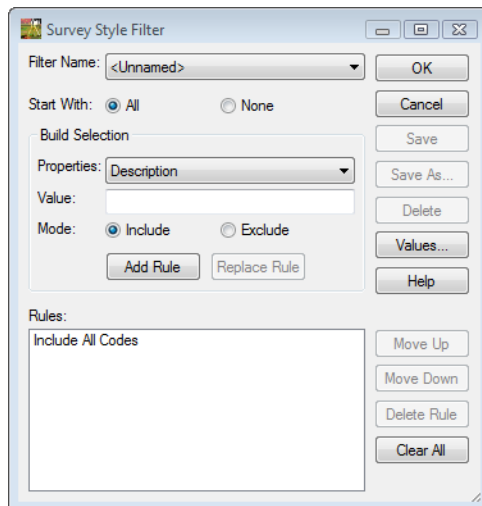


## Dialog Items

- ◆  **Survey Options** - opens the **Survey Options** dialog box.



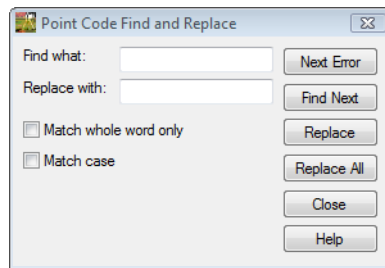
- ◆  **Survey Style Filter** - opens the **Survey Style Filter** dialog box.





- ◆  **Report** - opens the **Save** dialog box to generate a report.

**Note:** The report is generated based on what stations/observations are selected prior to clicking the report button. To generate a report on the entire fieldbook select all the Stations in the fieldbook then click the **Report** button.

- ◆  **Find/Replace Codes** - opens the **Point Code Find and Replace** dialog box.



- ◆  **Select Figure** – will only locate the nearest planimetric feature or chainage. The fieldbook will highlight the start of the chainage.
- ◆  **Insert Parallel Point** - will add an additional point to a chain based on an existing reference chain.
- ◆ **Duplicates** – filters only duplicate points found in the Stations or Observations. To view duplicate points select it from the drop down box.

## Duplicate Points General Rules:

### **Rule # 1**

If a Point Name is duplicated in a Station Setup then the two points are averaged.

Station 764

Observation 2000

Observation 2000

Observation 2001

Observation 2002

### **Rule #2**

If a Point Name is duplicated in two different Station Setups the points are not averaged and each point is used.

Station 764

Observation 2000

Observation 2001


Observation 2002

Station 766

Observation 2000

Observation 3001

Observation 3002

**Note:** For more information on how duplicate points are handled in InRoads Survey select the Help  button.

## Stations

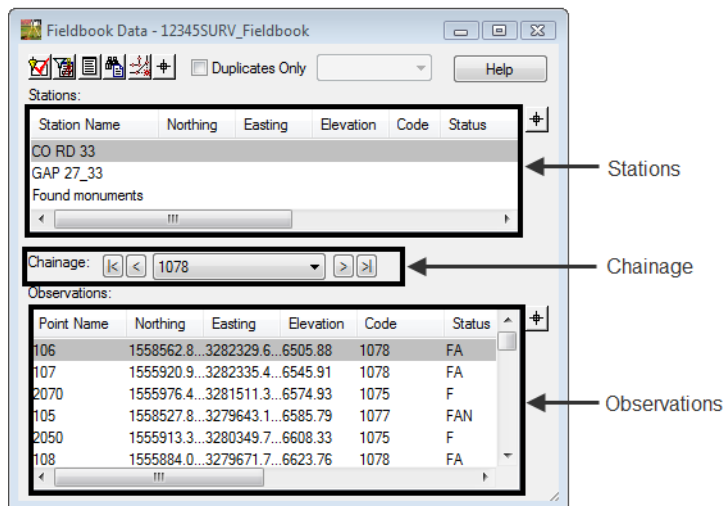
The top half of the dialog is the Stations or Instrument setup point.

## Chainage

Chainage commands are a useful way to locate displayed planimetric features. Use the buttons **First** [K], **Previous** [←], **Next** [→], and **Last** [J] to conveniently follow a chain.

## Observations

The bottom half of the dialog is the Observations or topo shots from the corresponding instrument setup.

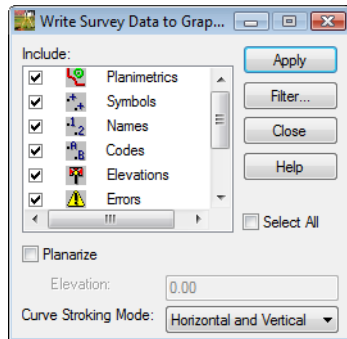














# Chapter 4 - Exporting the Fieldbook – Overview

## Write Survey Data to Graphics dialog

Writing Survey data to graphics creates the MicroStation design file (DGN) basemap. Once the file has been saved to a MicroStation design file there no longer is a link between the InRoads Survey fieldbook and MicroStation graphics. If there are changes that need to be made to the graphics, modify the InRoads Survey fieldbook and then re-export the graphics.



### Dialog Items:

-  **Planimetrics** – if checked Planimetrics such as lines, chorded arcs, and cells will be saved to the design file
-  **Symbols** – if checked a tic mark representing the location of the shot will be saved to the design file.
-  **Names** – if checked the point name of the shot will be saved to the design file.
-  **Codes** - if checked the point feature code of the shot will be saved to the design file.
-  **Elevations** – if checked the point elevation of the shot will be saved to the design file.
-  **Errors** – if checked any errors in the fieldbook will be saved to the design file.
-  **Notes** – if checked any notes in the fieldbook will be saved to the design file.
-  **Network** – if checked any traverse legs will be saved to the design file.
-  **Apply** – will save the checked items to the design file
-  **Filter**- will allow the user to include or exclude any feature codes by a set of rules. Only the feature codes that pass through the filter will be saved to the design file.

**Note:** The symbology for Symbols, Points, Elevations, Notes, Errors, and Codes is controlled in the Survey Options dialog.

### Planarize

- **Elevation** – if checked all points will place at a defined elevation.

## Curve Stroking Modes

Curves generated from Survey are chorded arcs based on the Chord Height distance in the **Survey Options** dialog. MicroStation will generate a number of small line segments to represent the arc. There are three settings for generating arcs in 2D and 3D graphics.

- **Horizontal and Vertical**

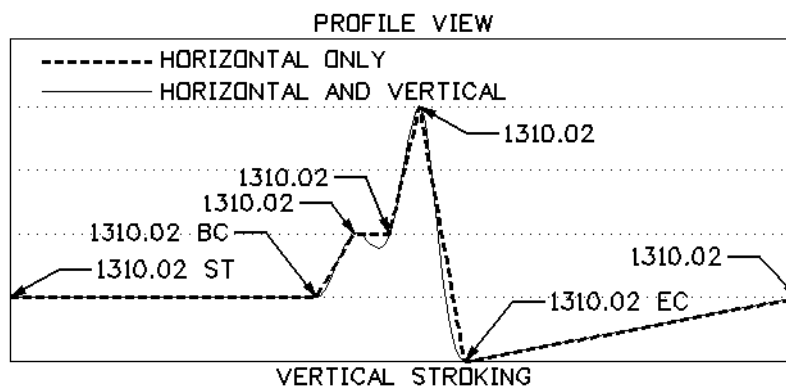
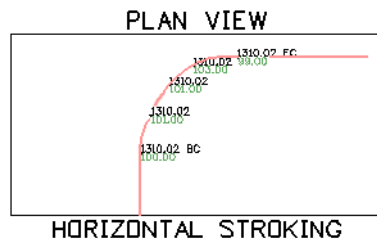
The curve is created by multipoint splines in the x, y, and z directions. In extreme variations in elevations unwanted sag or crest of a curve may occur.

- **Horizontal Only**

The curve is created by multipoint splines only in the x and y directions. The elevations or z values of the points are interpolated linearly between points.

- **Do Not Stroke**

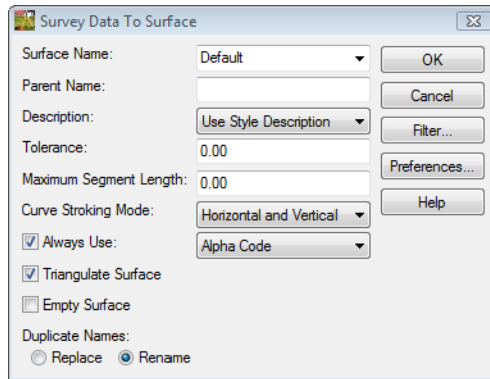
The curve is not created. It will be represented as linear elements between points.





## Survey Data to Surface dialog

Writing Survey data to surface creates the Digital Terrain Model (DTM). Each feature is triangulated based on the Point type set in the Survey Feature Style. The intelligence built in to the feature comes from the Feature Style setting in the Survey leaf of the Feature Style dialog.



### Dialog Items:

- **Surface Name**

Key-in field to create a new empty surface for export from survey. If a surface has already been created, choose it from the dropdown arrow.
- **Description**

Each feature in the DTM will be unique. When the feature is pushed to the DTM it will use one of the following options from the Feature table for the description.

  - ◆ **Use Feature Definition**
  - ◆ **Use Attributes**
  - ◆ **Use Codes**
- **Tolerance**

Tolerance will set the minimum distance between points. If there are any points closer than the minimum, the points will be dropped from the surface. If the value is set to 0 then tolerance is ignored and all points will be used in the surface.
- **Maximum Segment Length**

Maximum Segment Length defines the point density of an element. If points were taken every 100 feet and the segment length was set to 25 feet then the result would be three additional points along the feature that would be used in the triangulation.

### **Curve Stroking Mode**

Curve Stroking Mode defines a curve horizontally and vertically. Curves in InRoads are defined by short line segments from the Survey Options dialog Chord Height.

- **Horizontal and Vertical**

The curve is created by multipoint splines in the x, y, and z directions. If extreme variations in elevations exist, unwanted sag or crest of a curve may occur.

- **Horizontal Only**

The curve is created by multipoint splines only in the x and y directions. The elevations or z values of the points are interpolated linearly between points.

- **Do Not Stroke**

The curve is not created. It will be represented as linear elements between points.

### **Always Use:**

Defines what each feature style name will be in the surface. CDOT has defined a Style for each survey feature that corresponds to an InRoads Feature Style. By default if it is unchecked the feature style will be assigned in the following order.

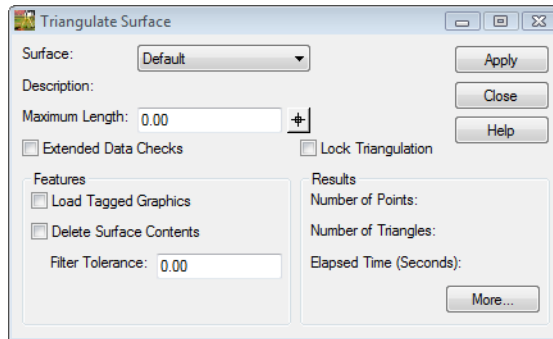
- **Style** – Preference Style name defined in the feature table.
- **Alpha Code**
- **Numeric Code**

### **Triangulate Surface**

If checked the Triangulate Surface dialog will appear after the surface has been exported.

## Triangulate Surface dialog

This dialog will appear when triangulate surface in the **Survey to Surface** dialog is checked. Exporting Survey data to Surface without triangulating it will result with the data being pushed to the surface, but the triangle network will not exist yet.



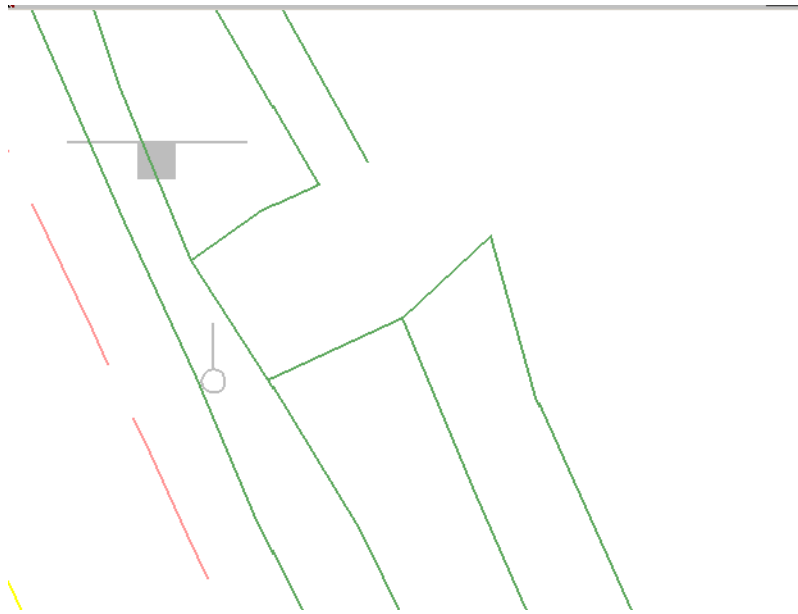
### Dialog items:

- **Surface** – drop down box shows the active surface by default, other surfaces selectable from the drop down.
- **Extended Data Checks** - checks DTM integrity (during triangulation) as to crossing breaklines and miss-matched elevations.
- **Maximum Length** - maximum length of any one triangle segment (leg) can span during the triangulation process. If set to 0, triangle legs can extend to any length. Used to constrain triangulation to prevent unnecessary ‘surface’ data.
  - ◆ **Target button** – define a Maximum Length distance by picking two points in a MicroStation view.
- **Load Tagged Graphics** – scans the design file for any InRoads tagged data and loads the elements into the surface.
- **Delete Surface Contents** – empties the surface prior to adding any tagged elements.
- **Results** – readout of triangulation outcome.
- **More...** **More** – opens the **Surface Properties** dialog.

## Multiple Feature coding and the DTM

- Rule #1 Multicoded linear features to be triangulated

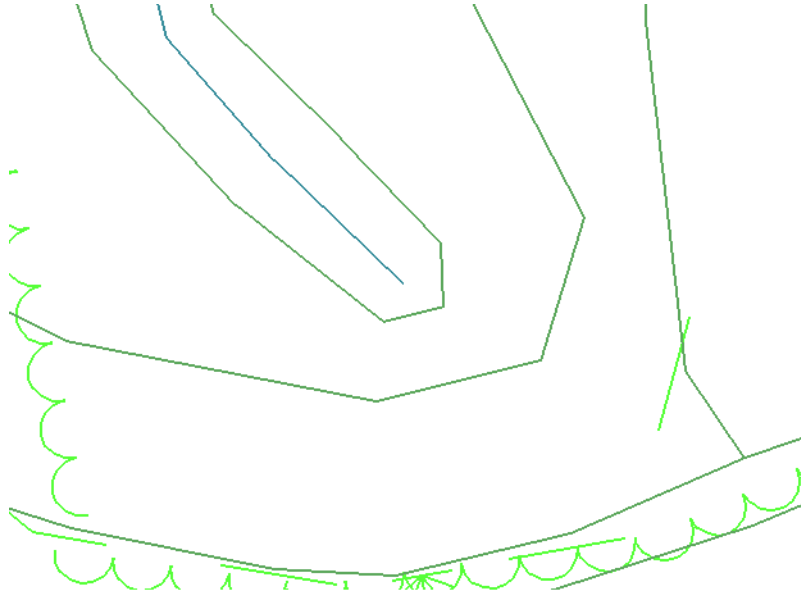
Survey linear features that are also DTM point type breaklines will be moved to the Surface. When duplicate points are triangulated, one will be dropped and will create a shared triangulation point.



- Rule #2 Multicoded linear features with random points to be triangulated

Survey linear features and random points will be moved to the Surface. However, when duplicate points are triangulated the breakline will override and the random point will be dropped entirely from the surface.

The only way to keep this from happening is to exclude the random point from triangulation with a control code “X”. This will allow the feature to remain part of the surface.



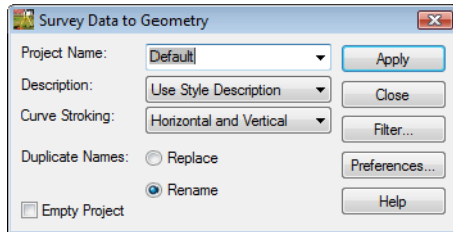
- Rule #3 Multicoded linear features excluded from triangulation with random points to be triangulated

Survey linear features that are excluded from triangulation and random point types will be moved to the Surface. When duplicate points are triangulated the linear feature will remain and the random point will be used for triangulation.



## Survey Data to Geometry dialog

Saving Survey Data to Geometry creates a Geometry Project (ALG) which can contain multiple horizontal and vertical alignments from any planimetric linear feature. Any single point such as property corners or trees will also be saved to the same Geometry Project and placed into the Cogo buffer.



### Dialog Items:

- ***Project Name***

Key-in field to create a new empty Geometry Project for export from survey. If a Geometry Project has already been created, choose it from the drop down arrow.

- ***Description***

Each alignment in the Geometry Project will be unique. When the alignment is pushed to the Geometry Project it will use one of the following options from the Feature table for its description.

- ◆ **Use Feature Definition**
- ◆ **Use Attributes**
- ◆ **Use Codes**

### Curve Stroking

Curve Stroking mode defines a curve horizontally and vertically. Curves in InRoads Survey are defined by short line segments from the Survey Options dialog Chord Height. If a simple curve is collected in the field when the curve is exported to an alignment the curve data is calculated and stored as a curve. The curve will most likely be shown as noncollinear.

- ***Horizontal and Vertical***

The curve is created by multipoint splines in the x, y, and z directions. In extreme variations in elevations unwanted sag or crest of a curve may occur.

- ***Horizontal Only***

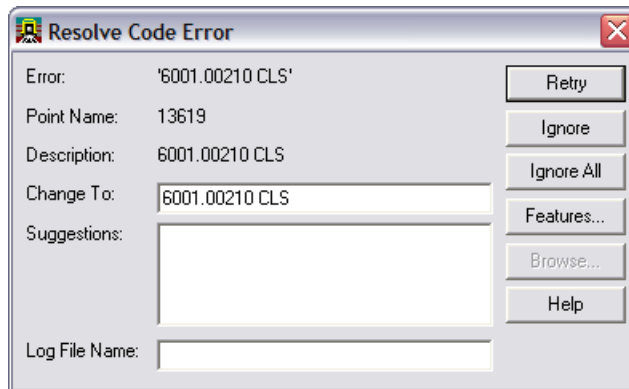
The curve is created by multipoint splines only in the x and y directions. The elevations or z values of the points are interpolated linearly between points.

- ***Do Not Stroke***




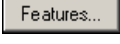
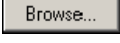
The curve is not created. It will be represented as linear elements between points

# Chapter 5 - Importing Data

## Resolving Code Error dialog



### Dialog Items:

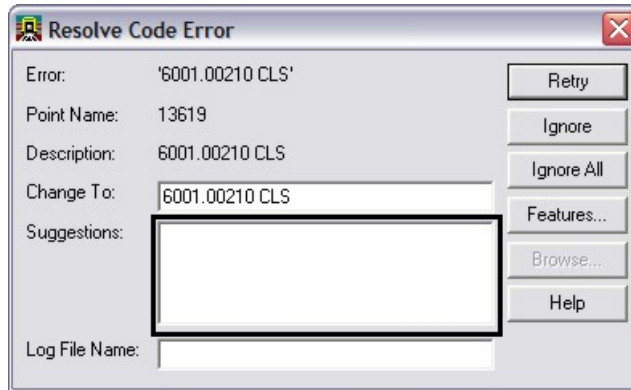
- Change To – field used to type the new correct feature code
- Suggestions – pick list of codes that nearly matches. Only available when using Alpha feature codes.
- Log File Name – specifies a text file name and directory that can save out the code errors that are found.
-  Retry – rechecks the Change To field to make sure the updated code is correct.
-  Ignore – the current code that has an error will be ignored during import.
-  Ignore All – all codes that have errors will be ignored and will be added to the fieldbook.
-  Features... – opens the Feature Table dialog.
-  Browse... – opens the Save As dialog. The Browse button only becomes active when the Log File Name field is selected.

## Resolving Code Errors options

### Suggestions

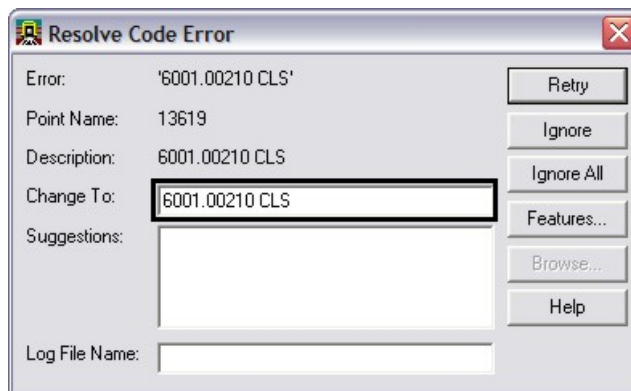
- Choose one of the Suggestions: to change the code.

- <D> the Retry button. The code will be corrected and processed. The dialog will then move on to the next code error. Continue correcting code errors until complete.



## Manually Correct

- Key in the correct code in the Change To: field.
- <D> the Retry button. The code will be corrected and processed. The dialog will then move on to the next code error. Continue correcting code errors until complete.

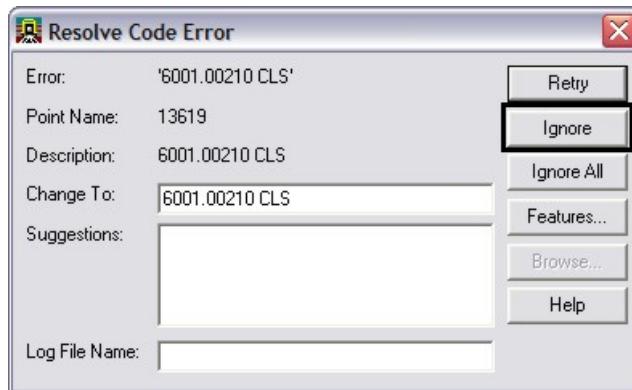


## Ignore

- When unsure of the correct code <D> the Ignore button.
- The code will be ignored. The dialog will then move on to the next code error. Continue ignoring code errors until complete.

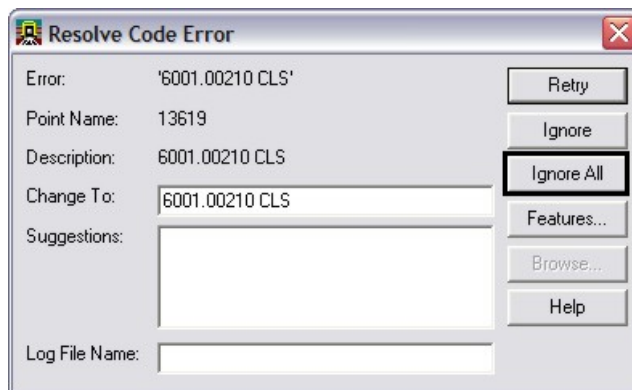


- The Results dialog will appear showing what codes still have errors. This report can be saved as a text file to the project directory or dismissed.

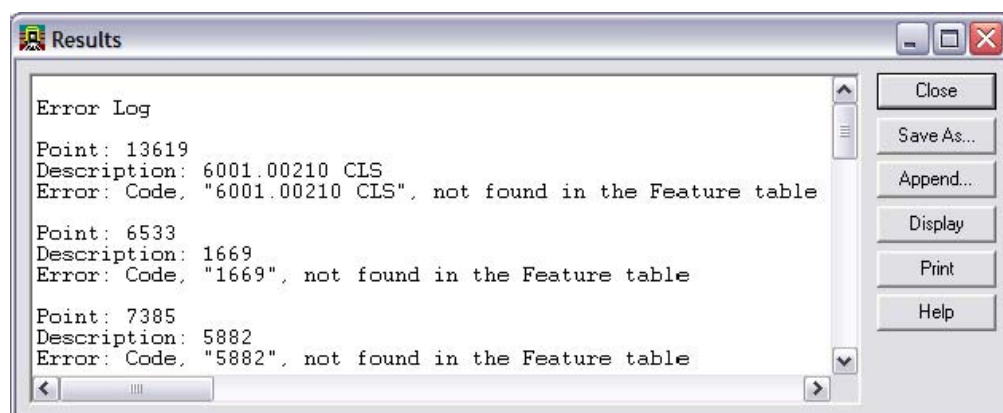


## Ignore All

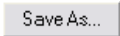
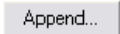
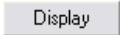

- When unsure of all the correct codes <D> the Ignore All button.
- All codes will be ignored. The Resolve Code Error dialog will then close.
- The Results dialog will appear showing what codes still have errors. This report can be saved as a text file to the project directory or dismissed.



## Saving Error Results



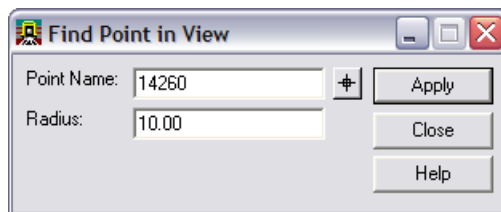
**Dialog items:**


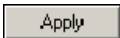
- ◆  Save As – opens the Save As dialog. This will create a text file that can be opened in Notepad.
- ◆  Append – opens the Append dialog allowing the user to add additional errors to the end of an existing file.
- ◆  Display – will write the text to graphics. The text will be displayed using the active text style.
- ◆  Print – opens the Print Setup dialog. The file will be printed and will not save the file to disk.

## Finding Points in a MicroStation View

Find point in View command will locate a specified point in the active fieldbook and center the point in the active MicroStation view.

- From the pull-down menu, select Survey > Find Point in View...

**Dialog items:**

- Point Name – key-in field to enter point numbers.
- Radius – view ratio around the specified point.
-  Target button – select point from the MicroStation view
-  Apply – executes the locate and centers the point to the view

# Chapter 6 - Feature Codes and Control Codes

The Feature Styles defined for Survey control how a feature is displayed in the design file, written to a DTM, or exported to Geometry.

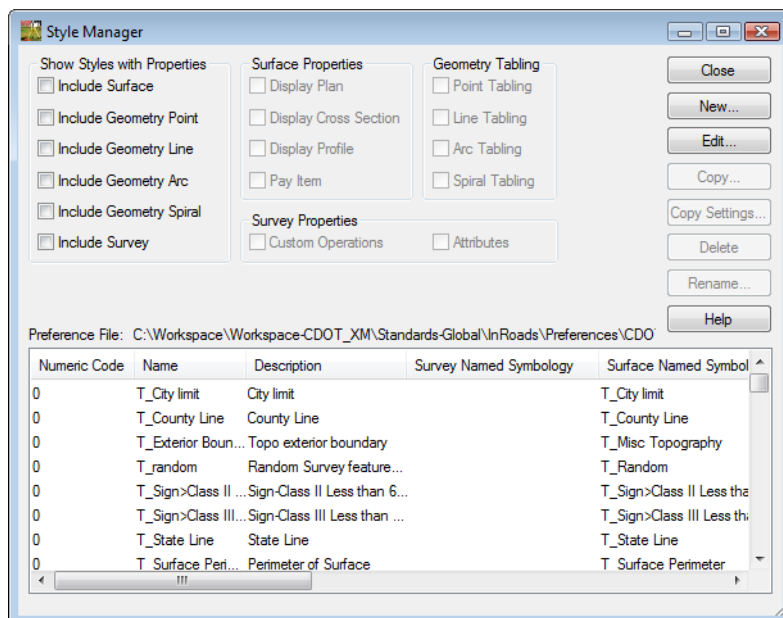
There are two main types of graphic displays: lines and cells. Additionally, there are a few codes that place text through the use of Custom Operations. The Styles definition also controls, through the association with a Named Symbology, the symbology for the graphics such as level, color, style, and weight.

Extensive effort has been made to ensure the correct symbology is defined in the Feature Style. Changes to Feature Styles will be made only by the CDOT CADD Manager. Any suggested changes should be submitted to the CADD Manager as all of CDOT's InRoads configuration is stored in the standard delivered CDOT\_Civil.xin file.

## Style Manager dialog

The Style Manager dialog controls how each surveyed feature is displayed graphically. Each feature can be displayed as Lines, Cells, Text, or Symbols. The feature definitions have been standardized by CDOT and should only be modified by the CADD manager.

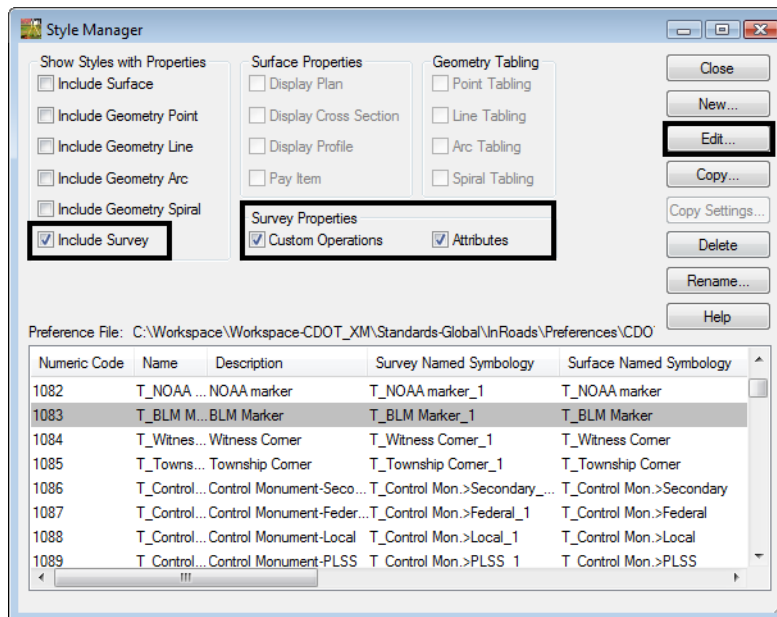
From the pull-down menu, select **Tools > Style Manager...**



## Feature Styles

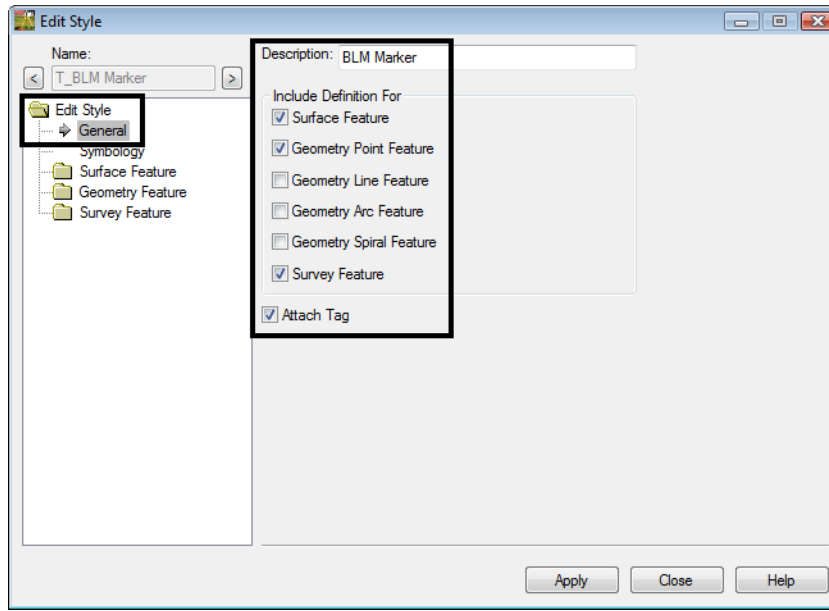
### Dialog Filtering:

- Toggle on **'Include Survey'** to filter the dialog to show only features configured specifically for data collection.
- Additional toggles for styles that have attributes defined for *Custom Operations* and *Attributes* further refines the list of displayed styles.



### Feature Editing:

From the list of Features, <D> a specific Feature and select **Edit** on the *Style Manager* dialog to open the *Edit Style* dialog. The *Edit Style* dialog controls the attributes for each available *Feature* in the CDOT configuration including survey coding for field collection and processing.

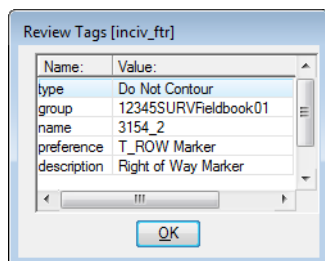


- **Graphic Attributes**

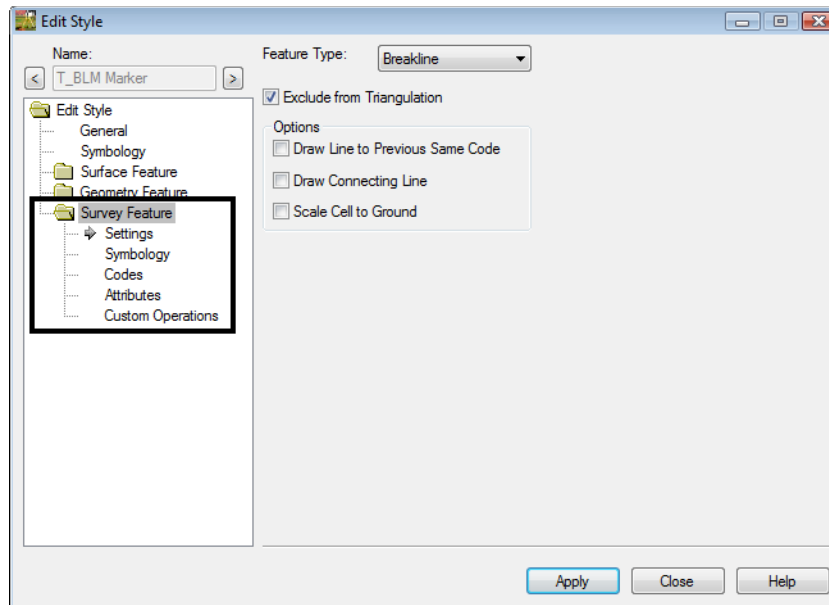
An InRoads Survey Fieldbook can be written to 3 different deliverables. These are; Planimetrics (CAD file), to a Surface (DTM), and to Geometry project (ALG). For each of these outputs unique graphic attributes can be associated during the export. Each definition corresponds to a Named Symbology in the CDOT\_Civil.xin file. This will be covered later in this chapter.

- **Attach Tag**

Attaches a MicroStation tag value to the feature when written to the design value, such as DTM type, Point name, Preference, and Description. To review attached tags use the Review Tags button from the Main toolbar in MicroStation.



Detailed information about survey features can be viewed by expanding the *Survey Feature* leaf.



### **Edit Style dialog**

- **Name:**  
The selected *Style*.
- **Feature Type**
  - ◆ **Random**  
*Regular* or *spot* elevations. These points do not have a direct relationship with adjoining points other than a linear interpolation. For example: high or low elevations, topography shots such as trees, valves, signs, etc.
  - ◆ **Breakline**  
Breaklines are comprised of linear features where a change in grade may occur. For example: curb lines, a roadway crown, edge of pavement, ditches, ridges, toe of slope, etc. A breakline must contain at least 2 points and will restrict triangulation from crossing.
  - ◆ **Interior**  
Interior boundaries are comprised of a closed shape. They define obscure areas (voids) in a surface model. Triangulation does not occur inside interior boundaries thereby eliminating any contouring, surface modeling, or volume computations within said interior feature. Multiple interior boundaries can exist in a surface model.  
  
For Example: Bodies of water, building pads, areas not surveyed, etc.
  - ◆ **Exterior**  
By definition, an exterior boundary must be a closed shape. It defines the limits of the data InRoads can work with. Only one exterior boundary can exist in a surface model. For example: limits of survey data or limits of slope intercepts for a new design.

◆ **Exclude from Triangulation**

These shots will collect the X,Y, and Z position of the feature but when it comes time for InRoads to triangulate the DTM these points will be left out of the surface model. Think of underground utilities or a shot on the top nut of a hydrant. If these shots were part of the triangulation there would be incorrect valleys and spikes in the DTM. However these points are stored in the DTM for other purposes such as profile or cross section display.

◆ **Draw Line to Previous Same Code**

Controls planimetric line work for the specific feature. This option is used in conjunction with the control code **ST**.

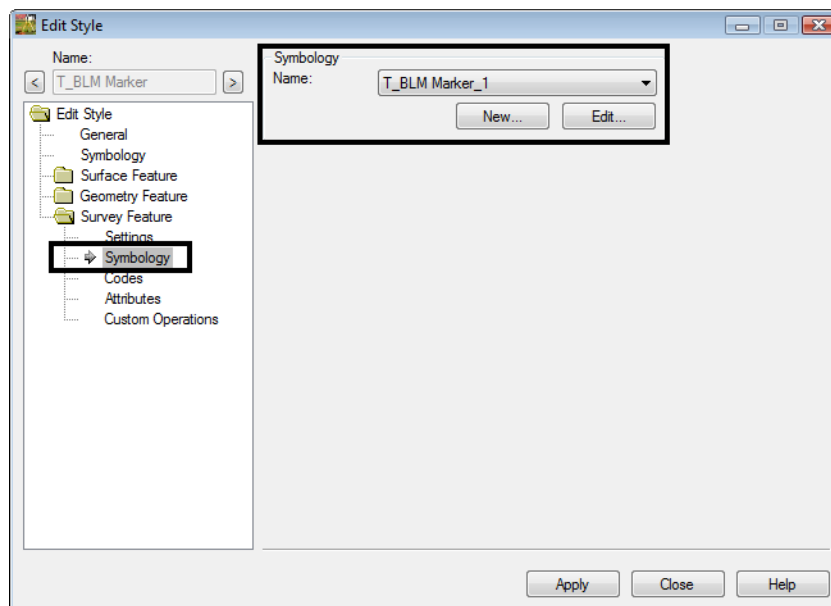
◆ **Draw Connecting Line**

Controls planimetric line work for the specific feature. This option is used in conjunction with the control codes **JPT**, **JNC**, and – (dash).

◆ **Scale Cell to Ground**

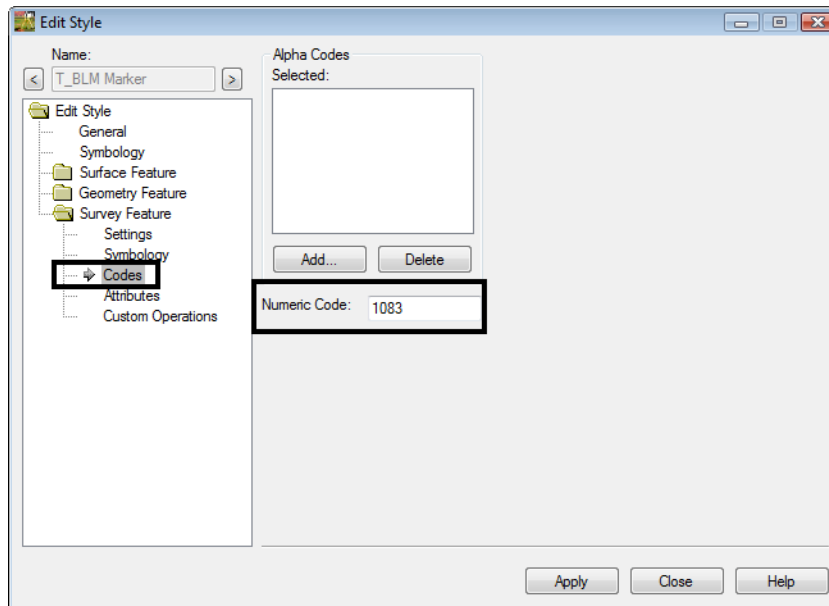
Overrides all scale factors and uses a scale factor of 1 for cell placement

• *Symbology leaf*



- ◆ Defines the *Named Symbology* associated with the Style which in-turn defines graphic attributes for Plan line, text, and point symbology (cell) when writing the field book to a CAD file as planimetrics.

- **Codes leaf**



- ◆ **Alpha Code**

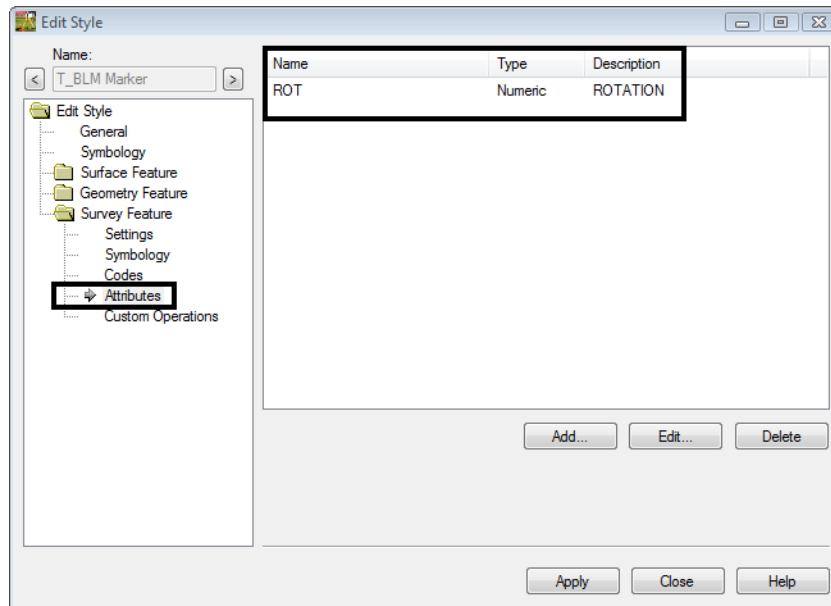
Alpha codes are used as an additional way to collect the survey data in the field. Alpha feature codes are not to be used as part of the CDOT collection process.

- ◆ **Numeric Code**

Associates a unique numeric code with the Feature Style.



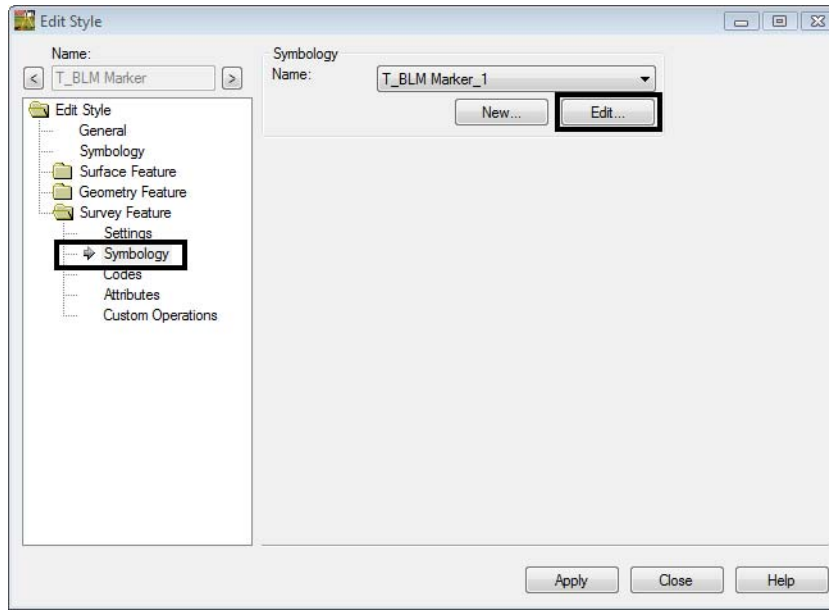
- **Attributes leaf**



- ◆ Attributes are used to help further define or control survey features collected in the field. Attributes can be collected as numeric or alpha data. As an example, additional information such as size, flow, and silt levels in a culvert pipe can be added to a single shot taken in the field. Any survey shots taken in the field without attributes defined will display an 'A' in the status column of the electronic fieldbook. If a value is defined, a 'V' will display in the fieldbook.
- **Custom Operations leaf**
  - ◆ Custom operations can be thought of as a script file or a list of commands that are run on a certain survey feature. It can be used to control graphic types, symbology, text, placement, and also perform math functions. MicroStation and InRoads key-ins are used to enter commands strings. To view examples of custom operations <D> the **Help** button.

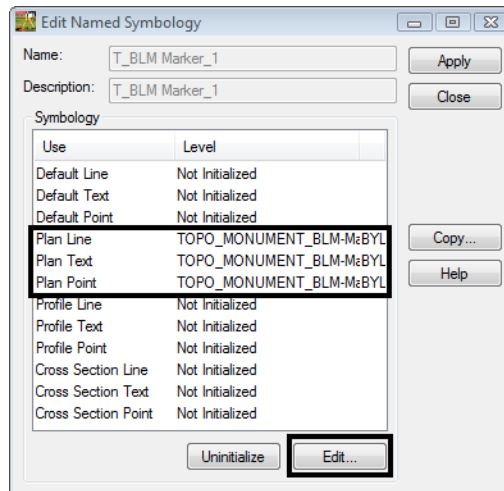
- **Graphic Attributes**

As mentioned previously, an InRoads Survey Fieldbook can be written to 3 different deliverables. These are: Planimetrics (CAD file), to a Surface (DTM), and to Geometry project (ALG). For each of these outputs unique graphic attributes can be associated during the export. This style corresponds to a Named Symbology in the CDOT\_Civil.xin file.



## Edit Style dialog

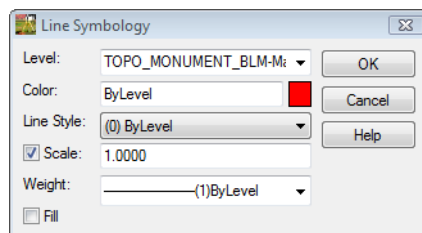
Selecting the **Edit** button in the symbology portion of the Edit Style dialog opens the identified Named Symbology.



Identifying a specific attribute and selecting **Edit** opens additional detailed information on how the graphics will be written as linework, text, or cell to the CAD file.

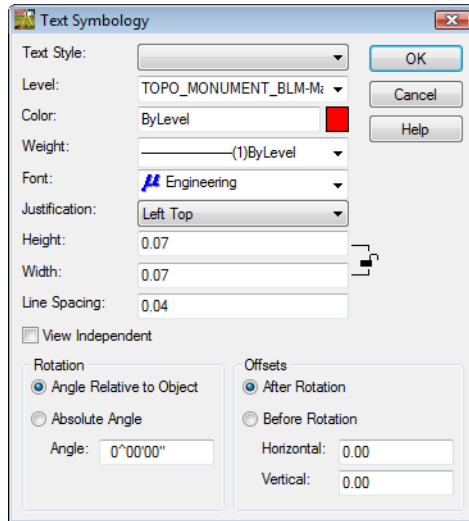
- **Line Symbology**

Controls the Level, Color, Style, and weight of lines or arcs for individual features written to graphics.



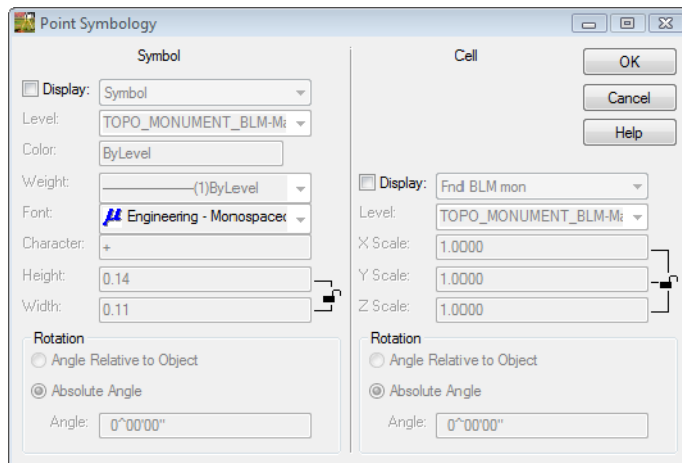
- **Text Symbology**

Controls the symbology, text size, and font for any text displayed with through the use of custom operations.



- **Point Symbology**

Controls the symbology, text size, and font for any text displayed with through the use of custom operations.

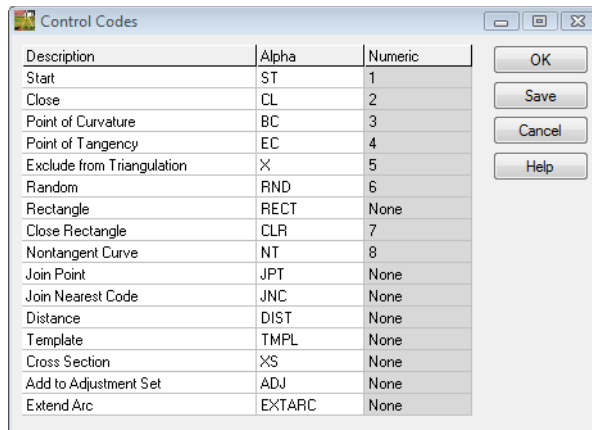


**Note:** The radio buttons for both Symbol and Cell display is disabled for all survey items represented by cells in the CDOT configuration. The placement of these is accomplished through the use of *Custom Operations* so field-collected attributes such as rotation can be applied at time of cell placement.

A symbol is a custom font character, similar to a True Type Font Wingdings. Symbols can be used in addition to any cells being placed. CDOT does not currently use any Symbols.

## Control Codes

Control Codes are also stored in the CDOT\_Civil.xin file. To access these select **Survey > Control Codes**. Control codes are used in conjunction with CDOT's *Numeric feature codes*. By using control codes the surveyor can define such items as the beginning of strings, points of tangency, offset shots as well as other shot modifiers. Control codes can be either alpha (upper or lower case) or numeric characters and are input following the feature code. Each code has an example below.



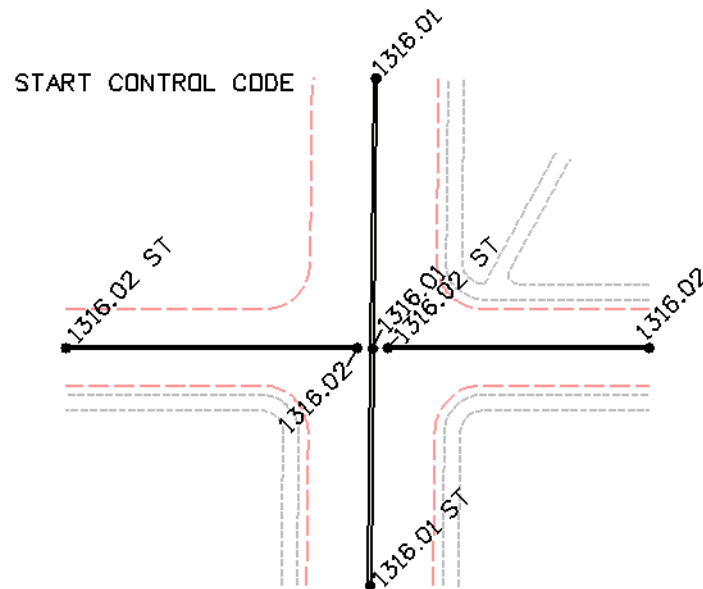
Description	Alpha	Numeric
Start	ST	1
Close	CL	2
Point of Curvature	BC	3
Point of Tangency	EC	4
Exclude from Triangulation	X	5
Random	RND	6
Rectangle	RECT	None
Close Rectangle	CLR	7
Nontangent Curve	NT	8
Join Point	JPT	None
Join Nearest Code	JNC	None
Distance	DIST	None
Template	TMPL	None
Cross Section	XS	None
Add to Adjustment Set	ADJ	None
Extend Arc	EXTARC	None



- Start

Alpha *ST* | Numeric *I*

Control Code *Start* begins planimetric lines; there is no code to end a string. InRoads Survey will continue a string until no further data is collected using that code and string identifier. If the same code and string identifier is entered using the ST control code, the previous string will be terminated and a new string begun. See the example below for feature code 1316.02 (feature.string# ST)

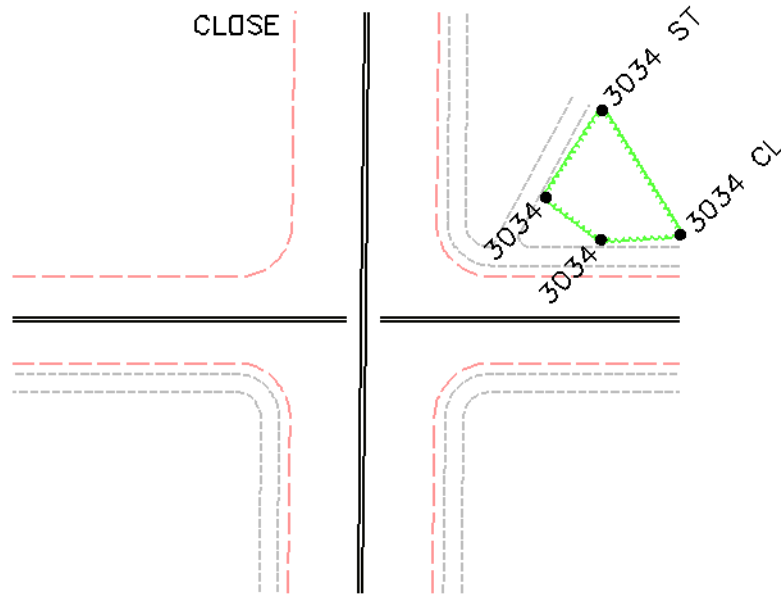


**Note:** It is not mandatory that string identifiers be used. This is only necessary if you wish to collect data using identical feature codes and need to develop multiple strings simultaneously. Examples of this may be when surveying in a crisscross fashion and wish to collect multiple 1310 (edge of oil) strings. If surveying in a linear fashion (collecting the entire length of the physical feature) a code such as 1310 st could be used and reused when moving from one pavement edge to another

- Close

Alpha *CL* | Numeric *2*

Control Code Close will create a closed shape from the last shot to the first shot of the feature. Closed shapes in InRoads can be used as Interior or Exterior DTM point types. Closed shapes in MicroStation will become linestrings.



**Note:** Only a survey feature with a point type Breakline will honor the Close control code when it is pushed to a surface.



- Point of Curvature

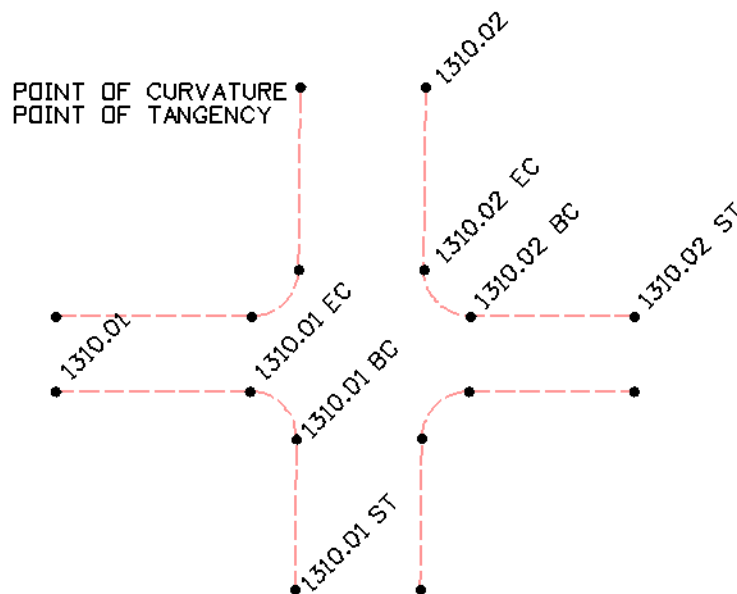
Alpha **BC** | Numeric **3**

Control code Point of Curvature identifies the beginning of the curve. The incoming tangent of the curve controls the degree of curve.

- Point of Tangency

Alpha **EC** | Numeric **4**

Control code Point of Tangency identifies the end of the curve. The outgoing tangent of the curve controls the degree of curve



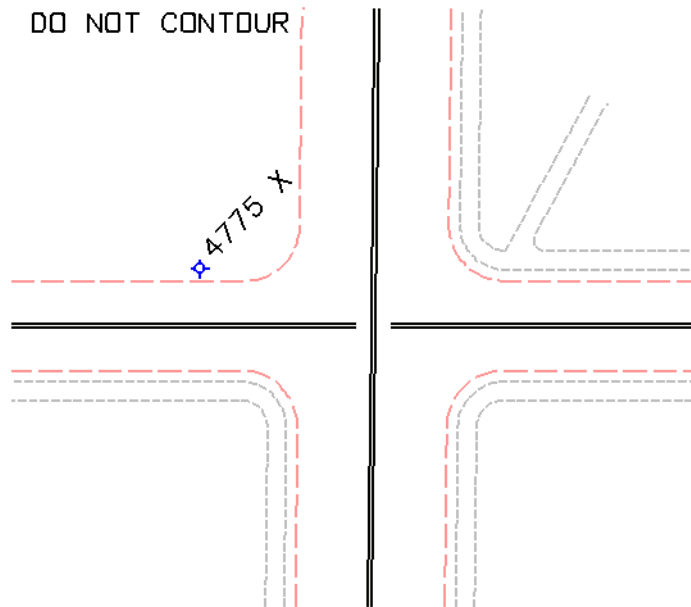
**Note:** If a single point on arc is taken then the tangent lines are ignored and the curve is generated by the three points PC, POC, and PT.

**Note:** If more than one point is taken on the arc then the tangent lines are used when calculating the PC and PT of the curve. CDOT has standardized using the control code NT non-tangent to follow all BC and EC shots. Coding with NT will not add calculated PC's and PT's to the linear features. The PC's and PT's will be observed points as in the field.

- Exclude from Triangulation

Alpha **X** | Numeric **5**

Control code Exclude from Triangulation identifies points that will not (and should not) be used to generate surface contours. Any point not resting on the terrain should be excluded from triangulation. Points that are coded with “**X**” could include such items as fire hydrants, manhole inverts, benchmarks and control points, valve boxes, and other similar features.



- Random

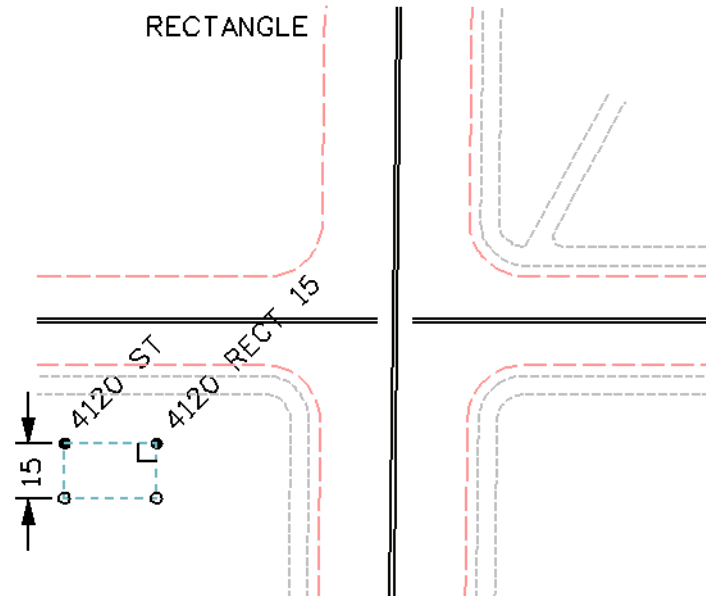
Alpha *RND* | Numeric *6*

Control code Random overwrites DTM point types set in the Survey Feature table. For example Breaklines become Random types and Do Not Contour point types become Random points Excluded from triangulation.

- Rectangle

Alpha *RECT* | Numeric *None*

Control code Rectangle will draw a rectangle based on two points shot in the field and a measured distance. The two points collected in the field define the direction of the baseline and the measured distance defines the width. The previous two points collected in the field define the direction of the baseline. To turn left of the baseline use a negative number (-15); to turn right of the baseline use a positive number (15). Each added point using the Rectangle command will be considered a derived point in Survey.

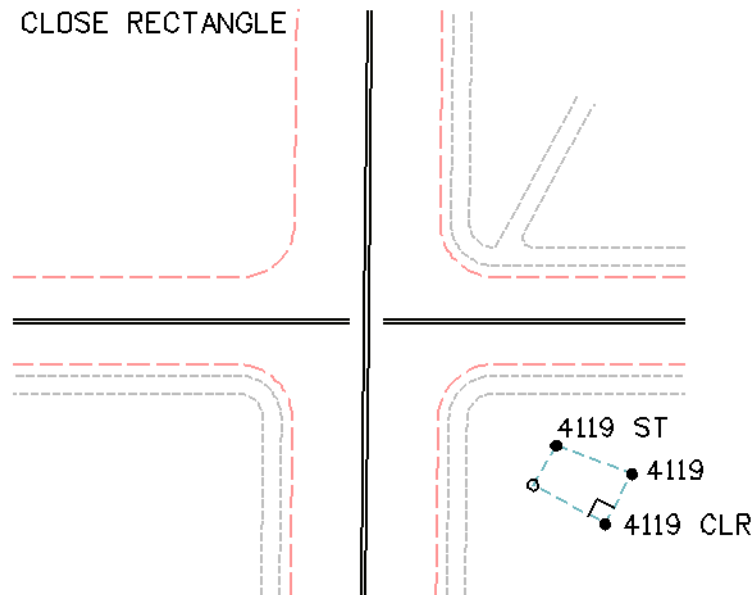


**Note:** Only a survey feature with a point type Breakline will honor the Rectangle control code when it is pushed to a surface.

- Close Rectangle

Alpha **CLR** | Numeric 7

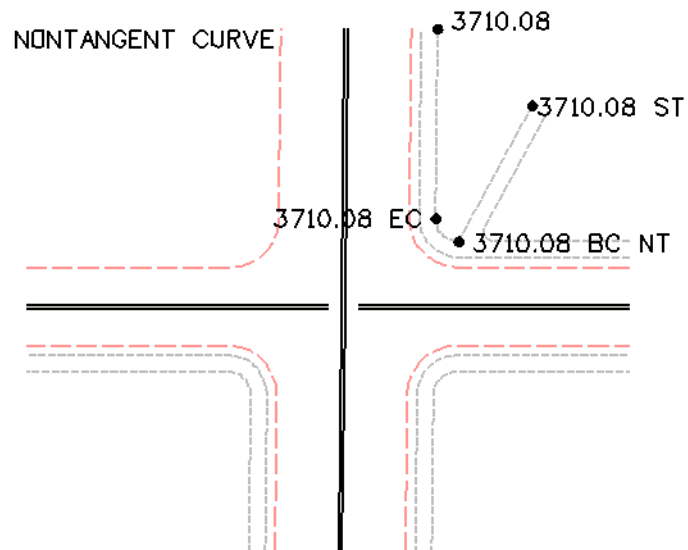
Control code Close Rectangle will draw a trapezoid based on three points shot in the field. The last two points become the baseline and the fourth point generated will be 90 degrees to the baseline.



**Note:** Only a survey feature with a point type Breakline will honor the Close Rectangle control code when it is pushed to a surface.

- Nontangent Curve  
Alpha *NT* | Numeric *8*

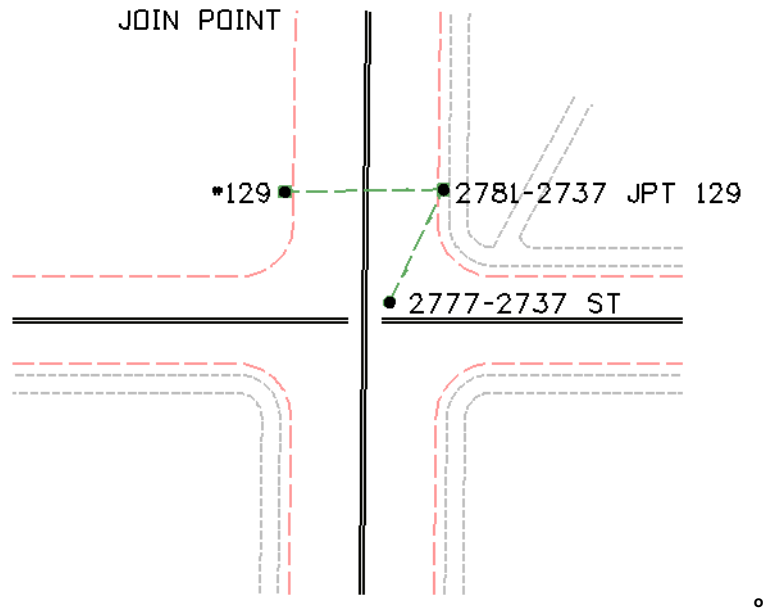
Control code Nontangent Curve identifies a curve that will be nontangent to either the incoming or outgoing tangent lines. This control code works in conjunction with BC or EC.



- Join Point

Alpha **JPT** | Numeric **None**

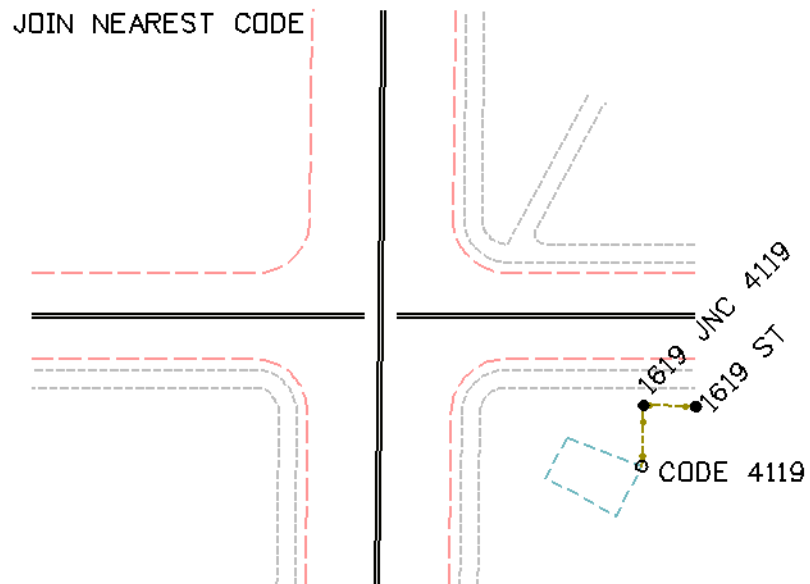
Control code Join Point will draw a connecting line to the specified point number in the fieldbook using the current feature style.



- Join Nearest Code

Alpha **JNC** | Numeric **None**

Control code Join Nearest Code will locate the closest code specified and draw a connecting line using the current feature style.

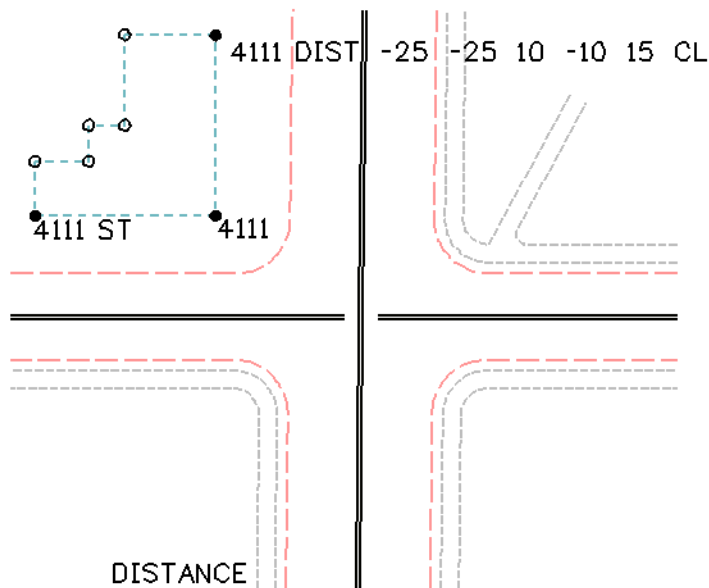


- Distance

Alpha ***DIST*** | Numeric ***None***

Control code Distance will continue to draw lines based on measured distances and direction. The previous two points collected in the file will define the direction the next point will be calculated from. The angle will always be a 90 degree deflection angle, turned looking forward from the last point collected or calculated. To turn left of the baseline use a negative number (-25) to turn right of the baseline use a positive number (10). ***Each point using the Distance command will be considered a derived point in Survey and will also be used in calculation of DTM surfaces and ALG geometry alignments.***

**Note:** Attention should be paid to the elevations assigned by this method that the surface is only as good as this info is. There may be work-arounds for these instances, but if accurate info is needed, the effort should be made in the field to collect actual data.



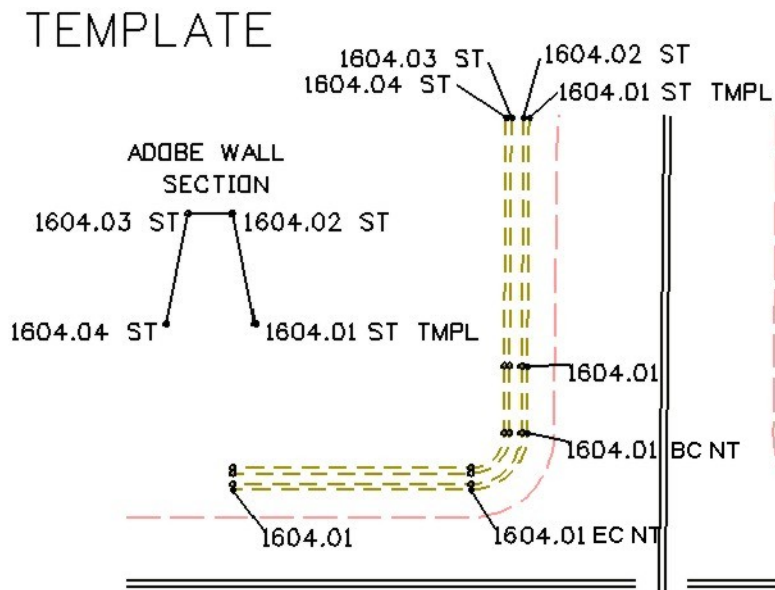
**Note:** Only a survey feature with a point type Breakline will honor the Distance control code when it is pushed to a surface.



- Template

Alpha **TMPL** | Numeric **None**

Control code Template defines multiple survey features that are uniform in distance and elevation from a baseline. Using the template control code will lessen the number of shots needed in the field.

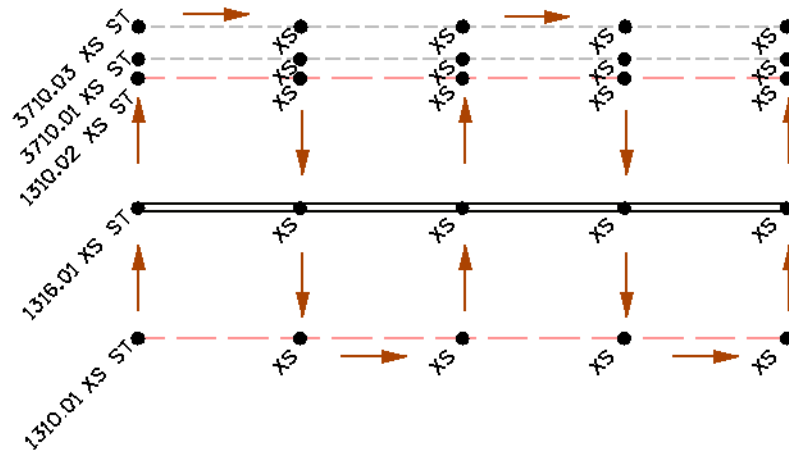


- Cross Section

Alpha **XS** | Numeric **None**

Control code Cross Section allows any uniform set of corridor shots to be collected efficiently. Start by collecting the start of each new feature, and then continue to collect the shots in a crossing pattern.

## CROSS SECTION



**Note:** When the raw data is imported into the field book it will convert the code XS to the correct feature code.

- Add to Adjustment Set

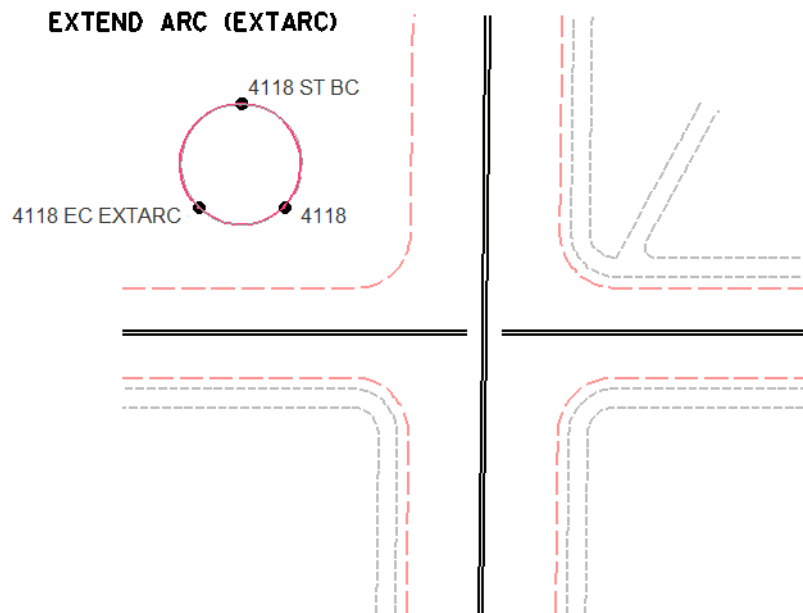
Alpha *ADJ* | Numeric *None*

Control code Add to Adjustment Set defines a sideshot of an unknown point to be included to the adjustment set data.

- Extend Arc

Alpha *EXTARC* | Numeric *None*

Extend Arc command works with the code PC to create a circular shape. The shape is created by joining two arcs which are defined by three shots taken in the field

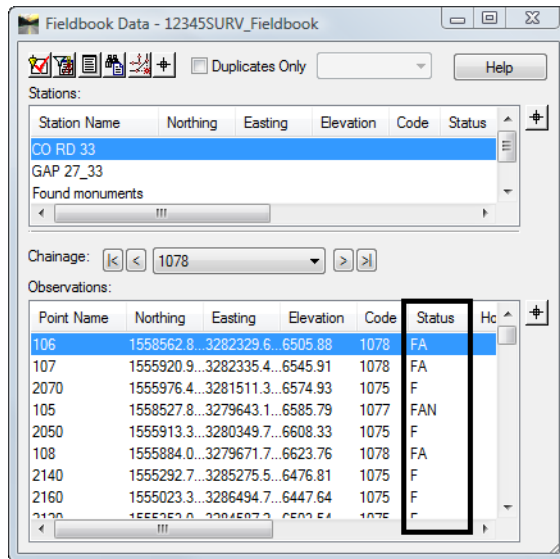


**Note:** When the feature is pushed to a DTM the feature will not keep the circular shape. The DTM feature will be made up of two line segments.



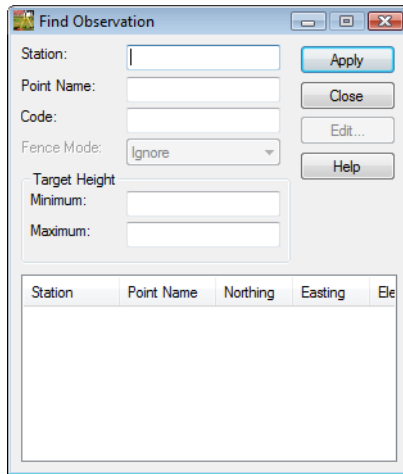
# Chapter 7 - Fieldbook Edits

## Fieldbook Data dialog



- Status Codes
  - ◆ **N** – The point has a Note
  - ◆ **E** – The point has been Edited
  - ◆ **F** – The point is Fixed or has been keyed in
  - ◆ **A** – The point has an Attribute associated to the Survey Feature
  - ◆ **V** - The point has a Value for an associated Attribute
  - ◆ **I** – The point has been Inserted into the fieldbook
  - ◆ **C** – The point has been adjusted

## Find Observation dialog



### Dialog items:

- **Station** – key-in field used to locate Station point numbers in the active fieldbook.
- **Point Name** - key-in field used to locate Observation point numbers in the active fieldbook.
- **Code** - key-in field used to locate Alpha or Numeric codes in the active fieldbook.
- **Fence Mode** – used to constrain a lookup area. If a fence is placed in the design file then the item will be activated so fence mode is selectable.
- **Target Height** – locates survey shots based on a target height range
  - ◆ **Minimum**
  - ◆ **Maximum**
- **List** – points found based on the selection criteria.
  - ◆ Use the Shift and Ctrl keys to select multiple points in the list.
- **Apply** – locates the points in the active fieldbook and places them in the list section.
- **Edit** – opens the **Edit Observation** dialog for the selected point numbers.

## Edit Observation dialog

When editing points in the electronic fieldbook the original raw imported data is *not* edited. The **Edit Observation** dialog allows the fields that are not grayed out to be edited. After the point has been edited the point will show an “E” in the Status column of the fieldbook. Edits will also be tracked in the Audit Trail file.

Attributes:		
Code	Name	Value
4375	ROT	

### Dialog items:

- **Point Name** – assigned point value in the fieldbook.
  - ◆ Use the arrows to easily cycle through the points.
- **Type** – definition of the point in the fieldbook
  - ◆ **Computed** – point is defined from measured distances and angles.
  - ◆ **Fixed** – point is based on a set of coordinates fixed by key-in or by an absolute observation (GPS).
  - ◆ **Geometry** – point is defined in the Cogo buffer.
- **Horizontal Observation** – measured value
- **Vertical Observation** – measured value
- **Slope Distance** - measured value
- **Code** – feature and control codes
- **Target Height** - prism height above measured point
- **Notes** – any notes added to the shots in the field
- **Northing, Easting, Elevation** - point values for point
- **Attributes** – any additional information collected for the point





# Chapter 8 - Exporting the Fieldbook

## Final Export and save

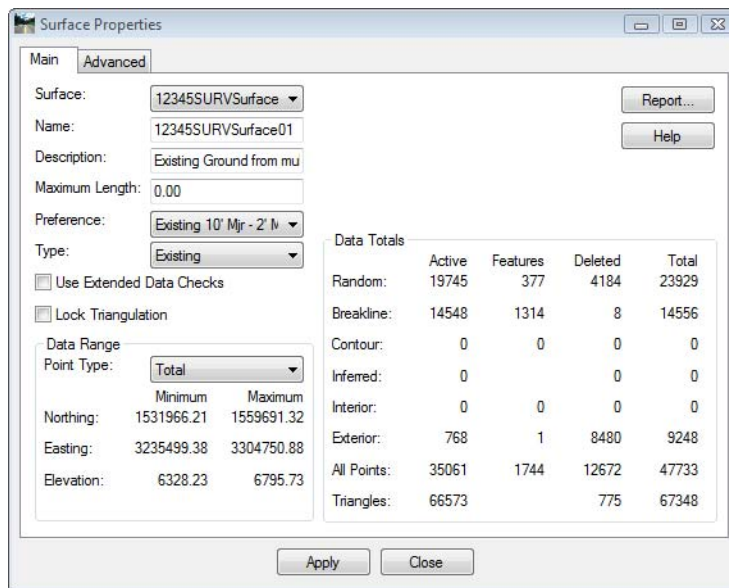
The fieldbook has been corrected until there are no more visible errors. Now the fieldbook will be exported to a DGN, DTM, and ALG files.



# Chapter 9 - DTM Evaluation


As part of the deliverables the survey department will provide to the designers is the Surface DTM file. The DTM file is to be an exact copy of what exists in the fieldbook. Meaning that any edits required to the DTM for correction of crossing breaklines or busted elevations is fixed first in the Survey fieldbook and the DTM is then reexported from the fieldbook.

## Surface Properties dialog



### Dialog Items

- **Surface** - drop-down shows the active surface by default, other surfaces are selectable
- **Name** – the name of the DTM as InRoads has it stored in memory (not necessarily the file name on disk). The surface can be renamed here by typing in a new name.
- **Description** – user defined description
- **Maximum Length** – maximum length any one triangle segment (leg) can span during the triangulation process. If set to 0, triangle legs can extend to any length. Used to constrain triangulation to prevent unnecessary ‘surface’ data.
- **Preference** – predetermined display settings – bypasses the **View Contour** dialog box if the Style lock is enabled.
- **Type** – surface identifier for cross sections, used in end-area volume computations. Set to ‘Existing’ for newly created original ground surfaces.
- **Use Extended Data Checks** – checks DTM integrity (during triangulation) for crossing breaklines and miss-matched elevations. Will eliminate crossing breaklines and miss-matched elevations by deleting segments or elevations. These errors should be corrected in the fieldbook.

-  **Report** – generates a separate window summarizing surface properties. The generated report can be printed, written to the CAD file, or stored as an ASCII file
- **Lock Triangulation** – user will not be prompted to retriangulate when surface data is out of date. Not recommended for use.
- **Data Range** – selectable field to show minimum and maximum Northing, Easting, and Elevation of surface features.
- **Data Totals** – displays as summary of the surface composition.
- **Advanced** tab – graphic display attribute settings (named symbologies) related to profiles & cross section display of the surface. Also input fields for defining multiple-line parallel offsets for use in profile display. The ‘Use Features Only’ check box instructs InRoads to interpolate cross-section elevations from crossing features vs. from triangle legs.

## Data File Naming & Saving

- As noted above, a user can rename a surface in the **Surface Properties** dialog. A critical point to remember is that InRoads is a memory based program. The name given the file on disk can differ from the name used in memory. While they do not have to be the same, it is highly recommended that they share a common name.
- Assigning a different name to a surface in the **Surface Properties** dialog box or by using **Surface > Rename Surface** simply redefines the surface name as it resides in memory, not on disk.
- Renaming a surface in both memory and on disk is a two step process. Use one of the methods described in the preceding paragraph to rename the surface in memory and then use the **File > Save As** command, using the new name, to save it to disk.

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# Index

