# AutoCAD® Civil 3D® 2013 for Surveyors

Supplemental Files

Tutorial files on enclosed CD

# Chapter 2

## Survey I

This chapter contains the following topics:

✓**Survey Workflow Overview**

✓**Introduction to the Survey Toolspace**

✓**The Survey Database**

✓**Survey Networks**

✓**Survey Figures**

✓**Importing a Field Book**

✓**Working with Figures**

✓**Filtering a Survey Database**

✓**Points Overview**

✓**Point Label Styles**

✓**Point Settings**

✓**Creating Points**

✓**Transparent Command**

✓**Description Key Sets**

✓**Importing and Exporting Points**

✓**Point Groups**

✓**Reviewing and Editing Points**

✓**Locking/Unlocking Points**

✓**Point Reports**

# Learning Objectives

This chapter provides instruction to enable you to do the following:

### 2.1 Survey Workflow Overview

List the steps in a typical survey workflow that are going to be used to create linework from coordinate files.

### 2.2 Introduction to the Survey Toolspace

Display the Survey Toolspace and content that is listed under each of its trees.

### 2.3 The Survey Database

Create a new survey database within the required working folder.

### 2.4 Survey Networks

Establish horizontal and vertical control for the project by creating a survey network.

### 2.5 Survey Figures

Create a figure database for stylizing linework automatically on importing field book or ASCII files.

### 2.6 Importing a Field Book

Import a field book file and process linework to automatically display the collected field data in the drawing.

### 2.7 Working with Figures

Modify figures in a survey database to correct errors or add additional linework to the database.

### 2.8 Filtering a Survey Database

Filter a survey database to isolate only the points or figures needed for the tasks being completed in the current drawing to reduce file sizes.

### 2.9 Points Overview

Create a point marker style to ensure that the correct symbol is assigned to specific points.

### 2.10 Point Label Styles

Create a point label style for annotating groups of points with the required information.

### 2.11 Point Settings

Set the appropriate point creation values and next available point number.

**2.12 Creating Points**

Create additional points using the Create Points toolbar for points that were not imported from the survey data.

**2.13 Transparent Command**

Snap to and zoom to points using the Transparent Command toolbar.

**2.14 Description Key Sets**

Assign point symbols, labels, layers, etc., automatically when importing points by setting up Description Key Sets.

**2.15 Importing and Exporting Points**

Import points from and export points to ASCII files created from the field survey.

**2.16 Point Groups**

Group points together using common properties, such as name, elevation, description, etc.

**2.17 Reviewing and Editing Points**

Review and edit points using the Panorama window to ensure accuracy.

**2.18 Locking/Unlocking Points**

Prevent unwanted edits to points by locking them.

**2.19 Point Reports**

Share information about points used for error checking or staking out points using predefined reports.

# 2.1 Survey Workflow Overview

List the steps in a typical survey workflow that are going to be used to create linework from coordinate files.

This chapter focuses on automated **Field to Finish** tools that aid in drafting an accurate and efficient *Existing Condition Plan*. These tools create a correct existing topography, property lines, right-of-way, and center line locations.

## Workflow

To create linework from coordinate files, use the following survey workflow:

1. Data needs to be entered into the data collector. The proper language, methodology, and basic rules regarding data entry into the data collector begin with an understanding of Figure Commands and Field Codes (raw descriptions).

2. Data can be transferred from the data collector to the computer using an ASCII file. An ASCII file can be opened in Notepad and data can be separated or delineated by spaces or commas. The most popular transferred format is Point Number, Northing, Easting, Elevation, Description. This material focuses on the different types of Descriptions that can be entered into a data collector so that the user obtains the required automated symbology and linework.

3. If using a field book file (a type of ASCII file), data needs to be converted from the raw coordinate file to a field book (*.FBK) using Survey Link or other methods of the AutoCAD® Civil 3D® software. Autodesk has collaborated with major survey equipment vendors to develop API and drivers that interface their specific survey equipment (Trimble Link, TDS Survey Link, Leica X-Change, TOPCON Link, etc.) with the AutoCAD Civil 3D software.

   If following the **Linework Code Set** command format, you do not need to convert the coordinate file to a field book. Import the file with linework processing turned on.

4. The AutoCAD Civil 3D software needs to have all of the necessary Styles, Settings, and Figure Prefixes to create, sort, and place points and linework on the required layers.

The surveying department can substantially increase productivity and efficiency by standardizing field codes and figure commands, and learning some new fundamentals. This new knowledge enables field and office staff to better coordinate their efforts.

## Data Entry in the Field

Entering field data using methodology that takes advantage of the AutoCAD Civil 3D analysis and drafting tools (that uses automated linework connectivity) can save a significant amount of time in the office. As the figure is essentially created during the survey field pick up, this workflow reduces discrepancy and interpretation as to what exists in the field. The linework can be part of the final deliverable building outlines, surface breakline center line of pavement, parcel segment, control lines, etc.

Retracement methodology used to establish boundary, traverse closure and adjustments, and error findings are not always the surveyor's focus. Many of these functions are easily calculated in the AutoCAD Civil 3D software. Third party software and data collectors can also perform these functions in the field during the survey. With the rise in popularity of GPS units, the need for traverse, setups, or back sights is reduced.

Field crews are the *witnesses* to a site and should be responsible for drawing the lines. Errors are made by office surveyors and draftsman when analyzing hand-drawn field sketches and many hours can be spent connecting points and solving connection errors.

## Survey Results as Coordinate Files

There are two methods of importing point files containing the Point Number, Northing, Easting, Elevation, and Description. One is using the **Point Creation** tool and the other is using the Survey Database.

When importing point files outside the Survey Database using the **Point Creation** tool, the Description Key Sets, Point Groups, and Point and Label Styles work together to categorize points into layers, organize points into groups, and display symbols. However, line work is not generated. When importing files using the Survey Database, you have all of the benefits of importing through the **Point Creation** tool, as well as automatic line generation and additional features.

## Preparing Coordinate Files for Linework

A coordinate file produces linework when it contains survey figure codes that match preset figure prefixes in the AutoCAD Civil 3D software and/or have the proper figure commands before or after them. Survey codes are field-entered values and when processed correctly, create the required linework within the AutoCAD Civil 3D drawing.

There are two strategies for processing the files to generate figures (linework). The first is to convert the coordinate file into a field book file. The resulting field book contains figure control commands that create the linework. For some time, this was the only option to create figures. The major disadvantage to the field book language is that it requires you to only input commands defined by Autodesk. These commands are hard-coded and you cannot customize them to conform to legacy methodology.

The most popular method used to create a field book is with Autodesk's Survey Link, which was created before the MCE and MCS (multiple curve start and end commands) were created. Therefore, it does not recognize these commands. Finally, curve observations in the field must be consecutive. This means that when a curve is started the rodman has to complete the curve before another non-curve shot can be taken. One of the major advantages of the use of a field book format is the ability to use the analysis tools within the networks created in the Survey Database.

An innovation in Survey is the introduction of Linework Code Sets. By default, a code set is the traditional field book language codes. A coordinate file with valid **Linework Code Set** commands produces the same figure that comes from importing a field book without having to convert the file into a field book.

A Linework Code Set is changeable, but the field book language is not. For example, in a field book, B is the only way to begin a figure. In a Linework Code Set, you can enter almost any character as a starting figure command. Offices that use numbers for descriptions can now use numbers to start a figure. In the following portion of code, the number 1 starts a figure:

    7,631397.3883,2208901.6900,809.6300,1 EPA

By default, the letter B starts a figure instead of the number 1, as shown in the following portion of code:

    7,631397.3883,2208901.6900,809.6300,B EPA

The second advantage of Linework Code Sets is that when importing, they manage all of the starts, ends, and continues without actually being in the coordinate file. Finally, Linework Code Sets support multiple point curves without the points having to be consecutive points. You can now create multiple point curves (more than three points) with other described points between the points creating the curve. The field book method does not support this.

In the practice for this section, you process a coordinate file to a field book, import it, and review the resulting linework. In the second practice, you import the coordinate file directly without having to create a field book and get the same results.

These two methods assume that no adjustment is needed because the files contain coordinates, rather than observations. A later section uses a survey with observations to create linework. From the import of this file type, you can perform an adjustment if required.

# 2.2 Introduction to the Survey Toolspace

> Display the Survey Toolspace and content that is listed under each of its trees.

The Survey Toolspace displays a panel through which all surveys are processed. Survey uses graphics to display field book imports, figure and network previews, and points. If you toggle off these graphics, you can process a survey without a drawing being open. If you want to display these graphics, you need to have a drawing open. Survey prompts you if you do not have one open.

The Survey Toolspace contains Survey settings, Equipment defaults, Figure Prefixes, and Linework Code Sets. Survey's settings can be on a local or network folder. Using a network folder is preferred for larger offices because all users can then standardize the file values.

## Displaying the Survey Toolspace

If your Toolspace does not display the *Survey* tab, click
(Survey Toolspace) in the *Home* tab>Palettes panel, as shown in Figure 2–1.
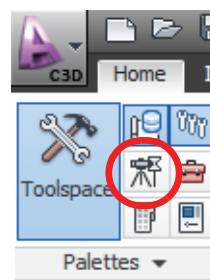


**Figure 2–1**

## Typical Survey Database Settings

Surveys are either in a State Plane Coordinate system or an assumed coordinate system (e.g., 5000 for Northing and 5000 for Easting). Either of these coordinates systems are typed in a data collector at the first survey control found by the field crew. In the AutoCAD Civil 3D software, these different settings can be stored as definitions that you assign when creating a database, or are assigned by editing a survey's settings.

# 2.3 The Survey Database

Create a new survey database within the required working folder.

After collecting and coding the data, and then downloading and converting it, the next step in Survey is to import the survey data, review it, and place the survey points and figures into a drawing. A working folder defines where the local Survey Database is located. The preferred location is a network folder, in which you place the local Survey Databases. The Survey User Settings dialog box sets the defaults for all new Survey Databases. You should set these before starting Survey. The Survey Working Folder is the location for all Survey Databases and can be local or on the network. The default working folder is *C:\Civil 3D Projects\*.

**How to:**

**Set the working folder for the Survey Database**

1. In the Survey tab, select **Survey Databases**.
2. Right-click and select **Set working folder…** as shown in Figure 2–2.
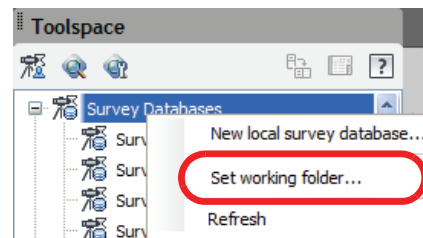


**Figure 2–2**

## Survey Database

A Survey Database is a subfolder in the working folder. The Survey Working Folder contains the Survey's settings and observation database. This database contains the Survey's Networks, Figures, and Survey Points.

Each local Survey Database references files to perform some of its tasks. The Equipment Database is an *.EDB file and the Figure Prefix Database is an *. FDB file. The Equipment settings file contains values to estimate errors for the Least Squares adjustment process. The Figure Prefix Database lists definitions for Survey figures (figure style and layers).The default location for these files is *C:\Documents and Settings\All Users\ Application Data\Autodesk\C3D 2013\enu\Survey.*

*Survey Database Folders cannot be deleted within AutoCAD Civil 3D Survey. If you want to delete the working folder, this process must be done manually external to the AutoCAD Civil 3D software.*

Survey has four nodes: *Import Events*, *Networks*, *Figures*, and *Survey Points*. *Import Events* is where files are imported into the Survey's networks. The files can be a coordinate, a field book, a LandXML file, and points from a drawing. When importing a file, depending on its contents, the import results in figures and points. Information in the file also populates portions of a Survey's Network. When importing a coordinate or field book file containing only coordinates, the *Figures* and *Survey Points* nodes are your focus. When processing a file with observations, turned angles, zenith angles, slope distances, and setups, your focus is the network and its nodes.

## Open a Survey Database for Editing

Only one Survey Database can be edited at a time. When opened for editing, this prepares the survey for reading and writing. The process is analogous to Autodesk's previous Civil/Survey software, AutoCAD® Land Desktop, where an external database in a project folder stored all of the data that was created in the drawing.

There are options to set the path or location for the Survey Database project files, as well as all the settings. When you create a new Survey Database, a Windows folder is created with the same name. If you close a drawing with a survey open, the Survey Database closes automatically. You must start a new drawing and then open the required Survey Database. You can only have one Survey Database open at a time.

**How to:** | **Open a survey database**

1. Expand the Survey Database branch.
2. Select the survey database that you want to open, right-click and select **Open for edit** or **Open for read-only**, depending your requirements, as shown in Figure 2–3.
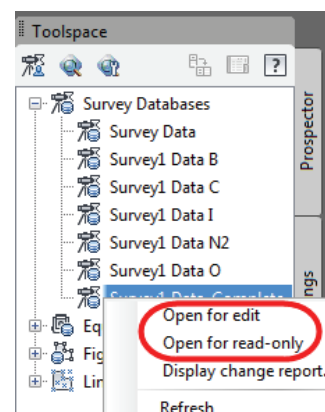


**Figure 2–3**

# Practice 2a

# Creating a Survey Database

Create a new survey database within the required working folder.

*Estimated time for completion: 15 minutes*

In this practice you will set up a Survey project.

1. Open **SUV1-A1-Survey.dwg** from the *C:\Civil 3D Projects\Civil3D-Training\Survey* folder.

2. The arial images used in this chapter was attached using the AutoCAD® Map 3D FDO connection. You might have to change the draw order of the image if it hides your AutoCAD® or civil objects.

3. In the *Home* tab>Palettes panel, click ⬚ (Survey Toolspace) to display the *Survey* tab, as shown in Figure 2–4.
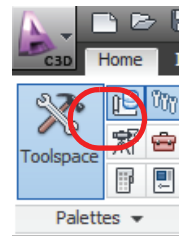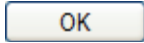


**Figure 2–4**

4. Select the *Survey* tab in the Toolspace.

5. The Survey Toolspace displays four nodes: *Survey Databases*, *Equipment Databases, Figure Prefix Databases*, and *Linework Code Sets*. Each has a Sample database with default values. Expand the *Equipment Database* until the *Sample* database displays.

6. To create an Equipment database, right-click on Equipment Database and select **New**, as shown on the left in Figure 2–5. Type **Training** as the equipment database name as shown on the right. Click ⬚OK⬚ to accept and close the dialog box.
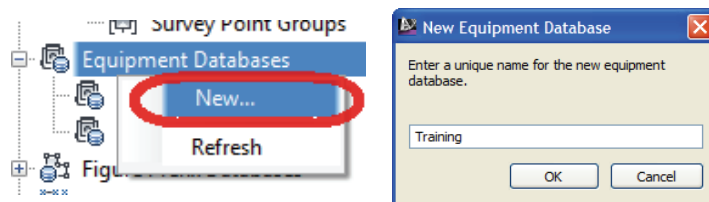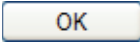


**Figure 2–5**

7.  To open the Equipment Properties dialog box, select **Training**, right-click, and select **Manage Equipment database…**

8.  Review the settings. When done, click OK to close the dialog box.

9.  The AutoCAD Civil 3D software saves the Equipment database files in the folder shown in Figure 2–6. To change to path to a network drive, click (Survey User Setting), scroll down to Equipment Defaults and browse for a new path.
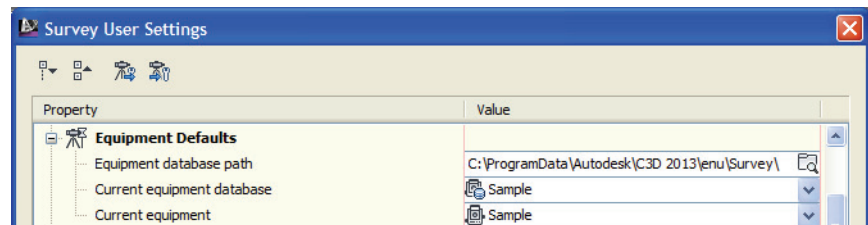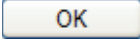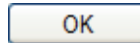


**Figure 2–6**

10. Review the settings. When done, click OK to close the dialog box.

11. To set the working folder for the Survey Database, in the *Survey* tab, select **Survey Databases**, right-click, and select **Set working folder…**, as shown on the left in Figure 2–7. Browse and select the *C:\Civil 3D Projects\Civil3D-Training/Survey/Survey Databases* folder, as shown on the right. When done, click OK to close the dialog box.
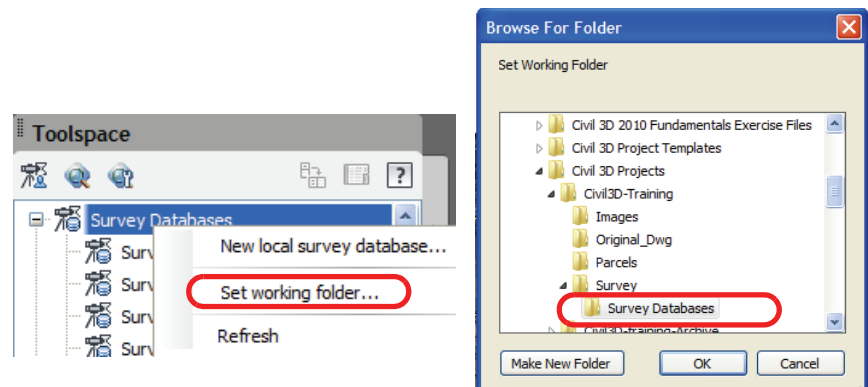


**Figure 2–7**

12. To create a new local Survey Database, select **Survey Databases** in the *Survey* tab, right-click, and select **New local survey database…**, as shown on the left in Figure 2–8. Type **Survey Data** as the name of the Survey Database, as shown on the right. Click ⌗OK⌗ to accept and close the dialog box
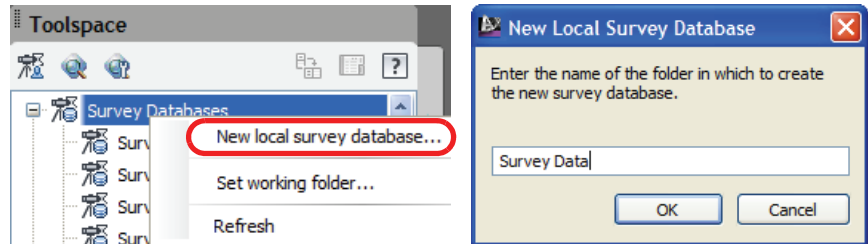


**Figure 2–8**

13. A Survey Database is now created in the *Survey* tab, as shown on the left in Figure 2–9. This Survey Database is a folder that is located under the specified Geomatics working folder, as shown on the right.
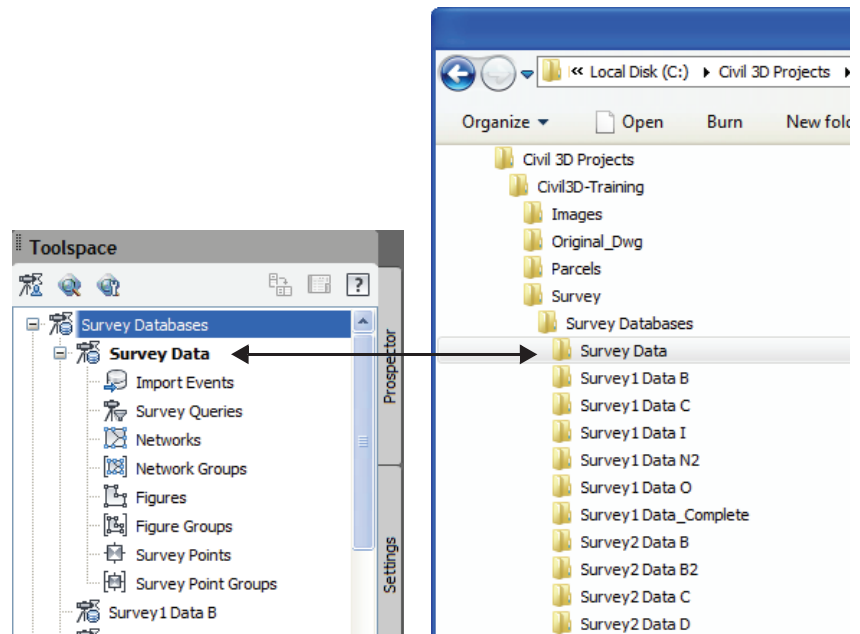


**Figure 2–9**

14. To edit the Survey Database settings, select **Survey Data**, right-click, and select **Edit survey database settings…**, as shown in Figure 2–10.
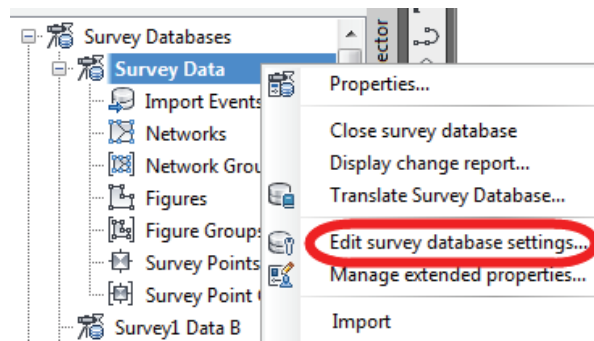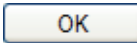
**Figure 2–10**

15. Under *Units* in the dialog box, click ⬚ for the *Coordinate Zone*, select **NAD83 California State Planes, Zone VI, Meter** (as shown in Figure 2–11), and click [ OK ]. Note that although some of the survey was done in CA83-VI and our drawings are in CA83-VIF, you can import the survey data to any coordinate system or units and the AutoCAD Civil 3D software converts the coordinates and units in the drawing.
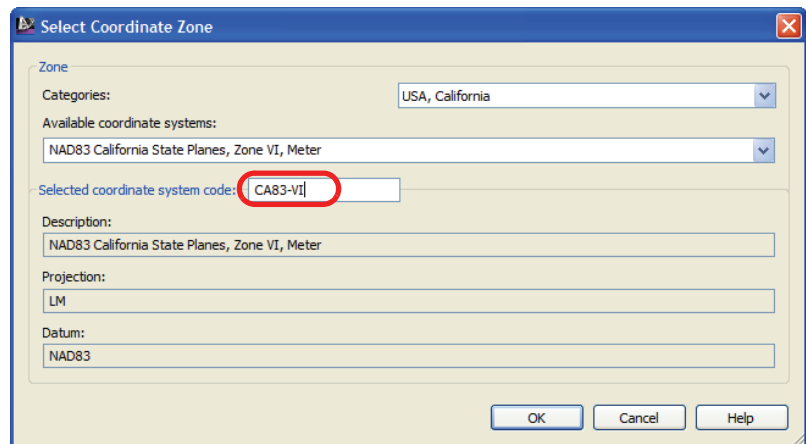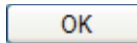


**Figure 2–11**

16. Set the *Distance* to **Meter**, the *Direction* to **North Azimuths**, the *Temperature* to **Celsius**, and the *Pressure* to **Millimeters Hg,** as shown in Figure 2–12. When done, click [ OK ] to close the dialog box.



**Figure 2–12**

# 2.4 Survey Networks

Establish horizontal and vertical control for the project by creating a survey network.

A survey network is a collection of all known control points, instrument setups, and directions. They are usually represented by a series of interconnected lines indicating where the instrument was set up and side shots taken from. A local Survey Database has one or more networks. You can import one or more field books or point files into a network when the Survey spans more than one field book or point file. For example, networks are usually a day of field work. The larger the area of interest, the greater number of networks needed. At least one network is necessary when importing fieldbook files to create linework and points.

Before importing a Survey, you create a named network first or during the importation process. To create a new network, select the Survey's network heading, right-click, select **New**, and type the network's name. After creating a named network, Survey creates five nodes below its name: *Control Points*, *Non-Control Points*, *Directions*, *Setups*, and *Traverses*, as shown in Figure 2–13.
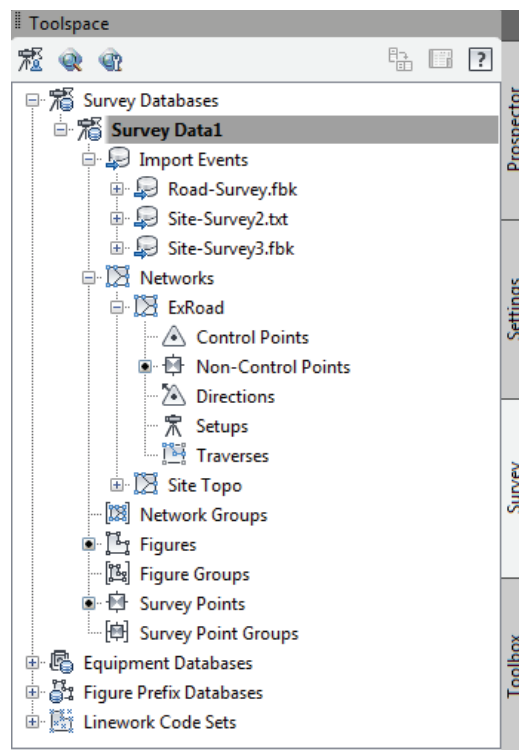


**Figure 2–13**

You can import one or several field books or LandXML files into the same network. By default, each import supplements the previous import. When you re-import a file, Survey automatically deletes the information from the original file import and recalculates the observations from the re-imported file.

Importing multiple files with the correct settings creates a single network whose data is a combination of the imported files. This enables you to create traverse(s), or perform a Least Squares analysis from data that spans more than one file.

When importing a file, Survey sequentially processes each line, creating setups and processing the setup's observations. When processing the setup's observations, Survey stores them in the observation database and calculates a point's preliminary coordinates from the observation values.

When toggling on interactive graphics, Survey displays the setups, draws figure linework, and populates the *Control Points*, *Non-Control Points*, *Directions*, and *Setups*.

When completing the import, Survey populates all or some of the nodes under the *Networks* heading.

Control points are NE or NEZ entries in a field book. Directions are azimuth entries between points used in the stationing process. Survey points are initially calculated coordinates from the file's setups and observations. Any NE SS entries become non-control points. These points have coordinates, but are not control points (not used in a setup or as stationing points). You can promote them to control points by using them as part of a traverse or referencing them as part of a setup.

Non-control points can also be the result of importing a point coordinate file instead of an observation-based file.

| | |
|---|---|
| **Practice 2b** | # Creating a Survey Network |

Establish horizontal and vertical control for the project by creating a survey network.

*Estimated time for completion: 5 minutes*

In this practice you will create a Survey network. This practice assumes that you have successfully created a Survey Database.

## Task 1 - Open drawing and database.

1. Continue working with the drawing from the previous practice or open **SUV1-A1-Survey.dwg**.

2. Select the *Survey* tab.

3. Continue with the opened survey database from the previous practice, or close the survey database that is currently open, and open **Survey1 Data B**. To open a survey database, expand the survey database branch, select the appropriate survey database that you want to open, right-click and select **Open for edit**, as shown in Figure 2–14.
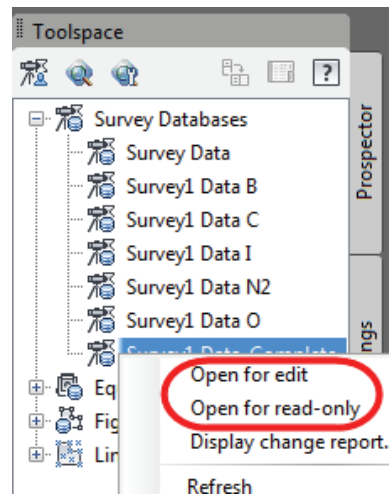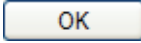


**Figure 2–14**

## Task 2 - Create a network.

1. In the *Survey* tab, expand Survey Databases and select the opened Data Base (it will be highlighted in bold). Alternatively, open **Survey1 Data B**, right-click on the Networks branch, and select **New**.

2. In the New Network dialog box, type **Site Topo** for the network name, as shown on the left in Figure 2–15, and click OK to create the network. The new network displays under the *Survey Data1>Networks* collection, as shown on the right. Expand the *Site Topo* network by selecting its **+** sign.
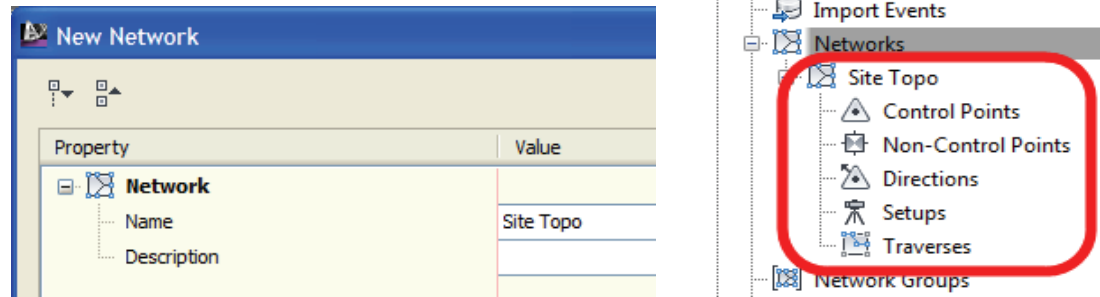


**Figure 2–15**