Trimble Geomatics Office™

User Guide

◈ Trimble™

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Introduction

Welcome to the Trimble Geomatics Office™ software from Trimble Navigation Limited.

Geomatics is the design, collection, storage, analysis, display, and retrieval of spatial information. The collection of spatial information can be from a variety of sources, including GPS and terrestrial methods. Geomatics integrates traditional surveying with new technology-driven approaches, making geomatics useful for a vast number of applications.

Trimble Geomatics Office is a link and survey reduction package. It provides a seamless link between your field work and design software. The software includes an extensive feature set which helps you to verify your field work quickly, and easily perform survey-related tasks and export your data to a third-party design package.

Using the Software

Use Trimble Geomatics Office for tasks such as:

- GPS baseline processing (if you have the WAVE™ Baseline Processing module installed)

- Survey network adjustment (if you have the Network Adjustment module installed)

- GPS and conventional topographic survey data processing

- Quality assurance and quality control of data (QA/QC)

- Road design data import and export

- Survey data import and export

- Digital terrain modeling and contouring

- Datum transformation and projections

- GIS data capture and data export

- Feature code processing

- Project reporting

- Survey project management

C **Warning –** Trimble Geomatics Office stores its data in a Microsoft Access version 9.0 database (filename TGO_V160.mdb in the *Project* folder). Microsoft Access 2000 uses the version 9.0 database. Trimble Navigation Limited reserves the right to modify the structure of the database at any time. This may affect users who develop applications to interact directly with the Access database.

Getting Started

Trimble recommends that, after reading this chapter and installing the software, you work through Chapter 1, Trimble Geomatics Office. This chapter shows you how to get started with the software, and how to set up a project.

The remaining chapters describe the extended functionality of Trimble Geomatics Office.

About this Manual

This manual describes how to set up and use the Trimble Geomatics Office software.

Even if you have used other Global Positioning System (GPS) products before, Trimble recommends that you spend some time reading this manual to learn about the special features of this product.

If you are not familiar with GPS, visit Trimble's website at www.trimble.com for an interactive look at Trimble and GPS.

Trimble assumes that you are familiar with Microsoft Windows and know how to use a mouse, select options from menus and dialogs, make selections from lists, and refer to online help.

Related Information

Sources of related information include the following:

- Help – Trimble Geomatics Office and its accompanying utilities include extensive online help. Become familiar with the relevant sections in the manual before starting, and then use the Help for in-depth answers to any questions. For context-sensitive help, press [F1].

- Release notes – the release notes include information not contained in the manuals, and any changes to the manuals. They are provided in Portable Document Format (PDF) on the CD. Use Adobe Acrobat Reader to view the contents of the release notes.

- ftp.trimble.com – use the Trimble FTP site to send files or to receive files such as software patches, utilities, service bulletins, and FAQs. Alternatively, access the FTP site from the Trimble website at www.trimble.com/support/support.htm.

- Trimble training courses – consider a training course to help you use your GPS system to its fullest potential. For more information, visit www.trimble.com/support/training.htm.

Technical Assistance

If you have a problem and cannot find the information you need in the product documentation, *contact your local Distributor.* Alternatively, do one of the following:

- Request technical support using the Trimble website at www.trimble.com/support/support.htm

- Send an e-mail to trimble_support@trimble.com.

Your Comments

Your feedback about the supporting documentation helps us to improve it with each revision. To forward your comments, do one of the following:

- Send an e-mail to ReaderFeedback@trimble.com.

- Complete the Reader Comment Form at the back of this manual and mail it according to the instructions at the bottom of the form.

If the reader comment form is not available, send comments and suggestions to the address in the front of this manual. Please mark it *Attention: Technical Publications Group.*

Document Conventions

The document conventions are as follows:

Convention	Definition
Italics	Identifies software menus, menu commands, dialog boxes, and the dialog box fields.
Helvetica Narrow	Represents messages printed on the screen.
Helvetica Bold	Identifies a software command button, or represents information that you must type in a software screen or window.
"Select *Italics* / *Italics*"	Identifies the sequence of menus, commands, or dialog boxes that you must choose in order to reach a given screen.
[Ctrl]	Is an example of a hardware function key that you must press on a personal computer (PC). If you must press more than one of these at the same time, this is represented by a plus sign, for example, [Ctrl]+[C].

Trimble Geomatics Office

In this chapter:

- ■ Introduction
- ■ The Trimble Geomatics Office graphics window
- ■ Getting started
- ■ Project coordinate systems
- ■ Ground coordinate systems

Introduction

This chapter introduces the Trimble Geomatics Office™ graphics window, helps you to quickly get started with the software, and then describes how to use the main functionality of the software.

The Trimble Geomatics Office Graphics Window

When you start Trimble Geomatics Office, the main graphics window opens in the Survey view.

The Trimble Geomatics Office graphics window contains standard Microsoft Windows functionality such as menus, shortcut menus, and toolbars, as well as a number of special features. Some of these items change according to which view you are using to display data in the graphics window: the default Survey view or the Plan view.

To become familiar with all these items, use the software's ToolTips, or access the Trimble Geomatics Office Help by pressing [F1].

Figure 1.1 shows the graphics window, including the features that are common to both views of the software, while Table 1.1 gives further information about the window's special features.
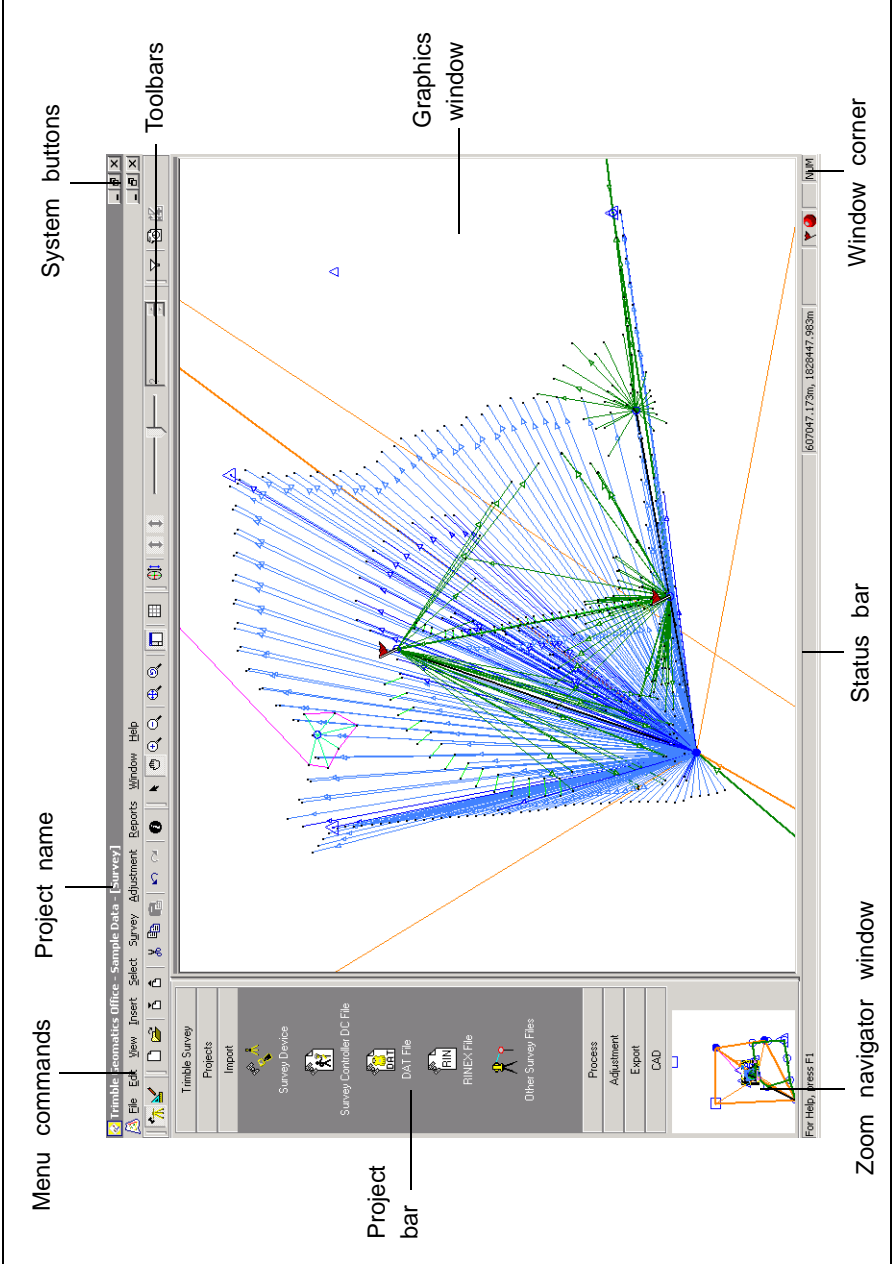
Figure 1.1   Parts of the graphics window common to both views

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Table 1.1   Special features of the graphics window

Feature	What it does
Project bar	Contains named groups that list shortcuts to commonly performed tasks. To show or hide the project bar, use the *View* menu.
	When there are no projects open, only the *Projects* and *Utilities* groups are available. When there *is* a project open, the *Utilities* group is unavailable.
Zoom navigator	Reflects the data displayed in the main graphics window. If you use any of the zoom tools in the main window, the zoom navigator changes to reflect this. To show or hide the zoom navigator, in the project bar, right-click to access the shortcut menu and then select *Zoom Navigator*.
	To use the zoom navigator, click an area of the project in the zoom navigator. This area becomes the center of the main graphics window.
	To use the zoom navigator to zoom, in the zoom navigator, drag a box around the area of interest. The main graphics window displays the same data.
	When you point to the middle of the box in the zoom navigator, the pointer becomes a $^+\!\!\text{🖑}$; you can drag the box over the project area without changing the zoom.
Status bar	Displays icons that show the current status of the project. To perform the action indicated by an icon, double-click it. For a description of each icon, refer to the Help.

The Survey View

In the Survey view, GPS and terrestrial observations appear as colored lines, while control points and network-adjusted points also have special displays. If Trimble Geomatics Office finds any problematic observations, warning flags appear at the point where the problem occurs.

Use the Survey view to perform survey-related tasks such as:

- checking GPS and conventional observations

- correcting erroneous data

- GPS processing (if you have the WAVE™ Baseline Processing module installed)

- GPS site calibration

- GPS loop closures

- inverse calculations

- network adjustment (if you have the Network Adjustment module installed)

The Plan View

In the Plan view, entities—points, lines, arcs, curves, text styles, and annotations—are displayed according to the style you give them, so you can view topographic features observed during your field survey.

You can add entities to the project, or change the style of an entity by using the *Properties* window or the *Multiple Edit* dialog, or by processing feature codes. These changes do not affect the underlying survey observations.

Use the Plan view to prepare a topographic survey for export to your design software package.

Getting Started

The following sections describe how to set up a project so that you can start working with your data in Trimble Geomatics Office.

Creating a Project

Your first task is to create a project, because this is the way that the software organizes data. A project usually covers one site, and may contain several days' data, collected using different equipment.

To start Trimble Geomatics Office:

- Click **Start** and then select *Programs* / *Trimble Office* / *Trimble Geomatics Office*.

To create a project:

1. Select *File* / *New Project.* The following dialog appears:
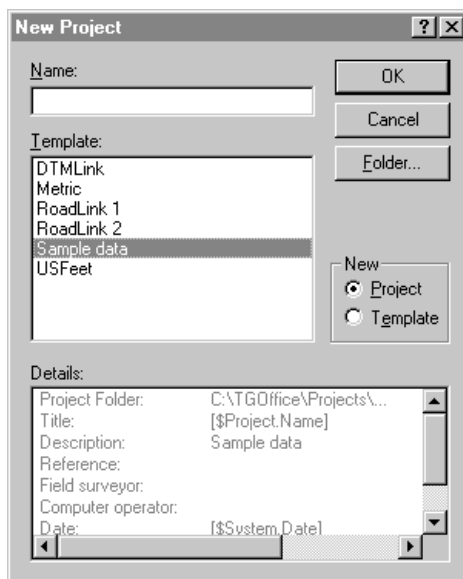
2. Enter a name for the project.

3. Select a template. This will determine your project's units and coordinate system, and how it displays data.

B   **Tip –** Create a template that contains the properties and data that are common to all of your projects so that you can create and set up new projects more quickly. For more information, refer to the Help.

4. In the *New* group, make sure that the *Project* option is selected.

5. If necessary, specify which folder the software is to store project files in. Otherwise, it stores the files in the folder specified at installation.

6. Click **OK**.

The project is created and the *Project Properties* dialog appears. Use this dialog to view and further specify the project's properties.

Note – You can also access the Project Properties dialog by selecting File / Project Properties.

Changing Project Properties

Once you have created the project, you may need to modify its properties, and to do this you use the *Project Properties* dialog.

Table 1.2. describes what you use each tab in the *Project Properties* dialog for. For more information, refer to the Help.

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Table 1.2   Tabs in the Project Properties dialog

Use this tab ...	to specify ...
Project Details	the project information that you want included in reports and plots.
	When the project is created, the *Description* and *Date* fields are filled in automatically. All other fields are optional and you can enter values for them any time.
Coordinate System	or view the coordinate system for your project. The default coordinate system for the project is determined by the project template. For more information about changing the coordinate system, see Changing to a Different Project Coordinate System, page 14.
Units and Format	Trimble Geomatics Office unit values—for onscreen display, importing, exporting, and reporting—for the current project.
Features	the feature and attribute settings for the Trimble Geomatics Office project. You can choose to automatically process feature codes when importing a Survey Controller (*.dc) file, using the feature and attribute library that you specify. You can also set up your project to use attributes, again, using the feature and attribute library that you specify.
Reporting	how you are notified when a system-generated report has been created. For example, the software creates an Import report when you import a Survey Controller (*.dc) file into a project. System-generated reports usually inform you of problems or errors in your data that Trimble Geomatics Office finds. To view these reports, access them from the *Reports* folder in their project folder.
Recompute	how Trimble Geomatics Office calculates the positions for all points in the project. The software calculates a position for each observation to a point. If there are multiple observations, it uses tolerance values to determine when a misclosure is reported. For more information about recomputation, refer to the Help.

Working with Your Project

Once your project is created and you have specified its properties, you can then enter or import data. For more information, see Chapter 2, Importing, Exporting, and Using Trimble Devices.

Trimble Geomatics Office Workflow

Figure 1.2 shows a workflow that you can follow when using Trimble Geomatics Office. Moreover, this is the workflow that is represented in this manual.

Set up project and select coordinate system - This chapter

↓

Import data files - chapter 2

↓

Transfer files to the Trimble Survey Controller software for fieldwork - chapter 2

↓

Complete fieldwork

↓

Transfer fieldwork files - chapter 2

↓

Check and edit observations - chapter 3

↓

Process GPS baselines - chapter 7

View raw GPS data using Timeline - chapter 7

Perform a Network Adjustment - chapter 8

↓

Perform a GPS site calibration - chapter 4

↓

Process feature codes - chapter 4

↓

Edit the project in the Plan view - chapter 3

↓

Produce database reports - chapter 5

↓

Export to a third-party format - chapter 2

Figure 1.2   Trimble Geomatics Office User Guide Workflow

Completing a Session and Opening an Existing Project

When you finish working with your project, you do not need to save it. Trimble Geomatics Office saves all edits to a project as they are completed, so just exit the software.

In the future, you can open your project by selecting *File* / *Open Project*. The project opens in the Survey view at the size it was when you last had it open.

Note – When you open a project that was created using software that included different modules (that is, WAVE Baseline Processing and Network Adjustment), you can still view all of the survey data, such as error ellipses and processed baselines, because it stays the same. However, you cannot perform any other tasks that require these modules.

Project Coordinate Systems

You must have the correct coordinate system selected for your project. Otherwise, the software computes and displays incorrect coordinate values.

When you specify a template for a new project, the project template determines the coordinate system. However, you can change this coordinate system at any time, within certain guidelines.

This chapter introduces the coordinate system database, and shows you how to use geoid models and specify the coordinate system for a project.

The Coordinate System Database

The coordinate system database is stored as a file called Current.csd. This file contains information about coordinate systems, zones, sites, and geoid models. When you specify the coordinate system for a project, the information comes from this database.

When you want to work with the coordinate system database, use the Coordinate System Manager utility to:

- view the published coordinate system definitions

- add new parameters (ellipsoids, datum transformations, coordinate systems, sites, and geoid models)

- edit user-defined parameters

For more information, refer to the Coordinate System Manager Help.

Using Geoid Models

Points observed with GPS have heights based on the WGS-84 ellipsoid. These heights are known as *ellipsoid heights*. To obtain estimated elevations based on these heights, use a geoid model. A geoid model gives the separation between the ellipsoid and the geoid, or the mean sea level surface. By applying this separation to an elevation, you can obtain a height which then provides an elevation.

Geoid Grid (*.ggf) files

Geoid models are stored as Geoid Grid (*.ggf) files. A geoid model contains a name and a reference to a .ggf file. These files contain geoid-ellipsoid separations (also known as geoid separations) over a defined area.

The coordinate system database already contains defined standard geoid models; each coordinate system has a default geoid model. However, you can create a new geoid model, using the Coordinate System Manager utility.

If you have the Grid Factory utility installed, you can use it to view the geoid separation in the .ggf files.

Using a geoid model to determine the elevation for GPS points

When you select a geoid model, Trimble Geomatics Office uses the .ggf file to interpolate the geoid separation (N) at the position of each GPS point observed. It then adds the value to the observed ellipsoid height (h). This gives an approximate elevation above sea level (e) for the GPS point.

Note – For accurate elevations, observe points with known elevations and perform a GPS site calibration. For more information, see Chapter 4, GPS Site Calibration.

Figure 1.3 shows the relationship between the geoid and the local ellipsoid.
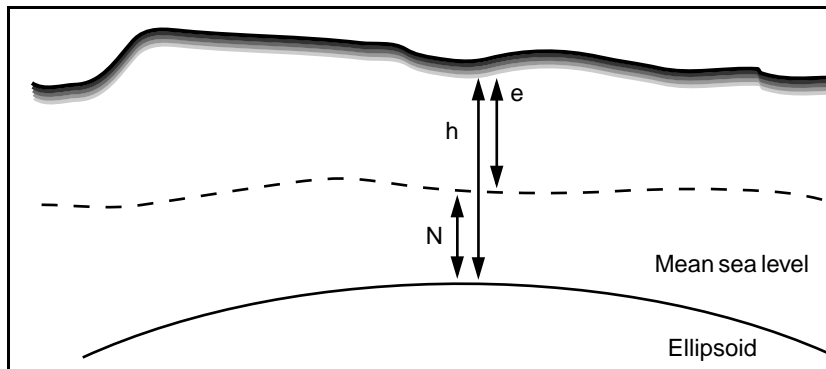
Figure 1.3   Geoid-ellipsoid separation

If you do not use a geoid model or perform a GPS site calibration, the elevation of a point will be the same as the ellipsoid height and is not an accurate elevation.

Note – If you use a geoid model in the project coordinate system, the software uses it to convert between local ellipsoid heights and elevations for all point types, not just GPS.

Selecting a geoid model

To select a geoid model for the project coordinate system, use one of the following methods:

- Use the default geoid model defined for the project coordinate system.

- In the Coordinate System Manager utility, specify a geoid model as part of the coordinate system definition. For more information, refer to the topic Geoid Model dialog in the Coordinate System Manager Help.

- In Trimble Geomatics Office, change the coordinate system for the project. Select a geoid model from the list of available models. For more information, see Changing to a Different Project Coordinate System, page 14.

Note – You can only select a geoid model for a coordinate system zone or the default Transverse Mercator projection. If you select a site, you can only change the geoid model that it uses by editing the site in the Coordinate System Manager utility.

Selecting the geoid model quality

Use the *Recompute* tab of the *Project Properties* dialog to select the quality for the geoid model used for the project. A recomputation uses this quality to determine the quality of elevations (for a GPS point) or height (for terrestrial points) derived from the geoid model.

For information on selecting the geoid model quality, see Changing Project Properties, page 7.

Changing to a Different Project Coordinate System

You may need to change to a different coordinate system (and geoid model) from the one determined by your project template. Trimble recommends that you do this *before* adding points to the project. Otherwise, the point coordinates in your project will change.

Select a different coordinate system by using one of the following:

- The Coordinate System wizard from the *Project Properties* dialog

- Data imported from a controller or control unit with a coordinate system defined.

- Data to initialize a default Transverse Mercator projection

The Coordinate System wizard

You can select a coordinate system and zone, a recently-used coordinate system, a site, or a default Transverse Mercator projection that you have defined parameters for.

A site is a set of coordinate system parameters that you name and save to use again in other projects. It can also include GPS site calibration (horizontal adjustment, vertical adjustment) values. For more information on creating a site calibration, see Chapter 4, GPS Site Calibration.

B **Tip –** If you have applied a GPS site calibration to your project, the software stores the calibration parameters as part of the coordinate system definition. If you want to create other Trimble Geomatics Office projects for the same area, save the coordinate system as a site so that you do not have to perform a GPS site calibration each time.

A defined default Transverse Mercator projection is one that you have defined parameters for. Define parameters for an undefined Transverse Mercator projection if you require a local projection, and know the origin, and false northing and false easting values for the projection. For more information, refer to the Help.

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To open the *Select Coordinate System* dialog and access the Coordinate System wizard:

1. Select *File / Project Properties*. The *Project Properties* dialog appears.

2. In the *Coordinate System* tab, in the *Coordinate System Settings* group, click **Change**.

The Coordinate System wizard guides you through the selection of a different coordinate system, site, and/or geoid model, if necessary.

Coordinate Systems in Survey Controller (*.dc) Files

When you import a Survey Controller (*.dc) file, Trimble Geomatics Office compares the coordinate system in the .dc file with the one in the project. If they are different, the *Project Coordinate System* dialog appears so that you can specify which coordinate system the software is to use.

If necessary, view the differences between the coordinate systems first. Do one of the following:

•   Click **Details** for each coordinate system.

•   Click **Summary** to view a comparison report of the full parameters of the two coordinate systems.

Note – If the project coordinate system is an undefined default Transverse Mercator projection, (that is, it does not have an origin latitude and origin longitude defined) the software automatically changes the project coordinate system to the coordinate system in the .dc file. The Project Coordinate System dialog does not appear and any existing points in the project do not change.

Using the .dc file coordinate system

If the coordinate system in the data file is *not* Scale factor-only, the project coordinate system definition changes to the one that is specified in the data file; all points in the project are transformed to the new coordinate system. However, for Trimble Geomatics Office to change the coordinate system, one of the following must be true:

- All points in the database have elevations.

- The project has a default elevation specified.

If Trimble Geomatics Office cannot change the coordinate system, a warning message appears.

If the coordinate system in the data file *is* Scale factor-only, the steps taken depend on the coordinate system that is defined for the project. For more information, see the following section.

Using a Scale Factor-Only Coordinate System

To import Scale factor-only files in Trimble Geomatics Office:

1. Use arbitrary grid coordinates (for example, 10000, 10000) in your file.

2. Create a project in Trimble Geomatics Office with the default Transverse Mercator projection. For example, use the *Metric* or *US feet* project template.

3. Import the file into your project. For more information, see Chapter 2, Importing, Exporting, and Using Trimble Devices. The *Default Projection Definition* dialog appears.

Use the dialog to specify the false origin values for the coordinate system. Trimble Geomatics Office automatically enters the default projection with the scale that is defined in the file. It enters the false northing and false easting of the projection, using the first grid position in the imported file. For more information, refer to the topic Scale Factor-Only Files – Overview in the Help.

Note – In the Project Properties dialog, the Reduce terrestrial observations to ellipsoid (Sea Level correction) check box in the Recompute tab is clear. This is because sea level corrections are not applied in the software when you are using a Scale factor-only job.

Note – If you have a defined coordinate system in the project, when you import a file with a Scale factor-only coordinate system, the existing coordinate system will be used. Make sure that the scale factor in the project coordinate system is the same as the scale factor in the file. If it is not, import the file into a project with a compatible coordinate system.

Using a Default Transverse Mercator Projection

The default coordinate system for a standard project template is an undefined Transverse Mercator projection. An undefined default projection does not have an origin latitude or origin longitude defined.

To use the default Transverse Mercator projection as the coordinate system for the project, select a standard template (for example, the *Metric* and *US Feet* templates) when you create the project.

When you first enter survey data to a project using an undefined default projection, the *Default Projection Definition* dialog appears. The dialog suggests projection parameters that are suitable for the data that you are entering.

The following situations are possible:

- You import a file with a GPS point to a project (with an undefined default projection) containing grid points.

- You import a Scale Factor-Only file to a project (with an undefined default projection).

- You import or key in a WGS-84 point to an empty project (with an undefined default projection).

- You key in a grid point to an empty project (with an undefined default projection).

Note – When you import a file containing GPS points to a project with an undefined default projection, the project coordinate system automatically changes to the coordinate system specified in the file.

To specify the projection parameters, from the *Default Project Definition* dialog, do one of the following:

- If a GPS or WGS-84 point is added to the database, enter the grid coordinates for the point.

- If only a grid point is added to the database, accept the false northing and false easting values, or enter new values.

Ground Coordinate Systems

To use ground coordinates in Trimble Geomatics Office, you need to select a coordinate system for the project. Then do the following:

1. Select *File / Project Properties*.

2. In the *Coordinate Systems* tab, in the *Local site settings* group, click **Change**. The *Local Site Settings* dialog appears.

3. Enter coordinates for the project location.

4. Enter the ground scale factor, or compute it using the coordinates for the project location.

Importing, Exporting, and Using Trimble Devices

In this chapter:

- Introduction
- How to Import Files in Trimble Geomatics Office
- Transferring Files from a Controller
- How to Export Files in Trimble Geomatics Office
- Transferring Files to the Trimble Survey Controller Software

Introduction

Once you have set up your Trimble Geomatics Office project, you can then enter or import data into it. You can import CAD or ASCII data files from a folder on your computer, or import/transfer data from a controller such as a one running the Trimble Survey Controller software. You can export data to a folder on your computer, or export/transfer data to a controller.

Table 2.1 shows a workflow that you might use with Trimble Geomatics Office. The table shows the potential relationship between importing files into your project, then transferring files to and from a controller, and exporting files to third-party software.

Table 2.1   Workflow for importing, transferring, and exporting files

	Perform this task ...	using this method ...
1	Import a CAD or ASCII data file into your Trimble Geomatics Office project.	In the *Import* dialog, use the *CAD* / *ASCII* or *Custom* tab (if you have defined your own import format). Alternatively, use Windows' drag-and-drop functionality.
2	Transfer a file containing the design points to the controller so that you can use the design points in the field.	In the *Export* dialog, use the *Survey* tab.
3	Transfer the files back to your computer and into your project for checking, editing, or processing.	In the *Import* dialog, use the *Survey* tab.
4	Export project data to a third-party format for further processing or analysis.	In the *Export* dialog, use the *CAD* / *ASCII* or *Custom* tab (if you have defined a format). Alternatively, use drag-and-drop.

The following sections describe how to import, transfer, and export files, using Trimble Geomatics Office.

How to Import Files in Trimble Geomatics Office

When you select *File* / *Import*, the *Import* dialog appears, as shown below:
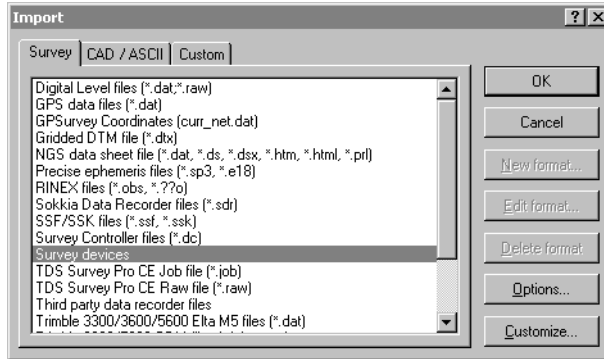
The dialog contains three tabs; the file that you are importing determines which tab you need to use, as shown in Table 2.2.

Table 2.2   Tabs in the Import dialog

Use this tab ...	if you are importing ...
Survey	survey data from a controller or from another folder on your computer.
CAD / ASCII	an ASCII data file in a format supported by Trimble Geomatics Office.
Custom	an ASCII data file in a format that you have defined. For more information about creating custom import formats, refer to the Help.

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To import a file, use one of the procedures in Table 2.3.

Table 2.3   How to import files

If you are importing ...	then ...	and ...
an ASCII data file	in the *CAD / ASCII* or *Custom* tab, select the format of the file to be imported and click **OK**. (If the format does not contain coordinate system information, and the file to be imported is in a different coordinate system from the project, in the *Settings* tab, click **Options**, then **Change** to select the coordinate system for the file.)	in the *Open* dialog that appears, locate the file that you require, select the point quality for the points in the file, and click **Open**. **Note** – The quality that you select under the **Options** buttons is assigned to both horizontal and vertical components of the points. You can change the quality of the coordinate components later using the *Properties* window.
survey data from another folder on your computer	in the *Survey* tab, select the format of the file to be imported and click **OK**.	in the *Open* dialog that appears, locate the file that you require and click **Open**.
survey data from a controller	in the *Survey* tab, select the Survey devices option and click **OK**. (If you do not have a controller set up, refer to the Data Transfer Help.)	in the *Open* dialog that appears, select a device and click **Open**. Once your computer is correctly connected to the device, in the *Open* dialog, select the file that you want to import, specify the format of the file, and click **Open**.

Once you have imported a file, Trimble Geomatics Office does the following:

- Creates a selection set for it. You can view the selection sets in a project by choosing *Select* / *Selection Sets*.

- Performs a recomputation. It examines all observations to points and shows the best coordinates. It then creates a homogenous data set, ensuring that all data is derived from points in the same coordinate system. Any misclosures are reported in the Recompute report, and need to be corrected before the data is processed. For more information, see Chapter 6, Recomputation, or refer to the Help.

Note – If you import a file more than once to the same project, the file is added to the appropriate folder, with a dash and a number at the end of the file name. For example, if you import a .dxf file named MyDXFFile twice, MyDXFFile.dxf and MyDXFFile-1.dxf are stored in the Data Files folder.

Events that May Occur When Importing Files

When you import a file, Trimble Geomatics Office performs several checks on it, depending on the type of file. If the software finds any problems, one of the following occurs:

- A message appears, alerting you to the problem.

- An appropriate dialog appears. Correct the details in the dialog and try importing the file again.

For more information about a message or dialog, press [F1] to access the context-sensitive Help.

Managing duplicate points when importing data

Points that have the same name are known as *duplicate points*. To specify how the software will manage and resolve duplicate points at import, in the *Import* dialog, click **Options**.

You can also separate merged points, using the *Explode Points* dialog. For more information, refer to the Help.

Import Report

Each time you import or transfer a file to a project, Trimble Geomatics Office creates a report for the file, named *<name of imported file>*.html. This report contains:

*   Project Details – shows the project name and coordinate system details.

*   Messages (if any occurred on import).

*   Recompute report – the Import report includes a link to the Recompute report, which is created in the *Reports* folder. This report summarizes the results of the recomputation process.

A report named Import.html is also created. It lists all of the files that are imported to the project. Any files that are imported in another session are automatically added to this report.

The way that you are notified of system-generated reports is controlled in the *Reporting* tab of the *Project Properties* dialog.

Transferring Files from a Controller

The procedures for importing/transferring all files from controller software are basically the same. However, the following sections give further details about specific files, where necessary.

Survey Controller (*.dc) and GPS Data (*.dat) Files

Survey Controller (*.dc) files contain data from fieldwork carried out using Trimble Survey Controller. They can include GPS and terrestrial data. To view .dc files, use the DC File Editor utility. For more information about .dc files, refer to the DC File Editor Help.

GPS Data (*.dat) files contain raw GPS data from a Trimble GPS receiver. You can transfer this data to your computer from the receiver, or from Trimble Survey Controller.

GPS .dat files do not contain coordinate system information, so the coordinate system defined for your Trimble Geomatics Office project must be correct.

The Dat Checkin dialog

After you have selected the .dat file(s) to be imported, the *Dat Checkin* dialog appears:
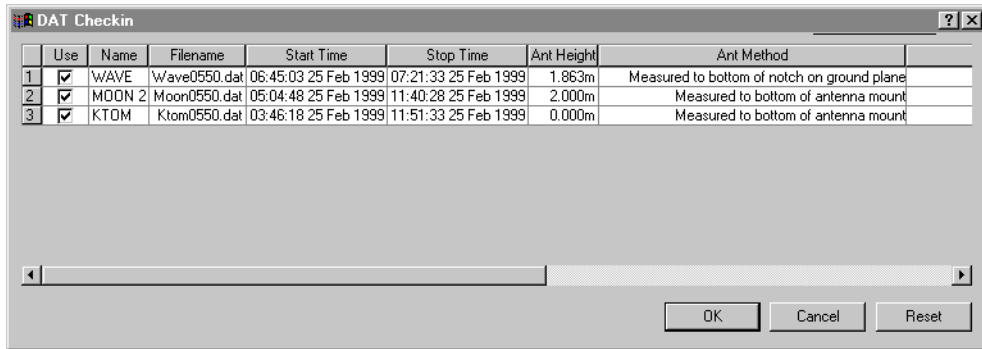
Use this dialog to check or edit the values in the file(s) before import.

If you change a value in the dialog, Trimble Geomatics Office uses this new value. However, the value in the .dat file (your field data) remains unchanged. After editing you can revert to the original file values, if necessary, by clicking **Reset**.

Note – If you import a .dat file more than once to the same project, existing occupations in the project are not selected in the DAT Checkin dialog. You cannot import the same GPS segment more than once.

Assigning qualities to points in Trimble Geomatics Office

When you perform a GPS postprocessed Kinematic or Static survey—using Trimble Survey Controller and a Trimble GPS receiver—and store the GPS data in your controller, this data is stored as a .dat file.

This file is linked to the .dc file that is created from the Trimble Survey Controller job, so when you import the .dc file to your project, the .dat file is imported too.

Note – On version 7.7 or earlier Survey Controller files, the GPS file is stored as a .raw file. When you transfer the GPS data to your computer, the .raw file is converted to a .dat file.

Trimble Survey Controller assigns each point a class, and because the .dc and .dat files are loaded together, point information from the .dc file can link with points in the .dat file. Trimble Geomatics Office uses information about the point's class, and the method used to determine its position, to assign the point a quality. The software then uses this quality to compute the best position for the point.

If you collect and store your GPS data in a Trimble GPS receiver, when you transfer the data from the receiver to your computer, Trimble Geomatics Office receives no information about class. The software generally assigns such classless points the quality of *unknown*.

For more information about Trimble Survey Controller point classes, or point and observation qualities and recomputation in Trimble Geomatics Office, refer to the Help.

RINEX Files

Receiver INdependent EXchange (RINEX) files contain raw satellite tracking information and navigation, and meteorological data collected by a GPS receiver. They are an ASCII representation of data collected by GPS receivers.

To use the RINEX file format, you need the following files on your computer:

- Observation Data *.obs / *.XXo

- Navigation Message file *.nav / *.XXn

- Meteorological file (optional) *.met / *.XXm file

Note – If the observation and navigation files do not have the same name, you can match them in the Navigation File Matching dialog.

Trimble Geomatics Office treats RINEX files similarly to the way it treats Trimble GPS Data (*.dat) files.

Digital Level Files

Leveling observations or delta elevations often form part of the terrestrial adjustment network. You can also use them to improve the elevations derived from GPS observations. You can use Trimble DiNi or Leica NA 2002/3000 digital levels.

Note – The software does not support Leica measurement records recorded outside of the level run, that is, 330 records.

Imported level data is reported in the Point Derivation and Recompute reports.

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Digital Level Import dialog

After you have selected the Digital Level file(s) that contain the data to be imported, the *Digital Level Import* dialog appears:
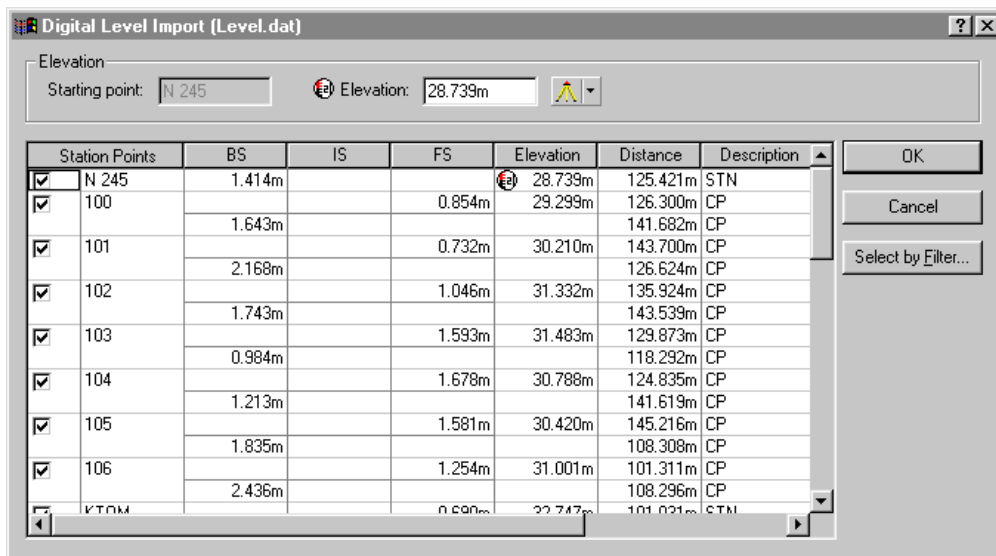
If a point is checked it is considered to be a station point. Level data is used to compute delta elevations between station points. These delta elevations are imported into Trimble Geomatics Office. Foresight and backsight observations are not imported. Clear some check boxes or use the **Select by Filter** button to select the station points that you require.

Note – You cannot select an intermediate sight unless the preceding backsight is selected. When you select any sight except an intermediate sight, all other sights with the same name are selected also.

Use the *Digital Level Import* dialog to check and correct the values in the file(s) before import. If you change a value in the dialog, Trimble Geomatics Office uses this new value. However, the value in the Digital Level file (your field data) remains unchanged.

Editing Starting Point Elevations Before Import

In the *Digital Level Import* dialog, enter an elevation for starting points—the software uses this elevation to compute elevations for other points. You can then compare the computed elevations with known values:

1. Click on any point in the loop—the starting point elevation for the loop will appear in the *Elevation* group.

2. Edit the elevation and quality and press [Enter]. The elevation will be computed for all station points.

Note – Only elevations with the elevation symbol are imported; other station points have delta elevations imported. Their elevations are computed during a recomputation.

For information about other file types that can be transferred from a controller, refer to the Help.

How to Export Files in Trimble Geomatics Office

When you select *File* / *Export*, the *Export* dialog appears, as shown below:
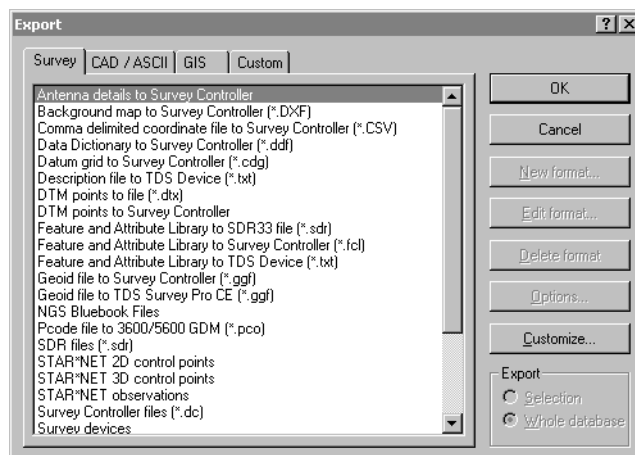
The dialog contains four tabs; the file that you are exporting determines which tab you need to use, as shown in Table 2.4.

Table 2.4   Tabs in the Export dialog

Use this tab ...	if you are exporting ...
Survey	survey data to a file or controller.
CAD / ASCII	data to a variety of ASCII and CAD formats.
GIS	points and their associated attributes to GIS formats.
Custom	data in a custom ASCII format. For more information about creating custom import formats, refer to the Help.
	Tip – To add a new format by installing an external filter, in any tab of the *Export* dialog, click **External**.

Once you select the appropriate format, click **Options** if you want to:

- configure the version or format of the file that you are exporting

- select the coordinate system of the file to be exported. (Use this option to export coordinates in a different coordinate system from your project).

Events that May Occur When Exporting Files

When you export a file, Trimble Geomatics Office performs several checks, depending on the type of file. If the software finds any problems, a message appears alerting you to the problem. For more information about a message, press [F1] to access the context-sensitive Help.

To export a file, use one of the procedures in Table 2.5.

Table 2.5   How to export files

If you are exporting ...	then ...	and ...
data to a controller such as a one running Trimble Survey Controller	in the *Survey* tab, select the Survey devices option and click **OK**. (If you do not have a controller set up, refer to the Data Transfer Help.)	in the *Save As* dialog that appears, select a controller and click **Save**. Once your computer is correctly connected to the device, in the *Save As* dialog, specify where the exported file is to be stored in the device, and the name of the file to be exported, and click **Save**.
data to another folder on your computer	in the *Survey* tab, select the format of the file to be exported and click **OK**.	in the *Save As* dialog that appears, locate the folder that you want to export the file to, specify the name of the file to be exported, and click **Save**.
data in a third-party software format. **Note** – The export formats supported by Trimble Geomatics Office are listed in the Help.	in the *CAD / ASCII* or *Custom* tab, select the format of the file to be exported and click **OK**.	in the *Save As* dialog that appears, locate the folder that you want to export the file to, specify the name of the file to be exported, and click **Save**.

B   **Tip –** You do not have to export your whole project. You can export selected entities only, using the *Select* menu.

Note – The Trimble Data Exchange Format helps you to export survey data to other Trimble Geomatics Office projects and other applications for geodetic operations, such as network adjustment. For more information about this format, refer to the Help.

Transferring Files to Trimble Survey Controller

You can transfer to Trimble Survey Controller any files that you need to complete fieldwork, for example, Survey Controller (*.dc) files containing points to stake out, Geoid Grid (*.ggf) files, and Feature and Attribute Library (*.fcl) files. For information about the versions of Trimble Survey Controller that you can export each file type to, refer to the Help.

The procedures for exporting all files are basically the same. However, the following sections give further details about specific files, where necessary.

Geoid Grid (*.ggf) Files

If you want to use a geoid model in your coordinate system when you are in the field, you need to transfer a Geoid Grid (*.ggf) file to Trimble Survey Controller (version 6.0 or later). These files are stored in the \Program Files\Common Files\Trimble\Geodata folder.

When you are transferring a .ggf file, Trimble Geomatics Office gives you the opportunity to create a subgrid of the geoid model specified in the coordinate system definition for your project. This process creates a smaller .ggf file that is easier to transfer to your controller.

Note – Although you can transfer any .ggf file, you can only subgrid from the one that is selected for your project.

Begin exporting a .ggf file in the normal way. Once you choose to create a subgrid, the following dialog appears:

The yellow box on the globe defines the area covered by the geoid model. (There is no yellow box if the geoid model covers the world.)

Inside the yellow box, use the tools provided in the dialog to drag a box around the area to be represented in the new .ggf file. You can then continue to export this .ggf file. For more information about how to subgrid .ggf files, refer to the Help, or to your Trimble Survey Controller documentation.

Note – You can also transfer Geoid Grid (*.ggf) files to the TDS Survey Pro (CE) software version 4.0 or later.
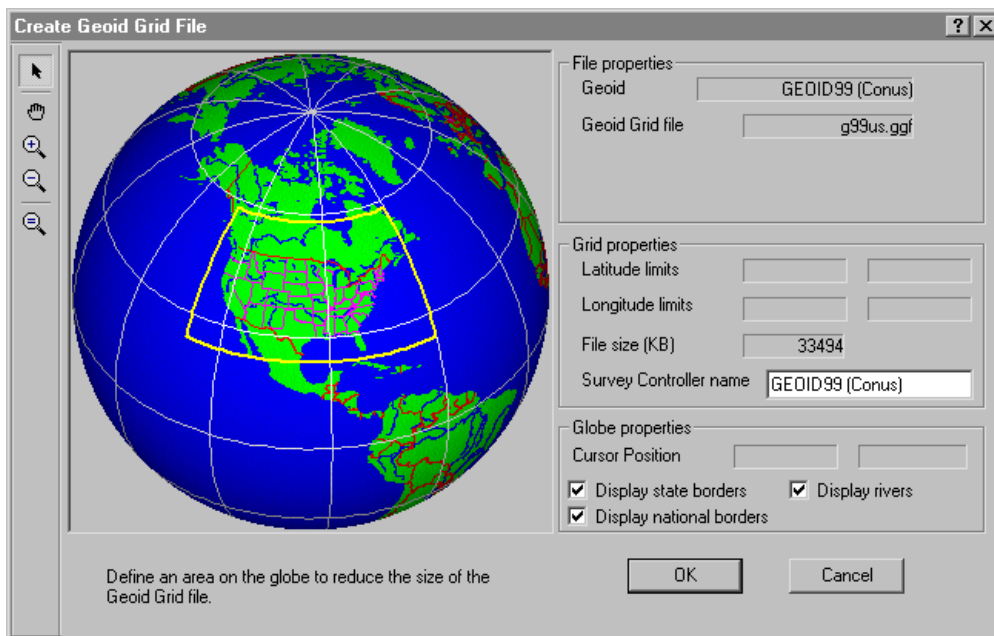
Combined Datum Grid (*.cdg) Files

If you want to use a datum grid in your coordinate system when you are in the field, you need to transfer the grid to Trimble Survey Controller (version 7.0 or later) as a Combined Datum Grid (*.cdg) file.

Transfer an existing .cdg file, or create a new one in Trimble Geomatics Office. The software uses a Longitude Grid (*.dgf) file and matching Latitude Grid (*.dgf) file to create the .cdg file. These files are stored in the \Program Files\Common Files\ Trimble\Geodata folder.

Note – To create a Combined Datum Grid (*.cdg) file, the coordinate system for the current project must use a datum grid as its datum transformation method. For more information, refer to the Coordinate System Manager Help.

Creating a .cdg file is very similar to subgridding a .ggf file. Begin exporting the .cdg file as normal, and the software will give you the opportunity to create a new one. In the *Create Combined Datum Grid File* dialog, specify the size and scope of the .cdg file that you require. You can then continue to export this .cdg file. For more information about creating .cdg files, refer to the Help.

Feature and Attribute Library (*.fcl) and Data Dictionary Files

You can use a feature and attribute library in the field to select feature codes for points and store attribute definitions. However, before you export the library:

• In the *Export* dialog, click **Options** and specify the library to be exported, and the version of Trimble Survey Controller you are exporting to.

For information about how to export Data Dictionary (*.ddf.) files, refer to the Help.

Digital Terrain Model (*.dtx) Files

You can use the DTMLink™ utility to transfer a regular (North-South and East-West) grid of points interpolated from a Surface Model as a Digital Terrain Model (*.dtx) file for stakeout. To export this DTM file, use the *Export* dialog in DTMLink.

You can also import a Digital Terrain Model (.dtx) file from DTMLink into a Trimble Geomatics Office project for transfer to Trimble Survey Controller.

Antenna Files

Transfer the Antenna.ini file so that you can use the antennas from the *Survey Controller* group in the Antenna.ini file in Trimble Survey Controller. Once the file has transferred, you can only use the antennas from the *Survey Controller* group in Trimble Survey Controller.

Note – If you transfer an Antenna file to a controller running Trimble Survey Controller 6.0 or earlier, the Antenna.dat file is used.

UK National Grid Files

To transfer UK National Grid (*.pgf) files to a controller running Trimble Survey Controller 7.5 or later, use the standalone Data Transfer utility, which is available with the Trimble utilities in the *Start* menu. You can transfer any of the existing .pgf files located in the \Program Files\Common files\Trimble\ GeoData folder.

For information on using the utility, refer to the Data Transfer Help.

Viewing, Selecting, and Editing Data

In this chapter:

- ■ Introduction
- ■ View Options
- ■ Customizing onscreen information
- ■ Selecting entities
- ■ Viewing the details of entities
- ■ Viewing and editing points
- ■ Viewing and editing observations
- ■ Viewing erroneous data
- ■ Editing survey data
- ■ Editing multiple entities at one time
- ■ Using the data analysis tools

Introduction

Once you have imported your data into the Trimble Geomatics Office software, you can view it in different ways, select particular entities, check for errors, and edit it. You can do all of this in the graphics window.

View Options

You can control how the Trimble Geomatics Office software presents data, using the *View Options* dialog. This dialog appears when you select *View* / *Options*. Each of its tabs are described in Table 3.1.

Table 3.1   Tabs in the View Options dialog

Use this tab ...	to ...
Survey Data	change the way that survey data is displayed in the Survey view.
Grid Lines	show the scale of the project and to help you to easily find particular coordinate locations.
	Note – You can print a plot with its grid lines by selecting *File* / *Plot*/*Print*.
Survey Legend	select the colors used to display survey data in the graphics window. For more information about colors used, refer to the Help.
Error Ellipse Controls	specify how error ellipses are displayed, if you have the Network Adjustment module installed.
Background Map	select a background map file to display.
	You can import Drawing Exchange Format (.dxf), Windows Bitmap (.bmp), or Tagged Image File Format (.tif) files to display as background maps. To be displayed correctly, these files must be georeferenced, using the ESRI World file format (an ASCII text file with a .tfw or .wld extension).
	The World file must use the same coordinate system and units as your project.

Customizing Onscreen Information

When you are viewing a project in the graphics window, you can use the following methods and tools to customize the information that you see. For more information about each tool described, refer to the Help.

- Zoom tools – magnify, reduce, or move the data that is visible in the graphics window.

- Point labels – show the details of points. Select *View* / *Point Labels* and then complete the *Point Labels* dialog.

  Note – When you close and then re-open a project, the labels settings are restored. However, labels are not stored in the project database, so if you want labels that can be exported and reported, use annotations in the Plan view.

- View filters – only show the data that you specify in the graphics window; all other data is hidden, so you can view and edit your work in the Survey view more easily. In the Survey view, select *View* / *Filters* and complete the *View Filters* dialog.

  Once a filter is applied to a project, the *View Filters are on* icon appears in the status bar. Like point labels, view filters are restored after closing and reopening a project.

  Note – In the Plan view, use layers to filter data. For more information, refer to the Help.

- The zoom navigator. For more information, see Table 1.1, page 4.

Selecting Entities

You can select some or all of the entities in a project. Using the mouse, you can randomly select entities individually, or drag a selection box around a group. Alternatively, use the commands in the *Select* menu (Survey view) shown below:
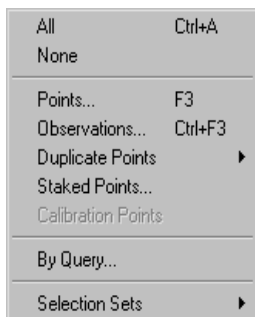
All	Ctrl+A
None	
Points...	F3
Observations...	Ctrl+F3
Duplicate Points	▶
Staked Points...	
Calibration Points	
By Query...	
Selection Sets	▶

Table 3.2 lists the commands and selection methods to use with certain software functions.

Table 3.2   Selection methods

If you are ...	use this Select menu command ...
processing feature codes	*Selection Sets* – because the order of the selected entities is important.
managing duplicate points	*Duplicate Points* – in both views, you can select duplicate points by coordinate, name, and name and positions within a specified distance.
	By Query
performing a multi-edit	*Points*, *Observations*, or *By Query*
making staked point enquiries	*Staked Points*
exploding calibration points to make pure Grid/GPS points	*Calibration Points*

Table 3.2   Selection methods (Continued)

If you are ...	use this selection method ...
processing baselines (If you have the WAVE module installed)	Select individual baselines to process. Use the *Dependent Baseline View* tool when the Timeline window is open.
browsing point information	Click on any entity or entities.

In the Survey view, you can only select entities that are currently visible in the graphics window; that is, you cannot select filtered out data. In the Plan view, you cannot select data that is in a locked layer.

Selecting Points and Observations

When you choose *Select* / *Select Points*, the *Select Points* dialog appears. Each tab in the dialog is described in Table 3.3.

Table 3.3   Tabs in the Select Points dialog

Use this tab ...	to select points by ...
General	name, quality, source, feature code, layer, or point style. If you specify values for more than one field, the software selects points that satisfy all criteria. **Note** – For information about rules for selecting points by name, refer to the topic Select Points dialog – General tab in the Help.
GPS	GPS quality.
Occupation	occupation details, such as antenna height.

When you choose *Select* / *Select Observations*, the *Select Observations* dialog appears. This dialog is similar to the *Select Points* dialog, but does not have an *Occupation* tab, and is only available in the Survey view. Use it when selecting observations and GPS baselines.

Note – When completing the Select Points or Select Observations dialogs, you can use wildcards to select multiple point names.

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Using Selection Sets

A *selection set* is anything that you currently have selected in the software. You can save it and retrieve it later. These saved selection sets maintain the order of their entities. If you delete entities that are part of the selection set, the selection set still works with the remaining entities.

To save or retrieve a selection set, or access a recently-used set, use the *Selection Sets* submenu.

Note – When you import a data file, the software automatically creates a selection set for you. This selection set has the same name as the file you imported.

Selecting Entities by Queries

A query retrieves data from multiple fields in one or more tables in the database, based on the criteria specified.

To specify the type of query:

• Choose *Select* / *By Query.*

If necessary, use the options in the *Selection* group to create specific selections:

• *New* – creates a new selection set.

• *Add to current* – adds the selection set that you create to the current selection set.

• *Refine current* – using the current selection set, the software finds points that are common with the selection set you are about to create.

Selecting Entities in the Plan View

In the Plan view, you can also use the *Select* menu to select entities based on the following Plan view properties: layers, styles, types, and point features.

Viewing the Details of Entities

You can view the details of entities (points, observations, lines, arcs, curves, text, annotations), using the *Properties* window. The selection set you define appears in the *Properties* window, and from this set, you can choose the entities whose details you want to view.

To open the *Properties* window, select *Edit* / *Properties*, or double-click a graphical entity. Figure 3.1 shows the *Properties* window, and the table following it describes each part.
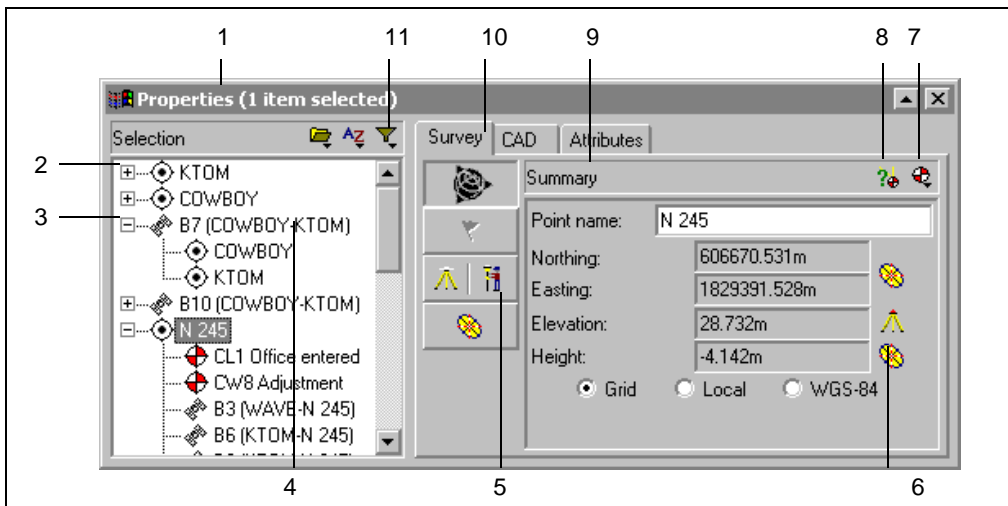

Figure 3.1   The Properties window

Part	Function
1	Shows the number of items selected.
2	Lets you expand and collapse the tree view outline.
3	Lists the entities in your current selection set. You can only view the details of one entity at a time. If you have more than one entity selected, from the list select the entity you want to look at.
4	Shows the source of the coordinates.
5	Page buttons occur in the *Survey* and *Stakeout* tabs. Use them to access different pages.

Part	Function
6	Point quality indicators.
7	*Add Coordinate* tool
8	*Show Derivation Report* tool.
9	Page names show which page in the tab that you are viewing.
10	The tabs organize data into groups. The availability of the tabs depends on the type of entity selected.
11	Selection tools
Not shown	*Insert Current Value* ⊙ tool. This tool is only available when you are adding a new coordinate.

The information and tabs available on the right side of the *Properties* window depend on the entity type currently selected. This right side of the window is organized by pages. To change the page that you can see, click the appropriate page button.

The following sections describe how to use the *Properties* window to view data for each type.

For specific information on each page and section of the *Properties* window, use the ToolTips or press [F1].

Viewing and Editing Points

Each tab in the *Properties* window lets you view and edit different point details. Table 3.4 shows how the information is organized.

Table 3.4   Tabs in the Properties window

Use this tab ...	to view and/or edit...
Survey	survey-related details such as the derived position, warning messages, occupation and setup details, coordinates, and observation statistics.
Stakeout	details about staked out points.

Table 3.4   Tabs in the Properties window (Continued)

Use this tab ...	to view and/or edit...
CAD	CAD-related details (for example, CAD style, layer, feature code value, and description). **Tip** – To view any CAD entities assigned to the point (for example, lines, curves, arcs, and annotations), click the plus (+) icon beside the point. Then, click the entity that you want to view.
Attributes (if the selected point contains attribute information and you have set up the project for attributes)	attribute information, if the selected point contains attribute information and you have set up the project for attributes (for example, you can view, edit, add, and delete attributes).
Station and Offset	station and offset details.

You can also view how the software calculated the position of a point, by selecting the *Show Derivation Report* 🛂 tool and accessing the Point Derivation report. Select this tool while a point is currently highlighted.

Note – You can only view a Point Derivation report after a recomputation.

B   **Tip –** To view the *from* and *to* points for any observation, click the plus (+) icon beside the observation. Then, click the point that you want to view and edit.

Entering Coordinates for a Point

Each point in Trimble Geomatics Office can only have one keyed-in WGS-84 coordinate and one keyed-in grid/local coordinate. A keyed-in coordinate can be added either by entering one using the *Properties* window as an *office-entered coordinate*, or by importing a coordinate file.

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Using the Properties window to enter coordinates

To enter a coordinate for a point, use the *Add coordinate* 🔁 tool. You can choose to add a Grid, Local, or WGS coordinate. If you already have a coordinate for the point, you cannot enter another of the same type (Grid/Local or WGS-84).

If the original coordinate is incorrect, you should edit this coordinate.

To edit the quality of the coordinate, you must set the quality to either control or survey to ensure that the coordinate is used to position the point.

Tip – When you add a new coordinate, all of the fields are null (?). Use the *Insert Current Value* 🔘 tool to enter the current point position and quality. You must select each field before the *Insert current value* tool is available.

Changing the status of coordinates

To determine whether or not a coordinate is used to derive the position of a point, in a *Coordinate* page of the *Properties* window, specify whether the coordinate's status is enabled, disabled, or enabled as check (the coordinate will be used only if there are no other enabled observations or coordinates).

The software performs a recomputation, and you can view the new derived position for the point in the *Summary* page of the *Properties* window. (Disabled coordinates are not shown in the Recompute report.)

Renaming Points

If you have points with duplicate names in a project that are not to the same physical point, you can resolve the duplicate points by renaming them.

Select the required points, and then select *Edit* / *Rename Points*. In the dialog that appears, use one of the available methods to rename the points.

Note – If the duplicate points are to the same point, then you should resolve them by merging them.

Viewing and Editing Observations

You can view the survey details of any observation type, such as:

- GPS observations (for example, RTK, Static, FastStatic and postprocessed kinematic baselines)

B   **Tip –** To view an observation from or to a point, click the plus (+) icon beside the point. Then, click the observation that you want to view.

- Conventional observations

- Level observations

- Laser rangefinder observations

- Azimuth observations

- Reduced observations

Viewing Erroneous Data

Trimble Geomatics Office may find the following errors:

- An incorrectly observed point

- A misclosure between two or more observations to the same point

When this happens, the graphics window displays a warning flag on the point or observation, and the *Flag* 🚩 icon appears in the status bar. View the warning details in the *Properties* window.

Note – Warning flags only indicate a possible error in the point; they do not disable the point.

Resolve or suppress all warning flags before exporting coordinates. When you resolve an out-of-tolerance closure by disabling a bad observation or renaming the point if the observation was to a different physical point, the warning flag disappears.

B **Tip –** Use the Point Derivation report to investigate the cause of the error.

GPS Loop Closures

You can check the quality of, and identify any errors in, a set of GPS observations within a network by performing loop closures and viewing the GPS Loop Closures report.

Select *Reports* / *GPS Loop Closures Report* and use the failed loops sections of the report to identify:

- loops where the misclosures are outside the specified tolerance values

- GPS observations that do not fit in the network

- GPS station occupations for the baselines that do not fit in the network.

For information on GPS loop closures, see Chapter 7, WAVE Baseline Processing, or refer to the Help.

Editing Survey Data

During the inspection of the project, you identify problems with the survey data. The following sections describe methods you can use to resolve these problems before you continue with the next task.

Changing the Status of Observations

By default, observations are always *enabled*. However, to determine whether a recomputation will use GPS or terrestrial observations to derive the calculated position of an observed point, change this enabled status. In the *Summary* page of the *Properties* window, select Enabled, Disabled, or Enabled as check.

For information on other ways to change observation status, refer to the Help.

When your edits to the survey data could change the coordinates for a point in the database, the red *Recompute* 🔴 icon appears in the status bar.

Note – If the difference between the derived position and the position calculated from an observation enabled as check is outside the tolerance set for the project, then a warning flag is generated on the point and the misclosure reported in the Recompute report.

Reversing the Direction of Observations

GPS and terrestrial observations flow out in the direction in which the baseline was observed. For RTK observations, the direction will be from the base to the rover. The direction of postprocessed Static and FastStatic baselines is based on the positional qualities of the *from* and *to* points. The direction is applied from the point with the higher quality to the point with the lower quality. For terrestrial observations, the direction will be from the instrument point to the target point.

A recomputation applies the observation in the direction that is stored in the project. For more information, see Chapter 6, Recomputation.

You can reverse the direction of an observation so that a recomputation applies the observation in the opposite direction—this may change the calculated coordinates and qualities of the point.

C **Warning –** If the point that you want the observation to flow out from does not have a known position, the observation is not applied.

To reverse the direction of a GPS baseline, select the GPS observation and then *Edit* / *Reverse Observation flowout.*

When the edits to the survey data could change the coordinates for a point in the database, the *Recompute* 🔴 icon appears in the status bar.

The recomputation reapplies the observation to flow out from the opposite point.

Editing Multiple Entities at One Time

Use the *Multiple Edit* dialog to edit the survey- and CAD-related properties of more than one entity in your current selection set at the same time. This dialog changes depending on the properties that are common to the selection set, so you can only make valid changes.

For example, you can correct the antenna or instrument heights for a group of stations if they have been incorrectly entered during setup. You can also add a group of entities to a specific layer.

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To access the *Multiple Edit* dialog, select the entities that you want to edit and then *Edit / Multiple Edit*:

Use the *Survey* tab to edit survey-related properties, and the *CAD* tab to edit the CAD-related properties.

For more information on each option, refer to the Help.

Using the Data Analysis Tools

The following sections describe the tools that are available to help you analyze your data. For example, you can check the inverse between two points, or determine the extent of the survey area.

Viewing the Inverse Between Two Points

You can display the inverse to determine the difference between any two points in the project. To do this:

• Select *Survey* / *Inverse* and complete the *Inverse* dialog that appears. You can use field fill-in to select the points defining the inverse from the graphics window.

Measuring Positions within the Graphics Window

You can measure the distance, azimuth, and any area from the graphics window. This is useful if you want to quickly determine the extent of the survey area. To do this:

• Select *Survey* / *Measure* and complete the Measure dialog that appears. Again, you can use field fill-in to click any position in the graphics window and define the object being measured.

With three or more points selected, the software shows the area of the figure formed by closing back to the first point. The units of the computed area vary depending on the distance display settings. For more information, refer to the Help.

GPS Site Calibration

In this chapter:

- Introduction
- Computing a GPS site calibration
- Saving a GPS site calibration

Introduction

A GPS site calibration establishes the relationship between WGS-84 points collected by GPS receivers, and local grid positions on a local map grid. The local map grid includes elevations above sea level, and the GPS data includes WGS-84 heights.

Published coordinate systems and geoid models do not usually allow for local variations in the projection. You can compute a GPS site calibration to reduce these variations and obtain more accurate local grid coordinates.

You can compute any number of GPS site calibrations in a project. If you apply a new calibration to a project, the coordinate system is updated with the new parameters, and all points in the database are updated with the new coordinate system values.

Computing a GPS Site Calibration

The following procedure shows how to select parameters for, and compute, a GPS site calibration:

1. To access the *GPS Site Calibration* dialog, select *Survey* / *GPS Site Calibration*:
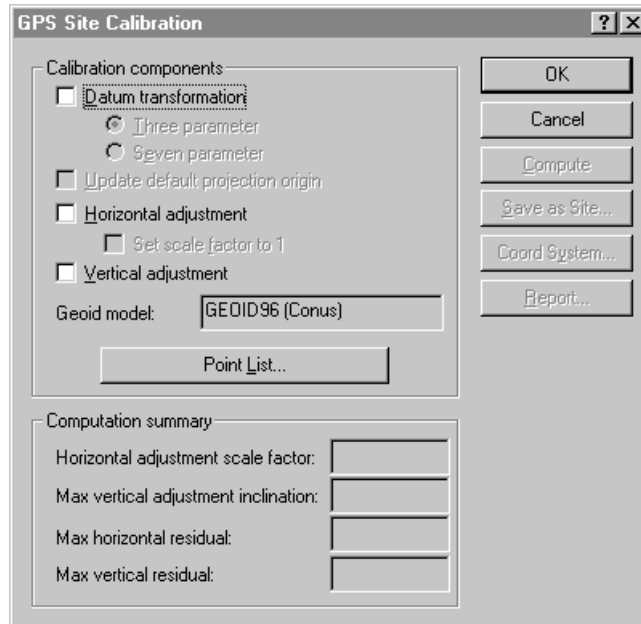
2. Select components by completing the appropriate items in the *Calibration Components* group. For more information about completing the *GPS Site Calibration* dialog, refer to the Help.

3. Select the point pairs for calculating the GPS site calibration parameters by clicking **Point List**. The following dialog appears:
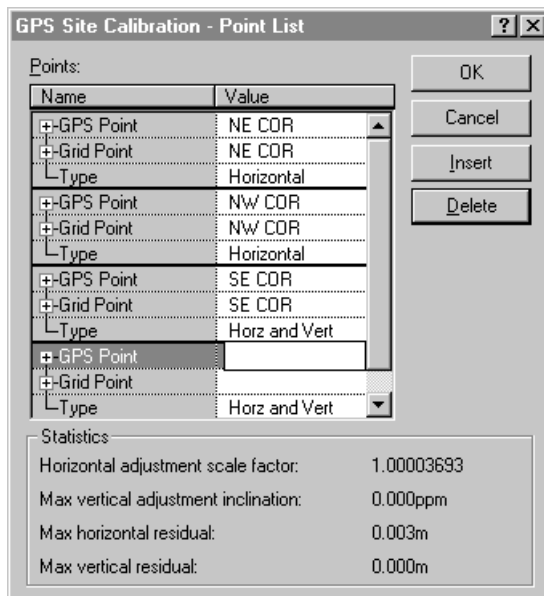
Each calibration point pair must consist of:

–   a GPS point (a point with a GPS position or derived from GPS data)

–   a grid point (not a GPS-derived point), which is normally a control point (or an adjusted point)

As you specify each point pair, the software checks that each GPS point has a GPS derivation, and that each grid point does *not* have a GPS derivation.

Note – If you have two separate points (a GPS point and a grid point) with the same name, when the GPS point is selected, the grid point with the same name is automatically selected. If the GPS and grid coordinates are saved under the same point, you need to explode the points by type. For more information about exploding points by data type, refer to the Help.

Trimble recommends that you use at least four 3-dimensional control point pairs, so that the results will have redundancy.

For more information about the *Point List* dialog, refer to the Help.

4. To compute the calibration parameters, click **Compute**.

5. Check the calibration parameters in the *Computation summary* group. If any of the parameters are not within expected ranges, use one of the following methods to find the problem point pairs:

    –   Examine the point pairs.

        *Note – You can view a report of the last computed calibration by clicking **Report** in the GPS Site Calibration dialog. The report is stored as Calibration.html in the Reports folder.*

    –   Check that the grid points have the correct coordinates.

    –   Check that you have the best known coordinates for the base point of your GPS survey. If the errors in the calibration are small, they may be caused by errors in the observations. An error in the observation of up to one part per million (1 ppm) can be introduced by each 10 m (33 ft) of error in the base coordinates. If you reobserve with a more accurate base position, you may improve the observations and consequently the calibration results.

B   **Tip –** To locate any errors, repeat the calibration procedure but leave out a different point pair each time. When the computation summary values are as you expect, you have found the problem pair.

If you locate an error in one of the point pairs, fix the error and recalibrate. If you cannot fix the error, delete the calibration point pair from the point list and recalibrate.

6. Once you are satisfied with the GPS site calibration, click **OK** to apply it to your project. You can then view the new coordinate system details in the *Project Properties* dialog.

Saving a GPS Site Calibration

If you plan to do future fieldwork in the immediate area, save the coordinate system (which includes the calibration parameters) as a site by clicking **Save as Site** in the *GPS Site Calibration* dialog and completing the dialog that appears.

You can then use the site as the coordinate system for future projects. However, make sure that the project area is within the points used in the calibration. For example, in Figure 4.1, save the calibration as a site in project A, then use the site in project B. However, do not use the site in project C because the area is outside the points used in the GPS site calibration.
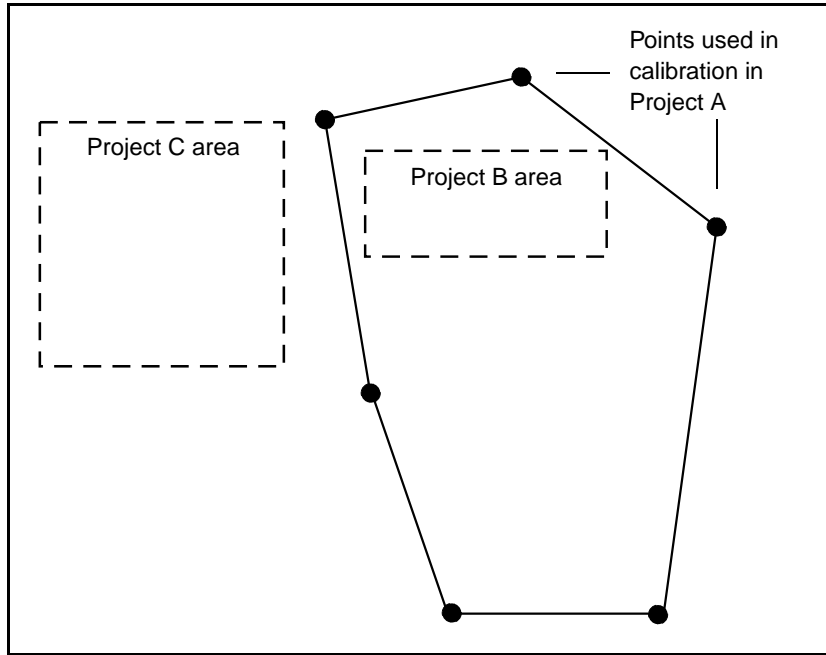
Figure 4.1   Site used for other projects

Reporting on a Project

In this chapter:

- ■ Introduction
- ■ Additional reports
- ■ Report links

Trimble Geomatics Office

Introduction

This chapter describes some of the reports that you can create using Trimble Geomatics Office. The reports provide summaries of projects and give you information that you can pass on to clients.

You can create a report for an entire project, or for only a particular selection of entities in the project. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

Trimble Geomatics Office displays the reports on the default HTML viewer installed on your computer (Microsoft Internet Explorer 4 and 5, and Netscape Navigator 4).

To specify the information that appears in the report, create a custom report format. For more information, refer to the Help.

Additional Reports

Trimble Geomatics Office also provides system database and custom reports.

System database reports are predefined report formats that you can use to obtain a summary of the current project. Normally, you do not need to edit these reports. However, you can modify them by editing the Asciirpt.dat file located in the \Program Files\Trimble\Trimble Geomatics Office\System folder.

Custom reports are determined by primary record types or queries that you define, and which are in the database. You can create, or edit a custom report format. You can prevent these reports from being modified by editing the Asciirpt.dat file located in the \Program Files\Trimble\Trimble Geomatics Office\System folder.

To access these additional reports:

- Select *Reports* / *Additional Reports* and then use the dialog that appears to create or view a report.

Report Links

Many of the reports in Trimble Geomatics Office contain links to:

- other parts of the report

- other reports

- the graphics window

- the *Properties* window

These links let you find points and investigate erroneous data more easily. For example, if you find a misclosure reported in the Recompute report, you can select the relevant point, locate it in the graphics window, and then investigate it further in the *Properties* window.

For information on report links in specific reports, refer to the Help.

5 Reporting on a Project

Recomputation

In this chapter:

- Introduction
- Recomputing data
- Calculating positions for observed points
- An example of a recomputation
- The Recompute report

Introduction

A recomputation is the process of determining the *calculated* position of a point. Trimble Geomatics Office performs a recomputation on all data—all GPS, conventional, terrestrial, delta elevation, and laser rangefinder observations, and keyed-in (by import or manually) coordinates for a point. It uses these observations and keyed-in coordinates to determine the position and quality for the point.

A recomputation calculates the position for points measured in the field, gives a point position an appropriate quality, detects and reports misclosures in data, and then creates a Recompute report.

If a point has redundant survey data, the Point Derivation report shows which observation/s or keyed-in coordinates were used to establish the calculated position. The Recompute report shows any redundant observations that are out of tolerance. Tolerances are defined in the *Recompute* tab of the *Project Properties* dialog.

Recomputing Data

A recomputation is needed whenever you add data to a project or edit existing data; the red *Recompute* 🔴 icon appears in the status bar to show when a recomputation is needed.

To perform a recomputation:

• Select *Survey* / *Recompute*.

A recomputation uses adjusted, control, or survey quality keyed-in coordinates in preference to observations. It does *not* distribute errors.

Calculating Positions for Observed Points

Figure 6.1, on the following page, shows how the calculated positions for points observed in the field are found.
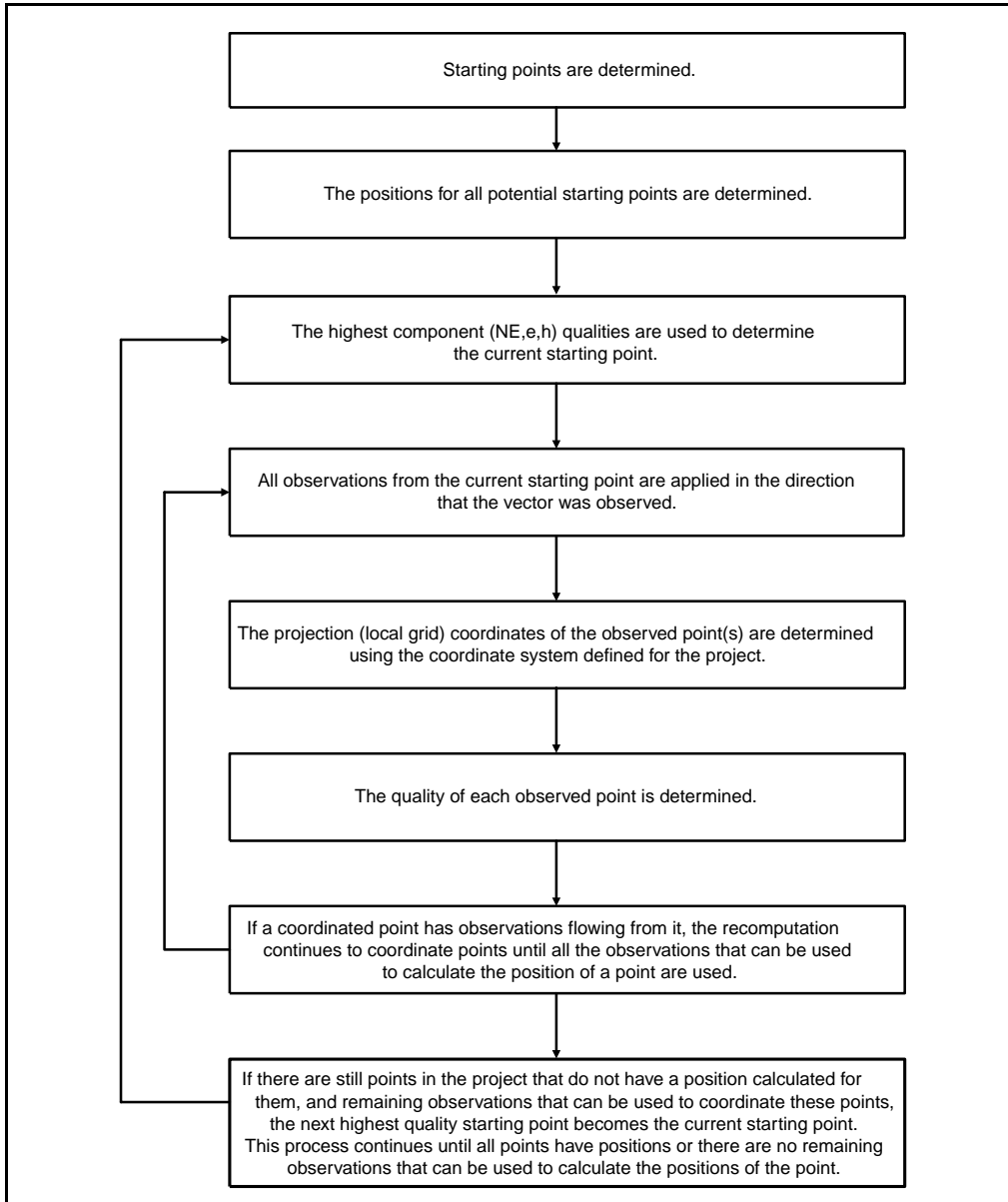
Figure 6.1   The recomputation process

> *Note – When determining the calculated position for a point, a recomputation does not use disabled observations or disabled keyed-in coordinates. It only uses observations or keyed-in coordinates that are enabled as a check if the positions of points in the project cannot be determined by any other observations or coordinates. To enable and disable observations, use the Properties window. For more information, see Chapter 3, Viewing, Selecting, and Editing Data.*

For more information about recomputation, refer to the Help.

An Example of a Recomputation

Figure 6.2 is an example of how a recomputation coordinates points. Points *A* and *I* are both control quality points; the remaining points are survey quality.

The recomputation establishes points *A* and *I* as potential starting points as both of these points have keyed-in coordinates and observations flowing from them. Points *A* and *I* are of the same quality (control L,L,h), so the recomputation chooses point *A* as the current starting point because it was entered in the database first.

To coordinate the observed points, the recomputation uses all of the observations from the starting point until the remaining observations flowing from *A* cannot be used to coordinate any more points. Therefore, the following points are coordinated from point *A*: *B*, *C*, *D*, *E*, *F*, *G*, and *H*.

There are no further observations from the current starting point (point *A*), so the recomputation chooses point *I* as the new current starting point. The recomputation coordinates points *J*, *K*, and *L*.

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There are observations from point *I* to points *D* and *H*. The recomputation has already coordinated these points so the figure shows a closure for these points. If the closure error is larger than the tolerance settings in the *Recompute* tab of the *Project Properties* dialog, an error flag appears on the observed point in the graphics window. The Recompute report reports the misclosure. It also reports if the closure error is smaller than the tolerance setting.

Note – If the recomputation can use more than two observations/coordinates to derive the position of the point, you can see a misclosure and a closure on the same point. For more information about how recomputation uses multiple observations and coordinates for a point, refer to the Help.
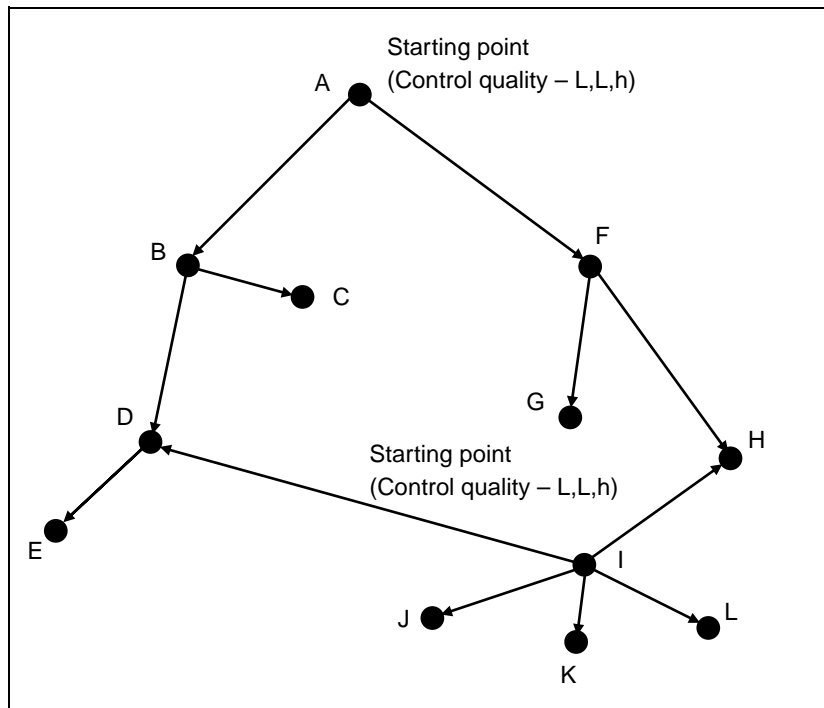
Figure 6.2   Recomputation example

C
Warning – Point D can be derived from observations from *B* and *I*. The observation from *B* is used regardless of the quality of these observations. This is because *D* is coordinated from *B* first. The software warns you that the quality of *D* could be improved. If you want to make sure that the observation from *I* is used, change the status of the observation from *B* to *D* to enabled as check.

The Recompute Report

The Recompute report summarizes the results of a recomputation. Use it to eliminate warning flags by doing the following:

- Checking occupation details

- Checking that points are named correctly

- Disabling the coordinate if you suspect that the coordinate has been keyed in incorrectly

- Reobserving if necessary

The Recompute report shows the following:

- Tolerance errors where multiple observations or coordinates result in positions outside tolerance (tolerances are defined in the *Recompute* tab of the *Project Properties* dialog)

- Closures for station points

- Unused observations and errors

- Starting coordinates and the order in which the coordinates were derived

- Observations and coordinates referenced in the report

A Recompute report is generated after each recomputation and is stored in the *Reports* folder. You can determine whether you are notified of its generation, by completing the *Reporting* tab of the *Project Properties* dialog.

The Recompute report shows general project details and the following:

- Errors
- Warnings
- Closures
- Point Derivations
- Starting Points
- Traverse Report
- Survey Data (Observations and Coordinates)

WAVE Baseline Processing

In this chapter:

- Introduction
- The WAVE baseline processor
- Determining potential baselines
- Selecting baselines to process
- GPS processing styles
- Processing GPS baselines
- Viewing the processing results
- Baseline acceptance criteria
- Saving processing results
- Timeline
- Viewing Timeline information
- Viewing detailed information

Introduction

The WAVE baseline processor computes baselines from GPS field observations made using Static, FastStatic, or Kinematic data collection. It uses carrier phase and code observations to produce three-dimensional GPS baselines between survey points.

Table 7.1 shows the functionality that the WAVE Baseline Processing module adds to your Trimble Geomatics Office software. (You only have this functionality if you have purchased the WAVE Baseline Processing module.)

Table 7.1   The WAVE Baseline Processing module

Use this function ...	to ...
WAVE Baseline processor (available from the *Survey* menu or the project bar)	process raw GPS observations, including Kinematic, Continuous Kinematic, Static/FastStatic, and infill data.
WAVE processing styles	specify different processing controls for the WAVE baseline processor, and to save the control sets as named styles.
Timeline window	view and edit raw GPS measurements and survey information. Displays GPS data in a chronological view. The close integration of the Timeline window with the graphics window makes this a powerful quality control tool.
GPS Baseline Processing report (HTML)	display detailed information about postprocessed baseline solutions. These reports are available both during processing and also later from the *Reports* menu.

The WAVE Baseline Processor

Once you have transferred raw data from receivers, controllers, or your computer into the Trimble Geomatics Office project, you can process GPS baselines in the Survey view.

The WAVE baseline processor examines the data to be processed and then determines the default values to be used, so little setup is required for processing. However, if you want to change specific processing parameters, you can use the advanced controls.

The baseline processor computes baselines from GPS measurements made by two or more receivers that collected data at the same time.

There are many factors to consider when processing GPS data. The following sections describe some of these factors and provide more information on how the baseline processor handles them.

Determining Potential Baselines

Trimble Geomatics Office automatically determines potential baselines. When new GPS measurements are imported into a project, the software searches for other overlapping data sets. A potential baseline is added to the project whenever there is an overlap in time between two data sets equivalent to, or exceeding, the value specified for minimum baseline observation time, or whenever an occupation identifier is encountered in kinematic data sets. The minimum baseline observation time is set on the *Static* tab of the *GPS Processing styles* dialog.

Selecting Baselines to Process

By default, the software processes all of the potential baselines in a project. However, you can also select which baselines are processed, using a selection set. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

B   **Tip –** You can reverse the direction in which Static and FastStatic baselines are processed by selecting *Edit* / *Reverse Observation Flowout*.

Selecting an Independent Baseline Set

To decrease the amount of artificial redundancy in your network when you process baselines, make sure that you only process independent baselines, by creating an independent baseline set. Artificial redundancy (inflated degrees of freedom) can lead to underestimation of the error in adjusted coordinates.

An independent baseline set consists of the minimum number of baselines required to connect all point occupations in a given GPS field session. For any given set of n simultaneous GPS point occupations, there are $n - 1$ independent baselines. For example, in a field session with five receivers, there are 10 possible baselines, but only 4 independent baselines.

Figure 7.1 shows independent baselines.
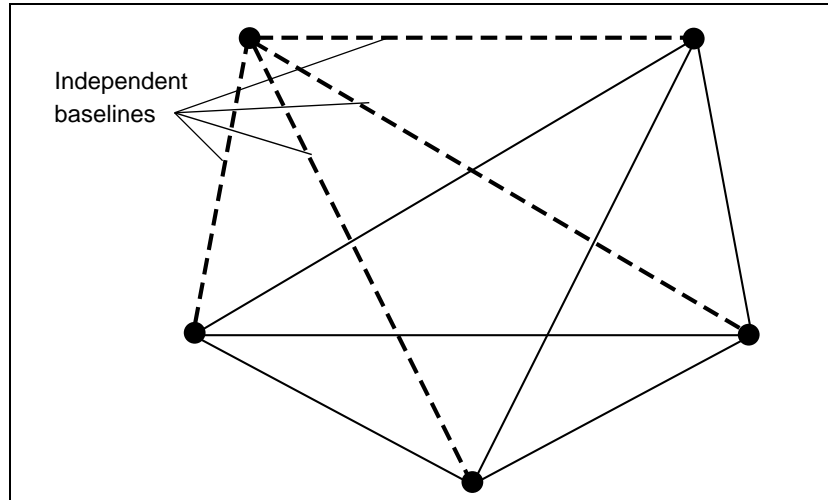
Figure 7.1   Independent baselines

Note – Independent baseline sets apply to Static and FastStatic surveys. They are particularly important for projects that include network adjustment.

The baselines derived from GPS field sessions using more than two receivers can be formed into multiple independent baseline sets. The choice of baselines included in the independent set can be based on the quality of the baseline solutions, or on achieving a desired network geometry.

To specify an independent baseline set, do one of the following:

•   Select and process only an independent set of baselines from among all potential baselines for a GPS field session.

•   Process all potential baselines for a GPS field session and select an independent set at the time the results are saved to the project.

•   Process all potential baselines for a GPS field session and save all the results to the project, then specify that the dependent baselines are not considered in a network adjustment.

Disabling dependent baselines

When the Timeline window is open, use the *Dependent Baseline View* tool to show the baselines that were observed at the same time. Then, disable the dependent baselines by selecting *Edit* / *Multiple Edit* and using the *Multiple Edit* dialog.

GPS Processing Styles

A GPS processing style contains specific settings for the baseline processor. You can use Trimble's default style, or specify your own settings and save them as a processing style, which you can then use for future processing sessions.

Selecting a Processing Style

To select a style to use for a processing session:

• Select *Survey* / *GPS Processing Styles* and complete the *GPS Processing Styles* dialog that appears:
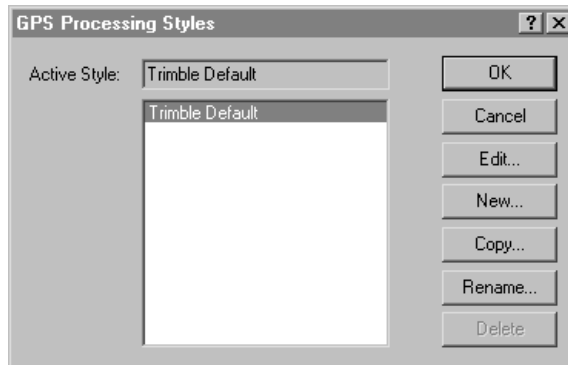
The style that you select becomes the *active* style.

Creating Processing Styles

To create a baseline processing style, in the *GPS Processing Styles* dialog, select a style that is similar to the one you need and then click **Copy**. Name and modify the style's common settings, as shown below:
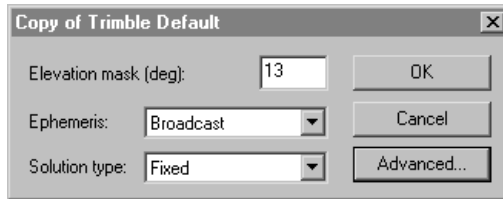
This is usually the most efficient way to create a new style.

Advanced processing settings

For most survey applications you do not need to modify advanced settings. Make sure that you understand the possible effects of any changes.

When you are modifying the common controls shown above, click **Advanced** to access the following dialog:
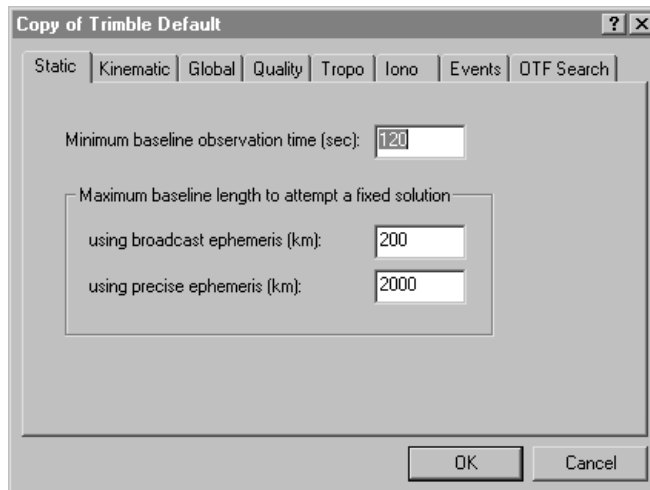
Table 7.2 describes each tab.

Table 7.2   Advanced processing controls dialog

Use this tab ...	to ...
Static	control Static and FastStatic baseline processing.
Kinematic	control Kinematic baseline processing.
Global	control Static **and** Kinematic processing.
Quality	identify and remove marginal data and solutions while processing and before saving the processing results to the project.
	determine which solutions pass, are flagged, or fail.
Tropo	select and apply tropospheric models.
Iono	apply ionospheric modeling.
Events	interpolate and display events.
OTF Search	control on-the-fly initialization strategies.

Processing GPS Baselines

To process all potential baselines:

•   In a project containing one or more potential baselines, select *Survey / Process GPS Baselines*. The *GPS Processing* dialog appears and the baseline processing begins. The progress of the session is monitored in the status bar of the dialog.

If you want to only process a selection of baselines, create a selection set before starting the WAVE baseline processor.

When multiple baselines exist between points

In a large project there are often two or more baselines based on different field sessions between two points. If you only want to process one of the baselines:

1. In the graphics window, select the baseline that you want to process. Initially, your selection set will contain all the baselines observed between these two points.

2. Select the appropriate baseline in the *Properties* window and start the baseline processor.

B **Tip –** You can also use this procedure to select multiple baselines for processing from among a larger set.

Viewing the Processing Results

You can view your processing results in the *GPS Processing* dialog, which appears automatically as baseline processing begins.

You can also use the GPS Baseline Processing report, which will help you to judge the quality of baseline solutions and identify processing problems.

To access this report, in the *GPS Processing* dialog, click **Report**. Alternatively, select *Reports / GPS Baseline Processing Report*.

For more information on viewing processing results, refer to the Help.

Baseline Acceptance Criteria

After processing is complete, the baselines on the map in the Survey view change color to indicate that the processing is finished. One or more of these baselines may also have red warning flags on them. A one-line summary of each baselines is displayed in the *GPS Processing* dialog.

The first field in the one-line summary is the *Use* check box. When this box is selected, it indicates that the Trimble Geomatics Office software has determined that, based on the criteria in the *Quality* tab of the active processing style, the baseline should be accepted into the project when a Save is applied. The acceptance criteria is also used to determine which baselines receive flags.

Levels of Acceptance

Trimble Geomatics Office has three levels of acceptance:

- Pass – the baseline has met the acceptance criteria as specified in the active processing style. The *Use* check box is selected for these baselines and no red warning flags are generated.

- Flag – one or more of the quality indicators for the baseline does not meet the criteria set for a pass status, but is not sufficiently bad to warrant a fail status. These baselines should be examined more closely to see how well they fit into the network. The *Use* check box is selected for these baselines and red warning flags are generated.

- Fail – one or more of the quality indicators for the baseline does not meet criteria set for a pass or flag status. The *Use* check box is clear for these baselines, and by default they are not saved to the project. If the *Use* check box is manually selected for these baselines, the baseline will be saved to the project and a red warning flag will be generated.

Acceptance Criteria

Acceptance criteria settings are specified in the *Quality* tab of the advanced processing style dialog. Separate criteria can be specified for single and dual frequency solutions. For information about accessing this dialog, see Advanced processing settings, page 81.

Acceptance can be based on any combination of checks using rms, ratio, and reference variance. The default is to use all three of these quality parameters to determine the pass/flag/fail status. If more than one of the quality factors are used together, the status is based on the worst condition. For example, if ratio and reference variance pass, but RMS fails, the baseline is given fail status.

Note – It is not necessary to modify the acceptance criteria for most survey applications. The exception, however, is for code-only final pass solutions. Code-only solutions typically are flagged based on the criteria supplied in the Trimble Default processing style. It is recommended that you set up a code-only processing style with appropriate acceptance criteria if you routinely process code-only final pass solutions.

For more information about acceptance criteria, refer to the Help.

Saving Processing Results

Once you have completed baseline processing, you need to save the processing results. In the *GPS Processing* dialog, you can specify which baselines you want saved. For example, if you want to perform a network adjustment, you can save only independent baselines. For more information about independent baselines, refer to Selecting an Independent Baseline Set, page 78.

To save processing results:

- In the *GPS processing* dialog, select the *Use* check box for each baseline that you want to save and click **Save**.

The processing results are saved to the project database.

Note – The Overwrite duplicate baseline solutions option in the GPS processing dialog applies only to baselines that are processed a second time. It does not affect baselines between the same two points that are computed from GPS data collected at a different time or on a different day. Trimble recommends that you always overwrite duplicate baseline solutions.

After the processed baselines have been saved, a recomputation incorporates all of the new information into the project. The recomputation may generate additional red warning flags if misclosures are detected. For more information, see Chapter 6, Recomputation.

Timeline

The Timeline window displays GPS data found in raw observation files in a graphical, time-based format. This information, including station occupation information and receiver tracking, is represented at its appropriate position on a timeline, using icons and other graphical representations.

Use Timeline to do the following:

- Edit antenna information.

- Adjust the occupation times used in baseline processing.

- Enable and disable satellite observations for use in the baseline processor.

- View the location of events in continuous kinematic surveys.

- Create plots for satellite observations.

- View satellite health and other orbit information.

Timeline is available only if you have transferred one or more GPS data files into your project and are working in the Survey view.

To start Timeline:

- In your project, select *View* / *Timeline*.

The *Timeline* and *Plot* toolbars appear, and the Timeline view area appears at the bottom of the graphics window.

Table 7.3 describes the information displayed in the Timeline window.

Table 7.3   The Timeline window

Area	Information
Time Ruler	Displays the time span of the information currently displayed in the Time Span viewer.
	Tip – To change the time display, from the main menu, select *File* / *Project Properties*, then the *Units and Format* tab. Select *GPS*, *Local*, or *UTC* time from the drop-down list in the *GPSTime display type* field.
Control bar	Displays a data folder for each receiver used in the project. If two files with GPS observations were collected using the same GPS receiver, one GPS receiver data folder is displayed in the control bar, and the information from the two files is displayed at the appropriate location in the Time Span viewer.
	Use the + icon to expand the information in the Time Span viewer to include satellite tracking.
Time Span viewer	The Time Span viewer below the Time Ruler displays information from the GPS data files in the project.
	Shaded boxes indicate GPS observation files for the time span of the recorded survey. The boxes are highlighted when active or selected. Satellite observations are organized as groups of segments for each SV. Each segment represents uninterrupted observations for the two recorded GPS signals, L1 and L2.
	Use the + icon for the receiver data folder to display satellite tracking for that receiver.

WAVE Baseline Processing

Viewing Timeline Information

To view and edit Timeline information, use the following:

- Selection tool

- A double-click or right-click of the mouse

- View Controls toolbar

- Timeline toolbar

- Plots toolbar

These tools let you open menus and dialogs, and adjust views. Double-clicking or right-clicking on elements or an open area in Timeline opens dialogs that let you edit information. Shortcut menu commands vary, depending on where you right-click. For more information, refer to the Help.

Using Timeline Elements

Table 7.4 shows the graphic elements that Timeline uses to represent the GPS survey data that appears in the Time Span viewer.

Table 7.4   Timeline elements

Graphic element	Survey data that it represents
Data folder	The raw observation data collected by a single receiver during one or more survey sessions. To open the *Receiver Properties* dialog, double-click on the data folder in the control bar.
Satellite icon	The satellites contributing raw GPS observation data to a survey.
Survey	At least one survey exists for every data folder appearing in the control bar. The survey represents one .dat or .dc data file collected by a single receiver during a data logging session. To view GPS data file information and edit the session ID, you must access the *Survey Properties* dialog by double-clicking the survey element in the Time Span viewer.

Table 7.4   Timeline elements (Continued)

Graphic element	Survey data that it represents
Occupation	A span of time where GPS observations are collected. They are classified into two types: Static Occupations—FastStatic and Stop-and-Go occupations Continuous Occupation Segments—Roving and Continuous Kinematic segments. Use the *Occupation/Data Segment Properties* dialog to edit the following: segment type, segment start and stop time, antenna height, antenna type, and antenna measurement method. Right-click on a segment in the Time Span viewer. The ToolTip displays the point name when you pass over the segment.
Station icon	Station icons are small red triangular icons and labels that identify Static, FastStatic, and Stop-and-Go kinematic station occupations.
GPS observations	The type of GPS observations and the tracking history of those observations during a survey session. GPS observation elements only appear when one or more data folders are opened. To select satellite tracking data for editing, right-click on satellite tracking data, or inside a selection rectangle. Select *Properties*. The *GPS Observation Properties* dialog appears.
Ephemeris icons	The times where broadcast ephemerides were received by the receiver for individual satellites. They only appear when one or more data folders are opened to show the data collected during a survey session.
Event icons	System-generated and manually generated events that occurred during a survey data logging session. Event icons only appear in the Survey view window and are presented as diamonds centered on the position of the event.

You can select each element and view its associated data properties. You can also edit the time span of collected data, disable selected satellite tracking information, and delete occupation or survey elements.

Figure 7.2, on the following page, shows each Timeline element.
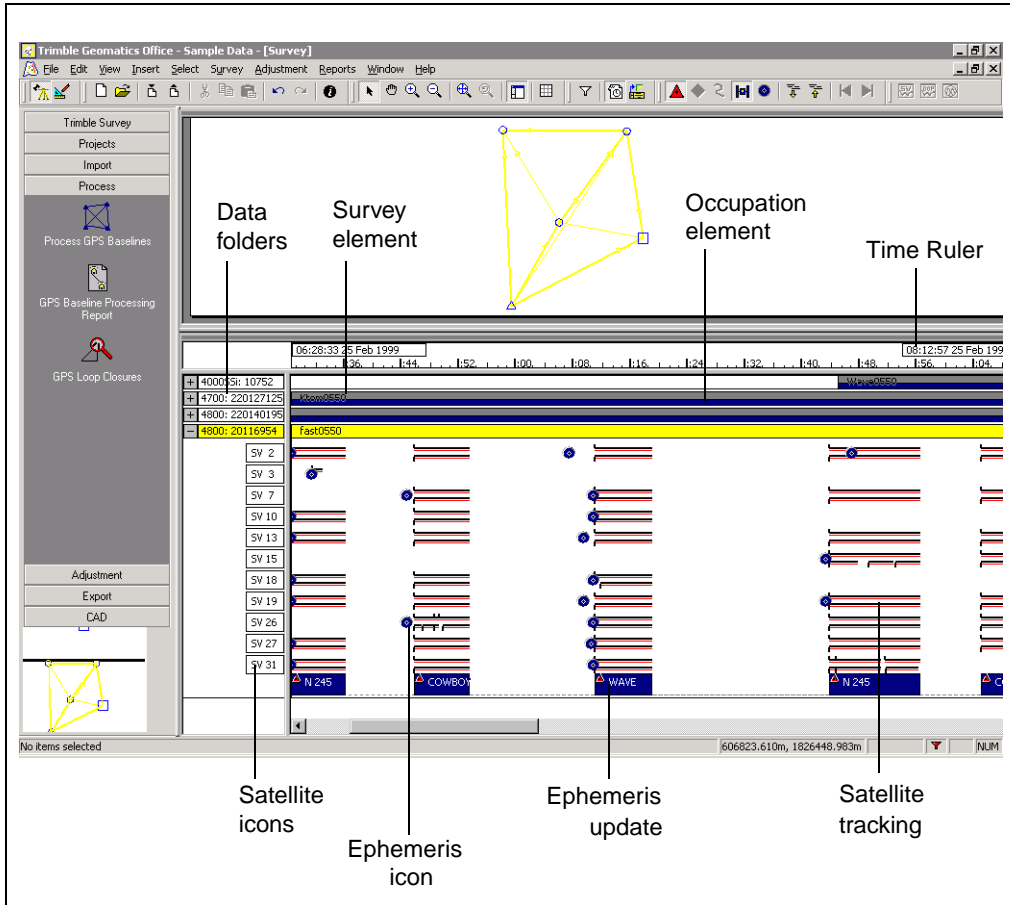
Figure 7.2   Timeline elements

Viewing Satellite Ephemeris Properties

Checking satellite ephemeris properties may provide some information in cases where processing problems occur. Select the *Ephemeris* tool [◆], then double-click a blue ephemeris icon on the SV tracking display. The *Satellite Ephemeris Properties* dialog appears.

Viewing Detailed Information

Use the Plot toolbar to display detailed plots and graphs of:

- DOP (Dilution of Precision) and the number of SV plots for a station occupation. Use the DOP Plot to analyze problematic baselines. It can help identify periods of time when the satellite constellation is weak. These periods may correspond to poor baseline solutions.

- Skyplots of satellites for a station occupation. The Skyplot provides a polar plot of the satellites that were visible at the location selected in the Time Span viewer. The Skyplot is derived from ephemeris information in the project that was current at the time of the occupation. The Skyplot displays azimuth and elevation for each SV with respect to the receiver location, which is at the center of the plot.

- GPS signal plots for a single satellite within a survey. GPS signal plots provide a detailed, advanced view of the GPS observations themselves. They can be used to show information such as the azimuth and elevation for each satellite. Satellites travelling at low elevations are more subject to multipath and cycle slips. Where orbit information is required, the ephemeris from the time of data collection is used.

The tools are shown in Table 7.5.

Table 7.5   Tools for graphical displays

Tool	Use to view the ...	It is available when ...
📊	*Occupation DOP/SV Plot* for a station	a station occupation is selected
🧭	*Occupation Skyplot* for a station	a station occupation is selected
📈	*GPS Signal Plots* for a session (You can also double-click on an SV label to view the graph.)	an SV label in the control bar is selected

WAVE Baseline Processing

8

Network Adjustment

In this chapter:

- ■ Introduction
- ■ Network adjustment workflow
- ■ The minimally constrained adjustment
- ■ The fully constrained adjustment
- ■ Combining GPS, terrestrial, and geoid observations in an adjustment

Introduction

When surveying, you should collect extra data so that you can check the integrity of your observations. When a survey has extra observations (redundancy), you can use them to minimize the effects of inherent errors before producing final results.

The Network Adjustment module helps you to do the following:

- Detect blunders and large errors in your measurements

- Account for systematic errors

- Estimate and model random errors

- Constrain your measurements to a published or assumed coordinate system, so that you can account for datum transformations

- Report estimated errors in your adjusted coordinates, adjusted observations, and transformation parameters

Table 8.1 shows the functionality that the Network Adjustment module adds to your Trimble Geomatics Office software. (You only have this functionality if you have purchased the Network Adjustment module.)

Table 8.1   The Network Adjustment module

Use this function ...	to ...
Network adjustment (available from the *Adjustment* menu or the project bar)	perform a network adjustment for GPS and terrestrial observations, analyze the results, edit the network parameters, and readjust the network.
	set variance groups and weighting strategies, and select observations to include in the adjustment.
Network adjustment styles	specify different controls for the network adjustment and to save the control sets as named styles.
Network Adjustment report	review the results of the adjustment in an HTML report and perform quality-control checks.
Ellipses toolbar	specify the appearance of error ellipses in the graphics window after a network adjustment.

Perform a network adjustment after the following:

- postprocessing your GPS raw data

- importing your RTK baselines (with QC2 data)

- importing and checking your terrestrial data (conventional and leveling observations)

You can also adjust geoid observations extracted from a geoid model selected for your Trimble Geomatics Office project.

Note – You can remove a network adjustment and return your network to the configuration that you originally had, by selecting Adjustment / Remove Adjustment.

Network Adjustment Workflow

Two major steps are used to perform a network adjustment:

- the minimally constrained adjustment

- the fully constrained adjustment

This chapter describes the procedures for both steps, starting with a minimally constrained adjustment, then moving on to the fully constrained adjustment.

Note – Before you adjust data in your Trimble Geomatics Office project, you must first import control points of a good quality. This is because after you import your data into the software, you need to perform a recomputation to determine the calculated position of the imported points. For more information about the importance of coordinate homogenization, refer to the Help.

Figure 8.1 shows the typical workflow for a minimally constrained adjustment, and the following sections give more information about each step.

Network Adjustment

Network Adjustment

Checking the Project Properties

Setting the Adjustment Datum (Minimally Constrained Adjustment)

Selecting and Editing the Adjustment Style

Selecting Observations for Use in Adjustment

Constraining a Control Point

Adjust **The Minimally Constrained Adjustment**

Viewing the Minimally Constrained Adjustment Report

Results acceptable? — No → Troubleshooting the Minimally Constrained Adjustment

Yes

Locking the Weighting Strategy Scalar

Saving Calibration Coordinates (Optional)

Fully Constrained Adjustment

Mistakes Still Present? — No → Changing Weighting Strategies

No → Viewing and Excluding Observations Flagged as Outliers

Yes → Reprocess or Reobserve

Figure 8.1   Minimally constrained adjustment flow

Setting the Adjustment Datum (Minimally Constrained Adjustment)

Set the adjustment *datum* before performing an adjustment.

For GPS observations, use the WGS-84 datum in a minimally constrained adjustment. Otherwise, you will have different weighting results. When the adjustment is completed, you can easily switch to your project datum for the fully constrained adjustment.

For terrestrial observations, use the project datum for performing a minimally constrained adjustment.

To change the adjustment datum:

- From the Survey view, select *Adjustment* / *Datum* / *WGS-84*.

Network Adjustment Styles

A network adjustment style contains specific settings for the Network Adjustment software. You can use one of Trimble's default styles, (for most surveys you can use the 95% Confidence Limits style) or specify your own settings and save them as a network adjustment style, which you can then use for future adjustments.

Network Adjustment

Selecting an Adjustment Style

To select a style to use for an adjustment:

•   Select *Adjustment* / *Adjustment Styles* and complete the
    Network Adjustment Styles dialog that appears:
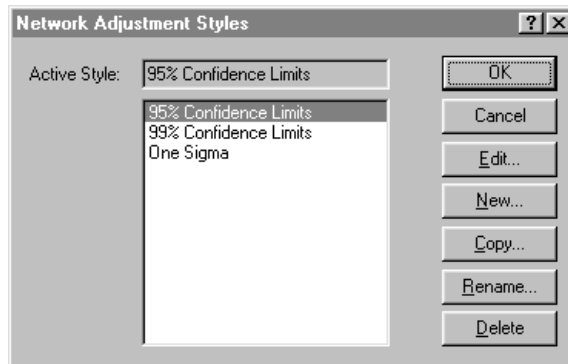
The style that you select becomes the *active* style.

Viewing and editing adjustment styles

To view an adjustment style, in the *Network Adjustment Styles* dialog,
click **Edit** to open a dialog for the selected style, as shown below:
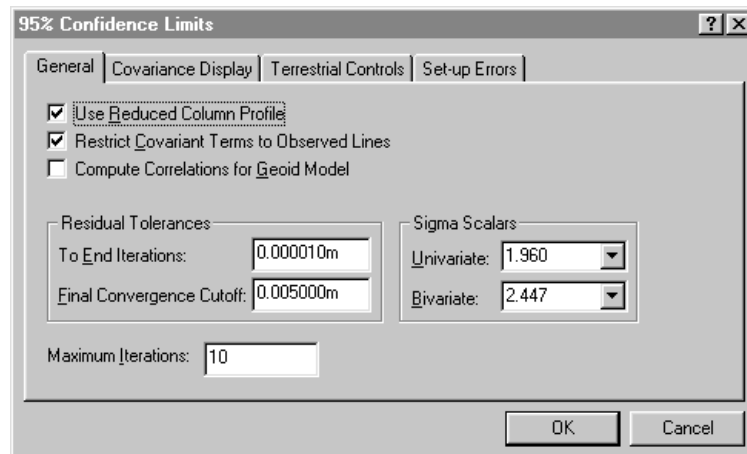
Table 8.2 describes each tab in the dialog.

Table 8.2   Tabs in the style settings dialog

Use this tab ...	to set ...
General	sigma scalars and tolerances
Covariance display	reporting precision for both horizontal (2D) and three-dimensional (3D) covariant terms
Terrestrial Controls	set terrestrial error estimates (The error estimate value must always be greater than the minimum standard error.)
Setup Errors	estimated errors for the GPS antenna height measurements, GPS antenna centering (plumbing), height of instrument, and instrument centering.

B   **Tip –** To create an adjustment style, in the *Network Adjustment Styles* dialog, select a style that is similar to the one you need and then click **Copy**. Name and modify the style's common settings. This is usually the most efficient way to create a new style.

Selecting Observations for Adjustment

Trimble Geomatics Office automatically selects certain types of observations for adjustment after importing or postprocessing. Other observations need only the generated adjustment parameters (*transformation parameters*) applied to them. Consider the following:

- The observations used to establish control points are adjusted to detect and eliminate large errors, distribute the random error, and generate error estimates for the points established.

- Observations for secondary control points and other points may only need the transformation parameters applied to transform them to the local (project) datum.

However, you can also select which observations are adjusted, using a selection set. For more information about selecting entities, see Chapter 3, Viewing, Selecting, and Editing Data.

Table 8.3 shows the observations that are automatically selected and when they are selected.

Table 8.3   Observations selected automatically

These observation types ...	are selected when ...
Postprocessed:	
Static	
FastStatic	
Kinematic (Stop-and-Go only)	saving the postprocessed solution
Real-Time Kinematic (with QC2) (Stop-and-Go only)	importing a .dc file
Imported postprocessed .ssf and .ssk Files:	
Static	
Fast Static	
Kinematic (Stop-and-Go only)	importing an .ssf or .ssk file
Leveling observations	importing a .raw or .dat file

Constraining a Control Point

Choose whether you will use inner constraints (free adjustment) or constrain (fix) one of the control points in the adjustment. With inner constraints, the program does not constrain a point, but minimizes the amount of shifts to the coordinates of the points from their pre-adjustment values.

Using either method will produce the same statistics for your observations, but there are advantages to constraining a control point. For more information about constraining/fixing control points, refer to the Help.

Network Adjustment

The Minimally Constrained Adjustment

You can now start the minimally constrained adjustment of your network observations.

Performing an Adjustment

To start the network adjustment:

1. From the Survey view, select *Adjustment* / *Adjust*. The status bar displays the current iteration of the adjustment. The adjustment will perform as many iterations as required (up to the maximum set in the adjustment style) to meet residual tolerance.

    (If the adjustment fails the *residual tolerance* (it does not converge), see Troubleshooting the Minimally Constrained Adjustment, page 102.)

2. Once the adjustment passes the residual tolerance (it converges), the software does the following:

    –   Updates the coordinates of the adjusted points.

    –   Retains the constrained point's coordinates and point quality (control).

    –   Performs a recomputation. The recomputation determines new coordinates for all non-networked points. The new coordinates are computed using the non-networked observations, propagating from the adjusted (and fixed) coordinates.

    –   Changes the symbol for the adjusted points.

    –   Generates error ellipses and arrows for each point in the network adjustment.

3. Select *View* / *Options* and use the *View Options* dialog to control the size and display of error ellipses and arrows.

4. Click the error ellipse and arrows icon to view the error ellipse and arrows at each adjusted point in the survey.

Network Adjustment

5. Open the *Properties* window to view the adjusted values and *Error estimate* (Error ellipse button) for each point, as shown below*:*
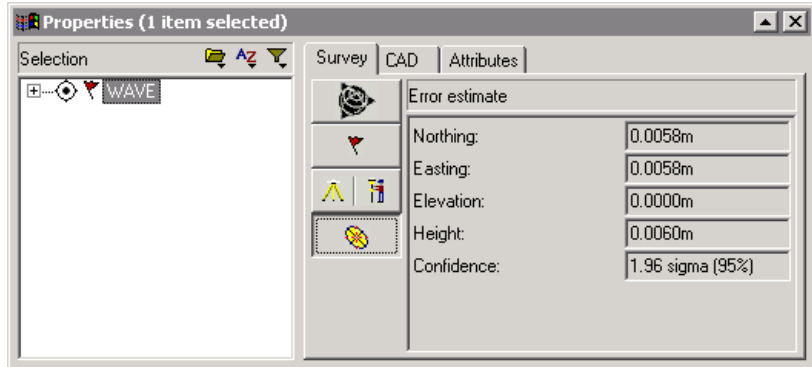
Now you can begin analyzing the results of the network adjustment by viewing the Network Adjustment report.

Viewing the Minimally Constrained Adjustment Report

You can view the results of the last iteration of the adjustment in the Network Adjustment report. To access this report, in the Survey view, select *Reports* / *Network Adjustment Report*.

For more information about analyzing the results of your network adjustment, refer to the Help.

Troubleshooting the Minimally Constrained Adjustment

The adjustment converges when the observation residual check is within the tolerance set in the adjustment styles. Trimble Geomatics Office computes the observation residuals using two independent methods, then differences the two sets of residuals.

Table 8.4 lists some problems you might see in a minimally constrained adjustment. For more information on how to perform each action, refer to the Help.

Table 8.4   Troubleshooting a minimally constrained adjustment

Problem	Possible cause	Action
Adjustment fails to converge after 10 iterations	One or more large errors or mistakes (blunders) exist in the observations. For example, an azimuth that is incorrect by 180 degrees.	With GPS data check suspect baseline solution statistics (Ratio, Reference Variance, RMS).
		Check the GPS Loop Closures report for suspect baseline.
		Check the Recompute report.
		Make sure that your observations flow out from good quality coordinates.
		Check antenna, instrument and target heights, correct any incorrect heights and perform a recomputation.
		Exclude (*Not used*) the suspect baseline from network adjustment (if not a critical observation in the network).
		Once you are confident the baseline is a problem that cannot be fixed, you can *Disable* the observation. Reobserve the suspect baseline (if critical to network redundancy).

Table 8.4 Troubleshooting a minimally constrained adjustment (Continued)

Problem	Possible cause	Action
Chi-square test fails	If no outlier is present:	
	A priori errors for your observations have been underestimated.	Change the weighting strategy to properly weight observations and estimate errors.
		Use the alternative scalar to scale the estimated errors.
	If outliers are present:	
	Large error(s) may be present in observation(s).	See observation outlier troubleshooting in this table.
	Blunders still exist in one or more observations	In your GPS data, check suspect baseline solution statistics (Ratio, Reference Variance, RMS).
	For example, an azimuth is incorrect by 180 degrees.	Check the GPS Loop Closures report.
		Check the Recompute report.
		Make sure that your observations flow out from good quality coordinates.
		If you are adjusting GPS data, check antenna height measurements, type, and method for each occupation. Correct antenna errors and perform a recomputation.
		If you are adjusting terrestrial data, check instrument and target heights. If necessary, correct height measurements and perform a recomputation.
		Exclude (*Not used*) the suspect observation from network adjustment (if not a critical observation in the network).
		Once you are confident the baseline is a problem that cannot be fixed, you can *Disable* the observation.
		Reobserve the suspect observation (if critical to network redundancy).

Table 8.4   Troubleshooting a minimally constrained adjustment (Continued)

Problem	Possible cause	Action
Observation Outlier (Standardize Residual > Critical Tau Value)	Noisy GPS baseline solution	Check suspect GPS baseline solution statistics.
		Troubleshoot and reprocess the suspect baseline.
		Exclude (*Not used*) the suspect baseline from network adjustment (if not a critical observation in the network).
		Once you are confident the baseline is a problem that cannot be fixed, you can *Disable* the observation.
		Reobserve the baseline (if critical to network redundancy).
	Bad antenna, instrument, or target height measurement or plumbing	Check GPS Loop Closures report for bad closures caused by antenna heights.
		Check field notes against antenna heights, types, and measurement methods for each station occupation. Correct antenna errors and perform a recomputation.
		Check instrument and target heights in field notes. Correct height error and perform a recomputation.
		Exclude (*Not used*) the suspect baseline from network adjustment (if not a critical observation in the network).
		Once you are confident the baseline is a problem that cannot be fixed, you can *disable* the observation.
		Reobserve the baseline (if critical to network redundancy).

Network Adjustment

Table 8.4 Troubleshooting a minimally constrained adjustment (Continued)

Problem	Possible cause	Action
Observation with zero Degrees of Freedom (Redundancy Number = 0.000)	The observation is a sideshot (one of the points at either end of the observation has only one observation to it).	Add redundancy to the network at point with one observation (observe additional observations).
		NOTE – The problem, possible cause, and action are only valid when an observation was not intended to be a sideshot.
		Sideshots can be included in a network adjustment for the purpose of error analysis.

Changing the weighting strategy for observations

Changing the weighting strategy used for the adjustment is useful for resolving the following problems:

- scaling the estimated errors of an observation outlier in an attempt to bring the observation's standard errors within the *Tau* criteria

- scaling underestimated a priori errors of the observations, allowing you to get a better idea of the true errors in your observations

Use the *Weighting Strategies* dialog to:

- view the scalar applied to the GPS, terrestrial, and geoid observations

- view the method used to apply the weights

- view the type of scalar used

- lock a value for the scalar

To access the *Weighting Strategies* dialog:

- In the Survey view, select *Adjustment* / *Weighting Strategies*.

For the first adjustment, the scalar weighting strategy is set as:

- Apply Scalars To: All Observations

- Scalar Type: Default

This strategy applies a scalar of 1.00 to all the observations, allowing the adjustment to use the initial a priori error estimates.

Note – For a minimally constrained adjustment, you do not need to use the Geoid tab to set the geoid observation scalar weighting strategy, since no observations are loaded.

As the adjustment progresses, you will make changes to the weighting strategies that will help you to analyze and properly distribute the errors in your network.

Note – Using the Automatic Scalar Type option, the alternative scalar process is applied to successive adjustment iterations until the Chi-square test passes. Before using the automatic scalar type, make sure that you remove all blunders from your data set. Blunders cause the over-scaling of other observations in the adjustment. For more information, refer to the Network Adjustment Help.

Continuing the Minimally Constrained Adjustment

Now that you have determined a troubleshooting plan, proceed with the minimally constrained adjustment by readjusting the network. Figure 8.2 illustrates the loop through a series of statistical results and decisions until all large errors are removed and the error is properly distributed in your observations; they pass the Chi-square test and the combined histogram appears to be normally distributed.

When you are satisfied with your minimally constrained adjustment, you can begin the fully constrained adjustment of your network. Any problems in the fully constrained adjustment will be related to the control points and how the network fits the control. Problems will not be due to incorrect error estimation or bad observations.

Network Adjustment
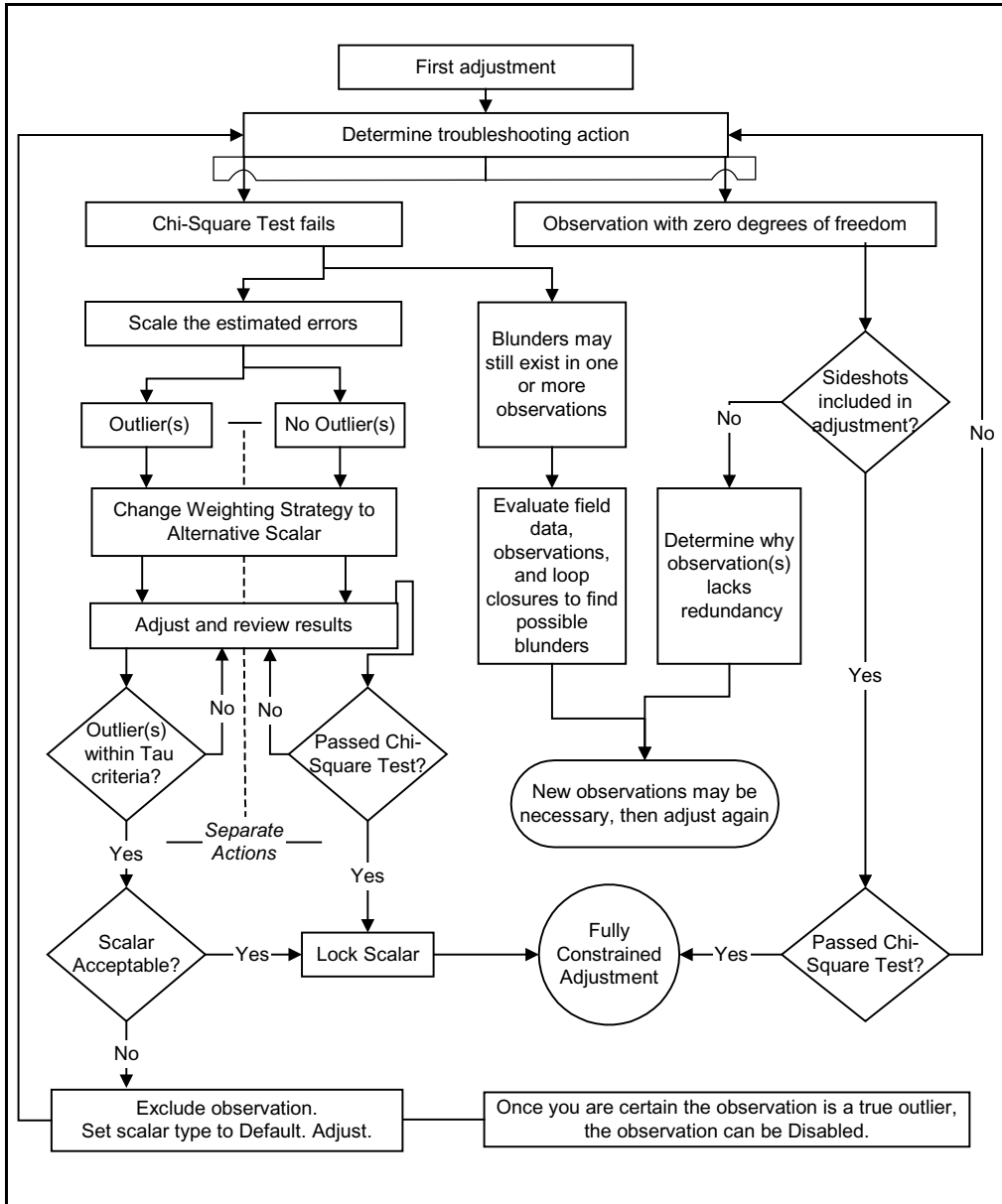
Figure 8.2 Troubleshooting – minimally constrained adjustment loop

Network Adjustment

Locking the Weighting Strategy Scalar for Observations

If you changed the weighting strategy to alternative scalar, you must now lock the weighting strategies scalar before proceeding to the fully constrained adjustment. The alternative scalar was used to scale the estimated errors of your observations, allowing you to get a better idea of the errors in each observation.

To lock the scalar:

•   In the Survey view, select *Adjustment* / *Weighting Strategies* and complete the appropriate tab in the *Weighting Strategies* dialog.

Saving Calibration Coordinates

After completing a minimally constrained adjustment, Trimble Geomatics Office allows you to save the WGS-84 coordinates of your adjusted points. These WGS-84 coordinates are saved for use as *GPS points* in a GPS site calibration. The *Adjustment Datum* must be set to *WGS-84* to save the calibration coordinates.

For more information, refer to the Help.

The Fully Constrained Adjustment

The next step in performing the network adjustment is to transform your observations to fit the fixed control point datum (or project datum).

Figure 8.3 shows the typical workflow in a fully constrained network adjustment, and the following sections give more information about each step.

Network Adjustment
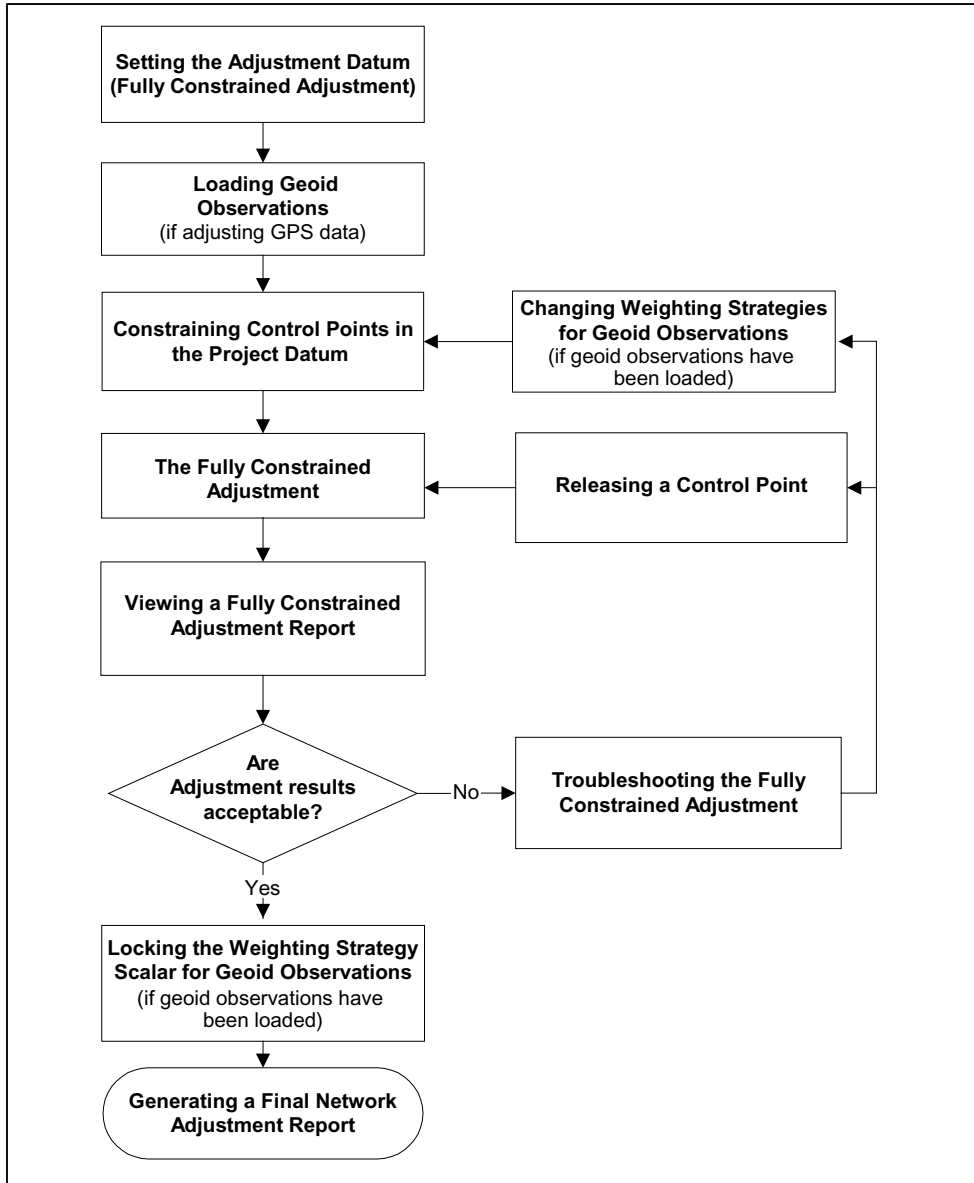
Figure 8.3   Fully constrained adjustment flow

Setting the Adjustment Datum (Fully Constrained Adjustment)

For a fully constrained adjustment, set the adjustment datum to your project datum.

Loading Geoid Observations

When adjusting GPS observations, geoid observations are required to determine elevations on all the points in the adjustment.

Note – You do not need to load geoid observations when performing a horizontal adjustment.

To load geoid observations you must select a geoid model in the *Project Properties* dialog.

To load geoid observations:

- •   From the Survey view, select *Adjustment* / *Observations* and complete the *Geoid* tab of the *Observations* dialog that appears.

Constraining Control Points in the Project Datum

Constraining (fixing) control points in the project datum allows you to do the following:

- •   Generate parameters that will transform your observations to your local coordinate system. As you constrain additional points (horizontally and vertically), transformation parameters are generated.

- •   Check the quality of the control point coordinates you are using in the network.

Trimble recommends that you use at least three horizontal and four vertical control points to generate transformation parameters with confidence. With the recommended control, you will generate the parameters and have an additional point to check the parameters created.

Network Adjustment

Note – Geoid and terrestrial parameters are not used in a recomputation. If you need these parameters to be applied to certain observations, then those observations must be included in the adjustment (for example, sideshots and azimuths.)

To change the status of these parameters for use in your network adjustment.

• Select *Adjustment / Observation Groups / Transformation Groups* and in the *Transformation Groups* dialog that appears, click **Edit**. Complete the appropriate tab in the *Edit Transformation Group* (GPS, terrestrial, and geoid) dialog.

Table 8.5 lists the number of fixed coordinates required to verify fixed control points.

Table 8.5   Coordinate components verified by fixing control points

Number of fixed coordinates			Check of fixed coordinates
2D	**Elev (e)**	**Height (h)**	**Component verified**
0–2	4 or >	0–3	Elevation
0–2	0–3	4 or >	Height
0–2	4 or >	4 or >	Elevation & Height
3 or >	0–3	0–3	2D
3 or >	4 or >	0–3	2D & Elevation
3 or >	0–3	4 or >	2D & Height
3 or >	4 or >	4 or >	All

Constraining a point (fully constrained adjustment)

For information on fixing control points, refer to the Help.

The Fully Constrained Adjustment

1. From the Survey view, select *Adjustment* / *Adjust*. The status bar displays the current iteration of the adjustment. The adjustment will perform as many iterations (up to the maximum set in the adjustment style) required to meet residual tolerance.

   Note – If the adjustment fails the residual tolerance (it does not converge), free and/or fix different control values. The adjustment may not be converging due to incorrect coordinate entry or poor coordinates.

2. Continue with the fully constrained adjustment by analyzing the initial results and constraining more control points.

Comparing Adjusted and Known Coordinates

After you fix the first point and perform an adjustment, you can compare the adjusted coordinates to the known coordinates of the other control points to determine the differences between the two. This gives you an idea of how well the other control points will *fit* in the adjustment.

C **Warning –** If insufficient coordinates are fixed to calculate transformation parameters during the adjustment, then the comparison between adjusted and known coordinates is only valid when working with a project datum that is similar to WGS-84 (geocentric). Some local datums require a considerable amount of transformation (such as azimuth rotation and network scale) before making a comparison of the coordinates. For this type of project datum, perform the comparison only after fixing the required number of points thus generating the transformation parameters.

Network Adjustment

Constraining Additional Control Points

To continue with the adjustment, constrain the other available control points. You can constrain any number of control points, as long as you have accurate coordinates for them.

Trimble recommends that you:

- Constrain a minimum of three horizontal and four vertical control points.

- Adjust the network.

- Analyze the results before constraining any additional control points.

Constraining the minimum number of points generates the transformation parameters and allows for a check on those parameters.

Note – As you constrain additional control points beyond the minimum, you should constrain them, one-by-one. This allows you to assess the results as each point is constrained.

Viewing a Fully Constrained Adjustment Report

The Network Adjustment report displays the results of the last adjustment.

Troubleshooting the Fully Constrained Adjustment

Use the Network Adjustment report to begin troubleshooting your network adjustment. The troubleshooting procedures for a fully constrained adjustment are essentially the same as those for a minimally constrained adjustment. You will review some of the same statistics, but find that the cause of the problem may be different than in the minimally constrained adjustment. Also, the required troubleshooting actions may differ.

Network Adjustment

Evaluating the statistics (fully constrained adjustment)

Constrain the minimum number of control points (three horizontal and four vertical) to perform a true evaluation of the fully constrained adjustment. If you constrain only two horizontal and three vertical points, you have only defined the parameters necessary to transform the observations to your control (datum). Additional fixed-control points allows you to evaluate or check the defined parameters. You then know that any problems you encounter are related directly to your control points.

When the adjustment converges and you have viewed the Statistical Summary section in the Network Adjustment report, you must decide if you need to troubleshoot.

Consider the following:

- Control coordinate comparisons in the Network Adjustment report
- Large jumps in the reference factor between adjustments

Table 8.6 lists some of the problems that you might see in a fully constrained adjustment.

Table 8.6 Troubleshooting a Fully Constrained Adjustment

Problem	Possible cause	Action
The adjustment failed to converge after 10 iterations.	One or more large errors or mistakes (blunders) exist in one or more control points, as a result of:	Systematically "unfix" or fix the control points, leaving the minimum number fixed, until the suspect point is found. Then:
	• occupying the wrong point	Verify correct occupation.
	• the condition of the point (moved or disturbed)	Check physical condition of control point.
	• measuring the wrong antenna height on all occupations of the point (vertical)	Check field notes. Check antenna heights, type, and measurement method.
	• measuring the wrong instrument or target height on all occupations of the point.	Check instrument and target heights. Check keyed-in or imported coordinates.
There are large jumps in the reference factor between adjustments.	One or more large errors or mistakes (blunders) exist in one or more control point coordinates, such as:	Verify correct coordinates and datum.
	• coordinate(s) entered incorrectly	Check coordinate source.
	• wrong coordinate(s)	
	• unreliable coordinates	
	Errors in the geoid observations are underestimated.	Apply a scalar (alternative) to the *Geoid Observation* group.

Network Adjustment

Continuing a Fully Constrained Adjustment

Now that you have determined and set a troubleshooting plan, proceed in the same manner as the minimally constrained adjustment. You will re-adjust the network after constraining each point, evaluate the results, and continue with the same troubleshooting action or change to another as you progress.

You begin to loop through a series of statistical results and decisions until you are confident that you have removed all large errors, properly distributed the error in your geoid observations, and correctly defined the transformation parameters.

Locking the Scalar for Geoid Observations

If you have changed the geoid observation weighting strategy to alternative scalar, you must now lock the weighting strategies scalar for geoid observations.

To lock the scalar:

1. From the Survey view, select *Adjustment* / *Weighting Strategies* and complete the *Geoid* tab of the *Weighting Strategies* dialog that appears.

2. Perform one adjustment with the scalar locked to preserve the weighting strategy and update the report.

3. Generate a final Network Adjustment report.

Network Adjustment

Combining GPS, Terrestrial, and Geoid Observations in an Adjustment

The previous sections describe the basic principles of performing a network adjustment. The network adjustment involves performing a minimally constrained adjustment and then a fully constrained adjustment.

In Trimble Geomatics Office, three classes of observations are available for simultaneous adjustment: GPS, terrestrial, and geoid.

This section describes how a control network containing combinations of data can be adjusted. When combining observations, you must check each set of observations before performing a fully constrained adjustment. This helps you detect errors more easily.

Note – For information about adjusting level observations, refer to the Help.

B **Tip –** To perform a combined adjustment, you must tie terrestrial observations into the GPS network, so measure angles and distances at points that are common with the GPS network. You need to set up on at least two common points (observed in both the GPS and terrestrial data sets, or control points) that can tie the two sets together. This prevents a terrestrial traverse from "hanging off" a GPS observation by one point.

For more information on performing a network adjustment with a combination of observation types, refer to the Help.

Prepare the GPS data

To perform a minimally constrained adjustment of your GPS observations, do the following:

1.   Select your GPS data in the graphics window.

B **Tip –** To select different data types when performing a combined adjustment, use selection sets.

2. Process your GPS data. For more information on processing GPS data, see Chapter 7, WAVE Baseline Processing.

3. Perform a GPS loop closure and view the GPS Loop Closures report to ensure that the GPS data set is suitable for adjustment.

4. Remove any out-of-tolerance flags. These can appear because of incorrect control coordinates, bad antenna heights, or wrong point naming.

5. Select independent GPS baselines. For more information, see Chapter 7, WAVE Baseline Processing or refer to the Help.

6. Select the WGS-84 datum. To do this, select *Adjustment* / *Datum* / *WGS-84*.

7. If necessary, in the *Network Adjustment Style* dialog, change the adjustment style settings.

8. In the *Observations* dialog – *GPS* tab, select the GPS observations to be included in the adjustment.

B **Tip –** Use the **Filter** button in the *Observations* dialog to filter GPS observation types.

9. If necessary, define observation groups (variance and/or transformation groups) for the data.

10. Fix a control point in the *Points* dialog. (This is optional.)

11. Set the weighting strategy. For the initial adjustment, set the *Apply Scalar to* group to *All Observations* and the *Scalar Type* group to the default option.

12. Perform a minimally constrained adjustment. For more information on performing a minimally constrained adjustment, see The Minimally Constrained Adjustment, page 101.

13. View the statistical summary and the adjustment details in the Network Adjustment report.

Network Adjustment

14. If necessary, perform step 12 and step 13 again, and any troubleshooting, until the Chi-square test passes and you are satisfied with the adjustment results. If you have selected the Alternative Scalar option, lock the scalar value in the *Weighting Strategies* dialog.

Note – If you have selected the automatic scalar type option in the Weighting Strategies dialog, the adjustment iterations are performed until the Chi-square test passes.

Note – If you want to perform a calibration, save calibration coordinates at this stage of the adjustment. View the saved WGS-84 calibration coordinates in the Properties window.

Your GPS data is now ready for a fully constrained adjustment.

Prepare the terrestrial data

To perform a minimally constrained adjustment on your terrestrial data, do the following:

1. Select the terrestrial observations in the graphics window.

B   **Tip –** You can use view filters to view only terrestrial observations.

2. Select the project datum. To do this, select *Adjustment* / *Datum* / *Project Datum – <Datum Name>*

3. In the *Observations* dialog – *Terrestrial* tab, select the observations to be included in the adjustment.

   Note – If your terrestrial data does not consist of a closed traverse (that is, the terrestrial observations are hanging from the GPS observation network), you also need to load geoid observations to ensure that the GPS and terrestrial observations can be linked together using the geoid. If you incorporate geoid data into your terrestrial adjustment at this stage, you do not need to follow the "Incorporating geoid observations into your adjustment" step, which is outlined in the next section.

4. If necessary, define observation groups (variance and/or transformation groups) for the data.

5. Set the weighting strategy. For the initial adjustment, set the *Apply Scalar To* group to All Observations and the *Scalar Type* group to default.

   Note – If you set the Apply Scalar To group to Variance groups, your observations will be automatically separated into the appropriate groups.

6. Fix point(s) in the *Points* dialog.

   Note – To perform a combined adjustment, the point that you fix should be one of the points that is common between the GPS and the terrestrial network.

7. Perform a minimally constrained adjustment. For more information, see The Minimally Constrained Adjustment, page 101.

8. View the adjustment details in the Network Adjustment report.

9. If necessary, perform another adjustment until you are satisfied with the adjustment results. If you have selected the alternative scalar type, lock the scalar value in the *Weighting Strategies* dialog.

Note – If you have selected the automatic scalar type option in the Weighting Strategies dialog, the adjustment iterations are performed until the Chi-square test passes.

Incorporating geoid observations into your adjustment

Geoid errors are scaled in a constrained adjustment of the observations. To perform a vertically constrained adjustment of your geoid data, do the following:

1. Make sure that a geoid model has been selected for the project.

2. In the *Observations* dialog, select the *Geoid* tab and load the Geoid observations.

Network Adjustment

3. Set the weighting strategy in the *Weighting Strategies* dialog – *Geoid* tab. For the initial adjustment, set the *Scalar Type* group to the default.

4. Fix elevations (and/or heights) in the *Points* dialog. Use at least three constraints.

5. Select *Adjustment* / *Adjust* and view the adjustment details in the Network Adjustment report.

If necessary, select the *Alternative* scalar type option, perform another adjustment, and review the results in the Network Adjustment report. Do this until the Chi-square test passes and you are satisfied with the results. If you have selected the *Alternative Scalar Type* option, lock the scalar value in the *Weighting Strategies* dialog.

Performing the fully constrained adjustment

Once you have locked the error scaling in the minimally constrained adjustment, you can perform a fully constrained adjustment.

Network Adjustment

The RoadLink Utility

In this chapter:

- ■ Introduction
- ■ Defining a road
- ■ Transferring a road definition to a controller
- ■ Road reports
- ■ Additional features

Introduction

Trimble's RoadLink™ utility is a powerful interface between third-party road definitions and a Trimble controller.

Use it to:

- import or key in road definitions

- view road definitions graphically

- edit road definitions

You can then transfer the road definition to a Trimble controller for use during stakeout.

RoadLink provides two ways to transfer road definitions:

- Automated conversion of horizontal and vertical alignment files and cross-section files provided by third-party design software

- Manual input of the complete road definition, horizontal and vertical alignments, templates, and superelevation and widening records

An integral component of Trimble Geomatics Office, RoadLink also calculates cut and fill volumes for earthworks between the road definition and a surface model defined in Trimble's DTMLink utility.

To start RoadLink you need to open a Trimble Geomatics Office project, and in the Plan view, select *Tools* / *RoadLink* / *Start.*

Note – All parts of Trimble Geomatics Office, including RoadLink and other accompanying utilities, provide extensive online help.

Defining a Road

There are two ways to define a road:

- Import third-party road definition files. (For a list of supported third-party software packages, see the Help.)

- Key in a road definition.

Importing Third-Party Road Definition Files

A road definition file includes:

- Horizontal alignments

- Vertical alignments

- Cross-section data

To import a third-party road definition file:

- In the RoadLink utility, select *File* / *Import*. In the *Import* dialog that appears, select Third party road definition file. A wizard guides you through the import process.

The RoadLink software automatically creates a new road when the road definition is imported. You can confirm and edit the road, if necessary, before exporting it to a controller.

Keying in a Road Definition

To key in a road definition, you need to:

1. Create the templates (typical cross-sections).

2. Enter a horizontal alignment.

3. Enter a vertical alignment.

4. Assign the templates.

5. Enter superelevation and widening values.

The following sections describe each step.

Utilities

Creating and editing a template

The following steps show how to create and edit a template:

1. From the RoadLink utility, select *Utilities* / *Template Editor*.

2. In the *Template Editor* window, select *Template* / *New* and complete the dialog that appears.

   Every template consists of a single design surface consisting of a sequence of elements. Each template begins with element *Subgrade01*. This element defines the starting point of the surface.

3. Click **Apply** to accept the first element, and click **New** to continue adding elements.

4. Select an element type and complete the appropriate fields. Element types include:

   – Design line – select one of the following methods of definition: cross fall and offset, or delta elevation.

   – Side Slope.

Entering a horizontal alignment

Before entering the horizontal alignment, you need to create a new road, by selecting *File* / *New Road*, and completing the *New Road* dialog.

For more information about using surfaces and calculating volumes, refer to the Help.

B

Tip – To change the start station and surface for an existing road, select *Road* / *Options*.

Once you have completed the *New Road* dialog, the *Horizontal* dialog appears. With the *Horizontal* dialog you can enter and edit the arcs, spirals, and straights that make up the alignment. (You can also access the *Horizontal* dialog by selecting *Road* / *Horizontal*.)

There are two horizontal alignment input methods:

- By points of intersection (PI)
- By elements

To enter a horizontal alignment by inserting points of intersection and applying curves at each PI:

1. In the *Horizontal* dialog, select the *PI* tab.

2. Click **Insert** and complete the *Insert PI* dialog that appears, clicking **Apply** after entering each PI until finished.

3. Select the type of curve you require and complete the appropriate fields.

To enter a horizontal alignment as a series of connected Point, Line, Arc, and Spiral elements:

1. In the *Horizontal* dialog, select the *Element* tab.

2. Complete appropriate fields for each element that you select.

Entering a vertical alignment

Entering an alignment by inserting vertical points of intersection (VPIs) and applying curves at each VPI is similar to inserting a horizontal alignment by PI:

- Select *Road* / *Vertical* and complete the *Vertical Alignment* dialog.

Assigning the template

To assign the templates to the horizontal alignment at specific stations:

- Select *Road* / *Templates* and select a template library. In the *Left Template* and *Right Template* fields select the template you want to assign for the start station, then click **Insert** to insert a new start station.

For information on how to use the system templates <None> and <Interpolate> to control the road definition, and how to assign templates to achieve the required design, see the Help.

Entering superelevation and widening values

When you select *Road* / *Superelevation*, the *Superelevation* dialog appears. You can use this dialog to:

- manually insert superelevation and widening values

- enter parameters to automate superelevation application

To manually insert superelevation and widening values:

- In the *Superelevation* dialog, select the appropriate pivot option and enter station, left and right superelevation, and widening values. Click **Insert** to insert additional entries.

To enter parameters to automate superelevation application:

1. Select the PI of the curve to be superelevated, the appropriate pivot option, and the *Auto insert* check box.

2. Complete the *Maximum superelevation* and *Unsupered cross-fall* fields. For a circular curve enter complete the *Runoff% in curve In/Out* and *Runoff length In/Out* fields.

3. Manually enter any widening values.

Transferring a Road Definition to a Controller

Transferring a road definition to a Controller or data file from RoadLink is similar to transferring files from Trimble Geomatics Office. For more information, see How to Export Files in Trimble Geomatics Office, page 31.

Utilities

Road Reports

Select *Road* / *Report* to create the following types of report:

- Road – the horizontal and vertical alignments, templates, and superelevation of a road.

- Stakeout – points defining the road.

- Volumes – the cut/fill earthworks volumes. These reports are only available if the road has an associated surface. Select a surface when creating a road; otherwise, use the *Road Options* dialog.

Additional Features

Table 9.1 describes other functions accessed from the *Road* menu.

Table 9.1   Road menu functions

Use this command ...	to ...
Sections	view computed cross-sections and confirm the applied design.
Display Road Linework	display the linework connecting cross-sections.
Display Road Surface	display a surface model of the road.
Options	edit the parameters of a road at any time in the *Road Options* dialog.

10

The DTMLink Utility

In this chapter:

- Introduction
- Defining a contour surface model
- Modifying a contour surface model
- Transferring a surface model to a controller
- Additional features

Introduction

Trimble's DTMLink™ utility is a powerful system for generating contour surface models. Use it to import a third-party surface file, create new surfaces, and edit previously created surfaces. The utility lets you include boundaries and breaklines in the contour surface model, and provides advanced triangle editing to give more control over the contour surface model formation. You can use the surface model you create for earthworks calculations in Trimble's RoadLink utility.

Once you have imported or created a contour surface model, you can create a gridded or triangulated digital terrain model (DTM) for transfer to a controller or a data file. You can also export a 3D faces AutoCAD DXF file to third-party software.

The DTMLink utility also lets you create Volume reports. Typical applications for the volume calculations are:

- • stockpile calculations

- • volumes of layers of materials, such as coal seams

- • volumes of voids such as lakes behind proposed dams

The software uses the method of computing the volumes of individual triangular prisms. These are defined by the triangular planes forming the contour surface model by using the base areas and average heights of prisms.

You can also create comparison surfaces. A comparison surface is a contour surface model of the difference between two surfaces. You can use this surface in conjunction with the volumes calculation type above an elevation to calculate the cut and fill volumes between the two surfaces.

To start the DTMlink utility, you need to open a Trimble Geomatics Office project, and in the Plan view, select *Tools* / *DTMLink* / *Start*.

Defining a Contour Surface Model

There are two ways to define a surface:

- Import third-party surface files. (For a list of supported third-party software packages, see the Help.)

- From selected points and lines in Trimble Geomatics Office.

Importing a Contour Surface Model

To import a contour surface model:

- Select *File* / *Import* and then the appropriate third-party file type.

The imported surface appears.

Creating a Contour Surface Model

To create a contour surface model:

- In the Plan view in Trimble Geomatics Office, select *Tools* / *DTMLink* / *New Surface* and complete the *New Surface* dialog that appears.

A detailed contour surface model is formed, using all points in the database and all breaklines and boundaries selected.

To change the graphical display of the contour surface model, select *View* / *Options*, and complete the *Line Options* tab in the *Options* dialog that appears.

Modifying a Contour Surface Model

Each command in the *Design* menu opens a dialog to help you modify the surface model that you have created. For more information about each dialog, refer to the Help. The modifications that you can make to a surface model include the following:

- Including points – only existing points can be used.

- Excluding points.

- Swapping triangles – if the two selected triangles form a quadrilateral, the corners from which the diagonals run are exchanged and two new triangles are formed.

- Deleting triangles – these deleted triangles do not re-form on a surface update unless a boundary has been added to the model, or edited on the model.

- Adding breaklines and boundaries – use Field fill-in to enter the start and end co-ordinates of the line. Adding a breakline or a boundary does not automatically update the surface. Once additional breaklines or boundaries have been added to the surface the Update Surface indicator appears on the status bar and you need to rebuild the surface. To update the surface, select *Design* / *Update Surface.*

  To create an Include boundary that encompasses all of the points selected for the DTM, click **Shrink Wrap**.

B   **Tip –** To enter a series of joined breaklines or boundaries, select the start point with a single click and then double-click on each subsequent point. You do not need to use the **Add** button.

- Deleting lines – in some circumstances a line can be a boundary and a breakline, so to delete both, select *Design* / *Delete All Baselines*. If you do not want all line types deleted, select the line type to delete.

Transferring a Surface Model to a Controller

Once you have imported or created a contour surface model, you can create a gridded or triangulated digital terrain model for transfer to a controller or a data file.

Transferring a gridded DTM or triangulated DTM to a controller from DTMLink is similar to transferring files from Trimble Geomatics Office. During the procedure the software prompts you to create the gridded or triangulated DTM. For more information, see How to Export Files in Trimble Geomatics Office, page 31.

Consider the following:

- A gridded DTM allows a regular North-South / East-West grid of points to be interpolated from the selected contour surface model. When you select your export option, a rectangular grid appears in the graphics window.

  This rectangular grid shows the smallest rectangle that completely bounds the surface. Drag its boundaries to define the area that you want. Define the grid size by the number of columns and rows, and the width and height of the grid cells.

- A triangulated (TIN) DTM allows a rectangular area to be output from the selected contour surface model. When you select your export option, a rectangle appears in the graphics window. Again, drag its boundaries to define the area that you want.

Additional Features

Table 10.1 describes other functions that are available from the *Tools* menu.

Table 10.1   Tool menu functions

Use this command ...	to ...
Volume Report	compute the volume of a surface using the following methods: above an elevation, between two elevations, and by void volume. For more information about volume computation methods, refer to the Help.
Rebuild Surface	reconstruct the surface from the original surface points. Any surface points or triangles deleted from the model are reinstated, and the boundaries and breaklines from the last surface you saved are reinstated. If you have not saved a surface, this command reinstates the original surface. **Warning** – Swapped or deleted triangles are not retained after rebuilding a surface. Excluded points return after the surface is rebuilt.
Compare Surfaces	generate a surface-to-surface comparison of two selected surfaces. The resultant or comparison surface will provide a contoured surface of the difference in elevations between the major and base surfaces. You can use the comparison surface to calculate the volume between the two surfaces. For more information on calculating the volume between two surfaces, refer to the Help.

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