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In this section:

- Chapter 1, Introduction
- Chapter 2, Installation
Introduction

In this chapter:

- What you can do with the Trimble GPS Analyst extension
- Finding additional information
- Technical assistance
- Your comments

Welcome to the Trimble GPS Analyst Extension Getting Started Guide. This guide describes how to set up and use the Trimble® GPS Analyst™ extension for ESRI ArcGIS 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, go to the Trimble website (www.trimble.com) for an interactive look at Trimble and GPS.

This guide assumes that you know how to use ArcGIS Desktop software and the Microsoft® Windows® operating system.
What you can do with the Trimble GPS Analyst extension

The Trimble GPS Analyst extension enables you to store and work with Global Positioning System (GPS) data directly within the ArcGIS Desktop software environment.

The GPS Analyst extension enables you to import GPS data collected with other field applications, such as the Trimble TerraSync™ field software, or ESRI ArcPad software with the Trimble GPScorrect™ extension for ArcPad.

Once the GPS data is stored in the geodatabase, you can improve the accuracy of the collected or imported GPS data using postprocessed differential correction. The GPS Analyst extension also allows you to analyze the GPS data, and validate any GIS features that use GPS data to ensure that they meet your accuracy requirements.

You can use the Trimble GPS Analyst extension to:

- store GPS data linked to GIS features in a geodatabase
- import GIS and GPS data that is in the Trimble SSF file format
- import GIS and GPS data collected using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad
- differentially correct GPS data within ArcGIS Desktop
- validate the estimated accuracy of GPS-derived features

Storing GPS data in a geodatabase

The Trimble GPS Analyst extension extends the geodatabase data model to include support for GPS data. Use the GPS Analyst extension to GPS-enable your personal geodatabase, which allows raw GPS data to reside directly within the geodatabase. GPS data is stored in the form of GPS sessions within the geodatabase.
Introduction

Working with SSF files

The Trimble GPS Analyst extension enables you to import and export Trimble Standard Storage Format (SSF) files. SSF files are used by Trimble data collection software products.

You can export GIS data from a personal geodatabase to an SSF file, which can then be used by Trimble data collection software products such as the TerraSync field software.

You can import SSF files into feature datasets in a GPS-enabled geodatabase. During the import process, SSF features are added to GPS-enabled feature classes in the geodatabase and GPS positions are stored in new GPS sessions. Once the data has been imported, you can use the GPS Analyst extension to differentially correct the GPS data and validate the estimated accuracy of the features that are constructed using GPS data.

Working with ArcPad and GPScorrect data

You can check out data from a geodatabase as shapefiles for collecting new features or updating existing features using ESRI ArcPad software and the GPScorrect extension for ArcPad. When you check in an ArcPad Shapefile, features are checked back into feature classes in the geodatabase and the GPS data from the corresponding SSF file is stored in new GPS sessions.

The GPS Analyst extension also enables you to import data collected in the field using ArcPad and the GPScorrect extension into a GPS-enabled geodatabase. During the import process, features are added to GPS-enabled feature classes in the geodatabase and GPS positions are stored in new GPS sessions. Once the data has been imported or checked in, you can use the GPS Analyst extension to differentially correct the GPS data and validate the estimated accuracy of the features that are constructed using GPS data.
**Differentially correcting GPS data**

The Trimble GPS Analyst extension enables you to differentially correct GPS field data. Differential correction reduces errors in GPS data by using an additional receiver at a fixed location, whose position is accurately known. This receiver is called a base station, and the GPS data collected by the base station is used to remove errors in data collected by other GPS receivers, called roving receivers.

GPS positions collected at the base station are compared against the known position of the base station, and errors are calculated for each satellite. These error calculations are used to correct the errors in the data collected by roving receivers. You need to know your base station position very accurately as the differential correction position accuracy depends on the accuracy of the coordinates of the base station.

**Validating the accuracy of GPS-derived features**

When you GPS-enable a feature class, you can specify the required accuracy for features in that feature class. During data analysis, you can use the GPS feature validation process to check that features constructed from GPS positions meet your accuracy requirements. Any feature that does not meet the required accuracy can be selected for further processing, deleted, or marked as an exception.

**Finding additional information**

Sources of additional information include the following:

- *Trimble GPS Analyst Extension Help* – the extension has built-in user help that provides detailed explanations of concepts and tasks you can perform using the GPS Analyst extension. To view the Help, do one of the following:
  - In ArcMap, select *Trimble GPS Analyst Help* from the *Trimble GPS Analyst* drop-down menu.
  - From the Windows Start menu, select *All Programs / Trimble / GPS Analyst / GPS Analyst Extension Help*. 
• What’s This? Help – the extension has built-in, context-sensitive help that lets you quickly find the information you need. To access it, click the question mark in the top right corner of a dialog, then click the field or control you want to view Help on. Alternatively, click a control and press Shift + F1. For dockable windows, click a tab and press F1.

• Release notes – the release notes provide information not included in the documentation, and describe any changes to the documentation. They are provided as a PDF file on the Trimble GPS Analyst Extension CD and are installed in the program directory (typically C:/Program Files/Trimble/GPS Analyst) when you install the software. To view the PDF, select All Programs / Trimble / GPS Analyst / Release Notes from the Windows Start menu.

• For more information about GIS, refer to Getting Started with ArcGIS and Building and Editing Geodatabases, which you received from ESRI in your ArcGIS package.

**Technical assistance**

If you have a problem and cannot find the information you need in the product documentation, **contact your Trimble reseller**.

**Technical support**

Go to the GPS Analyst extension technical support page (www.trimble.com/gpsanalyst_ts.asp) on the Trimble website for the latest support information about the software, including:

• FAQs
• support notes detailing the latest support issues
• documentation
• the latest files available for download
Windows error reporting

If for any reason a Microsoft Windows Error Reporting dialog appears, indicating that the Trimble GPS Analyst extension has encountered a problem and needs to close, you are asked whether you wish to send an error report to Microsoft.

Trimble recommends that you click **Send** and then click any subsequent links that are used to obtain additional information.

Trimble can access the report that is sent to Microsoft and use it to improve the GPS Analyst extension.

Your comments

Your feedback about the supporting documentation helps us to improve it with each revision. Email your comments to ReaderFeedback@trimble.com.
CHAPTER 2

Installation

In this chapter:
- System requirements
- Registering the Trimble GPS Analyst extension
- Installing the Trimble GPS Analyst extension
- Enabling the Trimble GPS Analyst extension
- Updating the Trimble GPS Analyst extension
- Managing licenses for the Trimble GPS Analyst extension

This chapter describes how to install version 2.10 of the Trimble GPS Analyst extension for ESRI ArcGIS software onto a Windows PC for the first time.

To install the Trimble GPS Analyst extension, you must:

1. Make sure your field or office computer meets the minimum platform requirements for successful operation of the Trimble GPS Analyst extension.

2. Register your copy of the Trimble GPS Analyst extension and obtain an installation code.

3. Install the extension using the Trimble GPS Analyst Extension CD and the installation code you obtained when you registered your copy of the extension.
System requirements

The Trimble GPS Analyst extension can be installed on a PC or Tablet PC running one of the following versions of ESRI ArcGIS Desktop software:

- ArcGIS Desktop software version 9.2 with Service Pack 1 installed
- ArcGIS Desktop software version 9.1 with Service Pack 2 installed
- ArcGIS Desktop software version 9.0 with Service Pack 3 installed

The GPS Analyst extension can be used with ArcView, ArcEditor, and ArcInfo licenses.

Table 2.1 describes the minimum system requirements to ensure successful operation of the GPS Analyst extension:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ArcGIS versions</td>
<td>ArcGIS 9.2 Service Pack 1</td>
</tr>
<tr>
<td></td>
<td>ArcGIS 9.1 Service Pack 2</td>
</tr>
<tr>
<td></td>
<td>ArcGIS 9.0 Service Pack 3</td>
</tr>
<tr>
<td>Operating system</td>
<td>Any of the following Microsoft® operating systems:</td>
</tr>
<tr>
<td></td>
<td>Windows® XP Professional Edition</td>
</tr>
<tr>
<td></td>
<td>Windows XP Tablet PC Edition</td>
</tr>
<tr>
<td></td>
<td>Windows XP Home Edition</td>
</tr>
<tr>
<td></td>
<td>Windows 2000 Professional</td>
</tr>
<tr>
<td>CPU speed</td>
<td>800 MHz</td>
</tr>
<tr>
<td>Processor</td>
<td>Pentium or higher</td>
</tr>
<tr>
<td>Memory/RAM</td>
<td>256 MB</td>
</tr>
<tr>
<td>Disk space</td>
<td>Approximately 100 MB. This does not include the 17 MB of disk space needed for installation.</td>
</tr>
<tr>
<td>Display color</td>
<td>Greater than 256 colors.</td>
</tr>
<tr>
<td>Internet explorer</td>
<td>Microsoft Internet Explorer version 5.0 or higher must be installed before installing the GPS Analyst extension.</td>
</tr>
</tbody>
</table>
Note – To transfer files to (or from) a device powered by Microsoft Windows Mobile® software you must also have the appropriate version of the Microsoft ActiveSync® technology installed.

**Supported GPS receivers**

You can use GPS data from any of the following receivers in the Trimble GPS Analyst extension:

- Trimble Mapping and GIS receivers:
  - GeoExplorer® series handhelds:
    - GeoXH™
    - GeoXM™
    - GeoXT™
  - Juno™ ST handheld
  - GPS Pathfinder® ProXH™
  - GPS Pathfinder ProXT™
  - GPS Pathfinder Pro XRS
  - GPS Pathfinder XB receiver
  - GPS Pathfinder XC receiver
  - Trimble Recon® GPS XB edition
  - Trimble Recon GPS XC edition
- NMEA GPS receiver
- any GPS receiver with a supported driver that enables the receiver to work with the Trimble GPS Analyst extension

Note – The GPS Analyst extension supports import and differential correction of data collected with the Juno ST handheld with ArcPad version 7.0 and later and GPSCorrect extension version 2.20, or with TerraSync software version 3.01 and later. For more information about connecting to a GPS receiver to collect data, see Chapter 9, Typical Data Collection Tasks.
Registering the Trimble GPS Analyst extension

Before you can install the Trimble GPS Analyst extension, you must register your copy of the extension to obtain an installation code that you enter during the installation process.

You can only register your copy of the Trimble GPS Analyst extension once. For information about obtaining your installation code when the extension has already been registered, see Obtaining your installation code after registration, page 33.

Trimble recommends that you register before beginning installation.

To register, you need:

- the Proof-of-Purchase Number (POPN) from the Trimble GPS Analyst extension packaging
  The Proof-of-Purchase Number (POPN) is labelled “POPN” and is located on the product label inside the software folder, below the software CD.

- Internet access (including a valid e-mail address)

**Note – If you do not have Internet access, contact your local Trimble reseller for assistance.**

To register your copy of the Trimble GPS Analyst extension:

1. Go to the My Trimble account login page.
   
   To do this, open your Web browser and go to www.trimble.com/register.

   Alternatively:

   a. Insert the Trimble GPS Analyst Extension CD in the CD drive of the office computer.
The Setup screen appears:

![Setup Screen]

**Note** – If this screen does not appear, select Autorun.exe from the CD drive folder.

b. Click Register.
Your default Web browser opens and displays the *My Trimble* account login page:

2. If you already have an account, skip this step and go to step 4 to log in.

   To create your *My Trimble* account, click *Create an account*. Enter your contact details and then click **Save**. Your account is created and you are returned to the *My Trimble* account login page.

3. Enter your e-mail address and password, and then click **Login**.
The *My Trimble* page for your account appears. It will look similar to the one shown below:

4. To register the Trimble GPS Analyst extension, scroll to the *My Products* section and then click **Add**.
5. Select the *Add a Proof-of-Purchase Number (POPN)* option and then click **Next**.
The Proof-of-Purchase Number (POPN) Details page appears:

6. Enter the Proof-of-Purchase Number (POPN) provided on the Trimble GPS Analyst extension packaging. The POPN is located on the product label inside the software folder, below the software CD.

7. If you want to enter your own reference code, for example a sales order number or an asset/inventory number, enter it in the Your Reference field.

8. Click Next.
Note – If a message warns that the POPN you entered has already been registered, click Cancel to cancel the registration process. Then obtain the installation code for your copy of the extension and install the extension. For more information, see Obtaining your installation code after registration, page 33.

9. If this is the first time that you have registered a Trimble Mapping and GIS product, the Mapping & GIS Industry Details page appears. From the drop-down lists, select your organization type and most common market segment and then click Save.

10. You are returned to your My Trimble page, where the extension you have just registered now appears in the My Products section:
11. If the two lines below the Trimble GPS Analyst extension do not appear, click the + beside the copy of the Trimble GPS Analyst extension that you have just registered.

The Installation Code field shows the installation code for your copy of the Trimble GPS Analyst extension. Make a note of this code. You will need to enter this code when you install or reinstall the extension.

Note – If you are entitled to an upgrade from a previous version of the Trimble GPS Analyst extension, you can install version 2.10 of the extension using the installation code that you obtained when you first registered the product. If you are not entitled to an upgrade, the installation program will not accept your installation code. Contact your local Trimble reseller to purchase a software maintenance option.

Obtaining your installation code after registration

To reinstall the Trimble GPS Analyst extension, for example if you have uninstalled it from one computer and wish to reinstall it to another, you must use the same installation code that you received when you registered the extension before installing it for the first time.

If you do not know the installation code, do one of the following:

- If someone else at your company registered the extension ask them for the installation code.
  
  If you cannot find out who registered the extension, send an e-mail containing the Proof-of-Purchase Number (POPN) for your copy of the extension to Trimble_support@trimble.com.

- If you registered your copy of the extension yourself, you can check your installation code from the My Trimble page of the Trimble website.
To do this:

a. Open your Web browser and go to www.trimble.com/register.

Your default Web browser opens and displays the *My Trimble* account login page:

Enter your e-mail address and password, and then click **Login**.

The *My Trimble* page for your account appears.
b. Scroll to the My Products section, where any extension that you have already registered appears:

![Installation Code](image)

Installation code

*Installation Code* field shows the installation code for your copy of the Trimble GPS Analyst extension. Make a note of this code. You need to enter this code when you install or reinstall the extension.

c. If the two lines below the Trimble GPS Analyst extension do not appear, click the + beside the copy of the Trimble GPS Analyst extension that you have just registered.

The *Installation Code* field shows the installation code for your copy of the Trimble GPS Analyst extension. Make a note of this code. You need to enter this code when you install or reinstall the extension.
Installing the Trimble GPS Analyst extension

To install the Trimble GPS Analyst extension for ESRI ArcGIS software, the computer must have a CD-ROM drive, or have access to a CD-ROM drive over a network.

Before you begin

Before you begin the installation process, make sure that:

- The computer meets the minimum requirements for installing the Trimble GPS Analyst extension. For more information, see System requirements, page 24.

- You have registered your copy of the extension and have made a note of the installation code that you must enter during installation. For more information, see Registering the Trimble GPS Analyst extension, page 26.

- You have uninstalled any existing copy of the extension from your computer.
Running the installation program

To install the Trimble GPS Analyst extension:

1. Insert the Trimble GPS Analyst Extension CD in the CD drive of the office computer.

The Setup screen appears:

![Setup screen](image)

**Note** – If this screen does not appear, select Autorun.exe from the CD drive folder.

2. Click **Install**.
The Installation screen appears:

3. Depending on the version of ArcGIS Desktop software you are running, click either Install GPS Analyst for ArcGIS 9.0 and 9.1 or Install GPS Analyst for ArcGIS 9.2.

4. The GPS Analyst InstallShield Wizard appears. Click Next.

5. Read the software license agreement and then click Yes to accept it.

6. Enter your user name and your company name and then click Next.
Installation

The Choose your License Type page appears:

7. To install the extension using a:
   – license that is for your copy of the extension only, select the *Install GPS Analyst with a standalone license* option and then click **Next**.
   – floating license obtained from the Mapping & GIS License Manager software, select the *Install GPS Analyst using a license manager on the network* option and then click **Next**.

   **Tip** – You can change from a single use (standalone) license to a floating license obtained from a license manager on the network, and vice versa, at any time using the Trimble GPS Analyst License Administrator software. For more information search for the topic *Trimble GPS Analyst License Administrator* in the *Trimble GPS Analyst Extension Help*. 

Trimble GPS Analyst Extension Getting Started Guide  39
The Register your Software page appears:

8. Do one of the following:
   - If you have registered the extension and obtained your installation code for the extension, select the I have already registered option and then click Next.
   - If you have not yet registered the extension and do not have an installation code for the extension, select the I do not have an installation code. I want to register my copy over the Internet now option and then click Next.

The Register page opens in your default Web browser, displaying the My Trimble account log in. For more information, see Registering the Trimble GPS Analyst extension, page 26.
9. Enter the installation code assigned to your copy of the Trimble GPS Analyst extension when you registered the extension and then click Next.

The Setup Type page appears:
10. Select how you want to set up the extension. To install:
    - the default setup of the extension, select Typical and then click Next.
    - a custom setup of the extension, select Custom and then click Next. Then do the following:
      a. In the Choose Destination Location page, select the folder where the setup will install the program files and then click Next.
      b. In the Choose Sample Data Destination Folder page, select the folder where the setup will install sample data files used by the Trimble GPS Analyst extension (for example, for tutorials) and then click Next.
      c. In the Select Features page, select the features you want to install, and deselect the features that you do not want to install:
In the list of components, clear the check box beside any components you do not want to install. For more information about any component, highlight it in the list. The Description field beside the list provides a brief description of the highlighted component.

To install the GPS Analyst extension documentation for developers, select the Developer Documentation and Samples check box.

d. Click **Next**.

11. The **Start Copying Files** page appears. Click **Next**.

The final page of the installation wizard shows **InstallShield Wizard Complete**:

12. Trimble recommends that you click the **Yes, check for program updates** option and then click **Finish**.

The GPS Analyst Extension Updater utility appears. Use the utility to download the latest extension updates and documentation from the Trimble website.
Once you have downloaded files, you can install them immediately, or you can run the Updater utility later and select the downloaded files that you want to install (see Updating the Trimble GPS Analyst extension, page 47).

**Note** – You must enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap before you can use it. For more information, see Enabling the Trimble GPS Analyst extension, page 45.

### Installing the Data Transfer utility

Use the Trimble Data Transfer utility to transfer files to GIS devices, such as a data collector running the TerraSync field software.

To install the Data Transfer utility:

1. Insert the *Trimble GPS Analyst Extension CD* in the CD drive of the office computer.

   The Setup screen appears.

   If this screen does not appear, select Autorun.exe from the CD drive folder.

2. Click **Install**.

   The Installation screen appears.

3. Click **Install Data Transfer**.

4. The Data Transfer installation wizard appears.

   Follow the instructions on the screen to install the Data Transfer utility.

   For more information, refer to the *Data Transfer Utility Help*. 
Enabling the Trimble GPS Analyst extension

As with other extensions for ESRI ArcGIS Desktop software, you need to enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap before you can use it. You also need to display the Trimble GPS Analyst toolbar in ArcMap in order to access the tools and commands that allow you to work with GPS data. Any map document that is saved with the Trimble GPS Analyst toolbar displayed retains the toolbar the next time the map is opened.

In ArcCatalog

1. From the Windows Start menu, select All Programs / ArcGIS / ArcCatalog.
   
   ArcCatalog opens.

2. Select Tools / Extensions.
   
   The Extensions dialog appears:

   ![Extensions dialog]

3. Select the Trimble GPS Analyst check box and then close the dialog.
   
   The Trimble GPS Analyst extension is now enabled in ArcCatalog.

4. Close ArcCatalog to allow your changes to take effect.
In ArcMap

1. From the Windows Start menu, select All Programs / ArcGIS / ArcMap.

   ArcMap opens, displaying a dialog asking whether you want to want to start using ArcMap with a new map, a template, or an existing map.

2. Select A new empty map.


   The Extensions dialog appears:

4. Select the Trimble GPS Analyst check box and then close the dialog.

   The Trimble GPS Analyst extension is now enabled in ArcMap.

5. Close ArcMap to allow your changes to take effect.
Updating the Trimble GPS Analyst extension

Trimble recommends that you check for updates for the extension during the installation process (see Step 12, page 43).

To check for software updates at any other time, do one of the following:

- From the Trimble GPS Analyst drop-down menu in ArcMap, select Check for new updates now.
- From the Windows Start menu, select All Programs / Trimble / GPS Analyst / GPS Analyst Updater

For more information, search for the topic Updating GPS Analyst in the Trimble GPS Analyst Extension Help.

Managing licenses for the Trimble GPS Analyst extension

The Trimble Mapping & GIS License Manager software enables you to manage floating licenses for Trimble Mapping and GIS software products. Use the Mapping & GIS License Manager software to:

- View floating license information
- Add new or updated licenses

The Mapping & GIS License Manager is installed on a network computer and communicates with the client machine where the License Administrator software is installed (see Trimble GPS Analyst License Administrator software, page 49).

You can install the Mapping and GIS License Manager software onto a network computer running any of the following Microsoft operating systems:

- Windows XP Professional Edition
- Windows 2000 Professional (SP3)
Installing the Mapping and GIS License Manager software

1. Insert the Trimble GPS Analyst Extension CD in the CD drive of the network server computer.
   The Setup screen appears.
   If this screen does not appear, select Autorun.exe from the CD drive folder.
2. Click Install.
   The Installation screen appears.
3. Click Mapping & GIS License Manager.
4. The Mapping & GIS License Manager installation wizard appears.
   Follow the instructions on the screen to install the Mapping & GIS License Manager software.

Mapping and GIS License Manager Help

The Mapping & GIS License Manager Help is installed on the server machine with the Mapping & GIS License Manager software. It provides detailed information about using the software.

To view the Help, do one of the following:

• in the Mapping & GIS License Manager window, click the Help button
• from the Windows Start menu, select All Programs / Trimble / Mapping & GIS License Manager / License Manager Help.
**Trimble GPS Analyst License Administrator software**

The Trimble GPS Analyst License Administrator software is installed on the client machine when you install the Trimble GPS Analyst extension.

The Trimble GPS Analyst License Administrator displays information about the type of license used by your copy of the Trimble GPS Analyst extension. It also enables you to:

- Change the license manager that the Trimble GPS Analyst extension obtains its license from.
  
  For example, the license manager may be reinstalled on a different computer.

- Change from a single use license to a floating license, and vice versa.
  
  For example, if you take your PC to a site office for several days of field work, the Trimble GPS Analyst extension will not be able to communicate with the License Manager to obtain a floating license. To avoid this, change to a single use license. You can change it back once you return to the office.

For more information, search for the topic **Trimble GPS Analyst License Administrator** in the *Trimble GPS Analyst Extension Help*. 
WORKING WITH GPS DATA IN THE TRIMBLE GPS ANALYST EXTENSION

In this section:

- Chapter 3, The User Interface
- Chapter 4, Typical GPS Analyst Tasks
- Chapter 5, Tutorial 1: Checking Out and Checking In ArcPad and GPScorrect Data
- Chapter 6, Tutorial 2: Importing Trimble SSF Files
- Chapter 7, Tutorial 3: Processing GPS Data
The User Interface

In this chapter:
- In ArcCatalog
- In ArcMap
- Trimble GPS Analyst toolbox
- Measurement units
- Exiting the Trimble GPS Analyst extension

This chapter describes the toolsets and menu commands that comprise the Trimble GPS Analyst extension interface in ArcCatalog and ArcMap.

Whether you are using ArcView, ArcEditor, or ArcInfo, the same tools are available for you to work on your GPS data.
In ArcCatalog

In ArcCatalog, the Trimble GPS Analyst extension interface is a set of right-click menu commands. Depending on the item you right-click, different options appear.

*Note* – You must enable the Trimble GPS Analyst extension in ArcCatalog (see page 45) and GPS-enable a geodatabase (see page 67) before you can view the GPS Analyst extension interface.

To access menu items provided with the GPS Analyst extension, right-click items in a GPS-enabled geodatabase in ArcCatalog.

Table 3.1 on the following page describes each menu item, and how to access it.

<table>
<thead>
<tr>
<th>Right-click a...</th>
<th>and then select...</th>
<th>to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS-enabled geodatabase or feature dataset</td>
<td>Import / Schema from Trimble DDF</td>
<td>Open the Import Schema from Trimble DDF tool. Run the tool to import the data dictionary from a Trimble DDF or SSF file into the geodatabase as a schema for feature classes.</td>
</tr>
<tr>
<td></td>
<td>Import / From Trimble SSF</td>
<td>Open the Import from Trimble SSF tool. Run the tool to import SSF files collected using Trimble data collection software such as TerraSync into the geodatabase.</td>
</tr>
<tr>
<td></td>
<td>Import / From ArcPad shapefiles and GPScorrect SSF</td>
<td>Open the Import from ArcPad shapefiles and GPScorrect SSF tool. Run the tool to import data collected using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad into the geodatabase.</td>
</tr>
<tr>
<td>geodatabase, feature dataset, or feature class</td>
<td>Export to Trimble SSF</td>
<td>Open the Export to Trimble SSF tool. Run the tool to export the selected geodatabase or feature class(es) as an SSF file that you can update using Trimble data collection software, such as the TerraSync field software.</td>
</tr>
</tbody>
</table>
In ArcMap

In ArcMap, the Trimble GPS Analyst extension interface consists of the Trimble GPS Analyst toolbar, and several dockable windows. Use the Trimble GPS Analyst toolbar to access tools and commands that enable you to work with GPS data. Use the standard ArcMap Tools toolbar to select features, and to change the map extent displayed.

Note – You must enable the Trimble GPS Analyst extension in ArcMap (see page 46) before you can view the Trimble GPS Analyst extension interface.

The Trimble GPS Analyst toolbar

To display the Trimble GPS Analyst toolbar in ArcMap:

1. In ArcMap, select View / Toolbars.
2. Select Trimble GPS Analyst.
3. The Trimble GPS Analyst toolbar appears.

You can dock the toolbar above the map, or leave the toolbar “floating” on the map.

<table>
<thead>
<tr>
<th>Right-click a...</th>
<th>and then select...</th>
<th>to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS session</td>
<td><img src="image" alt="Differential Correction" /></td>
<td>Start the Differential Correction wizard with the selected session preselected in the Selected Sessions list of the wizard.</td>
</tr>
<tr>
<td>View audit log</td>
<td><img src="image" alt="View audit log" /></td>
<td>Open the audit log file for the selected GPS session (corrected GPS sessions only).</td>
</tr>
<tr>
<td>Edit Antenna Settings</td>
<td><img src="image" alt="Edit Antenna Settings" /></td>
<td>Edit the height of the antenna used to collect GPS data during the GPS session.</td>
</tr>
<tr>
<td>Rename</td>
<td><img src="image" alt="Rename" /></td>
<td>Rename the selected GPS session.</td>
</tr>
</tbody>
</table>
The Trimble GPS Analyst toolbar consists of:

- the *Trimble GPS Analyst* drop-down menu
- GPS position tools
- Office toolset

**Trimble GPS Analyst drop-down menu**

Use the commands on the *Trimble GPS Analyst* drop-down menu to:

- start and stop a GPS edit session, or save your edits
- access rebuild and correction settings
- set measurement units
- display or hide a toolset on the Trimble GPS Analyst toolbar
- check for software and documentation updates for the GPS Analyst extension from the Trimble website
- access the *Trimble GPS Analyst Extension Help*
GPS Analyst toolsets and toolbar buttons

*Note* – Most buttons on the Trimble GPS Analyst toolbar are not enabled until you start a GPS edit session. For more information, see GPS edit sessions, page 72 or search for the topic GPS edit sessions in the Trimble GPS Analyst Extension Help.

The GPS position tools enable you to select and display GPS positions on the map.

The Office toolset provides editing and analysis tools, and tools for working with ArcPad and GPScorrect data.

Table 3.2 describes the function of each button on the Trimble GPS Analyst toolbar.

<table>
<thead>
<tr>
<th>Item</th>
<th>Button Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS Position tools</td>
<td>Select GPS Positions for Selected Features</td>
<td>Selects and displays GPS positions used in the selected features on the map.</td>
</tr>
<tr>
<td></td>
<td>Select All GPS Positions for Selected Features</td>
<td>Selects and displays all GPS positions (original and corrected) for the selected features on the map.</td>
</tr>
<tr>
<td></td>
<td>Select GPS Positions</td>
<td>Selects GPS positions from the map.</td>
</tr>
<tr>
<td></td>
<td>GPS Position Properties</td>
<td>Opens the GPS Position Properties dialog.</td>
</tr>
<tr>
<td>Office toolset</td>
<td>Differential Correction</td>
<td>Opens the Differential Correction wizard. Use the wizard to reduce errors in collected GPS data.</td>
</tr>
<tr>
<td></td>
<td>Rebuild</td>
<td>Opens the Rebuild GPS-enabled Features tool. Run the tool to rebuild the geometry of features derived from GPS positions.</td>
</tr>
<tr>
<td></td>
<td>GPS Feature Validation</td>
<td>Opens the GPS Validation dialog.</td>
</tr>
<tr>
<td></td>
<td>Get Data for ArcPad</td>
<td>Opens the Get Data for ArcPad wizard. Use the wizard to check out files for updating using ArcPad software.</td>
</tr>
</tbody>
</table>

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Additional tools

The Field toolset provides tools for collecting GPS data in ArcMap (see page 160). By default, the Field toolset is not displayed.

**Tip** – You can display both toolsets on the Trimble GPS Analyst toolbar, or only the toolset for the tasks you are performing. To display or hide a toolset, select the appropriate command from the Trimble GPS Analyst drop-down menu. A check mark next to a toolset command indicates that the toolset is displayed.
The GPS group layer

When you add GPS-enabled feature classes to the map in ArcMap, the GPS group layer is automatically added as the top layer in the Table of Contents window. The GPS group layer contains the Features In Progress layer and GPS Positions layer.

Features In Progress layer

The Features In Progress layer shows the pending geometry for the line or polygon feature currently being created or edited using the GPS Analyst extension.

GPS Positions layer

The GPS Positions layer shows the GPS positions stored in the geodatabase. By default, the GPS Positions layer is enabled, but no GPS positions are selected for display. You can control how and which GPS positions are displayed on the map using the Layer Properties dialog.

To display the GPS positions for a feature:

1. Make sure you have added GPS data to your map.
2. Use the Select Features tool on the ArcMap Tools toolbar to select a feature.
3. Do one of the following:
   - To select all GPS positions for the selected feature, click the Select All GPS Positions for Selected Features button on the Trimble GPS Analyst toolbar.
To select the GPS positions that are used to construct the selected feature, click the Select GPS Positions for Selected Features button on the Trimble GPS Analyst toolbar. The GPS positions are shown even if the GPS Positions layer is set to display no GPS positions.

**Trimble GPS Analyst toolbox**

The Trimble GPS Analyst toolbox groups together the geoprocessing tools provided with the Trimble GPS Analyst extension.

The following tools are provided in the Trimble GPS Analyst toolbox:

- Rebuild GPS-enabled Features
- Check In ArcPad shapefiles and GPSCorrect SSF
- Export to Trimble SSF
- Import From ArcPad shapefiles and GPSCorrect SSF
- Import from Trimble DDF
- Import from Trimble SSF

The Check In ArcPad shapefiles and GPSCorrect SSF tool only works in ArcMap. The rest of the tools are available when you open ArcToolbox in either ArcCatalog or ArcMap. Depending on the tool, they can also be accessed from either the right-click menu in ArcCatalog or from the Trimble GPS Analyst toolbar in ArcMap.
Measurement units

To select the units used to display or enter numeric values used by the Trimble GPS Analyst extension, select Units from the Trimble GPS Analyst drop-down menu on the Trimble GPS Analyst toolbar. The Units dialog appears:

![Units dialog](image)

Use the Units dialog to choose units for distance, velocity, and angle, as well as the formats for bearings.

The units you select are used by the Trimble GPS Analyst extension for all GPS data in both ArcMap and ArcCatalog, except for geoprocessing tools and x and y values. The x and y values always use the units specified for the coordinate system of the data frame.

**Note** – The units you select do not change units used elsewhere in ArcMap and ArcCatalog.
Table 3.3 lists the measurements used in the Trimble GPS Analyst extension, and the available units.

Table 3.3  Available measurement units for the Trimble GPS Analyst extension

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Default Units</th>
<th>Available Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance</td>
<td>Meters</td>
<td>Inches, Feet, Yards, Miles, Nautical Miles, Millimeters, Centimeters, Meters, Kilometers</td>
</tr>
<tr>
<td>Velocity</td>
<td>Kilometers per Hour</td>
<td>Feet per Second, Meters per Second, Kilometers per Hour, Miles per Hour, Knots</td>
</tr>
<tr>
<td>Angle</td>
<td>Degrees</td>
<td>Degrees, Gradians, Mils</td>
</tr>
<tr>
<td>North Reference</td>
<td>True</td>
<td>True, Magnetic</td>
</tr>
<tr>
<td>Magnetic Declination</td>
<td>Auto</td>
<td>Auto, User Specifiable in angle units</td>
</tr>
</tbody>
</table>

Tip – To convert data into the configured units, simply enter the value followed by the abbreviation for the units it is in. For example, if Meters is the configured unit, and you enter 10 ft, the value is converted to 3.048 m. Automatic conversion applies only to fields that contain distances, offsets, heights, or coordinates.

Table 3.4 lists the available distance units and their abbreviations.

Table 3.4  Distance unit abbreviations in the Trimble GPS Analyst extension

<table>
<thead>
<tr>
<th>Unit</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inches</td>
<td>in</td>
</tr>
<tr>
<td>Feet</td>
<td>ft</td>
</tr>
<tr>
<td>Yards</td>
<td>yd</td>
</tr>
<tr>
<td>Miles</td>
<td>mi</td>
</tr>
<tr>
<td>Nautical Miles</td>
<td>nm</td>
</tr>
<tr>
<td>Millimeters</td>
<td>mm</td>
</tr>
<tr>
<td>Centimeters</td>
<td>cm</td>
</tr>
<tr>
<td>Meters</td>
<td>m</td>
</tr>
<tr>
<td>Kilometers</td>
<td>km</td>
</tr>
</tbody>
</table>
Exiting the Trimble GPS Analyst extension

From ArcCatalog, you do not need to save changes or exit the Trimble GPS Analyst extension. Changes are saved when the GPS Analyst function (for example, importing a Trimble SSF file) finishes processing.

From ArcMap, exit the Trimble GPS Analyst extension as follows:

1. If you have started a GPS edit session, select Stop GPS Editing from the Trimble GPS Analyst drop-down menu.

2. Do one of the following:
   - Click Yes to save the edits. The modified features as well as the GPS data that the features are linked to are saved in the geodatabase.
   - Click No to discard the edits.

If you also want to exit ArcMap:

1. Select File / Save. The map document is saved.

2. Select File / Exit. ArcMap is closed.

If the Trimble GPS Analyst toolbar is displayed when you save a map document, it is displayed the next time you open that document.
Typical GPS Analyst Tasks

In this chapter:
- Overview: Importing and processing GPS data
- Typical workflow

This chapter outlines the tasks you will typically perform when working with GPS data using the Trimble GPS Analyst extension in ArcCatalog and in ArcMap.

For step-by-step instructions and more detailed information about these tasks, refer to the tutorials provided in Chapters 5, 6, and 7.
Overview: Importing and processing GPS data

The Trimble GPS Analyst extension enables you to store and work with GPS-based data directly within the ESRI ArcGIS Desktop software environment.

The GPS Analyst extension supports GIS and GPS data in the Trimble SSF file format. You can import GPS data collected using either ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad, or other Trimble data collection software, such as the TerraSync field software, into a GPS-enabled geodatabase.

You can import data from the following versions of data collection software:

- ESRI ArcPad software version 6.0.1 with the Trimble GPScorrect extension version 1.01 and later
- ESRI ArcPad software version 7.0 and later with the Trimble GPScorrect extension version 2.00 and later
- TerraSync software version 2.40 and later

Usually when you use the GPS Analyst extension, you will add collected GPS and GIS data to a GPS-enabled geodatabase and then process the data. If you want to update existing data, you will first need to extract the data from the geodatabase and then update it using your data collection software.

Typical workflow

When you import and process GPS data using the Trimble GPS Analyst extension, you will typically complete some or all of the following steps:

1. Prepare the geodatabase for GPS data.
2. If you want to update existing features with GPS data, extract the data from the geodatabase.
3. Add the new and updated data back to the geodatabase.
4. Process and analyze the GPS data.
More information about each step is provided below. These steps assume that you will use the GPS Analyst user interface provided in ArcCatalog and ArcMap. You can also complete some steps using geoprocessing tools provided in the Trimble GPS Analyst toolbox, available when you open ArcToolbox. For more information, see Trimble GPS Analyst toolbox, page 60.

**Step 1: Prepare the geodatabase for GPS data**

*Note – To work with GPS data using the Trimble GPS Analyst extension, you must use a personal geodatabase.*

In ArcCatalog, open the *Database Properties* dialog and prepare the geodatabase for GPS data by doing the following:

1. GPS-enable the geodatabase and the feature classes that will contain the GPS-derived features.
2. Specify the spatial reference for the geodatabase.
3. Select a geographic transformation for the GPS data.

**GPS-enabling a geodatabase**

Before you can store or work with GPS data in the geodatabase, you need to GPS-enable it. GPS-enabling a geodatabase creates records in the geodatabase where GPS data is stored, and creates the GPS Sessions folder.

*Note – You can only GPS-enable a personal geodatabase.*

For more information, see Exercise 1 in Tutorial 1 or 2 or search for the topic **GPS-enabling the geodatabase** in the *Trimble GPS Analyst Extension Help*.

When GPS-enabling a geodatabase, you must specify its spatial reference. GPS positions stored in the geodatabase use the WGS-84 geographic coordinate system. If you select a spatial reference for the geodatabase that is not WGS-84, or if you GPS-enable feature classes
that use a different coordinate system to WGS-84, you need to select a geographic transformation to correctly convert the GPS positions from WGS-84 to the nominated coordinate system.

As part of the GPS-enabling process, you must also GPS-enable the feature classes in the geodatabase that you want to associate with GPS data and define the accuracy required for validation. All GPS-enabled feature classes must use the same coordinate system as the geodatabase.

**Setting a spatial reference**

The spatial reference for the geodatabase describes its coordinate system (for example, WGS-84, or UTM), its spatial domain, and its precision. The spatial domain is the allowable coordinate range for x, y, and z coordinates. All GPS-enabled feature classes in a GPS-enabled geodatabase must use the same coordinate system, and the spatial domain of each feature class must be within the bounds of the spatial domain defined for the GPS-enabled geodatabase.

When working with GPS data, you should specify a negative z domain value, especially if you are working in low-lying coastal areas, or if any features are likely to be underground, such as cables.

The spatial domain that you specify for the geodatabase affects the degree of precision that the feature geometries stored in the geodatabase will have. Precision defines the level of detail that is maintained when feature geometries are stored in the geodatabase. The smaller the spatial domain used, the greater the precision of the feature geometries in the geodatabase.

GPS positions are not affected by the resolution of the spatial domain for the geodatabase. They are always represented precisely in the geodatabase. If the spatial domain is too large, GIS features will be stored with less precision than their underlying GPS positions. This does not affect the quality of your data, but it can cause inaccuracies in the ArcMap display.
To minimize map display discrepancies between GPS positions and GIS features, choose an appropriate spatial domain for the geodatabase. You cannot change the spatial reference for a GPS-enabled geodatabase without deleting all its GPS data, so you need to define carefully the area to be mapped at the start of a project.

For more information, search for the topic Setting the spatial reference for the geodatabase in the Trimble GPS Analyst Extension Help.

**Selecting a geographic transformation**

Because GPS data always uses the WGS-84 coordinate system, you need to specify a geographic transformation if the geodatabase is using any coordinate system except WGS-84. This enables the ArcGIS Desktop software to project the GPS data into the correct coordinate system.

ArcGIS often provides different transformations for different areas in the same coordinate system. For example, there are separate NAD-83 to WGS-84 transformations for the continental US, Hawaii, and Alaska. There may also be several transformations for the same location, for example if the transformation has been revised over time.

**Step 2: Extract data from the geodatabase for updating**

There are two ways to extract existing data from a GPS-enabled geodatabase for updating in the field. The method you select depends on the type of data collection software that your field crews will be using to update the data.

**For ArcPad and the GPScorrect extension**

If your field crews will be using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad to update the data, use ArcMap to open a map document containing the feature classes you want to update. Use the Get Data for ArcPad button on the Trimble GPS Analyst toolbar in ArcMap to check out the feature classes from the
geodatabase to ArcPad. Then, use Microsoft ActiveSync technology to transfer the shapefiles to a field computer running ArcPad software and the GPScorrect extension.

**For Trimble data collection software**

If your field crews will be using Trimble data collection software such as the TerraSync software to update the data, export feature classes from the geodatabase as SSF files using the *Export to Trimble SSF* command in ArcCatalog. Then, use the Trimble Data Transfer utility provided with the GPS Analyst extension to transfer the SSF files to a field computer running the Trimble data collection software.

**Tip** – For information about how to install the Data Transfer utility, see Installing the Data Transfer utility, page 44. For more information about using the Data Transfer utility, refer to the *Data Transfer Utility Help*.

**Step 3: Add GPS and GIS data to the geodatabase**

The method you use to add GPS data to the geodatabase depends on the type of data collection software that your field crews used to collect the data.

If your field crews used ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad to collect the data, there are two ways to add the data to the geodatabase:

- If the field crews were updating data that you checked out of the geodatabase using the Get Data for ArcPad button on the Trimble GPS Analyst toolbar in ArcMap, you must check in the data using the Check In ArcPad shapefiles and GPScorrect SSF button in ArcMap.

- If the field crews were collecting new data that has not yet been added to the geodatabase, you must import the data using ArcCatalog.
Each method for adding GPS data to the geodatabase is described below.

**Checking in ArcPad and GPScorrect data**

Use ActiveSync technology to transfer the field data from the field computer to the office PC.

Once the data is transferred, open ArcMap and start a GPS edit session (see page 72) from the Trimble GPS Analyst drop-down menu. Use the Check In ArcPad shapefiles and GPScorrect SSF button on the Trimble GPS Analyst toolbar to check the updated shapefiles into the geodatabase. The shapefiles are checked in with their corresponding SSF file, which contains the GPS data associated with the shapefiles.

**Importing ArcPad and GPScorrect data**

Use ActiveSync technology to transfer the field data from the field computer to the office PC.

Once the data is transferred, open ArcCatalog and then use the Import / From ArcPad shapefiles and GPScorrect SSF command to import the shapefiles into the geodatabase. The shapefiles are imported with their corresponding SSF file, which contains the GPS data associated with the shapefiles.

**Importing data collected using Trimble data collection software**

If your field crews used Trimble data collection software such as the TerraSync software to collect the data, use the Trimble Data Transfer utility provided with the GPS Analyst extension to transfer the SSF files from the field computer to the office PC where the GPS Analyst extension is installed. Then, import the SSF files into the geodatabase using the Import From Trimble SSF command in ArcCatalog.

**Tip** – For information about how to install the Data Transfer utility, see Installing the Data Transfer utility, page 44. For more information about using the Data Transfer utility, refer to the Data Transfer Utility Help.
Step 4: Process and analyze the GPS Data

Once you have added GPS data to the geodatabase, you can use the GPS Analyst Office toolset in ArcMap to differentially correct, rebuild, and validate collected GPS positions. You will need to start a GPS edit session before you can edit GPS data.

Alternatively, you can use the Differential Correction command in ArcCatalog to differentially correct the collected data, and just use the GPS Analyst Office toolset in ArcMap to view, rebuild, and validate features.

GPS edit sessions

A GPS edit session enables you to collect or edit any feature that is linked to GPS data.

Note – To edit a feature that uses GPS data, start a GPS edit session, not a standard ArcMap edit session. A feature that is edited in a standard ArcMap edit session becomes unlinked from its GPS-derived geometry.

Tip – If you do unlink a feature from its GPS data, make sure that the Replace manually edited geometry with GPS-derived geometry check box in the Position Selection tab of the Rebuild Settings dialog is selected and then use the Rebuild command on the Trimble GPS Analyst toolbar to rebuild features and restore the link.

You cannot start a GPS edit session if an ArcMap edit session is already open.

For more information, search for the topic GPS edit sessions in the Trimble GPS Analyst Extension Help.
Tutorial 1: Checking Out and Checking In ArcPad and GPScorrect Data

In this chapter:
- Before you begin
- Scenario
- Connecting to your data
- Exercise 1: Preparing feature classes for GPS data
- Exercise 2: Checking out data to ArcPad
- Exercise 3: Checking in ArcPad shapefiles and the GPScorrect SSF file

This tutorial explains how to:
- GPS-enable the geodatabase
- check out data from a personal geodatabase for updating in the field using GPS data
- check data into the geodatabase that has been updated in the field using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad

The tutorial contains step-by-step instructions for the main tasks involved.

This tutorial will take between 30 and 45 minutes to complete.
Before you begin

Before beginning this tutorial, you will need to:

- Install the ESRI ArcGIS Desktop software. For more information, refer to the documentation provided by ESRI.
- Install the Trimble GPS Analyst extension. For more information, see Installing the Trimble GPS Analyst extension, page 36.
- Locate where the tutorial sample files are stored on your computer and, if required, reinstall them (see Loading the tutorial sample files below).
- Enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap (see page 45).
- Display the Trimble GPS Analyst toolbar in ArcMap (see page 55).

*Note – The tutorials assume that the default settings for the Trimble GPS Analyst extension are unchanged. If they have been changed, the extension may behave differently from the behaviour described in the tutorials.*

This tutorial assumes that you are familiar with GIS concepts and the ArcGIS software environment. For information on GIS concepts and the ArcGIS Desktop software environment, refer to *Getting Started with ArcGIS* and *Building and Editing Geodatabases*, which you received from ESRI in your ArcGIS package.

The exercises in this tutorial are designed to be completed in sequence.

Loading the tutorial sample files

The exercises use sample files supplied with the Trimble GPS Analyst extension. These sample files are located in the folder you specified at installation. The default location is *C:\ArcGIS\ArcTutor\GPS Analyst*.

If they have been deleted, reload them from the *Trimble GPS Analyst Extension CD*.
To reload the sample files:

1. Insert the *Trimble GPS Analyst Extension CD* in the CD drive of the computer.
2. Select *Install*.
3. Depending on the version of ArcGIS Desktop software you are running, click either *Install GPS Analyst for ArcGIS 9.0 and 9.1* or *Install GPS Analyst for ArcGIS 9.2*.
4. Select *Modify*.
5. Select the *Sample Data* check box.
6. Follow the instructions on the screen to install the sample files.

For more information, refer to *Installing the Trimble GPS Analyst extension, page 36*.

**Returning the contents of the tutorial folder to its original state**

Each tutorial folder contains a zip file to return the contents of the tutorial geodatabase to its original state.

*Note* – *You must return the contents of the tutorial folder to its original state before you do the tutorial. You will need to do this if you have done the tutorial before, even if you have uninstalled and then reinstalled the Trimble GPS Analyst extension.*

To return the contents of any GPS Analyst tutorial folder to its original state:

1. In Windows Explorer, delete all files inside the tutorial folder except the .zip folder.
2. Right-click the .zip folder and select WinZip. Extract the contents to the tutorial folder.
Scenario
The City of Westminster, Colorado, maintains a geodatabase of assets in an Open Space park. The geodatabase contains features such as access ways, sewers, building footprints, vehicle parking areas, and road centerlines. The City of Westminster wants to send field crews to the park to map new features and update existing ones. They will use field computers running ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad to map features using GPS data.

Your task is to prepare the feature classes in the geodatabase for use with GPS data. You will also check the data out of the geodatabase, so that the field crews can use ArcPad and the GPScorrect extension to update it.

Later, when the field crews return to the office, you will transfer the data from the field computers to the office computer, and check in the updated data.

Connecting to your data
The Catalog tree in ArcCatalog has a branch for each local hard drive. You can also create new branches in the Catalog tree to make it easier to navigate to your data. These branches are called connections.

Now you will add a connection to the folder that contains the tutorial data. This new branch remains in the Catalog tree until you delete it.

Make a connection to the tutorial data
1. In ArcCatalog, click the Connect to Folder button.
2. Navigate to the folder on the drive where the tutorial data is installed. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial1. Click OK.
The new connection appears as a branch in the Catalog tree:

3. Click the Tutorial1 folder to view its contents on the right side of the ArcCatalog window.

Table 5.1 on the following page describes the contents of the Tutorial1 folder.
Table 5.1  Contents of the Tutorial1 folder

<table>
<thead>
<tr>
<th>Folder or filename</th>
<th>File type</th>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial1 Folder</td>
<td>Folder</td>
<td></td>
<td>This is the main project folder where the City of Westminster geodatabase and map document are stored.</td>
</tr>
<tr>
<td>City of Westminster</td>
<td>Geodatabase</td>
<td>Tutorial1</td>
<td>The geodatabase containing the data for this tutorial.</td>
</tr>
<tr>
<td>City of Westminster_Tutorial1</td>
<td>Map document</td>
<td>Tutorial1</td>
<td>A map document of the Open Space park maintained by the City of Westminster.</td>
</tr>
<tr>
<td>Open Space</td>
<td>Raster dataset</td>
<td>Tutorial1</td>
<td>A raster dataset of images of the Open Space park, which provides the background image for the map.</td>
</tr>
<tr>
<td>ArcPad+GPScorrect Data</td>
<td>Folder</td>
<td>Tutorial1 \ArcPad+GPScorrect Data</td>
<td>A special folder for this tutorial. This is the folder where the ArcPad shapefiles and the GPScorrect SSF file that have been updated in the field are stored. You will check this data into the geodatabase.</td>
</tr>
</tbody>
</table>
Exercise 1: Preparing feature classes for GPS data

The field crew will travel to the Open Space Park to collect the new features. The City of Westminster has indicated that the features that need to be mapped or updated are:

- access ways
- storm drain access covers
- water points

Your task is to prepare the City of Westminster geodatabase for use with GPS data, and to GPS-enable the feature classes that contain the new features.

This exercise introduces you to the concepts of:

- GPS data in the geodatabase
- geographic transformations
- estimated accuracy
- required accuracy for validation

It shows you how to:

- GPS-enable a geodatabase and selected feature classes
- add estimated accuracy attributes to GPS-enabled feature classes
- specify the required accuracy for features in the same feature class to pass validation

For this exercise, you will be working with ArcCatalog, which is the ArcGIS Desktop data management application.
GPS data in the geodatabase

The Trimble GPS Analyst extension enables you to store GPS data directly in the geodatabase as a GPS session. GPS sessions are contained in the GPS Sessions folder. GPS positions are always stored in the geodatabase using the WGS-84 coordinate system.

Before you can store GPS sessions in the geodatabase, you need to:

- GPS-enable the geodatabase
- specify the spatial reference for GPS-enabled feature classes
- GPS-enable the feature classes that you want to use with GPS data

You also need to select a geographic transformation, because the feature classes in the geodatabase are not referenced to the WGS-84 coordinate system. The geographic transformation will ensure that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to coordinates in the same coordinate system as the feature classes.

To complete these tasks, use the Trimble GPS Analyst tab of the Database Properties dialog. You can GPS-enable a geodatabase at the same time that you create the geodatabase, or later, once it contains GIS features.

GPS-enabling the geodatabase and feature classes

1. Open ArcCatalog, if it is not already open. To do this, select All Programs / ArcGIS / ArcCatalog from the Windows Start menu.
2. Browse to the tutorial dataset folder connection you created for Tutorial 1.
3. Right-click the City of Westminster geodatabase and select Properties.

The Database Properties dialog appears.
4. Select the *Trimble GPS Analyst* tab:

5. Select the *GPS-enable geodatabase* check box.

6. Select the check boxes next to the AccessWays, StormDrainPoints, and WaterPoints feature classes.

   The field crew will collect new features in these three feature classes.

7. Click **OK**.
The Select Geographic Transformation dialog appears:

GPS data stored in the geodatabase uses the World Geodetic System of 1984 (WGS-84) geographic coordinate system. Because the City of Westminster geodatabase uses the North American Datum of 1983 (NAD 1983) coordinate system, you need to specify a geographic transformation so that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to NAD 1983 coordinates. You will use the NAD_1983_To_WGS_1984_4 geographic transformation, because it is the transformation that ESRI recommends for converting WGS-84 coordinates to NAD_1983 coordinates for data in the United States.

8. From the drop-down list, select the NAD_1983_To_WGS_1984_4 geographic transformation and then click OK.

The City of Westminster geodatabase is now GPS-enabled. The GPS Analyst extension has created the GPS Sessions folder that will contain GPS sessions for the geodatabase.

To view the GPS Sessions folder, double-click the City of Westminster geodatabase in the Catalog tree.
### Estimated accuracy values

When a feature is created using GPS data, the GPS Analyst extension calculates estimated accuracy values for the feature, and for the constructions that are used to build the feature.

For features that are made up of several vertices, the estimated accuracy is represented in two ways: the **average estimated accuracy**, which is the average for all the vertices in the feature, and the **worst estimated accuracy**, which is the estimated accuracy of the vertex that has the largest estimated accuracy of all the vertices in the feature. For a point feature, which always consists of only one averaged vertex, the worst estimated accuracy is always the same as the average estimated accuracy.

The average estimated accuracy and the worst estimated accuracy values for a feature are stored as part of the GPS data used to construct the feature. You can choose to map the average and worst estimated accuracy values to attributes in the feature classes that you have GPS-enabled. If you do so, and if you later unlink a feature from its GPS data or GPS-disable the geodatabase, the estimated accuracy values for the feature will be retained as attributes.

### Required accuracy for validation

The worst estimated accuracy value is used as part of the validation process. During GPS feature validation, the GPS Analyst extension checks whether the worst estimated accuracy of the feature is within the required accuracy specified for its feature class. The degree of accuracy you require depends on the type of feature collected and the purpose of the information. For example, underground cable features that maintenance crews will need to locate and repair require better accuracy than signpost features that are clearly identifiable.

You can specify or change the accuracy required for a feature class at any time, using the *Trimble GPS Analyst* tab of the *Feature Class Properties* dialog. You can learn more about validation by completing Tutorial 3: Processing GPS Data, beginning on page 129.
For this tutorial, you will specify the required accuracy before you check out the data to ArcPad.

**Specifying the required accuracy for features**

1. In ArcCatalog, expand the Open Space feature dataset:

   ![ArcCatalog screenshot]

   2. Right-click the AccessWays feature class and then click *Properties*.

      The *Feature Class Properties* dialog appears.
3. You have decided to store estimated accuracy values as attributes in the feature, so select the **Fields** tab:

![Feature Class Properties](image)

4. To add a new field to the feature class, click the next blank row in the **Field Name** column and then type **Average_Est_Accuracy**.

5. In the same row, click in the **Data Type** column. From the drop-down list, select Double.

6. Repeat Steps 4 and 5 to create a new field called **Worst_Est_Accuracy**. Define the data type as Double.

7. Click **Apply**.
8. Select the Trimble GPS Analyst tab:

![Trimble GPS Analyst screenshot]

The GPS-enable feature class check box is selected, because you enabled the feature class from the Database Properties dialog.

9. From the drop-down list next to Store average estimated accuracy in, select Average_Est_Accuracy.

10. From the drop-down list next to Store worst estimated accuracy in, select Worst_Est_Accuracy.

The City of Westminster map document uses meters to measure distance, so you will specify the accuracy required for validation in meters.

11. In the Accuracy required for validation field, enter 0.4 m.
All features in the AccessWays feature class now need to be accurate to within 40 centimeters in order to pass validation.

12. Click OK.

13. Repeat steps 2 through 12 above for the other GPS-enabled feature classes in the City of Westminster geodatabase:
   - StormDrainPoints
   - WaterPoints
Exercise 2: Checking out data to ArcPad

Now that you have prepared the City of Westminster geodatabase for GPS data, you need to check the GPS-enabled feature classes out of the geodatabase for use in ArcPad. All feature data is automatically converted into Shapefile format for ArcPad. The shapefiles will be transferred to the field computers used by the field crews.

This lesson introduces the concepts of:
- GPS layers in ArcMap

It shows you how to:
- check out GPS-enabled feature classes to ArcPad

GPS layers in ArcMap

Maps that contain GPS-enabled feature classes contain a GPS group layer. The GPS group layer is added as the top layer in the map when GPS-enabled feature classes are added to the map, or when you GPS-enable feature classes that are contained in the map document.

The GPS group layer in the City of Westminster map document contains two layers:
- Features in Progress
- GPS Positions

These layers are used for analyzing and editing features that are linked to a GPS-derived geometry. You will use these layers if you complete Tutorial 3: GPS Data Processing.

Exercise 2: Checking out data to ArcPad

Now that you have prepared the City of Westminster geodatabase for GPS data, you need to check the GPS-enabled feature classes out of the geodatabase for use in ArcPad. All feature data is automatically converted into Shapefile format for ArcPad. The shapefiles will be transferred to the field computers used by the field crews.

This lesson introduces the concepts of:
- GPS layers in ArcMap

It shows you how to:
- check out GPS-enabled feature classes to ArcPad

GPS layers in ArcMap

Maps that contain GPS-enabled feature classes contain a GPS group layer. The GPS group layer is added as the top layer in the map when GPS-enabled feature classes are added to the map, or when you GPS-enable feature classes that are contained in the map document.

The GPS group layer in the City of Westminster map document contains two layers:
- Features in Progress
- GPS Positions

These layers are used for analyzing and editing features that are linked to a GPS-derived geometry. You will use these layers if you complete Tutorial 3: GPS Data Processing.
Opening a map document that contains GPS-enabled feature classes

- In ArcCatalog, browse to the tutorial folder and double-click City of Westminster_Tutorial1.mxd. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial1.

ArcMap starts and displays a map of the Open Space park maintained by the City of Westminster:

Because you GPS-enabled three of the feature classes that are contained in the map document, two GPS layers are added to the map: the Features in Progress layer and the GPS positions layer. These appear in the GPS group layer, which is the first layer in the Display tab of the ArcMap table of contents.
Checking out GPS-enabled feature classes to ArcPad

1. Click the Get Data for ArcPad button on the Trimble GPS Analyst toolbar.

   The first page of the Get Data for ArcPad wizard appears:

   ![Get Data for ArcPad Wizard](image)

2. Click Select All to select all layers in the map.

3. Click the check box next to Open Space.sid to deselect the background layer and then click Next.
The second page of the *Get Data for ArcPad* wizard appears:

4. Click **Select All** to make all layers editable in ArcPad and then click **Next**.

The third page of the *Get Data for ArcPad* wizard appears:
5. In the spatial extent options group, make sure that *The current display extent* option is selected.

6. Type **field_data** as the name for the folder that will be created to store the data.

7. Click ![folder] and navigate to the Tutorial1 folder where the City of Westminster geodatabase is stored. The default location is `C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial1`.

   The field data folder will be stored in this folder.

8. Click **Finish**. The check out process starts.

9. When the check out process is complete, the *Get Data for ArcPad* summary dialog appears. Click **OK** to close the dialog.

The feature classes you selected are now checked out as shapefiles.

To view the contents of the **field_data** folder:

1. In ArcCatalog, select the Tutorial1 folder, then select **View / Refresh**.

2. Double-click the **field_data** folder.

   A Shapefile has been created for each feature class.

Usually, you would now use Microsoft software such as ActiveSync technology to transfer the shapefiles to a field computer that is running ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad. This step is not necessary for this tutorial.

Once the files have been transferred to the field computers, the field crews travel to the Open Park to collect features using GPS data. They connect the field computer to a GPS receiver, and use the GPScorrect extension to configure receiver settings and obtain detailed status for the GPS receiver. The field crews use the ArcPad software to collect or update features and attribute information. As features are created or updated, the GPScorrect extension records GPS positions for the feature in a Trimble SSF file. There is one SSF file, named GPScorrect.ssf, for each set of modified shapefiles.
Exercise 3: Checking in ArcPad shapefiles and the GPScorrect SSF file

The field crews have now returned to the office with the modified data stored in their field computers. They have collected new access way, storm drain access cover, and water point features.

Your task is to transfer the modified shapefiles and the corresponding SSF file from the field computer to the office computer. Then, you will check the new data into the geodatabase.

This exercise introduces the following concepts:

- GPS edit sessions
- checking in ArcPad and GPScorrect data

It shows you how to:

- check in ArcPad shapefiles and the GPScorrect SSF file to the geodatabase

Transferring files from the field computer to the office computer

Normally, you would use Microsoft software such as ActiveSync technology to transfer modified field data from the field computer to the office computer. For this tutorial, you will simulate the data transfer by copying the files using Microsoft Windows Explorer.

To transfer files:

1. From the Windows Start menu, select All Programs / Accessories / Windows Explorer.

   Windows Explorer opens.

2. Navigate to the Tutorial1 folder. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial1.

3. Double-click the ArcPad+GPScorrect Data folder to view its contents.
4. Press \texttt{Ctrl} + \texttt{A} to select all files in the folder and then press \texttt{Ctrl} + \texttt{C} to copy them.

5. Open the field\_data folder that you created when you checked out the data from the geodatabase.

6. Click anywhere inside the field\_data folder and then press \texttt{Ctrl} + \texttt{V} to paste the ArcPad shapefiles and the GPSCorrect SSF file into the folder.

   A dialog appears, asking if you want to overwrite the files.

7. Click \textbf{Yes to All}.

   The field\_data folder now contains the data that has been modified by the field crew.


\textbf{GPS edit sessions}

A GPS edit session enables you to edit any feature that is linked to GPS data.

\textit{Note} – \textit{To edit a feature that uses GPS data, start a GPS edit session, not an ordinary ArcMap edit session. A feature that is edited in an ordinary ArcMap edit session becomes unlinked from its GPS-derived geometry.}

You cannot start a GPS edit session if an ArcMap edit session is already open.

For more information, see GPS edit sessions, page 72 or search for the topic GPS edit sessions in the Trimble GPS Analyst Extension Help.
About checking in ArcPad and GPScorrect data

Always use the Check In ArcPad shapefiles and GPScorrect SSF button on the Trimble GPS Analyst toolbar when you check in features that were collected with ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad. This button opens the **Check In ArcPad shapefiles and GPScorrect SSF** dialog. Any shapefile checked in using this dialog is automatically checked in with the GPScorrect SSF file, if an SSF file exists.

**CAUTION** – If you use the standard Check In Edits from ArcPad button on the ArcPad toolbar to check in shapefiles, the SSF file is not imported with the shapefile, and the GPS data is lost.

The features in the shapfiles are imported into the GPS-enabled feature classes that they were checked out from. The GPS positions and other GPS data contained in the SSF file are stored in an imported GPS session in the GPS Sessions folder of the geodatabase.

Checking in the ArcPad shapefiles and the GPScorrect SSF file

The next step is to check the modified field data into the geodatabase.

1. Return to the City of Westminster map document in ArcMap.
2. From the **Trimble GPS Analyst** drop-down menu, select **Start GPS Editing**.
   
   This starts a GPS edit session and enables most of the buttons on the Trimble GPS Analyst toolbar.

   Because you have already checked out feature classes from this map document, the Check In ArcPad shapefiles and GPScorrect SSF button is also enabled.
3. Click the Check In ArcPad shapefiles and GPScorrect SSF button on the Trimble GPS Analyst toolbar.
The **Check In ArcPad shapefiles and GPScorrect SSF** tool appears:

![Check In ArcPad shapefiles and GPScorrect SSF tool](image)

The **Check In Shapefiles** list displays all of the layers in the field_data folder.

4. Click **Select All** to make sure all of the shapefiles are selected.

5. Click **OK** to begin the check in process.

When check in is complete, the **Check In ArcPad shapefiles and GPScorrect SSF** summary dialog appears.

6. Click **Close** to close the dialog.

The updated field data is now checked in. The corresponding SSF file is imported into the geodatabase as an imported GPS session, and the GPS data is linked to the GIS features.

You can see the new features on the map.

7. From the **Trimble GPS Analyst** drop-down menu, select **Save Edits**.
The modified features, and the GPS-derived geometries that they are linked to, are saved in the geodatabase.

8. From the Trimble GPS Analyst drop-down menu, select Stop GPS Editing.

9. Select File / Save to save the map document.

10. Exit ArcMap and exit ArcCatalog.

You have now finished this tutorial. In ArcCatalog, you have GPS-enabled the geodatabase, specified accuracy requirements for GPS-derived features, and checked out feature classes for updating using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad. In ArcMap, you have started a GPS edit session and checked in the features and GPS data that were updated using ArcPad and the GPScorrect extension. Understanding how to perform these basic tasks is the key to incorporating GPS data collected using ArcPad and the GPScorrect extension into a GPS-enabled geodatabase. For more information about using ArcPad and GPScorrect data with the GPS Analyst extension, refer to the Trimble GPS Analyst Extension Help.

Now that you have added GPS data to the geodatabase, you can learn more about analyzing the data using the Trimble GPS Analyst extension by completing Tutorial 3: Processing GPS Data, beginning on page 129.
Tutorial 2: Importing Trimble SSF Files

In this chapter:
- Before you begin
- Scenario
- Connecting to your data
- Exercise 1: Creating and GPS-enabling a geodatabase
- Exercise 2: Importing data from an SSF file
- Exercise 3: Specifying global feature class properties
- Exercise 4: Adding GPS data to the map

This tutorial explains how to:
- create and GPS-enable a geodatabase
- create a feature dataset
- import data from a Trimble SSF file into the feature dataset
- set global feature class properties for all features in the geodatabase
- add the imported features to a map document

The tutorial contains step-by-step instructions for the main tasks involved.
This tutorial will take between 30 and 45 minutes to complete.
Before you begin

Before beginning this tutorial, you will need to:

• Install the ESRI ArcGIS Desktop software. For more information, refer to the documentation provided by ESRI.

• Install the Trimble GPS Analyst extension. For more information, see Installing the Trimble GPS Analyst extension, page 36.

• Locate where the tutorial sample files are stored on your computer and, if required, reinstall them (see Loading the tutorial sample files below).

• Enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap (see page 45).

• Display the Trimble GPS Analyst toolbar in ArcMap (see page 55).

Note – The tutorials assume that the default settings for the Trimble GPS Analyst extension are unchanged. If they have been changed, the extension may behave differently from the behaviour described in the tutorials.

Note – This tutorial assumes that you are running ArcGIS Desktop version 9.2 with Service Pack 1. If you are using ArcGIS Desktop version 9.0 or 9.1, notes have been added to document any differences.

This tutorial assumes that you are familiar with GIS concepts and the ArcGIS software environment. For information on GIS concepts and the ArcGIS Desktop software environment, refer to Getting Started with ArcGIS and Building and Editing Geodatabases, which you received from ESRI in your ArcGIS package.

The exercises in this tutorial are designed to be completed in sequence.

Loading the tutorial sample files

The exercises use sample files supplied with the Trimble GPS Analyst extension. These sample files are located in the folder you specified at installation. The default location is C:\ArcGIS\ArcTutor\GPS Analyst.
If they have been deleted, reload them from the Trimble GPS Analyst Extension CD.

To reload the sample files:

1. Insert the Trimble GPS Analyst Extension CD in the CD drive of the computer.
2. Select Install.
3. Depending on the version of ArcGIS Desktop software you are running, click either Install GPS Analyst for ArcGIS 9.0 and 9.1 or Install GPS Analyst for ArcGIS 9.2.
4. Select Modify.
5. Select the Sample Data check box.
6. Follow the instructions on the screen to install the sample files.

For more information, see Installing the Trimble GPS Analyst extension, page 36.

Returning the contents of the tutorial folder to its original state

Each tutorial folder contains a zip file to return the contents of the tutorial geodatabase to its original state.

Note – You must return the contents of the tutorial folder to its original state before you do the tutorial. You will need to do this if you have done the tutorial before, even if you have uninstalled and then reinstalled the Trimble GPS Analyst extension.

To return the contents of any GPS Analyst tutorial folder to its original state:

1. In Windows Explorer, delete all files inside the tutorial folder except the .zip folder.
2. Right-click the .zip folder and select WinZip. Extract the contents to the tutorial folder.
Scenario

The Baylands County Parks and Recreation Department, California, is creating a geodatabase of assets in a new park, the Baylands County Park. The geodatabase will contain features such as a parking lot, benches, signs, and other park amenities. The Parks and Recreation Department has sent field crews to the park to map the features using GPS data. They used field computers running Trimble TerraSync software to map features using GPS data. When they returned to the office they transferred the Trimble SSF files containing the updated data from the field computers to the office computer.

Your task is to prepare the feature classes in the geodatabase for use with GPS data, and import the SSF files into the geodatabase.

Connecting to your data

The Catalog tree in ArcCatalog has a branch for each local hard drive. You can also create new branches in the Catalog tree to make it easier to navigate to your data. These branches are called connections.

Now you will add a connection to the folder that contains the tutorial data. This new branch remains in the Catalog tree until you delete it.

Make a connection to the tutorial data

1. In ArcCatalog, click the Connect to Folder button.
2. Navigate to the folder on the drive where the tutorial data is installed. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial2. Click OK.
The new connection appears as a branch in the Catalog tree:

3. Click the Tutorial2 folder to view its contents on the right side of the ArcCatalog window.

Table 6.1 describes the contents of the Tutorial2 folder.

Table 6.1 Contents of the Tutorial2 folder

<table>
<thead>
<tr>
<th>Folder or filename</th>
<th>File type</th>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial2</td>
<td>Folder</td>
<td></td>
<td>This is the main project folder where the Baylands Park map document is stored.</td>
</tr>
<tr>
<td>baylands_park</td>
<td>Map document</td>
<td>Tutorial2</td>
<td>A map document of the Baylands County Park and surrounding areas.</td>
</tr>
<tr>
<td>BaseMap_Data</td>
<td>Folder</td>
<td>BaseMap_Data</td>
<td>A folder containing layers used in the map document.</td>
</tr>
<tr>
<td>ImportSSF_file</td>
<td>Folder</td>
<td>ImportSSF_file</td>
<td>A folder containing the Trimble SSF data file you will import into the geodatabase.</td>
</tr>
</tbody>
</table>
Exercise 1: Creating and GPS-enabling a geodatabase

The field crew has returned from their trip to the Baylands County Park, and has transferred all Trimble SSF data files from their field computers to the office computer.

Your task is to create a new geodatabase for the Baylands County Park and to prepare the geodatabase for use with GPS data.

This exercise introduces you to the concepts of:

- GPS data in the geodatabase
- spatial references for geodatabases
- geographic transformations

It shows you how to:

- create a folder connection to the tutorial data
- create a new geodatabase
- GPS-enable a geodatabase

For this exercise, you will be working with ArcCatalog, which is the ArcGIS Desktop data management application.

Creating a new geodatabase

1. Open ArcCatalog, if it is not already open. To do this, select All Programs / ArcGIS / ArcCatalog from the Windows Start menu.
2. Browse to the tutorial dataset folder connection you created for Tutorial 2.
3. In the right pane of the ArcCatalog window, right-click anywhere in the Contents tab and select New / Personal Geodatabase.
   The new geodatabase appears and is already selected in the Contents tab.
4. Name the geodatabase Baylands Park.
GPS data in the geodatabase

The Trimble GPS Analyst extension enables you to store GPS data directly in the geodatabase as a GPS session. GPS sessions are contained in the GPS Sessions folder. GPS positions are always stored in the geodatabase using the WGS-84 coordinate system.

Before you can store GPS sessions in the geodatabase, you need to GPS-enable the geodatabase. As part of the GPS-enabling process, you need to specify the spatial reference for the geodatabase. The spatial reference for the geodatabase describes its coordinate system (for example, WGS-84, or UTM), its spatial domain, and its precision. The spatial domain is the allowable coordinate range for x, y, and z coordinates. All GPS-enabled feature classes in a GPS-enabled geodatabase must use the same coordinate system, and the spatial domain of each feature class must be within the bounds of the spatial domain defined for the GPS-enabled geodatabase.

If the coordinate system for the geodatabase is not WGS-84, you will also need to select a geographic transformation. The geographic transformation ensures that the GPS Analyst extension correctly converts GPS data from WGS-84 coordinates to coordinates in the same coordinate system as the geodatabase.

To complete these tasks, use the Trimble GPS Analyst tab of the Database Properties dialog. You can GPS-enable a geodatabase at the same time that you create the geodatabase, or later, once it contains GIS features. Because you will add features to the geodatabase at the same time as you import the GPS data, you need to GPS-enable the geodatabase now.
GPS-enabling the geodatabase

1. Right-click the Baylands Park geodatabase and select Properties. The Database Properties dialog appears.

2. Select the Trimble GPS Analyst tab:

3. Select the GPS-enable geodatabase check box.

4. Click the Set Spatial Reference button.
The *New Spatial Reference* dialog appears:

```
Name: Unknown
Details:
```

- Click **Select** to set the spatial reference of the geodatabase.
The *Browse for Coordinate System* dialog appears:

![Browse for Coordinate System dialog]

Since we know the data was collected in the Baylands County area, we will use the NAD 1983 StatePlane California III projection.


c. Click **Add** to return to the *New Spatial Reference* dialog.

Details for the coordinate system you selected are now displayed in the dialog.
d. Click **Next** to specify the X/Y domain (the extent) of the geodatabase:

![New Spatial Reference](image)

- Min X: 1596295
- Max X: 2146050
- Min Y: 330149
- Max Y: 879905


f. Click **Next** to specify the Z domain of the geodatabase:

![Image of New Spatial Reference dialog box]

**Tip** – When adding GPS data to the geodatabase, it’s a good idea to specify a negative minimum Z domain value, especially if you are working in low-lying coastal areas, or if any underground features (for example, cables) have been collected.

- Enter the following value:
  - Min Z: -1000

h. Click **Finish**.
The *Select Geographic Transformation* dialog appears:

![Select Geographic Transformation dialog]

Because the Baylands County Park data uses the North American Datum of 1983 (NAD_1983) coordinate system, you need to specify a geographic transformation so that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to NAD_1983 coordinates. For this tutorial, you need to select a geographic transformation that applies to the continental US. You will use the NAD_1983_To_WGS_1984_4 geographic transformation, because it is the transformation that ESRI recommends for converting WGS-84 coordinates to NAD_1983 coordinates for data in the United States.

i. From the drop-down list, select the NAD_1983_To_WGS_1984_4 geographic transformation and then click **OK**.

5. In the *Database Properties* dialog, click **OK**.

The Baylands Park geodatabase is now GPS-enabled. The GPS Analyst extension has created a GPS Sessions folder that will contain GPS sessions for the geodatabase.

6. Double-click the Baylands Park geodatabase to view the GPS Sessions folder.
Exercise 2: Importing data from an SSF file

Now that the Baylands Park geodatabase is ready for GPS data, you will create a feature dataset that you will import the Trimble SSF data into.

This exercise shows you how to:

- create a new feature dataset
- import data from a Trimble SSF file into a feature dataset

Creating a feature dataset

1. Right-click the Baylands Park geodatabase and select New / Feature Dataset.

The New Feature Dataset dialog appears:
If you are using ESRI ArcGIS Desktop software version 9.2 or later, go to Step 2 on page 114.

If you are using ESRI ArcGIS Desktop software version 9.0 or 9.1, the New Feature Dataset dialog looks slightly different to the dialog shown above. Complete the following steps:

a. Click the Edit button below the Spatial Reference Description area. The Spatial Reference Properties dialog appears.

b. Click Select to set the spatial reference of the geodatabase.

c. In the Browse for Coordinate System dialog, navigate to Projected Coordinate Systems\State Plane\Nad 1983 and select the NAD 1983 StatePlane California III FIPS 0403.prj file. Then click Add to return to the Spatial Reference Properties dialog.

d. Select the X/Y Domain tab to specify the extent of the feature dataset, and enter the following values:
   - Min X: 1596295
   - Max X: 2146050
   - Min Y: 330149
   - Max Y: 879905

e. Select the Z Domain tab and enter the following value:
   - Min Z: -1000

f. Click OK to close the Spatial Reference Properties dialog.

g. Click OK to close the New Feature Dataset dialog and create the new feature dataset.

The park_data1 feature dataset appears listed in the Contents tab of the Baylands Park geodatabase, above the GPS Sessions folder.

Now, skip steps 2 through 5 and go to Importing data from an SSF file on page 117.
2. In the Name field, enter park_data1 and then click Next. The coordinate system page for x/y coordinates appears:

3. Expand the tree of folders and navigate to Projected Coordinate Systems\State Plane\Nad 1983. Select NAD 1983 StatePlane California III FIPS 0403 and then click Next.
The coordinate system page for z coordinates appears:

Since the data you are importing does not use a vertical coordinate system, the feature dataset should not use a vertical coordinate system.

4. Make sure that <None> is selected and then click **Next**.
The distance tolerances for the coordinates page appears:

5. Leave the default values as they are and then click Finish to close the dialog and create the new feature dataset.

The park_data1 feature dataset appears listed in the Contents tab of the Baylands Park geodatabase, above the GPS Sessions folder.
Importing data from an SSF file

1. Right-click the park_data1 feature dataset and select Import / From Trimble SSF.

The Import from Trimble SSF tool appears:

![Import from Trimble SSF tool](image)

The Destination field at the bottom of the dialog displays the path and filename of the feature dataset you right-clicked.

2. Click next to the Source SSF Data Files field and navigate to C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial2\ImportSSF_file.

3. Select TUTDATA1.SSF and then click Open to return to the Import Trimble SSF dialog.

   The path and filename of the file you selected are added to the list of SSF files to be imported.

4. Click OK to begin importing the data.
The Import from Trimble SSF dialog appears showing the progress of the import process. When import is complete, the dialog shows the number of files, GPS positions, and GIS features that were imported into the geodatabase:

5. Click **Close** to close the summary dialog.

**Tip** – To view the imported feature classes, double-click the park_data1 feature data set. The imported feature classes appear in the Contents tab of the Baylands Park geodatabase.

6. In the Catalog tree, select the GPS Sessions folder for the Baylands Park geodatabase.
The Contents tab displays the imported GPS session that was created when you imported the SSF file into the geodatabase:
Exercise 3: Specifying global feature class properties

Now that you have imported GPS data into the geodatabase, you need to specify the required accuracy for features that are constructed from GPS positions. Specifying a required accuracy value will enable you to analyze and postprocess the data you have imported.

This exercise introduces you to the concepts of:

- estimated accuracy
- required accuracy for validation

It shows you how to:

- set global feature class properties for all feature classes in the geodatabase

Estimated accuracy values

When a feature is created using GPS data, the GPS Analyst extension calculates estimated accuracy values for the feature, and for the constructions that are used to build the feature.

For features that are made up of several vertices, the estimated accuracy is represented in two ways: the average estimated accuracy, which is the average of the estimated accuracy for each of the vertices in the feature, and the worst estimated accuracy, which is the estimated accuracy of the vertex that has the largest estimated accuracy of all the vertices in the feature. For a point feature, which always consists of only one averaged vertex, the worst estimated accuracy is always the same as the average estimated accuracy.

The average estimated accuracy and the worst estimated accuracy values for a feature are stored as part of the GPS data used to construct the feature. You can choose to map the average and worst estimated accuracy values to attributes in the feature classes that you have GPS-enabled. If you do so, and if you later unlink a feature from its GPS data or if you GPS-disable the geodatabase, the estimated accuracy values for the feature will be retained as attributes.
Required accuracy for validation

The worst estimated accuracy value is used as part of the validation process. During validation, the GPS Analyst extension checks whether the worst estimated accuracy of the feature is within the required accuracy specified for its feature class. The degree of accuracy you require depends on the type of feature collected and the purpose of the information. For example, underground cable features that maintenance crews will need to locate and repair require better accuracy than signpost features that are clearly identifiable.

You can specify or change the accuracy required for a feature class at any time, using the Trimble GPS Analyst tab of the Feature Class Properties dialog. You can learn more about validation by completing Tutorial 3: Processing GPS Data, beginning on page 129.

Specifying properties for all feature classes

1. Right-click the Baylands Park geodatabase and select Properties.
   The Database Properties dialog appears, displaying the Trimble GPS Analyst tab.
2. Click the Feature Class Properties button.
   The Global Feature Class Properties dialog appears:
3. In the *Store average estimated accuracy in* field, enter *Average_Est_Accuracy*.

4. In the *Store worst estimated accuracy in* field, enter *Worst_Est_Accuracy*.

5. In the *Accuracy required for validation* field, enter 0.4 m.
   
   All features in the Baylands Park geodatabase now need to be accurate to within 40 centimeters in order to pass validation.

6. Click **OK** to close the *Global Feature Class Properties* dialog.

7. Click **OK** to close the *Database Properties* dialog.
Exercise 4: Adding GPS data to the map

For this exercise, you will add the imported features to the map in ArcMap.

This exercise introduces you to the concepts of:

- GPS layers in ArcMap

It shows you how to:

- add GPS-enabled feature classes to the map
- select the geographic transformation you want to use to convert GPS data to the spatial reference used by the map data frame

GPS layers in ArcMap

Maps that contain GPS-enabled feature classes contain a GPS group layer. The GPS group layer is added as the top layer in the map when GPS-enabled feature classes are added to the map, or when you GPS-enable feature classes that are contained in the map document.

The GPS group layer that will be added to the baylands_park.mxd will contain two layers:

- Features in Progress
- GPS Positions

These layers are used for analyzing and editing features that are linked to a GPS-derived geometry.

Adding GPS-enabled feature classes to a map document

1. In ArcCatalog, double-click baylands_park.mxd to launch ArcMap.

   The Baylands Park map opens in ArcMap, displaying the state of California, USA.

2. Select View / Bookmarks / Region Overview.
The map zooms to the bookmarked view, showing an overview of the region you will be working in:

At this scale, there are seven layers being rendered on the map: CA cities, CA roads, CA counties, CA rivers, CA zipcodes, CA state, and San Jose Orthophoto.

3. To zoom to the Baylands County Park area, select View / Bookmarks / GPS Editing.

4. To add the GIS features that you imported from the Trimble SSF file, click the Add Data button on the ArcMap toolbar.
5. The Add Data dialog appears:

![Add Data dialog]

6. Browse to Baylands Park.mdb\park_data1. From the list of feature classes, hold down [Ctrl] and select the following feature classes:
   - Park
   - Parking_lot
   - Park_Amenities
   - Bench
   - Sign

7. Click Add.
The **Select Geographic Transformation** dialog appears:

![Select Geographic Transformation dialog](image)

Because the map data frame uses the North American Datum of 1983 (NAD_1983) coordinate system, you need to specify a geographic transformation so that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to NAD_1983 coordinates.

8. From the drop-down list, select the NAD_1983_To_WGS_1984_4 geographic transformation and then click **OK**.

   The feature classes are added to the map as layers. The layers are listed in the ArcMap table of contents, below the GPS layers that were also added to the map. The GPS layers indicate that GPS data is included in the map document.

   The park layer has been added on top of the other layers you added. You need to move the park layer underneath the other layers, so that you can see the other features.

9. In the ArcMap table of contents, drag the park layer to the end of the list of GPS layers, so that it is just above the Basemap Data layer.
The park is now displayed on the map behind the other GPS feature layers:

10. Select File / Save to save the map document.

11. Exit ArcMap and exit ArcCatalog.

You have now finished this tutorial. In ArcCatalog, you have created a new geodatabase and GPS-enabled it, created a new feature dataset and imported Trimble SSF data files into the dataset. In ArcMap, you added the new features that were imported from the SSF files to the map, and you can see that they contain GPS data.
Understanding how to perform these basic tasks is the key to incorporating GPS data from Trimble SSF files into a GPS-enabled geodatabase. For more information about using SSF files with the GPS Analyst extension, refer to the Trimble GPS Analyst Extension Help.

Now that you have added GPS data to the geodatabase, you can learn more about analyzing the data using the Trimble GPS Analyst extension by completing Tutorial 3: Processing GPS Data, beginning on page 129.
Tutorial 3: Processing GPS Data

In this chapter:
- Before you begin
- Scenario
- Connecting to your data
- Exercise 1: Differentially correcting GPS sessions
- Exercise 2: Analyzing GPS positions on the map
- Exercise 3: Validating features

This tutorial explains how to:
- process and analyze GPS data inside the ArcGIS software environment
- differentially correct the GPS data you have checked into the geodatabase, in order to improve the accuracy of the imported GPS positions
- rebuild features after differential correction
- validate those features to ensure they meet your accuracy requirements

The tutorial contains step-by-step instructions for the main tasks involved.

This tutorial will take between 30 and 45 minutes to complete.
Before you begin

Before beginning this tutorial, you will need to:

- Install the ESRI ArcGIS Desktop software. For more information, refer to the documentation provided by ESRI.
- Install the Trimble GPS Analyst extension. For more information, see Installing the Trimble GPS Analyst extension, page 36.
- Locate where the tutorial sample files are stored on your computer and, if required, reinstall them (see Loading the tutorial sample files below).
- Enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap (see page 45).
- Display the Trimble GPS Analyst toolbar in ArcMap (see page 55).

Note – The tutorials assume that the default settings for the Trimble GPS Analyst extension are unchanged. If they have been changed, the extension may behave differently from the behaviour described in the tutorials.

This tutorial assumes that you are familiar with GIS concepts and the ArcGIS software environment. For information on GIS concepts and the ArcGIS Desktop software environment, refer to Getting Started with ArcGIS and Building and Editing Geodatabases, which you received from ESRI in your ArcGIS package.

The exercises in this tutorial are designed to be completed in sequence.

Loading the tutorial sample files

The exercises use sample files supplied with the Trimble GPS Analyst extension. These sample files are located in the folder you specified at installation. The default location is C:\ArcGIS\ArcTutor\GPS Analyst.

If they have been deleted, reload them from the Trimble GPS Analyst Extension CD.
To reload the sample files:

1. Insert the *Trimble GPS Analyst Extension CD* in the CD drive of the computer.
2. Select *Install*.
3. Depending on the version of ArcGIS Desktop software you are running, click either *Install GPS Analyst for ArcGIS 9.0 and 9.1* or *Install GPS Analyst for ArcGIS 9.2*.
4. Select *Modify*.
5. Select the *Sample Data* check box.
6. Follow the instructions on the screen to install the sample files.

For more information, see *Installing the Trimble GPS Analyst extension*, page 36.

**Returning the contents of the tutorial folder to its original state**

Each tutorial folder contains a zip file to return the contents of the tutorial geodatabase to its original state.

*Note – You must return the contents of the tutorial folder to its original state before you do the tutorial. You will need to do this if you have done the tutorial before, even if you have uninstalled and then reinstalled the Trimble GPS Analyst extension.*

To return the contents of any GPS Analyst tutorial folder to its original state:

1. In Windows Explorer, delete all files inside the tutorial folder except the .zip folder.
2. Right-click the .zip folder and select WinZip. Extract the contents to the tutorial folder.
Scenario

The City of Westminster, Colorado, maintains a geodatabase of assets in an Open Space park. The geodatabase contains features such as access ways, sewers, building footprints, vehicle parking areas, and road centerlines. Field crews have been sent to the park to map new features using ESRI ArcPad software and the Trimble GPScorrect extension for ArcPad. Upon their return to the office, the data from the field computers was transferred to the office computer, and the new GPS data was checked into the geodatabase.

Your task is to process the data collected at the Open Space park, using the Differential Correction wizard to improve the accuracy of the imported GPS positions and then rebuild the updated features using the corrected GPS positions. You will view GPS positions on the map, and examine the properties of some GPS positions. Finally, you will validate the accuracy of features that have a GPS-derived geometry against the required accuracy for the feature class.

Connecting to your data

The Catalog tree in ArcCatalog has a branch for each local hard drive. You can also create new branches in the Catalog tree to make it easier to navigate to your data. These branches are called connections.

Now you will add a connection to the folder that contains the tutorial data. This new branch remains in the Catalog tree until you delete it.

Make a connection to the tutorial data

1. In ArcCatalog, click the Connect to Folder button.
2. Navigate to the folder on the drive where the tutorial data is installed. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial3. Click OK.
The new connection appears as a branch in the Catalog tree:

3. Click the Tutorial3 folder to view its contents on the right side of the ArcCatalog window.
Table 7.1 describes the contents of the Tutorial3 folder.

Table 7.1  Contents of the Tutorial3 folder

<table>
<thead>
<tr>
<th>Folder or filename</th>
<th>File type</th>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial3 Folder</td>
<td>Folder</td>
<td></td>
<td>This is the main project folder where the City of Westminster geodatabase and map document are stored.</td>
</tr>
<tr>
<td>City of Westminster</td>
<td>Geodatabase</td>
<td>Tutorial3</td>
<td>The geodatabase containing the data for this tutorial.</td>
</tr>
<tr>
<td>City of Westminster</td>
<td>Map document</td>
<td>Tutorial3</td>
<td>A map document of the Open Space park maintained by the City of Westminster.</td>
</tr>
<tr>
<td>Open Space</td>
<td>Raster dataset</td>
<td>Tutorial3</td>
<td>Raster dataset of images of the Open Space park, which provides the background image for the map.</td>
</tr>
<tr>
<td>Tutorial Base Files</td>
<td>Folder</td>
<td>Tutorial3\Tutorial Base Files</td>
<td>A copy of the base data files for the tutorial. Use the data in this folder if you do not have Internet access, and cannot use the GPS Analyst tutorial base provider. Use Windows Explorer to view the base files in this folder.</td>
</tr>
</tbody>
</table>
Exercise 1: Differentially correcting GPS sessions

Your task is to differentially correct the imported GPS sessions that were created when the GPS data was checked into the geodatabase.

This exercise introduces you to the concepts of:

- postprocessed differential correction
- base data
- rebuilding feature geometries with GPS data

It shows you how to:

- differentially correct GPS sessions

Postprocessed differential correction

Postprocessed differential correction can significantly improve the accuracy of GPS positions collected in the field. The Differential Correction wizard compares the collected GPS data with base data collected at a known location at the same time that the field data was collected. The process produces a new set of GPS positions that are stored in a corrected GPS session.

Each GPS position in a corrected GPS session corresponds to a GPS position in the original GPS session. Both GPS positions represent the same physical location at the same time, but the corrected position is generally a more accurate representation.

Base data

Many regions have reference stations that can supply the base data required for differential correction. The Trimble GPS Analyst extension provides a list of some stations that you can use to obtain base data. You can access this list in the Select Base Provider dialog.

The base data for the tutorial is on the Trimble FTP site and is available by selecting the GPS Analyst tutorial base files provider from the list in the Select Base Provider dialog.
Rebuild

Out of all the GPS positions in the geodatabase that represent the same point in space and time, only one GPS position is selected for use in feature geometries. This selected position is called the location.

Once differential correction is complete, the Trimble GPS Analyst extension rebuilds the features using the new, corrected set of GPS positions. For each location, the GPS Analyst extension selects the corrected GPS position, rather than the imported GPS position, as the location. The GPS Analyst extension uses the new locations to rebuild the constructions used in each feature, and to rebuild the GPS-derived geometry of every feature that is linked to GPS data.

Opening the map document

1. If ArcMap is not open, start ArcMap and open the City of Westminster map document.
   The default location of the City of Westminster.mxd is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial3.

2. Select View / Bookmarks / Features from GPS.
The map zooms to the bookmarked view, showing the features that were checked into the geodatabase:

Look at the two accessway features. You can see that the features on the map are close to, but do not exactly line up with, the path on the Open Space park background image.
Differentially correcting GPS sessions

1. From the Trimble GPS Analyst drop-down menu, select Start GPS Editing.

This starts a GPS edit session, and enables most of the buttons on the Trimble GPS Analyst toolbar.

2. Click the Differential Correction button on the Trimble GPS Analyst toolbar.

The first page of the Differential Correction wizard appears:

The Select GPS sessions to correct list is either empty, or it displays the imported GPS session(s) that were created the last time you imported GPS data into the geodatabase.

3. Remove any sessions that are listed by selecting them and clicking the Remove Sessions button.
To select the GPS session that was created when GPS data was imported into this map:

a. Click the Add GPS Sessions button. The Select GPS sessions to correct dialog appears:

b. Browse to the GPS Sessions folder for the City of Westminster geodatabase in the Tutorial3 folder. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial3\City of Westminster.mdb\GPS Sessions.

c. Select the imported GPS session that was created when the GPScorrect SSF file was checked into the City of Westminster geodatabase in the Tutorial3 folder.

d. Click Add. This confirms the selection and closes the dialog.

The selected GPS session appears in the Select GPS sessions to correct list in the Differential Correction wizard.

The fields below the selection list display information about the selected session. The Collected with H-Star receiver field indicates whether the GPS session contains data collected using a receiver with H-Star technology. The options
displayed in the rest of the Differential Correction wizard are dynamic; H-Star processing options are only displayed if the value for this field is Yes.

4. Click **Next**.

The Processing Type page of the wizard appears:

It displays the processing options available for processing the GPS data in the selected GPS sessions. The selected GPS session does not contain data collected using a receiver with H-Star technology, and so the only available option is Code Processing using base data from a single base station.

**Tip** – To learn more about H-Star processing options, search for the topic **Specifying the processing type** in the *Trimble GPS Analyst Extension Help*.

5. Click **Next**.
The Correction Settings page of the wizard appears:

![Correction Settings dialog](image)

It displays the settings that will be used to differentially correct the selected GPS session. The default settings are displayed above.

If the settings displayed are different to the default settings, click **Change**. The Correction Settings dialog appears. In each tab, select the appropriate options so that your settings match the default correction settings. Click **OK** to close the dialog and return to the Differential Correction wizard.

6. Click **Next**.

The Select Base Data page of the wizard appears.
If you have access to the Internet, download base data files from the tutorial base provider:

a. In the Base Data group, select Base Provider Search:

![Image of Base Provider Search dialog]

a. Click the Select button next to the Base Provider Search text box.

The Select Base Provider dialog appears. The dialog displays a list of available base providers. The list is arranged by distance from the location where the field data was collected, so that base stations closest to the location where the data was collected are at the top of the list.

For this tutorial, we have set up an FTP site for the tutorial base data and named it “GPS Analyst tutorial base files”.
b. In the list of base providers, click the **Integrity Index** column heading to reorder the base providers by integrity index:

![Select Base Provider](image)

b. Click the "GPS Analyst tutorial base files" provider (near the top of the base provider list) to select it and then click **OK**.

If you do not have access to the Internet, select the folder where base data files for the tutorial are stored:

a. In the **Base Data** group, select **Folder Search**.

b. Click the **Select** button next to the Folder Search text box.

The **Folder Search** dialog appears:

![Folder Search](image)
c. Click **Browse** to navigate to the tutorial base files folder. The default location is \ArcGIS\ArcTutor\GPS Analyst\Tutorial3\Tutorial Base Files.

d. Click **OK**.

The dialog closes and you are returned to the Base Data page of the wizard. The text box below the Base Data option you selected displays the selected base provider or path and folder name:

![Differential Correction Wizard](image)

7. In the **Reference Position** group, select **Use reference position from base files**.

8. Click **Next**.
The Rebuild Settings page of the wizard appears:

![Differential Correction Wizard](image)

It displays the settings that the GPS Analyst extension will use to rebuild each feature that is linked to GPS data. The default settings are displayed above.

If the settings displayed are different to the default settings, click **Change**. The **Rebuild Settings** dialog appears. In each tab, select the appropriate options so that your settings match the default rebuild settings. When you have made your changes, click **OK** to close the dialog and return to the **Differential Correction** wizard.

9. Click **Start**. The differential correction process starts.
As the GPS Analyst extension begins differentially correcting the selected GPS session, the Correct Processing page of the wizard appears:

![Differential Correction Wizard](image)

It displays details about the status of the differential correction process. If more than one GPS session is selected, each GPS session is processed sequentially. Once the GPS session has been differentially corrected, each feature that has a geometry derived from GPS data in that session is rebuilt from the new, corrected GPS positions. The Correct Processing page displays the number of corrected positions, and the number of recalculated locations, constructions, and features, for each GPS session.

When the last GPS session has been processed, the message **Differential correction complete** and a summary of the estimated accuracy values gained for the corrected GPS positions appears at the bottom of the Correct Processing page.
This summary provides immediate feedback as to the quality of the corrected GPS positions. For example, if too few base providers have been selected for multi-base processing, the results will indicate this by showing large estimated accuracy values.

10. Click **Close**.

The contents of the Correct Processing page are saved as the Differential Correction report. The report is stored in the Log Files folder in the same folder as the open geodatabase.

11. Look at the two accessway features in the centre of the map. You can see that the features on the map now line up with the path on the Open Space park background image.
Exercise 2: Analyzing GPS positions on the map

Now that you have created a new set of corrected GPS positions, and used those GPS positions to rebuild features, you need to visually check the features on the map to verify the data is acceptable.

This exercise shows you how to:

• display GPS positions on the map
• view GPS position properties

Displaying GPS positions on the map

The GPS Positions layer shows the GPS positions that are stored in the geodatabase. By default, the GPS Positions layer is enabled, but no GPS positions are selected for display. You can change the properties of the GPS Positions layer so that certain types of GPS positions are displayed. For more information, search for the topic Displaying GPS positions on the map in the Trimble GPS Analyst Extension Help.

Alternatively, you can select features and then click one of the GPS positions buttons on the Trimble GPS Analyst toolbar to display GPS positions for those features.

To display the GPS positions used to construct features on the map:

1. On the ArcMap Tools toolbar, click the Select Features button.
   The cursor changes to the Select Features tool.
2. Use the Select Features tool to select the two accessway features in the centre of the map.
3. Returning to the Trimble GPS Analyst toolbar, click the Select GPS Positions for Selected Features button.
   The GPS positions used to construct the selected features appear on the map.
Viewing GPS position properties

You can select GPS positions from the map and view detailed information about them, such as coordinate or quality information, in the GPS Position Properties dialog.

To view GPS position properties:

1. Ensure that the GPS positions are still displayed. Click the GPS Position Properties button on the Trimble GPS Analyst toolbar.

   The GPS Position Properties dialog appears:

   The left pane lists the GPS positions that are used in the selected features. The right pane displays the properties of the GPS position that is selected in the left pane.

2. In the left pane, click any GPS position.

   In the right pane, the GPS Session field shows the name of the corrected GPS session that you have just created.

   The Solution Time field shows “Postprocessed”, indicating that postprocessed differential correction has been applied to the GPS position.
3. To close the GPS Position Properties dialog, click the in the top right corner.

4. To deselect the GPS positions, click the Select GPS Positions button on the Trimble GPS Analyst toolbar and click an empty point on the map.

5. To clear the GPS positions from the map, first select Clear Selected Features from the ArcMap Selection menu. Then click the Select GPS Positions for Selected Features button on the Trimble GPS Analyst toolbar.
Exercise 3: Validating features

You have seen that the features on the map are now constructed using corrected GPS positions, and that the features seem to be accurate. The final step is to check whether the features meet your accuracy requirements. You will validate all features on the map that are built using GPS data, and process any invalid features so that they pass validation.

This exercise introduces you to the concepts of:

- GPS feature validation
- processing invalid features

It shows you how to:

- validate features built using GPS data
- rebuild selected features to ensure they pass validation

GPS feature validation

GPS feature validation provides an indication of the quality of GPS-derived features, in terms of their estimated accuracy. During the validation process, the worst estimated accuracy of a GPS-derived feature is compared to the required accuracy specified for the feature classes in the geodatabase. If the worst estimated accuracy is larger than the required accuracy, the feature is invalid due to insufficient accuracy.

Once the features have been validated, the GPS Feature Validation window displays a table showing the results of the validation process. The validation results provide a summary that enables you to make decisions about the quality of your GPS data. Each feature is listed in the table, along with its status. The status of any feature that fails validation is either:

- Insufficient Accuracy, where the worst estimated accuracy value for the feature is larger than the required accuracy specified for the feature class.
• No GPS positions, where the feature is linked to a GPS-derived geometry that does not contain any GPS positions. This can happen if the rebuild criteria is too strict.

The required accuracy column displays the estimated accuracy required for the feature to pass validation. This is the value entered in the Accuracy required for validation field in the Global Feature Class Properties dialog in ArcCatalog.

**Processing invalid features**

You can select any feature from the GPS Feature Validation window for further processing. You can choose to edit, rebuild, or delete features, zoom to the feature on the map, or mark an invalid feature as an exception. In this tutorial, you will rebuild the invalid features. Changing the different rebuild settings can improve the accuracy of a feature by eliminating GPS positions that have poor quality.

The list of features in the GPS Feature Validation window is dynamic: it is updated with new information as you process features selected from the list. As features change and become valid, their status is updated.

**Validating features with GPS-derived geometry**

To validate all features with GPS-derived geometry:

1. Click the GPS Feature Validation button on the Trimble GPS Analyst toolbar.

The GPS Validation dialog appears:
2. Select the All Features option to validate all of the features in the open map that have GPS-derived geometry.

3. To start the validation process, click OK.

When all of the features that have GPS-derived geometry are validated, the GPS Feature Validation window appears:

4. Select the Show Valid Features and Show Exceptions check boxes to show all features that have a GPS-derived geometry in the GPS Feature Validation window.

5. Click the Status column heading to sort the features by status.

Invalid features are listed first. In this tutorial, two features have not passed validation. They have failed due to insufficient accuracy.

You will now process those invalid features so that they pass validation.
**Rebuilding selected features**

Two line features, AccessWays 67 and AccessWays 68, both have a good average estimated accuracy, but they have failed validation because they both contain one invalid vertex. You will rebuild the features in order to exclude any invalid GPS positions from the features. By specifying an appropriate GPS filter, you can ensure that only valid GPS positions are used to calculate constructions, so that the rebuilt features will pass validation.

To rebuild selected features:

1. Press the **Ctrl** key and select the two invalid features from the features table: AccessWays 67, and AccessWays 68.
   
The selected features are highlighted on the map.

2. From the **Actions** drop-down menu, select **Rebuild**.
   
The **Rebuild GPS-enabled Features** tool appears:
Because you have already identified the features you want to rebuild in the GPS Feature Validation window, Selected features is already selected.

3. From the Use GPS Positions drop-down list, select Best quality.
4. Select the Filter by Minimum Estimated Accuracy check box.
5. In the Minimum Estimated Accuracy Filter field, enter 0.4 and make sure the selected units are Meters.
6. Click OK.

Once the selected features are rebuilt, the Rebuild Summary dialog appears:

The summary shows that in this example 173 locations and four constructions were recalculated. As a result of these recalculations, two features were rebuilt.

7. Click Close to close the dialog.

In the GPS Feature Validation window, the rebuilt features have passed validation and their status has been updated to Valid.

AccessWays 67 and AccessWays 68 no longer contain invalid positions in their GPS geometries. Because you filtered out all GPS positions that would not meet the required accuracy for the feature, all of the constructed positions used in the features have an estimated accuracy that is within the required accuracy.
8. Click the at the top of the window to close the GPS Feature Validation window.


   The modified features and the GPS data that the features are linked to are saved in the geodatabase.

10. From the Trimble GPS Analyst drop-down menu, select Stop GPS Editing.

11. Select File / Save to save the map document.

12. Exit ArcMap.

You have now finished the tutorial. In ArcMap, you have differentially corrected your imported GPS data, analyzed the corrected GPS positions on the map, validated the accuracy of features linked to GPS data, and rebuilt some features to ensure the estimated accuracy of the features.

Understanding how to perform these basic tasks is the key to using GPS data in your map. For more information about differentially correcting GPS data and analyzing features derived from GPS data, refer to the Trimble GPS Analyst Extension Help.
SECTION III

USING THE TRIMBLE GPS ANALYST EXTENSION IN THE FIELD

Note – The information in this section is helpful only if you have installed the ESRI ArcGIS software and the Trimble GPS Analyst extension onto a field computer and intend to use the Trimble GPS Analyst extension within ArcMap to collect features in the field.

In this section:

- Chapter 8, The Field User Interface
- Chapter 9, Typical Data Collection Tasks
- Chapter 10, Tutorial 4: Collecting GPS Data
This chapter describes the toolsets and menu commands that comprise the Field toolset provided with the Trimble GPS Analyst extension in ArcMap.

Whether you are using ArcView, ArcEditor, or ArcInfo, the same tools are available for you to work on your GPS data.
The Trimble GPS Analyst extension Field toolset

The Field toolset is an additional toolset available on the Trimble GPS Analyst toolbar in ArcMap.

Note – By default, the Field toolset is not visible on the Trimble GPS Analyst toolbar.

To view the Field toolset:

• Select Show Field Tools from the Trimble GPS Analyst drop-down menu.

The Field toolset is added to the Trimble GPS Analyst toolbar, and a check mark appears next to the Show Field Tools command in the Trimble GPS Analyst drop-down menu to indicate that the toolset is visible.

Tip – You can display both the Field toolset and the Office toolset on the Trimble GPS Analyst toolbar, or only the toolset for the tasks you are performing. To display or hide a toolset, select the appropriate command from the Trimble GPS Analyst drop-down menu. A check mark next to a toolset command indicates that the toolset is displayed.

The Field toolset consists of:

• Field Settings drop-down menu
• Field toolset buttons
• GPS Status panel
**Field Settings drop-down menu**

The *Field Settings* drop-down menu provides commands for settings used by the Trimble GPS Analyst extension when collecting GPS data. Use the menu to:

- select the type of GPS receiver you want to connect to
- access settings for the GPS receiver
- access data collection, and navigation settings

**Field toolset buttons**

*Note – Most buttons in the Field toolset are not enabled until you start a GPS edit session. For more information, see GPS edit sessions, page 72 or search for the topic GPS edit sessions in the Trimble GPS Analyst Extension Help.*

Table 8.1 describes the function of each button on the Field toolset of the Trimble GPS Analyst toolbar.

<table>
<thead>
<tr>
<th>Button</th>
<th>Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="connect.png" alt="Icon" /></td>
<td>Connect / Disconnect GPS</td>
<td>Connects to or disconnects from the selected GPS receiver.</td>
</tr>
<tr>
<td><img src="connect.png" alt="Icon" /></td>
<td>Connect / Disconnect External Source</td>
<td>Connects to or disconnects from the selected external real-time correction source.</td>
</tr>
<tr>
<td><img src="data_collection.png" alt="Icon" /></td>
<td>GPS Data Collection</td>
<td>Opens the GPS Data Collection window.</td>
</tr>
<tr>
<td><img src="status.png" alt="Icon" /></td>
<td>GPS Status</td>
<td>Opens the GPS Status window.</td>
</tr>
<tr>
<td><img src="navigation.png" alt="Icon" /></td>
<td>Navigation</td>
<td>Opens the Navigation window.</td>
</tr>
</tbody>
</table>
GPS status panel

The GPS status panel provides basic information about the status of the connected GPS receiver. It also displays the Current Estimated Accuracy (CEA) value for the feature currently being logged, and if you are collecting data with a Trimble receiver using H-Star technology, the Predicted Postprocessed Accuracy (PPA) of the GPS position currently being logged is shown below the CEA value. The GPS status panel appears in the Trimble GPS Analyst toolbar. It is always visible when the Field toolset is enabled, but the icons displayed depend on the current status of the GPS receiver. For a description of the icons displayed in the GPS status panel, search for the topic Trimble GPS Analyst toolbar in the Trimble GPS Analyst Extension Help.

Dockable windows

You can open several dockable windows from the Field toolset of the Trimble GPS Analyst toolbar. These are:

- GPS Data Collection
- GPS Status
- Navigation

You can dock any of these windows above, below, or beside the map, or you can leave the windows “floating” on the map. If you dock a window, the window appears in the docked position the next time you open it. These windows provide information and additional tools to help you collect and edit GPS data. Each dockable window is described below.
GPS Data Collection window

Use the GPS Data Collection window to collect features or update the geometry of existing features using GPS data while connected to a GPS receiver.

**Note** – You must connect to a GPS receiver before you can collect a feature or update an existing feature.

To open this window, click the GPS Data Collection button on the Trimble GPS Analyst toolbar.

When you click Create in the Create tab, or click Replace in the Update tab, the GPS Data Collection panel appears:

Use the buttons on the panel to log GPS positions, record feature attributes, or to change construction properties for the open feature.

For more information, search for the topic Data collection techniques in the Trimble GPS Analyst Extension Help.
GPS Status window

The GPS Status window provides information about the satellites currently being tracked, the connected receiver, and any connected real-time differential correction source. For example, the Receiver tab shows status information about the connected receiver, including the GPS status, the current level of charge in the GPS receiver battery, and the date of the current almanac.

*Note – Information may not be displayed in all fields in the GPS Status window if you are using a GPS receiver that is not a Trimble GPS receiver.*

To open the GPS Status window, click the GPS Status button on the Trimble GPS Analyst toolbar.

The skyplot provides a graphical display of the satellites being tracked by the receiver. It shows which satellites are being tracked. The green satellites represent the satellites that the receiver is using to compute its current GPS position. The red satellites represent satellites that the receiver is receiving signals from but is not using because the signals are too weak.

Your current GPS position is displayed at the bottom of the Skyplot tab, as well as the PPA value for any open feature, if you are collecting data with a Trimble receiver using H-Star technology.

For more information, search for the topic *About the GPS Status window* in the Trimble GPS Analyst Extension Help.
Navigation window

Use the Navigation window to find existing features, or to make sure that you follow a direct course to a target location using the lightbar or direction dial. The Navigation window also provides useful information such as your current heading, or the distance from your current position to the navigation target.

To open this window, click the Navigation button on the Trimble GPS Analyst toolbar. The figure to the right shows the direction dial and lightbar displayed in the Navigation window.

You can use real-time differential GPS to optimize navigation and provide in-field differential accuracy. When connected to a Trimble GPS receiver, the GPS Analyst extension supports a range of real-time correction sources.

For more information, search for the topic About navigation in the Trimble GPS Analyst Extension Help.
GPS receiver layers

When you add GPS-enabled feature classes to the map in ArcMap, the GPS group layer is automatically added as the top layer in the Table of Contents window. The GPS group layer contains the Features In Progress layer and GPS Positions layer.

When you connect to a GPS receiver, the GPS Cursor and Trail layer and the Navigation layer are also added to the GPS group layer.

GPS Cursor and Trail layer

The GPS Cursor and Trail layer tracks the movement of the GPS receiver. The GPS cursor shows the current GPS position, and indicates the current heading with the direction of the arrow. The GPS trail shows the path you have taken recently.

To automatically pan the map so that the GPS cursor is always visible, select Auto Pan to GPS from the Field Settings drop-down menu on the Trimble GPS Analyst toolbar.

Navigation layer

The Navigation layer shows icons indicating the features or map locations that are currently selected as the start and the target for navigation. When a start and target are selected, they are joined by the navigation line, which shows the most direct path from the start to the target. Use the Navigation window to navigate to the location of the selected target.
The Trimble GPS Analyst extension enables you to collect GPS-based data directly within the ESRI ArcMap software. Use the Field toolset provided with the Trimble GPS Analyst extension to collect GPS and GIS data within ArcMap. For more information about the Field toolset, see Chapter 8, The Field User Interface.

This chapter outlines the tasks you will typically perform when collecting data using the Trimble GPS Analyst extension.

For step-by-step instructions and more detailed information about these tasks, see Chapter 10, Tutorial 4: Collecting GPS Data.
Overview: Collecting GPS data

To collect GPS data using the Trimble GPS Analyst extension, install the ESRI ArcGIS software and the Trimble GPS Analyst extension for ESRI the ArcGIS software onto a laptop or Tablet PC, and then connect the computer to a supported GPS receiver. You can then use the GPS Analyst Field toolset provided in ArcMap to collect features with GPS data. When updating features you have previously collected using the Trimble GPS Analyst extension, you can use the GPS positions from the GPS receiver to navigate back to the selected feature.

Figure 9.1 shows the components required to collect GPS data using the Trimble GPS Analyst extension.
**Supported GPS receivers for data collection**

To collect GPS data, you can connect a computer running ESRI ArcGIS Desktop software and the Trimble GPS Analyst extension to any of the following GPS receivers:

- **Trimble Mapping and GIS receivers:**
  - GeoExplorer series handhelds:
    - GeoXH
    - GeoXM
    - GeoXT
  - GPS Pathfinder ProXH
  - GPS Pathfinder ProXT
  - GPS Pathfinder Pro XRS
  - GPS Pathfinder XB receiver
  - GPS Pathfinder XC receiver
  - Trimble Recon GPS XB edition
  - Trimble Recon GPS XC edition

- **NMEA GPS receiver**

- any GPS receiver with a supported driver that enables the receiver to work with the Trimble GPS Analyst extension

*Note – The type of GPS receiver determines which receiver settings options are available in the Trimble GPS Analyst extension. Some options, such as configuring and connecting to a real-time correction source, are available only when you are connected to certain models of Trimble GPS receiver.*
## Connection options

You can connect the GPS receiver to a port on the field computer using one of the following options:

<table>
<thead>
<tr>
<th>Port</th>
<th>Connection method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluetooth</td>
<td>Use the Bluetooth management software provided with the field computer and the GPS receiver to configure and then establish a connection using Bluetooth® wireless technology.</td>
</tr>
<tr>
<td>Standard RS-232 serial (COM)</td>
<td>Connect the GPS receiver cable to the curly straight-through cable. Trimble recommends that you use the cable with P/N 45052 to protect the field computer from power supplied by the receiver. Connect the curly straight-through cable to the field computer.</td>
</tr>
<tr>
<td>Customized serial (COM)</td>
<td>Connect the GPS receiver cable to the null modem adaptor (P/N 43197). The adaptor changes gender, and also protects the field computer from power supplied by the receiver. Connect the null modem adaptor to the data download cable that was supplied with the field computer. Connect the data download cable to the field computer.</td>
</tr>
<tr>
<td>CompactFlash serial</td>
<td>Connect a CompactFlash serial adaptor to the CompactFlash port. Then connect as for a standard COM port.</td>
</tr>
</tbody>
</table>

*Note – A field computer uses more power when a GPS receiver is connected to its CompactFlash serial port. This type of connection will discharge the battery in the field computer more quickly.*
Powered connections

**CAUTION** – Using COM port cabling that supplies power to the field computer can cause problems with, or even permanent damage to, the field computer. Some GPS receivers supply power, and some cables transfer power through one or more of their pins. Trimble *strongly recommends* that you protect the field computer by connecting either the null modem adaptor (P/N 43197) or the curly straight-through cable (P/N 45052) to the receiver cable. These two connectors do not supply power, so they will protect the field computer from power output by the receiver.

If a powered connection is acceptable or necessary, you can connect directly to the receiver, or you can use the curly straight-through cable P/N 30236 instead of cable P/N 45052. If you are unsure whether a powered connection will cause damage, refer to the documentation for the field computer or consult the manufacturer before using the cable P/N 30236.

Connecting to external real-time correction devices

To connect to a GPS receiver and an external real-time correction device such as a GeoBeacon receiver, use one of the following options:

- If you are using a serial cable connection to both receivers, use a splitter cable.
- If the field computer has **two** Bluetooth ports, you can connect to both the GPS receiver and the real-time correction device using Bluetooth wireless technology.
- If the field computer has only **one** Bluetooth port, use Bluetooth wireless technology to connect the real-time correction device to the GPS receiver, and then use Bluetooth wireless technology to connect the GPS receiver to the field computer. Alternatively you can use a combination of Bluetooth wireless technology and cabling.

For more information, refer to the documentation provided with the GPS receiver and the real-time correction device.
Typical workflow

When you use the Trimble GPS Analyst extension to collect data, you will typically complete some or all of the following steps:

1. Prepare the geodatabase for GPS data, and configure default construction properties for features.
2. Connect the Tablet PC or laptop computer running ArcGIS Desktop software and the Trimble GPS Analyst extension to a GPS receiver.
3. Configure GPS receiver and data collection settings.
4. Use ArcMap and the GPS Analyst Field toolset to collect or update GPS data.
5. Process and analyze the GPS data.

More information about each step is provided below. These steps assume that you will use the GPS Analyst user interface provided in ArcCatalog and ArcMap. You can also complete some steps using geoprocessing tools provided in the Trimble GPS Analyst toolbox, available when you open ArcToolbox. For more information, see Trimble GPS Analyst toolbox, page 60.

Step 1: Prepare the geodatabase for GPS data

Note — To work with GPS data using the Trimble GPS Analyst extension, you must use a personal geodatabase.

In ArcCatalog, open the Database Properties dialog and prepare the geodatabase for GPS data by doing the following:

1. GPS-enable the geodatabase and the feature classes that will contain the GPS-derived features.
2. Specify the spatial reference for the geodatabase.
3. Select a geographic transformation for the GPS data.
4. Set default construction properties for each feature class that will contain GPS-derived features.
For more information about steps 1 through 3, see Chapter 4, Typical GPS Analyst Tasks.

To configure the construction properties for a feature class, use the Feature Class Properties dialog.

The construction properties of a feature define how the feature is constructed from GPS positions. When you use the Trimble GPS Analyst extension to collect features, the extension uses default construction properties for features in the same feature class. To change the geometry of any line or polygon feature constructed from GPS data, change the construction properties.

For more information, search for the topic Constructions in the Trimble GPS Analyst Extension Help.

**Step 2: Connect to a GPS receiver**

Connect the computer to the GPS receiver using a cable or Bluetooth wireless technology. For more information, refer to the documentation provided with the GPS receiver. To receive real-time differential corrections as you collect data, connect the GPS receiver to a real-time correction source.

In ArcMap, use the Connect to GPS button on the Trimble GPS Analyst toolbar to connect the GPS Analyst extension to the GPS receiver.

Tip – To check the status of the GPS receiver, use the GPS status panel or the GPS Status window.

**Step 3: Configure GPS receiver and data collection settings**

In ArcMap, open a map document that contains GPS-enabled feature classes and make sure the Field toolset is displayed on the Trimble GPS Analyst toolbar (see page 160).

Use the Receiver Settings dialog to configure the GPS receiver, and the Data Collection Settings dialog to set up quality filters for GPS positions received during data collection.
Note – The type of GPS receiver determines which receiver settings options are available in the Trimble GPS Analyst extension. Some options, such as configuring and connecting to a real-time correction source, are available only when you are connected to certain models of Trimble GPS receiver.

Step 4: Collect features

In ArcMap, start a GPS edit session. Use the GPS Data Collection window to collect new features and GPS data for those features, or to update existing features. To navigate to an existing feature to update it, use the Navigation window.

GPS edit sessions

A GPS edit session enables you to collect or edit any feature that is linked to GPS data.

Note – To edit a feature that uses GPS data, start a GPS edit session, not a standard ArcMap edit session. A feature that is edited in a standard ArcMap edit session becomes unlinked from its GPS-derived geometry.

You cannot start a GPS edit session if an ArcMap edit session is already open.

For more information, see GPS edit sessions, page 94 or search for the topic GPS edit sessions in the Trimble GPS Analyst Extension Help.

Step 5: Process and analyze the GPS data

When you have collected the GPS data, either process the data in the field, or return to the office and use the Data Transfer utility to transfer the GPS and GIS data to an office computer for processing.

You can use the GPS Analyst Office toolset in ArcMap to differentially correct, rebuild, and validate collected GPS positions. To edit GPS data, you will need to start a GPS edit session.
Tutorial 4: Collecting GPS Data

In this chapter:
- Before you begin
- Scenario
- Connecting to your data
- Exercise 1: Preparing feature classes for GPS data
- Exercise 2: Configuring the GPS receiver
- Exercise 3: Collecting features using the Trimble GPS Analyst extension

This tutorial explains how to:
- GPS-enable the geodatabase
- set default construction parameters for features collected using ArcMap and the Trimble GPS Analyst extension
- connect the Trimble GPS Analyst extension to a GPS receiver
- check the GPS status of the receiver
- collect different types of features using the data collection functionality provided with the Trimble GPS Analyst extension

The tutorial contains step-by-step instructions for the main tasks involved.
This tutorial will take between 30 and 45 minutes to complete.
Before you begin

Before beginning this tutorial, you will need to:

- Install the ESRI ArcGIS Desktop software. For more information, refer to the documentation provided by ESRI.
- Install the Trimble GPS Analyst extension. For more information, see Installing the Trimble GPS Analyst extension, page 36.
- Locate where the tutorial sample files are stored on your computer and, if required, reinstall them (see Loading the tutorial sample files below).
- Enable the Trimble GPS Analyst extension in both ArcCatalog and ArcMap (see page 45).
- Display the Trimble GPS Analyst toolbar in ArcMap (see page 55).

Note – The tutorials assume that the default settings for the Trimble GPS Analyst extension are unchanged. If they have been changed, the extension may behave differently from the behaviour described in the tutorials.

This tutorial assumes that you are familiar with GIS concepts and the ArcGIS software environment. For information on GIS concepts and the ArcGIS Desktop software environment, refer to Getting Started with ArcGIS and Building and Editing Geodatabases, which you received from ESRI in your ArcGIS package.

The exercises in this tutorial are designed to be completed in sequence.

Loading the tutorial sample files

The exercises use sample files supplied with the Trimble GPS Analyst extension. These sample files are located in the folder you specified at installation. The default location is C:\ArcGIS\ArcTutor\GPS Analyst.

If they have been deleted, reload them from the Trimble GPS Analyst Extension CD.
To reload the sample files:

1. Insert the *Trimble GPS Analyst Extension CD* in the CD drive of the computer.
2. Select *Install*.
3. Depending on the version of ArcGIS Desktop software you are running, click either *Install GPS Analyst for ArcGIS 9.0 and 9.1* or *Install GPS Analyst for ArcGIS 9.2*.
4. Select *Modify*.
5. Select the *Sample Data* check box.
6. Follow the instructions on the screen to install the sample files.

For more information, see *Installing the Trimble GPS Analyst extension, page 36*.

**Returning the contents of the tutorial folder to its original state**

Each tutorial folder contains a zip file to return the contents of the tutorial geodatabase to its original state.

*Note* – *You must return the contents of the tutorial folder to its original state before you do the tutorial. You will need to do this if you have done the tutorial before, even if you have uninstalled and then reinstalled the Trimble GPS Analyst extension.*

To return the contents of any GPS Analyst tutorial folder to its original state:

1. In Windows Explorer, delete all files inside the tutorial folder except the .zip folder.
2. Right-click the .zip folder and select WinZip. Extract the contents to the tutorial folder.
**Scenario**

The City of Westminster, Colorado, maintains a geodatabase of assets in an Open Space park. The geodatabase contains features such as access ways, sewers, building footprints, vehicle parking areas, and road centerlines. The City of Westminster wants to send a field crew to the park to map new features, and to update existing features. The field crews will use Tablet PCs running ESRI ArcGIS Desktop software and the Trimble GPS Analyst extension.

Your task is to prepare the feature classes in the geodatabase for use with GPS data, and to set default construction settings for GPS-enabled feature classes. Then you will travel to the Open Space park, connect to a GPS receiver, and collect new features and update existing features.

**Connecting to your data**

The Catalog tree in ArcCatalog has a branch for each local hard drive. You can also create new branches in the Catalog tree to make it easier to navigate to your data. These branches are called connections.

Now you will add a connection to the folder that contains the tutorial data. This new branch remains in the Catalog tree until you delete it.

**Make a connection to the tutorial data**

1. In ArcCatalog, click the Connect to Folder button.
2. Navigate to the folder on the drive where the tutorial data is installed. The default location is `C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial4`. Click OK.
The new connection appears as a branch in the Catalog tree:

3. Click the Tutorial4 folder to view its contents on the right side of the ArcCatalog window.

Table 10.1 on the following page describes the contents of the Tutorial4 folder.
Table 10.1  Contents of the Tutorial4 folder

<table>
<thead>
<tr>
<th>Folder or filename</th>
<th>File type</th>
<th>Path</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tutorial4 Folder</td>
<td>Folder</td>
<td>Tutorial4</td>
<td>This is the main project folder where the City of Westminster geodatabase and map document are stored.</td>
</tr>
<tr>
<td>City of Westminster</td>
<td>Geodatabase</td>
<td>Tutorial4</td>
<td>The geodatabase containing the data for this tutorial.</td>
</tr>
<tr>
<td>City of Westminster</td>
<td>Map document</td>
<td>Tutorial4</td>
<td>A map document of the Open Space park maintained by the City of Westminster.</td>
</tr>
<tr>
<td>Open Space</td>
<td>Raster dataset</td>
<td>Tutorial4</td>
<td>Raster dataset of images of the Open Space park, which provide the background image for the map.</td>
</tr>
<tr>
<td>NMEA Data</td>
<td>Folder</td>
<td>Tutorial4\NMEA data</td>
<td>This is the folder where log files recorded using an NMEA GPS receiver are stored.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>You will use the log file in this folder as the GPS receiver for this tutorial.</td>
</tr>
</tbody>
</table>
Exercise 1: Preparing feature classes for GPS data

You will travel to the Open Space Park to collect new features and update existing features. The City of Westminster has indicated that the new features are:

- access ways
- storm drain access covers
- water points

The features that need updating are access ways that have been extended.

Your task is to prepare the City of Westminster geodatabase for GPS data, and to GPS-enable the feature classes that contain the storm drain access cover, water point, and access way features.

This exercise introduces you to the concepts of:

- GPS data in the geodatabase
- estimated accuracy
- validation
- construction properties

It shows you how to:

- GPS-enable a geodatabase and selected feature classes
- add estimated accuracy data to GPS-enabled feature classes
- specify the required accuracy for features in the same feature class to pass validation
- set default construction properties for feature classes
GPS data in the geodatabase

The Trimble GPS Analyst extension enables you to store GPS data directly in the geodatabase as a GPS session. GPS sessions are contained in the GPS Sessions folder. GPS positions are always stored in the geodatabase using the WGS-84 coordinate system.

Before you can store GPS sessions in the geodatabase, you need to:

- GPS-enable the geodatabase
- specify the spatial reference for GPS-enabled feature classes
- GPS-enable the feature classes that you want to use with GPS data

You also need to select a geographic transformation, because the feature classes in the geodatabase are not referenced to the WGS-84 coordinate system. The geographic transformation will ensure that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to coordinates in the same coordinate system as the feature classes.

To complete these tasks, use the Trimble GPS Analyst tab of the Database Properties dialog. You can GPS-enable a geodatabase at the same time that you create the geodatabase, or later, once it contains GIS features.

GPS-enabling the geodatabase and feature classes

1. Open ArcCatalog, if it is not already open. To do this, select All Programs / ArcGIS / ArcCatalog from the Windows Start menu.
2. Browse to the tutorial dataset folder connection you created for Tutorial 4.
3. Right-click the City of Westminster geodatabase and select Properties.
   
   The Database Properties dialog appears.
4. Select the Trimble GPS Analyst tab:

5. Select the GPS-enable geodatabase check box.
   You will be collecting new features or updating features in three of the feature classes in the geodatabase.

6. Select the check boxes next to the AccessWays, StormDrainPoints, and WaterPoints feature classes to GPS-enable them.

7. Click OK.
The *Select Geographic Transformation* dialog appears:

GPS data stored in the geodatabase uses the World Geodetic System of 1984 (WGS-84) geographic coordinate system. Because the City of Westminster geodatabase uses the North American Datum of 1983 (NAD 1983) coordinate system, you need to specify a geographic transformation so that the GPS Analyst extension can correctly convert GPS data from WGS-84 coordinates to NAD 1983 coordinates. You will use the NAD_1983_To_WGS_1984_4 geographic transformation, because it is the transformation that ESRI recommends for converting WGS-84 coordinates to NAD 1983 coordinates.

8. From the drop-down list, select the NAD_1983_To_WGS_1984_4 geographic transformation and then click **OK**.

The City of Westminster geodatabase is now GPS-enabled. The GPS Analyst extension has created the GPS Sessions folder that will contain GPS sessions for the geodatabase. The GPS Sessions folder appears below the feature dataset in the *Contents* tab for the City of Westminster geodatabase.
Estimated accuracy values

When a feature is created using GPS data, the GPS Analyst extension calculates estimated accuracy values for the feature, and for the constructions that are used to build the feature.

For features that are made up of several vertices, the estimated accuracy is represented in two ways: the average estimated accuracy, which is the average of the estimated accuracy for each of the vertices in the feature, and the worst estimated accuracy, which is the estimated accuracy of the vertex that has the largest estimated accuracy of all the vertices in the feature. For a point feature, which always consists of only one averaged vertex, the worst estimated accuracy is always the same as the average estimated accuracy.

The average estimated accuracy and the worst estimated accuracy values for a feature are stored as part of the GPS data used to construct the feature. You can choose to map the average and worst estimated accuracy values to attributes in the feature classes that you have GPS-enabled. If you do so, and if you later unlink a feature from its GPS data or if you GPS-disable the geodatabase, the estimated accuracy values for the feature will be retained as attributes.

Required accuracy for validation

The worst estimated accuracy value is used as part of the validation process. During validation, the GPS Analyst extension checks whether the worst estimated accuracy of the feature is within the required accuracy specified for its feature class. The degree of accuracy you require depends on the type of feature collected and the purpose of the information. For example, underground cable features that maintenance crews will need to locate and repair require better accuracy than signpost features that are clearly identifiable.

You can specify or change the accuracy required for a feature class at any time, using the Trimble GPS Analyst tab of the Feature Class Properties dialog. You can learn more about validation by completing Tutorial 3: Processing GPS Data, beginning on page 129.
For this tutorial, you will specify the required accuracy before you start collecting data.

**Specifying the required accuracy for features**

1. In ArcCatalog, expand the Open Space feature dataset:

2. Right-click the AccessWays feature class and then click Properties.

The Feature Class Properties dialog appears.
3. You have decided to store estimated accuracy values as attributes in the feature, so select the **Fields** tab:

![Feature Class Properties](image)

4. To add a new field to the feature class, click the next blank row in the *Field Name* column and then type **Average_Est_Accuracy**.

5. In the same row, click in the *Data Type* column. From the drop-down list, select Double.

6. Repeat steps 4 and 5 to create a new field called **Worst_Est_Accuracy**. Define the data type as Double.

7. Click **Apply**.
8. Select the Trimble GPS Analyst tab:

9. The GPS-enable feature class check box is selected, because you enabled the feature class from the Database Properties dialog.

10. From the drop-down list next to Store average estimated accuracy in, select Average_Est_Accuracy.

11. From the drop-down list next to Store worst estimated accuracy in, select Worst_Est_Accuracy.

   The City of Westminster map document uses meters to measure distance, so you will specify the accuracy required for validation in meters.

12. In the Accuracy required for validation field, enter 0.4 m.
All features in the AccessWays feature class now need to be accurate to within 40 centimeters in order to pass validation.

13. Click **OK**.

14. Repeat steps 2 through 12 above for the other GPS-enabled feature classes in the City of Westminster geodatabase:
   - StormDrainPoints
   - WaterPoints

**Constructions**

The Trimble GPS Analyst extension builds the geometry of a feature from GPS data using “building blocks” called constructions. A construction uses the GPS positions from locations or other constructions to calculate a vertex, which is used to construct the geometry of a feature.

By default, each feature type has a default type of construction: point features are constructed using averaged vertex constructions, line features use path constructions, and polygon features use ring constructions.

**Default construction properties**

For any line or polygon feature constructed from GPS data, you can change the construction properties to change the geometry of the feature. When you use the GPS Analyst extension to collect features, the GPS Analyst extension uses *default* construction properties for features in the same feature class.

The construction properties define which locations are used in the feature, or how constructed positions are calculated. For example, you can use the *Construction Properties* dialog to specify a minimum time between any two locations used in the feature.
The construction interval does not determine the rate at which GPS positions are logged to the geodatabase; this is controlled by the GPS receiver. This means that if you change the construction interval during data analysis, you don’t have to return to the field to collect additional GPS positions for the feature.

**Viewing default construction properties**

1. In ArcCatalog, right-click the AccessWays feature class and click *Properties*.
   
The *Feature Class Properties* dialog appears.

2. Select the *Trimble GPS Analyst* tab:
3. In the Default Construction field, Path is already selected. This is the default construction for all line feature classes collected using the GPS Analyst extension.

4. To view the default path construction properties, click the Settings button next to the default construction drop-down list.

   The Construction Properties dialog appears:

   ![Construction Properties Dialog]

   The default construction interval for line features in the Access Way feature class is a distance interval of 1 meter. This means that there will be 1 meter between any two locations used in the feature, except for the first and last locations recorded for the feature, which are always included in the feature.

5. For this exercise, we will keep the default construction properties. Click Cancel to close the dialog.

6. Click Cancel to close the Feature Class Properties dialog.
Exercise 2: Configuring the GPS receiver

Now that you have prepared the City of Westminster geodatabase for GPS data, you need to prepare your City of Westminster map document for collecting GPS data. In ArcMap, you will check that the default receiver settings will help you to collect GPS data that meets your requirements.

This lesson introduces the concepts of:

- GPS layers in ArcMap
- Trimble GPS Analyst extension tools in ArcMap
- log files pre-recorded using a NMEA receiver

It shows you how to:

- select the type of GPS receiver you will use
- configure settings for the GPS receiver

GPS layers in ArcMap

Maps that contain GPS-enabled feature classes contain a GPS layer. The GPS layer is added as the top layer in the map when GPS-enabled feature classes are added to the map, or when you GPS-enable feature classes that are contained in the map document.

The GPS group layer in the City of Westminster map document already contains two layers:

- Features in Progress
- GPS Positions

These layers are used for analyzing and editing features that are linked to a GPS-derived geometry.

When you connect to a GPS receiver later in this tutorial, two other layers will be added to the map:

- GPS Cursor and Trail
- Navigation
These layers are used to aid in collecting data and navigating to existing features. The GPS Cursor and Trail layer tracks the movement of the GPS receiver. The GPS cursor symbol shows the current GPS position, and the GPS trail symbol shows the path you have taken recently. The Navigation layer shows symbols indicating the features or map locations that are currently selected as the start and target for navigation.

Opening a map document that contains GPS-enabled feature classes

1. In ArcCatalog, browse to the tutorial folder and double-click the City of Westminster_Tutorial4.mxd.

ArcMap starts and displays a map of the Open Space park maintained by the City of Westminster:
Because you GPS-enabled three of the feature classes that are contained in the map document, two GPS layers are added to the map: the Features in Progress layer and the GPS positions layer. These appear in the GPS group layer, which is the first layer in the Display tab of the ArcMap table of contents.

The Open Space layer on the map points to an image file, which is used as the background image for the map.

2. Select View / Bookmarks / Features from GPS.

The map zooms to the bookmarked view, showing the area where you will be collecting features.

By default, the Field toolset is not displayed. You need to display the Field toolset in order to select tools and drop-down menu items that relate to collecting data using the GPS Analyst extension.

3. From the Trimble GPS Analyst drop-down menu, select Show Field Tools.

The Field toolset is added to the Trimble GPS Analyst toolbar:
Using GPS receivers and log files

With the Trimble GPS Analyst extension, you can connect a supported GPS receiver or, if you have a NMEA receiver, you can pre-record a log file with the receiver connected and replay the log file instead of connecting to a physical receiver.

For this tutorial, you will connect to a log file recorded at the Open Space park using a NMEA receiver. This means you can complete the data collection without going outside.

Selecting the GPS receiver

1. From the Field Settings drop-down menu, select GPS Receiver and then select NMEA GPS Receiver.
2. From the Field Settings drop-down menu, select Receiver Settings.

The Receiver Settings dialog appears:
3. In the GPS Settings tab, select the Replay NMEA File option.

4. Click Browse to navigate to the location of the NMEA log file. The default location is C:\ArcGIS\ArcTutor\GPS Analyst\Tutorial\NMEA Data.

5. Select Tutorial Receiver.LOG and click Open to confirm your selection and close the dialog.

6. In the Receiver Settings dialog, click OK to close the dialog.

Exercise 3: Collecting features using the Trimble GPS Analyst extension

Now that you have configured your receiver, you are ready to travel to the Open Space park and collect features using GPS data.

When you collect real data, you will need to move to a location where you have a clear view of the sky. Satellite signals can be received from any direction, but they can be blocked by people, buildings, heavy tree cover, large vehicles, or powerful transmitters. Anything that blocks light also blocks signals. GPS signals can go through leaves, plastic, and glass, but these all weaken the signal.

Because you will be replaying a pre-recorded log file rather than connecting to a real GPS receiver, you won’t need to go outside to complete this tutorial.

At the Open Space park, you will collect new waterpoint and access way features.

This exercise introduces the following concepts:

- GPS receiver status
- GPS edit sessions
- static GPS positions
- streaming GPS positions
It shows you how to:

• connect to the selected GPS receiver
• check the status of the GPS receiver
• start a GPS edit session
• collect a point feature
• collect a line feature
• disconnect from the receiver
• end the GPS edit session

Connecting to a GPS Receiver

You must connect the field computer to a GPS receiver before you can collect new data. Connect the GPS receiver and antenna to the Tablet PC or laptop according to the receiver manufacturer’s instructions.

You must also connect the GPS Analyst extension to the receiver, using the GPS Connect/Disconnect button on the Trimble GPS Analyst toolbar.

Once connected, the GPS Cursor and Trail layer and the Navigation layer are added to the map. The GPS Analyst extension begins to track visible satellites and to calculate its current position. When the current position is calculated (usually after a couple of seconds), the GPS cursor and trail symbols appear on the map, indicating the current position of the GPS receiver.

Checking the GPS Status

Click on the Trimble GPS Analyst toolbar and use the Status window to view the satellites being tracked and to check which satellites are being used to calculate the current position.

The skyplot shows which satellites are being tracked. The green satellites show the satellites that the receiver is using to compute its current GPS position. The red satellites represent satellites that
the receiver is receiving signals from, but is not using for calculations because the signals are too weak. The red circle inside the skyplot represents the minimum elevation setting.

Your current GPS position is displayed at the bottom of the skyplot tab.

**Tip** – To view detailed information on satellite positions and signal strengths, select the Satellite Information tab of the GPS Status window.

The GPS Status panel on the Trimble GPS Analyst toolbar displays the number of satellites being used to compute GPS positions. It also provides feedback on the status of any real-time source you have set up, and the receiver battery level. When you are logging a feature, it also provides the Current Estimated Accuracy of the feature being logged.

You need a minimum of four satellites, with good geometry, to compute a three-dimensional GPS position. When you turn on the receiver, it automatically starts to track visible satellites and to calculate its current position. If the receiver is computing GPS positions, the satellite icon in the GPS Status panel and the number beside the icon are solid. If the satellite icon or its number are flashing, the satellite geometry is poor or there are too few satellites available to compute GPS positions.

**GPS edit sessions**

A GPS edit session enables you to collect or edit any feature that is linked to GPS data.

**Note** – To edit a feature that uses GPS data, start a GPS edit session, not an ordinary ArcMap edit session. A feature that is edited in an ordinary ArcMap edit session becomes unlinked from its GPS-derived geometry.

You cannot start a GPS edit session if an ArcMap edit session is already open.

For more information, see [GPS edit sessions](#), page 72 or search for the topic **GPS edit sessions** in the *Trimble GPS Analyst Extension Help*. 

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Trimble GPS Analyst Extension Getting Started Guide
Logging now or later

When you collect features, you can choose to log GPS positions now or later. By default, the GPS Analyst extension does not begin logging features until you click the static GPS positions or streaming GPS positions buttons. This gives you time to enter the attributes for the feature, or to reach the start of the feature. Selecting the Log Now option means you can start logging GPS positions as soon as you open a new feature, so you can log GPS positions as the same time as you record the attributes.

Point features

To collect a point feature, remain stationary while the GPS Analyst extension logs static GPS positions. When you end static logging, the GPS Analyst extension uses smart averaging to calculate an averaged position. GPS positions with a better estimated accuracy are given more weight than GPS positions with a poorer estimated accuracy when calculating the constructed position.

While the GPS Analyst extension is logging GPS positions, the GPS positions counter indicates how many GPS positions have been logged for the feature. Generally, the more GPS positions you log for a point feature, the more accurate the constructed position for the feature will be.

Line features

To record a line feature, you need to travel along the feature. As you travel, the GPS Analyst extension records streaming GPS positions at the logging interval specified in the Construction Properties dialog. The GPS positions counter indicates how many GPS positions have been logged for the feature. Streaming GPS positions are used as a vertex in a line or area feature.
Alternatively, you can record a line feature by logging a series of points along the feature, called averaged vertices. To find out more about collecting line features using averaged vertices, search for the topic **Collecting line and polygon features using averaged vertices** in the *Trimble GPS Analyst Extension Help*.

**Connecting to the GPS receiver and logging GPS positions**

1. To connect to the GPS receiver, click the GPS Connect/Disconnect button on the Trimble GPS Analyst toolbar.

   The GPS Cursor and Trail layer and the Navigation layer are added to the GPS group layer in the ArcMap table of contents.

   The pre-recorded NMEA log file you selected starts playing. After a couple of seconds, the GPS Cursor and Trail appears on the map, indicating your current GPS position.

   Tip – The log file plays for approximately 8 minutes. When the log file stops you are automatically disconnected from the GPS receiver. If you need more time to collect features, restart the log file by reconnecting to the GPS receiver (click on the Trimble GPS Analyst toolbar).

2. Click the GPS Status button on the Trimble GPS Analyst toolbar. The *GPS Status* window appears, displaying the *Skyplot* tab.

   The skyplot shows which satellites are being tracked.

3. Dock the *GPS Status* window below the Table of Contents window in ArcMap.
4. From the Trimble GPS Analyst drop-down menu, select Start GPS Editing.

This starts a GPS edit session, and enables most of the buttons on the Trimble GPS Analyst toolbar. Now all GPS positions received from the GPS receiver are stored in the geodatabase in the open GPS session.

5. Click the GPS Data Collection button on the Trimble GPS Analyst toolbar.

The GPS Data Collection window appears, displaying the Create tab. The feature classes you GPS-enabled are listed:

You will use the GPS Data Collection window to collect new features that are linked to GPS geometries.
Collecting a line feature using Log Now

1. In the feature class list, select the AccessWays feature class.
2. Select Log Now.
3. Click Create. The GPS Data Collection panel appears inside the GPS Data Collection window:

![GPS Data Collection panel](image)

The icon on the Log Streaming GPS button is already moving, and the GPS position and feature vertex counters are increasing, showing that the “AccessWays n” feature is being recorded as the GPS cursor moves along the accessway. The n denotes the feature ID, which is a sequential number allocated to each feature class. Each subsequent feature of the same type added to the geodatabase is allocated the next feature ID in the sequence.

You can see the accessway in the background map image, while the feature is being recorded on the map in the Features in Progress layer.
4. Click the Attributes button in the GPS Data Collection panel. The attributes dialog appears:

![Attributes Dialog]

5. Click a value in the right column and edit it to record attributes for the accessway. When you have completed entering attribute information, click to close the dialog.
6. When the GPS receiver reaches the end of the accessway, (where the receiver meets the other accessway,) the GPS cursor pauses, showing that the receiver is stationary:

7. Click the Accept button to stop logging the feature and add the new accessway feature to the map.

The log file continues playing, and after a brief pause the GPS cursor starts moving again. While the receiver is moving, start collecting a point feature using the steps on the following page.
Collecting a point feature using Log Later

1. In the Create tab of the GPS Data Collection window, select WaterPoint from the feature class list.

2. Select Log Later. This means that the new feature will be created with logging paused.

3. Click Create to create a new WaterPoint feature.

   The GPS Data Collection panel appears inside the GPS Data Collection window. The new feature is called “WaterPoint n”:

4. Click the Attributes button in the GPS Data Collection panel. The attributes dialog appears.

5. Click a value in the right column and edit it to record attributes for the water point. When you have completed entering attribute information, click to close the dialog.
6. When the GPS cursor pauses again on the map, click the Log Static GPS button to begin logging static GPS positions for the feature:

Logging is indicated by:

- The icon on the Log Static GPS button is animated to show that GPS positions are being collected and averaged.
- The GPS position counter increases as GPS positions are logged for the feature.

7. When you have collected 10 GPS positions, click the Accept button to add the new feature to the map.
The GPS Data Collection panel closes, and the new WaterPoint feature appears on the map.

**Ending the GPS edit session**

When you have finished collecting data, end the GPS session and close ArcMap:

1. Close the *GPS Data Collection* window by clicking the \( \mathbb{F} \) in the corner.
2. Click the GPS Connect/Disconnect button \( \mathbb{F} \) to disconnect from the GPS receiver.
3. From the *Trimble GPS Analyst* drop-down menu, select *Save Edits*. The new features, and the GPS-derived geometries that they are linked to, are saved in the geodatabase.
4. From the *Trimble GPS Analyst* drop-down menu, select *Stop GPS Editing*.
5. Select *File / Save* to save the map document.
6. Exit ArcMap and exit ArcCatalog.

You have now finished this tutorial. In ArcCatalog, you have GPS-enabled the geodatabase, specified accuracy requirements for GPS-derived features, and checked the construction settings for GPS-enabled feature classes. In ArcMap, you have connected to a GPS receiver, checked the receiver status, and collected features using GPS data. Understanding how to perform these basic tasks is the key to collecting GPS data using the GPS Analyst extension. For more information about creating features derived from GPS data, refer to the *Trimble GPS Analyst Extension Help*.

If you have not already completed the data processing tutorial, you can learn more about analyzing GPS data using the Trimble GPS Analyst extension by completing *Tutorial 3: Processing GPS Data*, beginning on page 129.
# Glossary

This section explains some of the terms used in this manual.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>almanac</td>
<td>A file that contains orbit information on all GPS satellites, clock corrections, and atmospheric delay parameters. It is transmitted by a GPS satellite to a GPS receiver, where it facilitates rapid satellite acquisition. The orbit information is a subset of the ephemeris data, with reduced precision. See also ephemeris.</td>
</tr>
<tr>
<td>attribute</td>
<td>Information about a geographic feature in a GIS, usually stored in a table and linked to the feature by a unique identifier. For example, attributes of a river might include its name, length, and average depth.</td>
</tr>
<tr>
<td>averaged vertex</td>
<td>Also called a smart averaged vertex. The vertex of a point, line or polygon feature produced by a smart average construction. See also smart average construction.</td>
</tr>
<tr>
<td>base station</td>
<td>A GPS antenna and receiver positioned at a known location specifically to collect data for differentially correcting roving receiver data. The base station calculates the error for each satellite and, through differential correction, improves the accuracy of GPS positions collected at unknown locations by a roving GPS receiver. Base data needs to be collected at the same time as the roving receiver data is collected.</td>
</tr>
<tr>
<td>constellation</td>
<td>A specific set of satellites used for calculating positions; for example, the four satellites used for fixing a 3D position. Alternatively, all the satellites visible to a GPS receiver at one time. The optimum constellation is the constellation with the lowest PDOP. See also Position Dilution of Precision (PDOP).</td>
</tr>
<tr>
<td>construction</td>
<td>A &quot;building block&quot; used in the GPS Analyst extension to construct features from locations. A construction uses the GPS positions from locations or other constructions to calculate a vertex. See also path construction, ring construction, smart average construction and track construction.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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<td>---------------------------</td>
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</tr>
<tr>
<td>coordinate system</td>
<td>A fixed reference framework superimposed onto the surface of an area to designate the position of a point within it; a reference system consisting of a set of points, lines, and/or surfaces; and a set of rules, used to define the positions of points in space in either two or three dimensions. The Cartesian coordinate system and the geographic coordinate system used on the earth's surface are common examples of coordinate systems.</td>
</tr>
<tr>
<td>Current Estimated Accuracy</td>
<td>The estimated accuracy of the feature currently being logged, in either meters or feet or, if the value is less than 1, in centimeters or inches. This value is shown in the GPS status panel and the Skyplot tab of the GPS Status window. If a Trimble GPS receiver with H-Star technology is being used to collect the feature, the Predicted Postprocessed Accuracy (PPA) is also shown, below the Current Estimated Accuracy.</td>
</tr>
<tr>
<td>data dictionary</td>
<td>A catalog containing information about the datasets stored in a GIS database, such as the full names of attributes, feature class type, and map projections used. For Trimble data collection software, a data dictionary is a file that is created on a PC and then transferred to data collection software for use in the field.</td>
</tr>
<tr>
<td>datum</td>
<td>A datum or geodetic datum is a geodetic coordinate system that is used for surveying and mapping purposes. Before satellites were used for positioning on a global scale, different geodetic datums were developed for different regions. Each of these datums is a mathematical model based on the ellipsoid that most resembles the shape of the earth in a particular region. Each model is designed to fit part or all of the geoid. As a result, there are many distinct datums, each of which best fits a particular part of the earth's surface. A geodetic datum is defined by the relationship between an ellipsoid shape and the center of the earth. It takes into account the size and shape of the ellipsoid, and the location of the center of the ellipsoid with respect to the center of the earth (a point on the topographic surface established as the origin of the datum). Various datums have been established that best suit particular regions. The datum chosen for use in a particular region is referred to as the local datum. For example, maps in the United States are often based on the North American Datum of 1927 or 1983 (NAD-27, NAD-83). All GPS coordinates are based on the WGS-84 datum surface.</td>
</tr>
</tbody>
</table>
**Glossary**

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>datum transformation</td>
<td>See geographic transformation.</td>
</tr>
<tr>
<td>differential correction</td>
<td>The process of correcting GPS data collected with a roving receiver at an unknown location with data collected simultaneously at a known location, which is usually a base station. Because it is at a known location, any errors in data collected at the base station can be measured, and the necessary corrections applied to the roving receiver data. Differential correction can be done in real time, or after the data has been collected by postprocessing.</td>
</tr>
<tr>
<td>Differential correction (DGPS)</td>
<td></td>
</tr>
<tr>
<td>Dilution of Precision (DOP)</td>
<td>An indicator of satellite geometry for a constellation of satellites used to determine a position. A low DOP value indicates a higher probability of accuracy. Factors determining the total DOP for a set of satellites include PDOP (Positional DOP), HDOP (Horizontal DOP), VDOP (Vertical DOP), and TDOP (Time DOP).</td>
</tr>
<tr>
<td>elevation</td>
<td>Vertical distance above (or below) the geoid or mean sea level. See also geoid, mean sea level (MSL).</td>
</tr>
<tr>
<td>ellipsoid</td>
<td>A mathematical model of the earth formed by rotating an ellipse around its minor axis. For ellipsoids that model the earth, the minor axis is the polar axis, and the major axis is the equatorial axis. An ellipsoid is completely defined by specifying the lengths of both axes, or by specifying the length of the major axis and the flattening.</td>
</tr>
<tr>
<td>ephemeris</td>
<td>A list of predicted (accurate) positions or locations of satellites as a function of time. A set of numerical parameters that can be used to determine the position of a satellite. Available as broadcast ephemeris or as postprocessed precise ephemeris.</td>
</tr>
<tr>
<td>feature</td>
<td>A representation of a real-world object on a map. Features can be represented in a GIS as vector data (points, lines, or polygons) or as cells in a raster data format. To be displayed in a GIS, features must have geometry and locational information. Multipoint features consist of more than one point but only reference one set of attributes in the database. For example, a system of oil wells with a single set of attributes for multiple well holes. Features with GPS-derived geometry are constructed using GPS data.</td>
</tr>
<tr>
<td>field computer</td>
<td>A portable computer such as a handheld computer, laptop, or Tablet PC running data collection software such as the TerraSync software or ArcGIS Desktop and the GPS Analyst extension.</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>flattening</strong></td>
<td>A measure of the flattening of an ellipse. A circle has a flattening of 0. Flattening of the WGS-84 ellipsoid is approximately $1/298.257223563 = 0.00335281066474$.</td>
</tr>
<tr>
<td><strong>geodatabase</strong></td>
<td>An object-oriented data model introduced by ESRI that represents geographic features and attributes as objects and the relationships between objects, inside a database management system. A geodatabase can store objects, such as feature classes, feature datasets, nonspatial tables, and relationship classes. The GPS Analyst extension allows you to GPS-enable a personal geodatabase so that it can store GPS data.</td>
</tr>
<tr>
<td><strong>geodetic datum</strong></td>
<td>See datum.</td>
</tr>
<tr>
<td><strong>geographic information system (GIS)</strong></td>
<td>A computerized system used to input, manage, manipulate, analyze, and display geographic data in digital form.</td>
</tr>
<tr>
<td><strong>geographic transformation</strong></td>
<td>A method of converting data between two geographic coordinate systems or datums. In the GPS Analyst extension, geographic transformations typically convert data collected in the WGS-84 datum by GPS methods onto datums used for mapping in individual regions and countries.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
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</tr>
<tr>
<td>geoid</td>
<td>The surface of gravitational equipotential that closely approximates mean sea level. It is not a uniform mathematical shape but an irregular figure with an overall shape similar to an ellipsoid. Typically the elevations of points are measured with reference to the geoid. However, points fixed by GPS methods have heights established in the WGS-84 datum (a mathematical figure). The relationship between the WGS-84 datum and the geoid must be determined by observation since there is no single mathematical definition that can describe the relationship. This requires observing the elevation above the geoid (using terrestrial survey methods such as spirit leveling), and the height above the WGS-84 ellipsoid, at the same point for comparison purposes. By gathering a large number of observations of the separation between the geoid and the WGS-84 datum (geoidal separation), grid files of the separation values can be established allowing the interpolation of the geoidal separation at intermediate positions. Files containing these grids of geoidal separations are referred to as geoid models. Given a WGS-84 position that falls within the extents of a geoid model, the model can return the interpolated geoidal separation at this position.</td>
</tr>
<tr>
<td>Global Positioning System (GPS)</td>
<td>A constellation of radio-emitting satellites deployed by the U.S. Department of Defense and used to determine location on the earth's surface. The orbiting satellites transmit signals that allow a GPS receiver anywhere on earth to calculate its own location through trilateration. The system is used in navigation, mapping, surveying, and other applications in which precise positioning is necessary.</td>
</tr>
<tr>
<td>GPS data</td>
<td>The collection of measurements, observations, settings, and other data associated with a GPS position.</td>
</tr>
<tr>
<td>GPS position</td>
<td>A set of coordinates that gives the latitude, longitude, and altitude of a point, at a given instant in time.</td>
</tr>
<tr>
<td>GPS session</td>
<td>A set of GPS positions and related GPS data stored inside a GPS-enabled geodatabase. Collected GPS sessions contain GPS positions collected using the GPS Analyst extension and a GPS receiver. Imported GPS sessions contain GPS positions imported from an SSF file. Corrected GPS sessions contain the same set of GPS positions as the collected or imported GPS session that the corrected session was derived from, but the GPS positions have different coordinates.</td>
</tr>
</tbody>
</table>
GPS time  A measure of time used internally by the NAVSTAR system. GPS time is based on UTC, but does not add periodic “leap seconds” to correct for changes in the earth's period of rotation. As of 1 January 1999, GPS time was 13 seconds ahead of UTC.

heading   The current direction in which one is moving.

H-Star technology  H-Star technology is a Trimble-patented technology allowing the collection of high accuracy GPS data. A GPS receiver with H-Star technology logs L1 data or, if used with an external dual-frequency antenna, logs L1 and L2 data. H-Star postprocessing uses base data from multiple base stations to obtain better postprocessed accuracy for the collected data.

ionosphere   The band of charged particles 120 to 200 km above the earth's surface.

latitude   The angular distance, usually measured in degrees, along a meridian north or south of the equator. Lines of latitude are also referred to as parallels.

location   For the GPS Analyst extension, a location is the GPS position that is selected to represent the location of a particular point, at a given instant of time. The GPS position used for the location may come from the original collected or imported GPS session, or the most recently corrected GPS session, or it may be the GPS position with the best quality.

log   To store data in a receiver or on a computer.

longitude   The angular distance, expressed in degrees, minutes and seconds, of a point on the earth's surface east or west of an arbitrarily defined meridian (usually the Greenwich prime meridian). All lines of longitude are great circles that intersect the equator and pass through the north and south poles.

mean sea level (MSL)   The mean height of the surface of the ocean for all stages of the tide. Used as a reference for elevations.

multipath error   Interference similar to “ghosts” on a television screen, that occurs when GPS signals arrive at an antenna having traversed different paths. The signal traversing the longer path yields a larger pseudo-range estimate and increases the error. Multiple paths can arise from reflections off the ground or structures near the antenna.
### Glossary

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>NAD 1927</td>
<td>North American Datum of 1927. The primary local geodetic datum and geographic coordinate system used to map the United States during the middle part of the 20th century, referenced to the Clarke spheroid of 1866 and an initial point at Meades Ranch, Kansas. Features on USGS topographic maps, including the corners of 7.5-minute quadrangle maps, are referenced to NAD-27. It is gradually being replaced by the North American Datum of 1983.</td>
</tr>
<tr>
<td>NAVSTAR</td>
<td>The name given to GPS satellites. NAVSTAR is an acronym formed from NAVigation Satellite Timing And Ranging.</td>
</tr>
<tr>
<td>NMEA</td>
<td>Initial letters of National Marine Electronics Association. NMEA 0183 defines the standard for interfacing marine electronic navigational devices. This standard defines a number of &quot;strings&quot;, referred to as NMEA strings, that contain navigational details such as positions. Most GPS receivers can output positions as NMEA strings.</td>
</tr>
<tr>
<td>path construction</td>
<td>A GPS Analyst extension construction used as the default construction for line features. A path construction is constructed from track and smart average constructions to form the line feature. The construction interval and offset settings for a path construction can be changed in the Construction Properties dialog.</td>
</tr>
<tr>
<td>Predicted Postprocessed Accuracy (PPA)</td>
<td>The Predicted Postprocessed Accuracy indicates the estimated accuracy that is likely to be achieved for the current feature after H-Star postprocessing all the positions collected since you locked onto the required number of satellites. The PPA only applies to data collected using a Trimble GPS receiver with H-Star technology. The PPA for the current feature is displayed below the Current Estimated Accuracy value in the GPS status panel and the Skyplot tab of the GPS Status window. The PPA has a confidence level of 68%.</td>
</tr>
<tr>
<td><strong>Position Dilution of Precision (PDOP)</strong></td>
<td>A unitless figure that expresses the relationship between the error in user position and the error in satellite position. It indicates when the satellite geometry can provide the most accurate results. The best data collection time can be selected based on reports and graphs showing PDOP. Geometrically, PDOP is proportional to one divided by the volume of the pyramid formed by lines running from the receiver to four satellites observed. It is the result of a calculation that considers the location of each satellite relative to the other satellites in the constellation. Good values are small, less than three. Values greater than seven are poor. Thus, small PDOP is associated with widely separated satellites. A low DOP indicates a higher probability of accuracy. A high DOP indicates a lower probability of accuracy. PDOP is related to horizontal and vertical DOP by PDOP² = HDOP² + VDOP². See also <strong>Dilution of Precision (DOP)</strong>.</td>
</tr>
<tr>
<td><strong>postprocess</strong></td>
<td>To differentially correct GPS data on a computer after it has been collected.</td>
</tr>
<tr>
<td><strong>precision</strong></td>
<td>The closeness of a repeated set of observations of the same quantity to one another. It is a measure of the control over random error. Assessment of the quality of a surveyor’s work is based in part on the precision of their measured values.</td>
</tr>
<tr>
<td><strong>projection</strong></td>
<td>A method by which the curved surface of the earth is portrayed on a flat surface. This generally requires a systematic mathematical transformation of the earth’s network of longitude and latitude lines onto a plane. It can be visualized as a transparent globe with a light at its center casting lines of latitude and longitude onto a sheet of paper. Generally, the paper is either flat and placed tangent to the globe (a planar or azimuthal projection), or formed into a cone or cylinder and placed over the globe (cylindrical and conical projections). Every map projection distorts distance, area, shape, direction, or some combination thereof.</td>
</tr>
<tr>
<td><strong>propagation delay</strong></td>
<td>The delay in travel time of a GPS signal due to atmospheric interference. When a satellite is at a low elevation and its signal must travel a great distance through the atmosphere, the signal has delayed reception by the GPS receiver. Since the distance to the satellite is calculated by the travel time, this slight delay in travel time can result in a large error in calculated distance. Signals are delayed at all elevation angles, but more so at lower elevation angles.</td>
</tr>
</tbody>
</table>
### Glossary

**pseudo-random noise / pseudo-random number (PRN)**

Pseudo-random noise. A signal carrying a code that can be reproduced exactly, but that appears to be randomly distributed like noise. Each NAVSTAR satellite has a unique PRN code.

**pseudo-range**

A measure of the apparent propagation time from the satellite to the receiver antenna expressed as a distance. Pseudo-range is obtained by multiplying the apparent signal-propagation time by the speed of light. Pseudo-range differs from the actual range by the amount that the satellite and user clocks are offset, by propagation delays, and by other errors.

The apparent propagation time is determined from the time shift required to align (correlate) a replica of the GPS code generated in the receiver with the received GPS code. The time shift is the difference between the time of signal reception (measured in the receiver time frame) and the time of emission (measured in the satellite time frame).

Pseudo-range is the distance from the satellite to the antenna plus the distance calculated from the clock offset. When the satellite sends the PRN code, the receiver aligns the received code with an internal replica of the code. The clock offset is the difference between the two codes.

**real-time differential correction**

*Also called real-time differential GPS or real-time differential correction.* Real-time differential GPS is the process of correcting GPS data as you collect it. This is achieved by having corrections calculated at a base station sent to the roving receiver via a radio link. As the roving receiver receives the position, it applies the corrections to give you a very accurate position in the field.

**rebuild**

The process of selecting the GPS position to be used as the location. When a location changes, any constructions that use the location are rebuilt using the new position. Any constructions based on these updated constructions are rebuilt, and the changes are propagated up to the GIS feature geometry.

**ring construction**

A GPS Analyst extension construction used as the default construction for polygon features. A ring construction is constructed from track and smart average constructions, and is able to correctly offset the start and end points of the construction to form the perimeter of the polygon feature. The construction interval and offset settings for a ring construction can be changed in the Construction Properties dialog.
roving receiver  Any mobile GPS receiver collecting data in the field. The position of a roving receiver can be differentially corrected relative to a stationary base GPS receiver.

satellite geometry  Position and movement of GPS satellites during GPS data collection.

schema  The structure or design of a database or database object such as a table. The schema defines the tables, the fields in each table, and the relationships between fields and tables. Schemas are generally stored in a data dictionary.

semimajor axis  One-half of the major axis of an ellipse.

Shapefile  A vector data storage format developed by ESRI for storing the location, shape, and attributes of geographic features. A Shapefile is stored in a set of related files and contains one feature class.

signal-to-noise ratio (SNR)  *Also called signal level or signal strength.* Arbitrary strength units used to determine the strength of a satellite signal. SNR ranges from 0 (no signal) to around 35. Higher-elevation satellites have SNRs in the high teens to low 20s. An SNR lower than 5 is considered unusable.

smart average construction  A GPS Analyst extension construction used for point features and vertices in line and polygon features. A smart average construction averages several locations to produce a single smart averaged vertex. The smart average construction takes into account the quality of the incoming GPS positions, and gives more weight to positions with better quality characteristics, such as PDOP and estimated accuracy. You cannot change the construction properties of a smart average construction.

SSF file  The Trimble Standard Storage Format data file for GPS data from a Trimble Mapping and GIS receiver.

static GPS position  A GPS position logged by the GPS Analyst extension when the GPS receiver antenna is stationary (static). When you are standing still at a point feature, or at a single vertex for a line or polygon feature, you log static GPS positions. During static logging, the GPS Analyst extension averages all GPS positions received from the GPS receiver to calculate a single smart average for the point or vertex. *See also smart average construction.*
streaming GPS position  A GPS position logged by the GPS Analyst extension when the GPS receiver antenna is moving. When you are moving along a line feature, or around the perimeter of a polygon feature, you log streaming GPS positions. The GPS Analyst extension logs a new vertex for every GPS position received from the GPS receiver.

track  To make a pseudo-range measurement from a GPS satellite with a GPS receiver.

track construction  A construction in the GPS Analyst extension used in line and polygon features. A track construction is a series of locations selected from streaming GPS positions and other data that forms a segment used in a path or ring construction. You cannot change the properties of a track construction.

transformation  Converting the coordinates of a map or an image from one system to another, typically by shifting, rotating, scaling, skewing, or projecting them. The conversion process requires resampling of values.

trilateration  A method used in surveying and mapmaking to determine the relative positions of three or more points by treating these points as vertices of a triangle or triangles of, which the angles and sides can be measured.

Universal Time Coordinated (UTC)  Local solar mean time at Greenwich Meridian. A uniform atomic time system maintained by the U.S. Naval Observatory. GPS time is ahead of UTC, because it does not use leap seconds. As of 1 January 1999, GPS time was 13 seconds ahead of UTC.

validation, GPS validation  The process of comparing the worst estimated accuracy of a feature that is linked to GPS data to the required accuracy you specified for the feature class. If the worst estimated accuracy is not within the required accuracy, the feature is invalid, and fails validation.

WGS-84  World Geodetic System of 1984. A geocentric datum and geographic coordinate system created by the United States military. WGS-84 is used for all GPS data.
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