

HELP

TRIMBLE® ACCESS™
SOFTWARE

TUNNELS

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Table of Contents

Introduction tunnels.....	1
Introduction.....	1
Interacting With Other Applications.....	2
Job Operations.....	3
Jobs.....	3
Properties of Job.....	4
Review Job.....	5
Point Manager.....	8
Map.....	16
Using the Map for Common Tasks.....	19
Select points.....	23
Units.....	24
Cogo Settings.....	25
Additional Settings.....	31
Define Tunnels.....	32
Define.....	32
Horizontal Alignment.....	34
Entry by Length / Coordinates.....	34
Entry by End station.....	37
Entry by PI.....	39
Transitions.....	41
Vertical Alignment.....	43
Entry by Vertical Points of Intersection (VPI).....	43
Entry by Start and End Points.....	44
Templates.....	46
Template Positions.....	48
Example Alignment.....	49
Rotation.....	50
Set out positions.....	51
Station Equations.....	52
Alignment Offsets.....	53
Import.....	54
Survey Tunnels.....	55
Survey.....	55
Auto Scanning Positions.....	56
Manually Measuring Positions.....	59
Position in Tunnel.....	61
Setting Out Positions.....	64
Machine positioning.....	67
On station adjustment.....	69
Set Out Position Tolerance.....	69
Measuring a Position with a Prism.....	70

Table of Contents

Review Tunnels.....	71
Review.....	71
File Transfer.....	74
Report - Export Custom Format Files.....	74

Introduction tunnels

Introduction

Welcome to the Tunnels software version 2.20 Help.

This help system makes it easy to find the information you need to effectively use the full power and capabilities of the Tunnels software.

For information that extends or updates this Help, refer to the Trimble Access Release Notes. Alternatively, visit the Trimble website (www.trimble.com) or contact your local Trimble dealer.

To use this application with other applications, see [Interacting with other applications](#).

Contents

From the Trimble Access menu tap Tunnels to:

- Manage your jobs
 - ◆ [Create](#) a new job
 - ◆ [Open](#) an existing job
 - ◆ [Review](#) the current job
 - ◆ Access the [Point manager](#)
 - ◆ See the [Map](#)
 - ◆ Review and edit the [Job properties](#)
- Define your tunnel
 - ◆ [Defined](#) by the key in of the tunnel components.
 - ◆ [Imported](#) from a LandXML file using the [ASCII File Generator] utility program available from www.trimble.com.
- [Survey](#) your tunnel
 - ◆ Auto scan cross sections
 - ◆ Manually measure positions
 - ◆ Measure positions relative to a tunnel
 - ◆ Set out positions
- [Position](#) machinery, typically a drilling rig, relative to a tunnel.
- [Review](#) your surveyed tunnel
 - ◆ Scanned and manually measured points
 - ◆ Set out points
- [Report](#) your surveyed tunnel
 - ◆ Report for surveyed tunnel data on the controller while in the field. Use these reports to check data in the field, or to transfer from the field to your client or to the office for further processing with the office software.

When defining, surveying, positioning, reviewing and reporting your tunnel the tunnel file must be in the same folder as the current job.

Legal Notices

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Interacting With Other Applications

You can run more than one application at a time and easily switch between them. For example, you can switch between functions in *Roads*, *Tunnels*, *Mines*, and *General Survey*.

To run more than one application at a time, use the Trimble button or Trimble icon in the top left corner of the screen to open the Trimble Access menu. From there, you can run the other application.

To switch between applications:

- Tap the Trimble button in the task bar to access the menu of available applications and services currently running, including the Trimble Access menu. Select the application or service to switch to.
- On the TSC2/TSC3 controller, a short press of the Trimble button accesses the menu of available applications and services currently running, including the Trimble Access menu. Select the application or service to switch to.
- On the Trimble GeoXR controller, tap the Trimble button to access the menu of available applications and services currently running, including the Trimble Access menu and the *Windows Start Menu*. Alternatively, press and hold the camera button for two seconds and then select the application or service to switch to.
- Tap *Switch to* and then select the required function from the list. If the *Switch to* button is not on your current screen, press **CTRL W** to open the *Switch to* pop-up list.
- Press **CTRL TAB**. This is the keyboard shortcut to scroll through the current list of *Switch to* functions.
- Tap *Favourites* or press **CTRL A** to select a preconfigured favorite.
- On a TSC2/TSC3 controller, configure the [Left App] button and [Right App] button for the functions you want to run. This method opens an application even if that application is not running.

For more information, see [Trimble Access Buttons](#).

Tip - You can use this functionality to return to the main menu of the application you are currently running e.g. if you are running the *Define* option in Trimble Access Roads and you want to view the *Map*, tap the Trimble button and select Trimble Access Roads from the drop down list.


Job Operations

Jobs

A job can contain several different surveys. Select a job before you measure any points or make any calculations.


Jobs can be saved in your data folder, or in a [project folder](#) below your data folder.

To create a new job:


1. From the main menu, tap *Jobs / New job*.
2. Enter a name for the new job.
3. Tap  to create a new folder or select an existing folder.
4. Select a *Template* from the drop down list.
5. Tap the *Coord. sys.* button and choose a [coordinate system](#) for the job. Tap *Next*.
6. Configure the coordinate system settings required for the job and tap *Store*.
7. Tap the *Units* button to specify the units and various other settings for the job. Tap *Accept*.
8. Tap the *Linked files* button to select a linked file(s) for the job. Tap *Accept*.
9. Tap the *Active map* button to select an active map file(s) for the job. Tap *Accept*.
10. Tap the *Feature library* button to associate a feature library with the job. Tap *Accept*.
11. Tap the *Cogo settings* button to set the cogo settings for the job. Tap *Accept*.
12. Tap the *Additional settings* button to set additional settings for the job. Tap *Accept*.
13. Tap the *Media file* button to set the media settings for the job. Tap *Accept*.
14. Optionally, tap the *Page down* button to enter *Reference*, *Description* and *Operator* details, and any *Notes*.
15. Tap *Accept* to save the job.

A new job adopts the system settings from the last used job.

To open a job:


1. From the main menu, tap *Jobs / Open job*.
2. Tap  to expand a folder and display the files within the folder.
3. Tap the job name, or highlight the job name and tap *OK*.
The job name appears in the title area of the main menu.

To delete a job:

1. From the main menu, tap *Jobs / Open job*.
2. Tap  to expand a folder and display the files within the folder.

If the job you want to delete is not highlighted, use the arrow keys to highlight it, or tap and hold it with the stylus.



Note - If you tap with the stylus without holding, the job that you highlight opens automatically.

3. Tap  to delete the file.
4. Tap *Yes* to confirm deletion, or *No* to cancel.

Note - When you delete a job, associated files (for example, *.t02, *.tsf *.jpg) are not automatically deleted.

Tip - You can also use [Fn+ Del] on the TSC2/TSC3 controller or [Ctrl + Del] on the Trimble CU/Trimble Tablet to delete jobs from the *File / Open* dialog.


To copy a job:

1. From the main menu, tap *Jobs / Open job*.
2. Highlight the name of the job to be copied and tap .
3. Browse and highlight the folder to paste the file into and tap .

Tip - You can also use *Windows/File Explorer* to copy, rename, or delete a file.

Note - When you copy a job to another folder, associated files (for example, *.t02, *.tsf *.jpg) are not automatically copied.

To create a new job with all the defaults (including Coordinate System settings) from another job:

1. From the main menu, tap *Jobs / Open job*.
2. Tap  to select the folder, if required.
3. Select and open the job that contains the settings to use as the defaults for the new job.

Note - To use the settings in the **current** job as defaults for the new job, omit steps 1 and 2. New jobs always use the settings from the previous job as defaults.

4. From the main menu, tap *Jobs / New job*.
5. Enter a name for the new job.
6. Tap the appropriate button to change job settings as required.
7. To save the job, tap *Accept*.

Properties of Job

Use this menu to configure settings for the current job.

For more information, see:

[Coordinate system](#)

[Linked files](#)

[Active map files](#)

[Feature library](#)

[Cogo settings](#)

[Additional settings](#)

[Media file](#)

Each button displays the current settings. When you create a new job, settings from the previous job are used as the defaults. Tap a button to change the settings.

Tap *Accept* to save any changes.

Review Job

To see the records stored in the job database:

1. From the main menu, tap *Jobs / Review job*.
2. Use the arrow keys, stylus, or softkeys to navigate the database.

Tips

- ◆ To move to the end of the database quickly, highlight the first record and press the up arrow key.
 - ◆ To highlight a field without selecting it, tap and hold briefly with the stylus.
3. To see more information about an item, tap the record. Certain fields, for example, *Code* and *Antenna height*, can be edited.
 - ◆ Offset points that are stored as coordinates are not updated when you change an antenna or target height record in the database. In addition, a change in antenna height does not affect any postprocessed points that will be processed using the Trimble Business Center software. Verify the antenna or target height information when you transfer the data to the office computer or transfer postprocessed points directly from the receiver to the office software. When you change an antenna or target height record in the database, stakeout deltas, Cogo points, averaged points, calibrations, resections, and traverse results are not automatically updated. Re-observe staked out points, and re-calculate Cogo points, averaged points, calibrations, resections, and traverses.
 - ◆ To search for a particular item, tap *Search* and select an option.

Tip - To review features from the *Map* screen, select the required feature(s), tap and hold on the screen and choose *Review* from the shortcut menu.

To change the coordinate view display in *Review job*:

1. From the main menu, tap *Jobs / Review job*.
2. Use the arrow keys, stylus, or softkeys to navigate the database.
3. Do one of the following:

- ◆ Tap + to expand the point tree list.

To change the coordinate display, tap one of the ordinates and then select the appropriate coordinate view from the list;
Grid, Grid (local), WGS84, HA VA SD (raw), As Stored.

- ◆ Tap the point name to view details about the point.

To change the ordinate display:

- Tap *Options* and then select the appropriate *Coordinate view* from the list;
As Stored, Local, Grid, Grid (local), ECEF (WGS84), Station and offset, Az VA SD, HA VA SD (raw), Az HD VD, HA HD VD, delta Grid.

If you selected *Station and offset*, select the entity type (Line, Arc, Alignment, Tunnel or Road) and the name of the entity the points position will be referenced from.

If you selected *Grid (local)*, select the *Transformation for grid (local) display* name. This transformation transforms the grid coordinates to Grid (local) coordinates using the selected transformation.

Unless the transformation selected here is the same as the input transformation, the Grid (local) coordinates shown will not match the original Grid (local) coordinates. To see the original Grid (local) coordinates, set the Coordinate view to *As Stored*.

Transformation (as stored) is displayed when reviewing Grid (local) and the *Coordinate view* is set to As Stored.

Transformation (display) is displayed when reviewing Grid (local) and the *Coordinate view* is set to Grid (local).

- Tap *Accept*.

To view a media file:

1. Highlight a media file record.

Tip - To highlight a field without selecting it, tap and hold briefly with the stylus.

2. Tap *Details*. The image appears.

Inserting notes

To store a note in the database:

1. Highlight a record.
2. Tap *Note*. The *Note* screen that appears displays the date and time that the current record was created.
3. Enter the note and then tap *Accept*. The note is stored with the current record. In *Review job*, the note appears below the record with the note icon.

Editing target/antenna records using Review job

Select *Review job* to edit existing antenna or target height records. These edits change the antenna or target height for all observations using that antenna or target height.

To edit a target/antenna record:

1. Tap the target/antenna record. The current target (conventional survey) or antenna (GNSS survey) details appear.
2. Enter the new details and then tap *Accept*.

The current record is updated with the new details, which apply to all subsequent observations using that record.

A note with a timestamp is attached to the record. This note documents the old details, including when the changes were made.

Editing target/antenna records using Point manager

Use [Point manager](#) to easily change the target or antenna height of a single observation or any number of observations.

Editing codes using Review job

If you have only a single code to edit, you can use *Review job*.

To edit a code:

1. From the main menu, tap *Jobs / Review job*.
2. Tap the observation record that contains the code you want to edit.
3. Change the code and then tap *Accept* to store the changes.

The Note stored with the observation is a record of the old code and the date and time it was modified.

Editing codes using Point Manager

You can use *Point manager* to edit single or multiple codes.

When you edit multiple codes, the *Point manager* is easier to use than *Review job*.

For more information, see [Point manager](#).

Editing point names and point coordinates using Point Manager

You can use [Point manager](#) to edit point names or point coordinates.

You cannot edit point names and point coordinates using *Review job*.

Deleted points, lines, and arcs



A deleted point, line, or arc is not used in calculations, but it is still in the database. Deleting points, lines, or arcs does not make a job file smaller.

When you transfer a file that contains deleted points, the deleted points are not transferred to the office software. If you transfer a file using the Trimble Data Transfer utility, however, the deleted points are recorded in the Data Collector (.dc) file. They have a classification of Deleted.

Some points, such as continuous offset points and some intersection and offset points, are stored as vectors from a source point. If you delete a source point, any point stored as a vector from that point has null (?) coordinates when you review the database point record.

To delete a point, line, or arc in the General Survey database:

1. From the main menu, tap *Jobs / Review job*.
2. Highlight the point, line, or arc to be deleted and tap *Details*.
3. Tap *Delete*. For points, the search class changes to Deleted (normal), Deleted (control), Deleted (staked), Deleted (backsight), or Deleted (check), depending on the original search classification.
4. Tap *Accept*. The General Survey software records a note with the original point, line, or arc record, showing the time it was deleted.

When you delete a point, line, or arc, the point symbol changes. For example, for a topo point, the  symbol replaces the  symbol.

When you delete an observation that has been recorded during a [Station setup plus](#), a [Resection](#), or [Measure rounds](#) operation, the mean turned angle records and station or round residuals records will not be updated. Deleting an observation that has been used to compute an average does not automatically update the average. Use *COGO / Compute average* to recompute the average.

Tips

To delete features from the *Map* screen:

You cannot delete points from a linked file.

Use Explorer to delete alignment files, road files, map files, or any other file type stored on the controller.

Note - You cannot delete points, lines or arcs from a linked map file (for example, a DXF or SHP file).

To restore a point, line, or arc in the General Survey database:

1. From the main menu, tap *Jobs / Review job*.
2. Tap the point, line, or arc record to be restored.
3. Tap *Undelete*.
4. Tap *Accept*.

Point Manager

As an alternative to *Review job*, use the *Point manager* to manage your data.

You can easily review:

- Point coordinates
- Observations
- The **best point** and all duplicate points
- Target and antenna heights
- Codes and notes
- Descriptions
- Notes

You can easily edit:

- Target and antenna heights (single or **multiple**)
- **Point names**
- **Point coordinates**
- Codes (single or **multiple**)
- Descriptions (single or multiple)
- Notes

Using Point manager

To open *Point manager*, select *Jobs / Point manager* from the main menu. The screen that appears shows a tabulated tree structure of all points and observations in the job database and linked files.

Viewing the data

When there are duplicate points of the same name, the best point always appears first. All occurrences of points of the same name, including the best point, appear in a list below the best point.

However, when the data is in the *Target height* view, all observations in the database appear in the order that they occur in the database.

To change the view of the data, select *Display*. For example, to view coordinates, set *Display* to Grid; to view or edit target heights, set *Display* to Target height.

Note - In *Point manager*, the *Target height* setting refers to both antenna height and target height.


To sort the data, tap the column heading.

To change the width of the column, or to hide the column, tap and drag the separator between headings.

To shrink an empty column double tap the separator to the right of the column.

Use the scroll bars to scroll horizontally or vertically through the data.

Tip - To freeze the Point name column, tap and hold the Point name column heading. To unfreeze the column, tap and hold the heading again.


To filter the displayed information using wildcard matching, tap . The screen that appears contains *Point name*, *Code*, and *Note* fields and, if enabled, two *Description* fields.

To filter the fields appropriately, use * (for multiple characters) and ? (for a single character). The filters specified for the separate fields are processed together and only points that meet the criteria of all the filters will appear. Use * in any field that you do not want to filter. Filtering is not case sensitive.

Filter examples:

Point name	Code	Descr. 1	Descr. 2	Note	Example results
1	*	*	*	*	1, 10, 2001, 1a
1*	*	*	*	*	1, 10, 1a
1?	*	*	*	*	10, 1a
1	Fence	*	*	*	All points with a name that contains a 1 and where code = Fence
1	*Fence*	*	*	*	All points with a name that contains a 1 and a code that contains Fence
1???	*	*	*	wrong*	All points with a name that starts with 1 and is 4 characters long and a note that starts with wrong
*	Tree	Aspen	25	*	All points where code = tree and Description 1 = Aspen and Description 2 = 25

To disable the filter, tap *Reset*, or set all fields to *.

Filter settings are remembered, but are not applied if Point manger is closed. To reactivate the filter, tap  and then tap *Accept*.

Note - To see a complete list of the icons and their descriptions used in the General Survey software see the [filter table](#).

To view more information on a point do one of the following:

- To reveal all associated points and observations, tap + to expand the point tree list. Expand the subtree to view individual point information. These records can include the point coordinates, observations, antenna or target details, and quality control records.
- To open the same point form as seen in *Review job*, tap a point, or highlight a point and tap *Details*. This allows you to edit information such as the point code and attributes.

To change the format of the indented coordinates or the observations that appear when you expand the point tree, tap the coordinates or observations displayed, or highlight them and press the space key. In the list that

appears, select the new data view.

This allows you to review the raw conventional observations (or WGS-84 observations) and the Grid coordinates at the same time.

Using Grid (local) in the Point manager

You can use Point manager to view Grid (local) coordinates using the input transformation or a display transformation.

To do this:

1. From the main menu, tap *Jobs / Point manager*.
2. Tap *Display* and then select *Grid (local)*.
3. To select the Grid (local) transformation for coordinate display, or to create a transformation, select *Options*.
4. Do one of the following:
 - ◆ To view the original Grid (local) values, select *Display original grid local* and then tap *Accept*.
 - ◆ To create a new display transformation, select *Create new transformation*, tap *Next* and then complete the [required steps](#).
 - ◆ To select an existing display transformation, select *Select transformation*, select the display transformation from the list and then tap *Accept*.

Notes

- ◆ The 'input' transformation transforms a point from the original entered Grid (local) coordinates to database grid coordinates.
The 'display' transformation transforms a point, regardless of how it was stored, from the database grid coordinates to display computed Grid (local) coordinates.
- ◆ When viewing the original Grid (local), points not stored as Grid (local) appear as null North (local), East (local), and Elev (local).
- ◆ When you select a display transformation, all database grid points appear using the current display transformation. If the display transformation is different from the original transformation, the computed Grid (local) coordinates are different from the original entered Grid (local) coordinates.
- ◆ A point entered as a Grid (local) point is stored in its original format to the General Survey job as a Grid (local) point. Typically, the input transformation to transform the point to a database grid point is assigned at the time the point is entered, but the transformation can be created at a later stage and then [assigned](#) to the point(s) using Point manager.

To change the input transformation:

1. From the main menu, tap *Jobs / Point manager*.
2. Tap *Display* and then select *Grid (local)*.
3. Highlight the point(s) stored as Grid (local) whose input transformation you need to change.
4. Tap *Edit* and then select *Transformations*.
5. Select the new transformation and then tap *OK*.

The new transformation is now used to transform the Grid (local) to database grid.

If the current view showed the original Grid (local), changing the input transformation does not change the Grid (local) coordinates displayed.

If the current view showed a different display transformation, changing the input transformation also changes the Grid (local) coordinates displayed.

Reviewing and editing antenna and target heights

Note - In *Point manager*, the *Target height* setting refers to conventional target heights and the GNSS antenna heights.

To change a target height record and update **all** observations using that target height record, edit the target height in [Review job](#).

To change an individual target height, or group of target heights, in *Point manager*:

1. From the main menu, tap *Jobs / Point manager*.
2. Tap *Display* and then select *Target height*. In the screen that appears, the point name, from point, target height, code, and note are listed in the order they exist in the database.

- To change the record order, tap the appropriate column heading.
- To filter the list, tap *Filter*, select the appropriate column and then enter the filter details.

Tip - If you enter a filter value of 2 for a point name, the system will show all points with 2 in their name, including 2, 1002, 2099, or 2day. To filter for a point name "2", select the Match whole word check box.

3. To select a target or multiple targets for editing, do one of the following:
 - Tap the *Target* field.
 - Use the arrow keys to highlight the record to edit and then tap *Edit*.
 - To select multiple fields, press and hold *Ctrl* and then tap the required fields. Then tap *Edit*.
 - To select a range of fields, tap the first required field, press and hold *Shift* and then tap the last required field. Then tap *Edit*.
4. In the *Target details* form enter the new *Target height* and/or *Prism constant*. To store the changes, tap *OK*.

When measuring to the bottom notch on a [Trimble prism base](#), tap the advanced pop-up arrow () and then select *Bottom notch*.

Point manager now displays the corrected target details. In *Review job*, view the inserted target records with notes that record the old target details.

Group editing Target heights (conventional) and Antenna heights (GNSS)

You can use the *Point manager* to edit details of antenna heights or target heights for multiple-selected points. This function is available when the *Display* softkey setting in the *Point manager* is set to *Target*

height. Use the standard Windows selection methods of *Ctrl-click* and *Shift-click* to choose the points to apply the target or antenna height edits to.

- When you edit antenna heights, you can edit the measured heights and the measurement method.
- When you edit target heights, you can edit the measured target height value, the measurement method (when applicable), and the prism constant.
- When you select points to edit, you can include points with target heights and points with antenna heights. When you tap *Edit*, two dialogs appear - one to edit antenna heights and one to edit target heights.
- You do not need to select contiguous target and/or antenna heights to edit.
- You cannot edit a selection of antenna heights that includes more than one type of antenna. In this case, select and edit the points in separate groups, according to the type of antenna used.
- You can edit a selection of different targets. In such a case, the new target heights are applied to each of the different targets but the target numbers remain unchanged.
- Some conventional measurements use calculated (system) targets, which have a zero height and zero prism constants, for example, Dual-prism offset. You cannot edit the target heights for system targets.
- You can sort *Point manager* columns to help you find and select groups of target or antenna heights to edit. Tap the column heading to sort that column.
- The *Point manager* automatically inserts the appropriate target and antenna equipment records into the job database to ensure that the correct heights and measurement methods are assigned to each point.
- When you edit points, the *Point manager* automatically inserts notes into the job database to record what was edited, the original measurement data, and the time of the edit.

Editing Point Coordinates using Point manager

You can use the *Point manager* to edit the coordinates of imported or keyed in points.

To edit the coordinates of a point:

1. From the main menu, tap *Jobs / Point manager*.
2. To select the record to edit, tap and hold the stylus on the record.
3. Tap *Edit* and then select *Coordinates*.
4. Edit the coordinates and then tap *OK* to save the changes.

You cannot edit the coordinates of:

- raw observations
- points in linked files
- a range of records at one time

A record of the changes made are saved to the *Note* record.

Renaming point names using Point manager

You can use the *Point manager* to edit the names of points and observations.

To rename a point or observation:

1. From the main menu, tap *Jobs / Point manager*.
2. To select the record to edit, tap and hold the stylus on the record.
3. Tap *Edit* and then select *Point names*.
4. Edit the name and then tap *OK* to save the changes.

You cannot edit the name of

- points in linked files
- an observation to the current station if a survey is running
- a backsight observation

A record of the changes made are saved to the *Note* record.

Editing point names and point coordinates in a dynamic database

The General Survey software uses a dynamic database. If you change the name or coordinates of a record, the positions of other records that rely on that record could change or disappear.

The rest of this section describes how changes to a base station position, station setup, or backsight position can affect other positions. In addition to these record types, changes to resections, lines, arcs, compute inverse records, and others may also affect other positions. For more details on specific records that may change, see the table below.

If you rename a point name that is used as a base in a GNSS survey, or as a station setup point in a conventional survey, this does not rename the point name that is referenced in the Base record or Station setup record. You cannot edit the point name referenced in the Base record or Station setup record in any way.

If you rename the base position or station setup position, and another record with the same name **does not** exist, then the positions of all records that are computed from that base position or station setup position cannot be computed, and those records will no longer be displayed in the map.

If you rename the base position or station setup position, and another record with the same name **does** exist, then the positions of all records that are computed from that base position or station setup position may change, as they will now be computed from the next best point with the same name.

If you edit the base position or station setup position, then the positions of all records that are computed from that base position or station setup position will change.

If you edit the azimuth in an a station setup with a keyed-in azimuth to the backsight, then the positions of all records that are computed from that station setup will change.

If you edit or rename the point record that is used as a backsight in a station setup with a computed azimuth to the backsight, then the positions of all records that are computed from that station setup may change.

If you select a range of records and change their name, all the selected records are renamed to the new name that you entered.

If you rename or edit the coordinates of points, all records that contain computed deltas to other points, for example as-staked, check, and backsight observations, are not updated.

In the following table, the * symbol against a record type shows the dynamic database records that may change if the name or the coordinates of the record that was used to derive their position is modified.

Record	Names	Coordinates
Topo points (GNSS)	*	*
Rapid points	*	*
FastStatic points	*	*
Observed control points	*	*
F1 Topo points (Conv.)	*	*
F2 Topo points (Conv.)	*	*
Mean turned angle	*	*
As-staked points	*	*
Check points	*	*
Continuous points	*	*
Construction points	*	*
Laser points	*	*
Lines	*	*
Arcs	*	*
Compute inverse	*	*
Resection points	-	-
Adjusted points	-	-
Averaged points	-	-
Cogo points (computed) (see note below)	* 1	* 1
Intersection points	-	-
Offset points	-	-
Roads	-	-
Alignments	-	-
Tunnels	-	-
Calibration points	-	-
Compute area	-	-

1 - Cogo points can change if the point they are computed from is modified, but it depends on how the Cogo points were stored. If they were stored as a vector, for example Az HD VD and the base point is moved, then the Cogo point will also move.

Adding or editing codes using Point manager

To enter a code or change an existing code, tap the *Code* field. Enter the code details, and the attributes, if required. Tap *Accept* to store the changes.

Group editing codes using Point Manager

You can use the *Point manager* to edit code details for more than one point at a time.

1. Use the standard Windows selection methods; press **Ctrl** or **Shift** and tap the records for which you want to change the code.
2. Tap *Edit* and then select *Codes*.
3. Enter the new code and then tap *Enter*.

If the code has attributes, you are prompted to enter them.

The new codes are updated and displayed in the *Point manager*. A note with the old code value is stored for each modified record.

Tip - You can edit Descriptions in the same way.

Adding or editing notes using Point manager

To enter a note or change an existing note, tap the *Note* field. Enter the note details and then tap *Accept* to store the changes.

Map

The *Map* screen is a graphical representation of features from multiple sources:

- points, lines, and arcs from the current job database
- points, lines, and arcs from linked jobs and linked CSV files
- points, lines, arcs, polylines, and other map entities from [map files](#) (for example DXF and SHP files)
- alignments defined as .rxl files
- Trimble roads defined as .rxl files
- surfaces (TTM and LandXML files)
- images from georeferenced background image files. The following image file types and associated world files are supported:

Note - Only Bitmap, JPEG, and PNG files with an associated world file are available for selection.

Tips

- ◆ If you have a Survey-Advanced license, you can export JPEG georeferenced image files from Trimble Business Center using [Image / Capture image]. Trimble Business Center enables large files to be reduced in size for improved performance on the controller.
- ◆ More memory is required to load a BMP file than is required to load a DXF file, and JPEG/PNG files are a compressed format file that requires more memory again when they are

uncompressed and loaded into memory.

To compare the memory required to load a BMP file to a DXF file, multiple the BMP file size by four; so a 850 KB BMP file uses 3.4 MB of memory.

To compare the memory required to load a JPEG/PNG file to a DXF file, multiple the JPEG/PNG image height by width multiplied by four; for example if a 130 KB image is 1024 pixels wide by 768 pixels high ($1024 \times 768 \times 4 = 3.14$ MB), and so would require 3.14 MB of memory to load the file.

Note - Rotated images are not supported.

Use the following links to learn more about using the map:

- [Accessing the map](#)
- [Using the map softkeys and options](#)
 - ◆ [Zoom previous and zoom default](#)
 - ◆ [Widescreen mode](#)
 - ◆ [Point type filtering](#)
- [Selecting a feature in the map](#)
- [Deselecting a feature in the map](#)
- [Tap and hold shortcut menu](#)
 - ◆ [Current job](#)
 - ◆ [Linked file or Active map](#)
- [Autopan](#)
- [Linked files \(.csv .txt .job\)](#)
 - ◆ [Transferring linked files](#)
 - ◆ [Stakeout points from a linked file](#)
- [Active map](#)
 - ◆ [Layers and selectability](#)
 - ◆ [Colors in the map](#)
 - ◆ [Transferring and selecting maps](#)
 - ◆ [Notes on active maps, including supported map entity types](#)

To access the *Map* screen:

1. Tap *Map*. The current position of the GNSS antenna is displayed as a vertical/horizontal cross. The current orientation of a conventional instrument is shown by a dotted line extending from the instrument to the end of the screen. The location of the prism is shown as a cross when a distance is measured.
2. Tap *Map*. The current position of the GNSS antenna is displayed as a vertical/horizontal cross.
3. Use the [map softkeys](#) to navigate around the map.

If there is a point with the same name as another point in the database, the point with the higher search class is displayed. For more information about how the General Survey software uses search classes, see [Database search rules](#).

Notes

- Only grid coordinates are displayed. If you have not defined a projection, only points stored as grid coordinates appear.
- [Grid \(local\) coordinates](#) cannot be displayed if the input transformation was not defined.
- If the *Grid coords* field in the [Cogo settings](#) screen is set to Increase South-West or Increase South-East, the map display is rotated by 180° such that increasing south coordinates are displayed up the screen.





Map Softkeys

Use the map softkeys to:

- navigate around the map
- change the map display options

Some softkeys can operate in an "active" mode. The effect of tapping on the map depends on the active softkey selected.

The functions are described in the following table:

Softkey	Function
	Tap this softkey to zoom in. Tap and hold the softkey to make it active. Tap the area of the map to zoom in on, or drag to create a box around the area of interest.
	Tap this softkey to zoom out. Tap and hold the softkey to make it active. Tap the area of the map to zoom out from.
	Tap this softkey to shift the center of the map area to another part of the map. Tap the softkey to make it active. Tap an area of the map to center on, or tap and drag the map area to where you want to pan.
	Tap this softkey to show all features on the screen. Tap the softkey to make it active.

Click the up arrow to access more softkey functions. The additional functions are described in the following table.

<i>Filter</i>	Shows a legend for the feature symbols and lets you choose which features are displayed.
<i>Pan to</i>	Displays the <i>Pan to point</i> screen. Enter a point name and scale value.
<i>Options</i>	Controls how name or code labels appear next to points in the map, including the label color.
	Controls the options to display road and alignment station values.
	Controls the option to display elevations in the map.
	Controls the options to display the points symbols and coded features for each point. If the <i>Display coded features</i> check box is selected, General Survey software draws lines between points that have feature codes with the <i>Feature type</i> configured to <i>Line</i> . When you create or edit a feature code, set the <i>Feature type</i> to <i>Line</i> and specify a <i>Line style</i> .
	Controls the option to display points from the stakeout list in the map. To do this, set the

	<p><i>Display stakeout list</i> points field to Yes.</p> <p>Controls the Automatic pan to your current position option.</p> <p>Controls the option to automatically start a measurement when you press the measure key.</p> <p>Controls the option to hatch polygons in a background file.</p> <p>Controls the option to display the map in Widescreen mode.</p> <p>Controls the option to display surfaces with a color gradient.</p> <p>Controls the option to display surface triangles.</p> <p>Enables a vertical offset to be specified that raises or lowers the surface when viewing from the map.</p>
<i>Layers</i>	<p>Controls the display of one or more active map files or layers.</p> <p>Controls the selectability of one or more active map files or layers.</p> <p>Controls the display and selectability of alignment files.</p> <p>Controls the display and selectability of Trimble road files.</p> <p>Controls the display and stake-ability of digital terrain models.</p>

To explode polylines into individual line and arc segments, enable the *Explode polylines* check box in *Map / Layers / Options*.

Zoom previous and Zoom default

In the map view, tap and hold the map softkey to display more navigation options:

- Zoom to the previous view
- Zoom to a default scale and location
- Set a default scale and location

Widescreen mode

The map appears in widescreen mode across the entire width of the screen.

To access the status bar while the map is in widescreen mode, tap the arrow on the far right of the map. The status bar appears for approximately three seconds, after which time the map returns to widescreen.

To change the widescreen mode, do one of the following:

- Tap and hold in the map window and then select *Widescreen*
- Tap *Options* within the map screen and then select the *Widescreen* setting
- Press the '.' key on the controller

Using the Map for Common Tasks

To select a feature from the map, do one of the following:

- Tap the required feature(s) from the map area. If there is more than one feature in the highlighted area, a list of features in this area appears. Select the features as required and then tap *OK* to return to the map.

Tip - When selecting a line, arc, or polyline to stakeout, tap near the end of the line, arc, or polyline that you want to designate as the start. Arrows are then drawn on the line, arc, or polyline to indicate the direction.

If the direction of the line, arc or polyline is incorrect, tap the line, arc or polyline to deselect it and then tap it at the correct end to reselect the direction required.

The direction of Alignments and Trimble roads is defined when they are created, and cannot be changed.

Note - The offset directions are not swapped when the line direction is reversed.

- Drag a box around the features you want to select.

When multiple features are selected in this way they are typically sorted in the order in which they are stored in the database. If the order of the entities in the selection is important, you should select them one by one.

To select a feature from a map file, the map file or layers must be made selectable.

To deselect a feature from the map, do one of the following:

- Tap the selected feature to deselect it. If there is more than one feature within the highlighted area, a list of features within this area appears. Deselect the features as required. Tap *OK* to return to the map.
- Tap and hold on the map and select *List selection* from the shortcut menu. A list of the selected features appears. Deselect the features as required.
- To clear the entire selection, double-tap off the selected features. Alternatively, tap and hold on the map and select *Clear selection* from the shortcut menu.

To carry out a task using the selected feature(s), do one of the following:

- Measure
 - ◆ If there are no features selected, tap *Measure* to measure the current position.

Tip - To change the code and/or descriptions when using *Measure* from the map, select a point in the map whose settings you want to be the default, tap and hold on the map briefly and then select *Set point details*.

Alternatively, if you want to change defaults values, but do not want to use the default from an existing point, make sure that there are no features selected before you set point details.
- Stakeout
 - ◆ If one or more features are selected, tap *Stakeout* to stake out the selected feature(s). If more than one point is selected, the points are added to the *Stake out points* list, from where you can select them for stakeout.

- ◆ If more than one line or arc is selected, the first item selected is the one used for stakeout.
- ◆ Double-tap a feature to stake out.
If there is more than one feature within the highlighted area, a list of features within this area appears. Select the feature to stake out.

Tip - If two points are selected, tap and hold on the map and then select *Stake out line* to stake a line defined by the two selected points.

If the selection contains different feature types (points, lines, arcs), only features of the first type selected can be staked out from the map. To stake out other feature types, clear the selection then reselect the other features.

Setting default point details

Tap and hold briefly on the map and then select *Set point details* from the menu.

Use *Set point details* to set the *Next point name*, *Code*, and *Description 1 and Description 2* (if enabled) that will be used as the defaults the next time you measure a point.

If you select a single point in the map when you select *Set point details*, the next available point name, and the code and descriptions of the selected point, become the defaults.

Tap and hold shortcut menu in the map

Tap and hold on the map area to access a shortcut menu. The shortcut menu provides quick access to common tasks. The tasks depend on the number and type of features selected.

In the following table, the * symbol against a task shows that you can access it through the shortcut menu for the feature at the top of that column.

Tap and hold menu options that are available for features in the current job:

Task	Feature					
	No Features	One point	Two points	Three or more points	Line	Arc
Review	-	*	*	*	*	*
List section	-	*	*	*	*	*
Clear section	-	*	*	*	*	*
Widescreen	*	*	*	*	*	*
Delete	-	*	*	*	*	*
Stake out point	-	*	*	*	-	-
Measure calibration point	-	*	-	-	-	-
Navigate to point	-	*	-	-	-	-
Turn to	*	*	-	-	-	-
Compute inverse	-	-	*	*	-	-

Key in point	*	-	-	-	-	-
Store tunnel	-	-	*	*	*	*
Set point details	*	*	-	-	-	-
Check backsight	*	-	-	-	-	-
Check shot	-	*	-	-	-	-

Tap and hold menu options that are available for features in a linked file or active map file:

Task	Feature							
	One active map or linked file point	Two active map or linked file points	Three or more active map or linked file points	Active map line	Active map arc	Active map polyline	Alignment	Trimble road
Review	*	*	*	*	*	*	*	*
List section	*	*	*	*	*	*	*	*
Clear section	*	*	*	*	*	*	*	*
Widescreen	*	*	*	*	*	*	*	*
Delete	-	-	-	-	-	-	-	-
Stake out point	*	*	*	-	-	-	-	-
Stake out line	-	*	-	*	-	-	-	-
Stake out arc	-	-	-	-	*	-	-	-
Create/Stakeout alignment	-	*	*	*	*	*	*	*
Stake out alignment	-	*	*	*	*	*	*	*
Measure calibration point	*	-	-	-	-	-	-	-
Navigate to point	*	-	-	-	-	-	-	-
Turn to	*	-	-	-	-	-	-	-
Compute inverse	-	*	*	-	-	-	-	-
Area calculations	-	-	*	*	*	*	-	-
Subdivide a line	-	-	-	-	-	-	-	-
Subdivide an arc	-	-	-	-	-	-	-	-
Key in point	-	-	-	-	-	-	-	-
Key in line	-	*	-	-	-	-	-	-
Key in arc: 3 points	-	-	*	-	-	-	-	-
Key in arc: 2 points + center	-	-	*	-	-	-	-	-
Set point details	*	-	-	-	-	-	-	-

Check backsight	*	-	-	-	-	-	-	-
Check shot	-	-	-	-	-	-	-	-

Notes

- If you select a point with the same name as another point in the database, then select the *Review* or *Delete* option from the shortcut menu, a list of the duplicate points appears. Select the point you want to review or delete.
- Field fill-in. Enter feature names into fields by selecting from the map. Select the feature(s) from the map then select a survey function, such as Cogo or Stakeout. The selected feature(s) are automatically entered into the appropriate fields.
- Map selection list. The *Map selections option* is available on the right side of the feature name field when you have selected features from the map. Tap it to access the list of the selected features. Only features that are specific to the field are shown.
- You cannot use General Survey to delete points from linked files. Points from linked files do not appear in the *Review* screen list of deleteable points.
- Turn to is available in a conventional survey when a station setup has been completed, and no points are selected. When chosen it turns to the position where the stylus tapped on the screen.
- *Check backsight* and *Check shot* options from the map are available only in conventional surveys.

Select points

From the tap and hold menu in the map, use the *Select* option to select points from the current job as well as points in files linked to the current job.

Select from

Use the *Select from* menu to specify where to select the points from. Options are from the Current job, Current job and linked files, or Scan files.


Scan files list any scan files (*.tsf) created in the current job using the Scanning option and the Trimble VX spatial station. You can select multiple scan files.

Notes

- You can select scan files only when the current job has scan data associated with it.
- Use the *Select* softkey to edit the list of selected scan files; use the *Reset* softkey to deselect all scan files.

To select points from the current job or the current job and linked files, define your selection using any combination of the following fields: Point name or Point range, Code, Description 1, Description 2, Minimum elevation, and Maximum elevation.

Notes

- Use the advanced pop-up arrow () to toggle between the Point name field and the point range (From point, To point) fields.
- Use wildcards in these fields to make multiple selections. Use * for multiple characters, and ? for a single character.
- If points are already selected, an *Append to current selection* check box appears on screen. Clear this option if you want to overwrite the current selection.
- Use the *Reset* softkey to clear all selection criteria from the fields.
- Any point selections made in the *Select* screen can be edited in the map view.

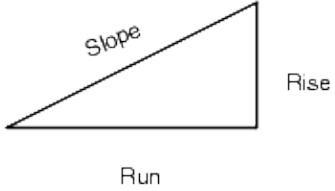
Units

To configure the Units, tap *Jobs / Properties of job / Units* and change the fields as required.

Tip - In some fields (for example, *Azimuth*), you can enter a value in units other than the system units. The *Units* softkey appears in these fields. When you tap *Enter* to accept the field, the value is converted to the system units.

Use *Units* to configure the display of the following settings:

This setting	Specifies how the following values are displayed
Distance and grid coords	Distance and Northing/Easting coordinates
Height	Height and elevation
Distance display	The number of decimal places in all distance fields
Coordinate display	The number of decimal places in all Northing/Easting coordinate fields
Angles	Angles
Azimuth format	Azimuths
Lat / Long	Latitude and longitude
Temperature	Temperature
Pressure	Pressure
Coordinate order	Coordinates The order for the displayed grid coordinates can be set to: - North-East-Elev - East-North-Elev - Y-X-Z (equivalent to East-North-Elev - field prompts changed) - X-Y-Z (equivalent to North-East-Elev - field prompts changed) For the Y-X-Z and X-Y-Z options, the convention used defines that the Y axis is the East axis and the X axis is the North axis.
Station display (also known as Chainage in some countries) This defines the	Station The station values can be displayed as either: - 1000.0 where the values are displayed as entered - 10+00.0 where the + separates the hundreds from the remaining values - 1+000.0 where the + separates the thousands from the remaining values

distance along a line, arc, alignment, road or tunnel.	<p>- <i>Station index</i></p> <p>The <i>Station index</i> display type uses an extra <i>Station index increment</i> field value as part of its definition. The station value is displayed as per the 10+00.0 option, but the value before the + is the station value divided by the <i>Station index increment</i>. The remainder is displayed after the +. For example if the <i>Station index increment</i> is set to 20, a station value of 42.0 m is displayed as 2 + 02.0 m. This display option is used in Brazil but may have application in other markets.</p>
Grade	<p>Grade</p> <p>The grade of a slope can be displayed as an angle, percent, or ratio.</p> <p>The ratio can be displayed as <i>Rise:Run</i> or <i>Run:Rise</i>.</p> 
Area	<p>Supported area units include:</p> <ul style="list-style-type: none"> - Square meters - Square miles - Square international feet - Square US survey feet - Acres - Hectares
Laser VA display	<p>Laser Vertical angles</p> <p>Can be vertical angles measured from the zenith, or inclinations measured from horizontal.</p>
Time format	Time

Cogo Settings

To configure the Cogo settings, tap *Job / New job / Cogo settings* when creating a new job. For an existing job tap *Job / Properties of job / Cogo settings*.

Use *Cogo settings* to configure:

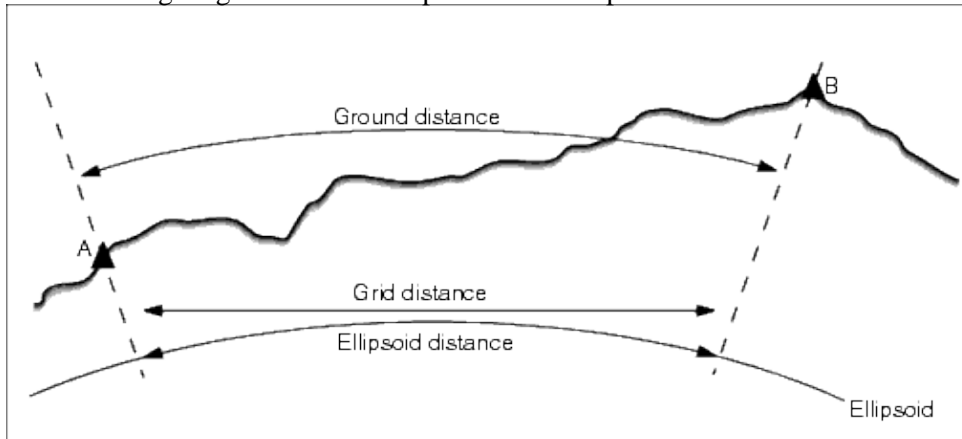
- [Distance display](#) (grid, ground, or ellipsoid)
- [Sea level \(ellipsoid\) correction](#)
- [Increasing grid coordinate direction](#)
- [South azimuth](#)
- [Neighborhood adjustment and weight exponent](#)
- [Magnetic declination](#)
- [Advanced Geodetic](#)
- [Averaging](#)

Distance Display

The *Distances* field defines how distances are displayed and which distances are used for calculations in the General Survey software. Select one of the following options:

- Ground (the default setting)
- Ellipsoid
- Grid

The following diagram shows the options between points A and B.



Ground distance

A ground distance is the horizontal distance calculated between the two points at the mean elevation parallel to the chosen ellipsoid.

If an ellipsoid has been defined in the job and the *Distances* field is set to *Ground*, the distance is calculated parallel to that. If no ellipsoid has been defined, the WGS84 ellipsoid is used.

Ellipsoid distance

If the *Distances* field is set to *Ellipsoid* then a correction is applied and all distances are calculated as if on the local ellipsoid, which usually approximates to sea level. If no ellipsoid has been specified, the WGS84 ellipsoid is used.

Note - If the coordinate system for a job is defined as *Scale factor only*, ellipsoid distances cannot be displayed.

Grid distance

If the *Distances* field is set to *Grid*, the grid distance between two points is displayed. This is the simple trigonometrically distance between the two sets of two-dimensional coordinates. If the coordinate system for the job is defined as *Scale factor only*, and the *Distances* field is set to *Grid*, the General Survey software displays ground distances multiplied by the scale factor.

Note - A grid distance between two measured GNSS points cannot be displayed unless you have specified a datum transformation and a projection, or performed a site calibration.

When you select *Scale factor only* in a conventional instrument only survey, grid and ground distances can be displayed.

Curvature Correction

In the General Survey system, all ellipsoid and ground distances are parallel to the ellipsoid.

Sea level (ellipsoid) correction

The *Sea level (ellipsoid) correction* check box enables you to choose whether or not the horizontal components of distances measured with a conventional total station should be corrected to their equivalent length on the ellipsoid.

In most case, select the *Sea level (ellipsoid) correction* check box to compute the correct geodetic grid coordinates from the total station observations.

However, if the local ellipsoid was inflated to provide computed ground coordinates, but the point heights were not changed to be in terms of the inflated ellipsoid, do not select sea level correction; for example, when using jobs with Minnesota county coordinate systems.

The sea level correction is carried out using the average height (not elevation) of the line above the local ellipsoid. If both ends of the line have null heights, the default height specified for the job is used to compute this correction.

The formula used for the computation is:

$$\text{Ellipsoid horizontal distance} = \text{HzDist} \times \text{Radius} / (\text{Radius} + \text{AvHt})$$

HzDist	Horizontal component of measured distance
Radius	Ellipsoid semi-major axis
AvHt	Average height above local ellipsoid of the measured line

Notes

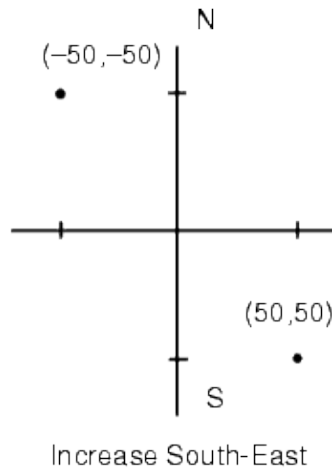
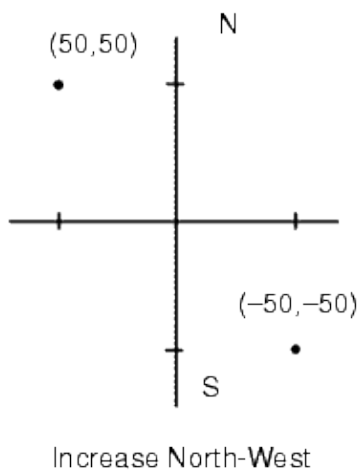
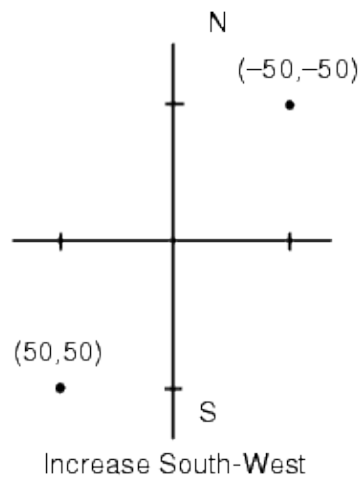
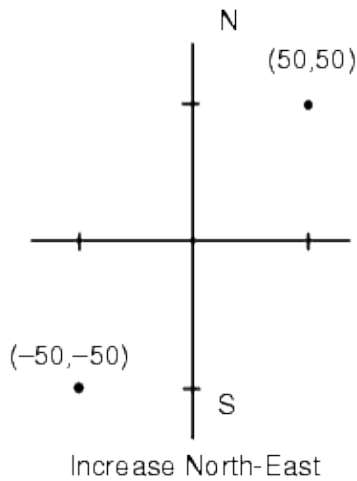
- In jobs where the coordinate system is configured to provide ground coordinates, the *Sea level (ellipsoid) correction* is always enabled and cannot be edited. This is because the sea level correction is already applied in the computation of the ground coordinates.
- In a Scale only job, there is no local ellipsoid available because this is not a geodetic projection. In this case, the correction computation defaults to using the semi-major axis of the WGS84 ellipsoid (6378137.0 m) as the radius value. The sea level correction in Scale only jobs also uses the point elevations because there are no ellipsoidal heights available.
- You cannot set a default height for Scale only jobs. This means that if the *Sea level (ellipsoid) correction* is enabled in a Scale only job, you must use 3D points, or null coordinates will be computed because it is not possible to compute the sea level correction.

Grid Coordinates

Use the *Grid coords* field to set the grid coordinates to increase in one of the following sets of directions:

- north and east
- south and west
- north and west
- south and east

The following diagram shows the effect of each setting.

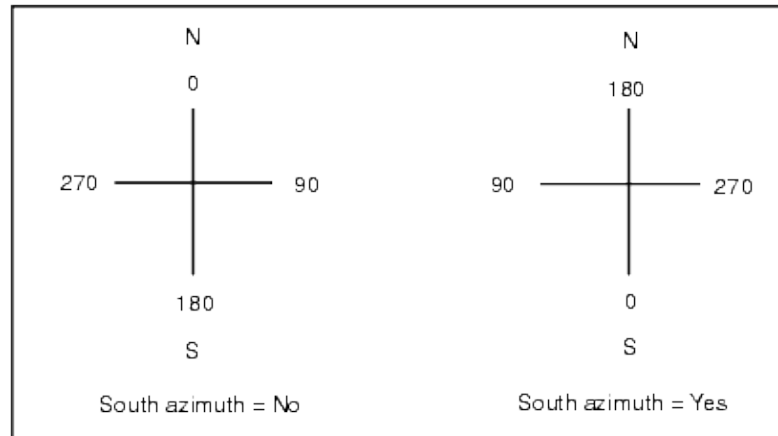


Azimuth Display

The azimuth displayed and used by the General Survey software depends on the coordinate system that you defined for the current job:

- If you defined both a datum transformation and a projection, or if you selected *Scale factor only* , the grid azimuth is displayed.
- If you defined both a datum transformation and a projection, the grid azimuth is displayed.
- If you defined no datum transformation and/or no projection, the best available azimuth is displayed. A grid azimuth is the first choice, then a local ellipsoidal azimuth, then the WGS84 ellipsoid azimuth.
- If you are using a laser rangefinder, the magnetic azimuth is displayed.

If a south azimuth display is required, set the *South azimuth* field to *Yes*. All azimuths still increase clockwise. The following diagram shows the effect of setting the *South azimuth* fields to No or Yes.



Neighborhood adjustment

You can apply a *Neighborhood adjustment* to all conventional foresight observations made from a Station setup plus or Resection, and to all GPS observations made in a job that has a valid GPS site calibration. To apply Neighborhood adjustment, select the check box in *Properties of job / Cogo settings*.

Neighborhood adjustment uses the residuals from *Station setup plus*, *Resection* or *GNSS site calibration* to calculate delta grid values to apply to subsequent observations made during the survey. Each observation is adjusted according to its distance from each of the backsight points (for a conventional survey) or calibration points (for a GNSS survey). The following formula is used to calculate the weight to give the residuals of each backsight or calibration point:

$$p = 1/D^n \text{ where:}$$

- p is the weight of the backsight or calibration point
- D is the distance to the backsight or calibration point
- n is the weight exponent

A weighted average is then computed and the resulting delta values are applied to each new observation to get an adjusted grid position.

Note - A high value for the weight exponent results in low impact (weight) of distant backsight or calibration points.

For *Neighborhood adjustment* to be applied, the station setup or calibration must have at least 3 known points with 2D grid residuals. That is, if you perform a:

- Station setup plus, you must have HA VA SD observations to at least 2 backsight points, each with known 2D coordinates.
- Resection, you must have HA VA SD observations to at least 3 backsight points, each with known 2D coordinates.
- Calibration, you must have GNSS observations to at least 3 control points, each with known 2D coordinates.

Notes

- Neighborhood adjustment will use a *GNSS site calibration* only if it has been observed in the current General Survey job. This is because a GNSS calibration that is part of the coordinate system in an uploaded job does not include the GNSS calibration residuals.
- For *Station setup plus*, the known station coordinate is included in the neighborhood adjustment calculation. In the calculation, the station coordinate is given grid residuals of zero.
- Neighborhood adjustment is a 2D-only adjustment. Any vertical residuals from station setup or calibration are not used in the neighborhood adjustment calculations.
- Neighborhood adjustment using GNSS site calibration residuals is applied to all WGS84 points in the job, not just GNSS observations.

Warning - Make sure that the backsight or calibration points are around the perimeter of the site. Do not survey outside the area enclosed by the backsight or calibration points (and for Station setup plus, the station point). The neighborhood adjustment is not valid beyond this perimeter.

Magnetic Declination

Set the magnetic declination for the local area if magnetic bearings are being used in the General Survey software. You can use magnetic bearings if you choose the *Cogo / Compute* point using the Brng-dist from a point method.

The magnetic declination defines the relationship between magnetic north and grid north for the job. Enter a negative value if magnetic north is west of grid north. Enter a positive value if magnetic north is east of grid north. For example, if the compass needle points 7° to the east of grid north, the declination is $+7^\circ$ or 7°E .

Note - Use the published declination values if available.

Note - If grid north in the job has been rotated away from true north due to the coordinate system definition (possibly via a GNSS calibration) then this must be allowed for in the magnetic declination specified.

Advanced Geodetic

Select *Advanced Geodetic* to enable the following options:

- **Station setup scale factor**
- **Helmert transformation for Resection**
- **Local transformations**

- **SnakeGrid**

Averaging

The *Averaging* field defines how duplicate points are averaged. Select one of the following options:

- Weighted
- Unweighted

Additional Settings

To configure the Additional settings, tap *Job / New job / Additional settings* when creating a new job. For an existing job tap *Job / Properties of job / Additional settings*.

Define Tunnels

Define

Use the *Define* option to:

- [Define or edit a tunnel](#)
- [Review a tunnel](#)

Define or edit a tunnel:

1. Tap *Define*.
2. Tap *New* and then enter a name for the tunnel definition.

(To edit or review an existing tunnel, highlight the tunnel name and then tap *Edit*.)

Tip - Use the *Copy* option to copy an existing tunnel definition with all its components into the current tunnel.

3. Choose a component to key in:

[Horizontal Alignment](#)

[Vertical Alignment](#)

[Templates](#)

[Template Positions](#)

[Rotation](#)

[Set Out Positions](#)

[Station Equations](#)

[Alignment Offsets](#)

Notes

- The Tunnels software treats all tunnel distances, including station and offset values, as grid distances. The value in the *Distances* field (accessed from the Trimble Access menu by selecting *Settings / Units Cogo / Cogo Settings*) has no effect on the tunnel definition or the way tunnel distances are displayed.
- If a ground coordinate system is defined in the job, the grid coordinates are, in effect, also ground coordinates.
- Keyed in tunnels are saved to the current project folder as 'tunnel name'.txt. Tunnels are available for all jobs in the current project folder.

- To use a file saved to the current project folder in another project, use Windows Explorer to copy or move the file to the appropriate project folder.

Review a tunnel:

1. Tap the *Review* softkey to see a plan view of the tunnel.

Tip - Tap on the pan softkey to make it active and then use the left, right, up, or down arrow keys on the controller to pan around the screen.

2. By default the first station is selected.

To select another station to review use one of the following methods:

- ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.
- ◆ Tap an individual station.
- ◆ Press an up or down arrow on the controller keyboard.

Tip - To add an unique station select *Add station*.

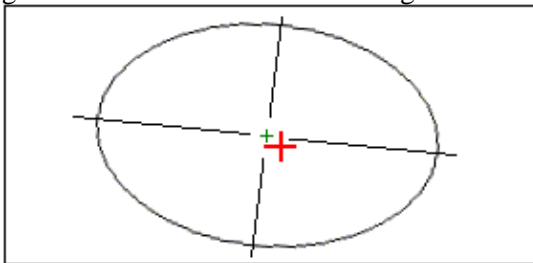
The selected station appears as a red circle.

Tips

- ◆ Tap and hold on a position to browse it's northing, easting and elevation.
- ◆ Tap and hold on the pan softkey to make it active and then use the left, right, up, or down arrow keys on the controller to pan around the screen.

3. To view the cross section for the selected station, tap the icon at the bottom right of the screen or press the **Tab** key.

A red cross indicates the design alignment. If rotation is applied, a smaller green cross indicates the alignment after rotation. The pivot position is not shown. Likewise, if the alignment is offset, a small green cross indicates the offset alignment. See the following diagram.



The station value of the selected station, its rotation value where applicable, and the alignment offset values where applicable, appear at the top of the screen.

Tip - Tap and hold on a position to see its horizontal and vertical offsets, northing, easting, and elevation. Note that:

- ◆ If the design alignment has been offset, the reported offset values are to the offset alignment.
- ◆ If rotation has been applied and the pivot position has been offset, the reported offsets are to the offset position.

To select another station to review use one of the following methods:

- ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.
- ◆ Press an up or down arrow on the controller keyboard.

Horizontal Alignment

To add a horizontal alignment to a tunnel definition, select *Horizontal alignment*. You can enter the alignment using one of the following methods:

- ◆ **Length / Coordinates**
- ◆ **End station**
- ◆ **PI**

Tip - You can also define the horizontal alignment (and vertical alignment if the line work has elevations) from features (points, lines, and arcs) in a file. To do this:

1. From the map, tap the *Layers* softkey, select the file and then make active the appropriate layer(s) that will be used to define the horizontal alignment.
2. Select the feature. See [Using the map for common tasks](#) for further details.
3. From the tap and hold menu, select *Store tunnel*.
4. Enter a name, start station, and station interval.
5. Tap *OK*.

From the *Define* menu, you can view the horizontal (and vertical alignment if applicable) for the resultant tunnel. You can enter other tunnel components if required.

Entry by Length / Coordinates

To add a horizontal alignment to a tunnel definition by entering the lengths of the elements or the end coordinates, select *Horizontal alignment* and then do the following:

1. Tap *New* to enter the first element that defines the alignment. The *Element* field is set to *Start point*. You cannot change this.
2. Enter the *Start station*.
3. In the *Method* field, choose one of the following options:
 - ◆ *Key in coordinates*
 - ◆ *Select point*

If you choose the *Key in coordinates* method, enter values in the *Start north* and *Start east* fields. If you choose the *Select point* method field, enter a value in the *Point name* field. The *Start north* and

Start east fields will update with the values for the entered point.

Tip - To edit the *Start north* and *Start east* values when they have been derived from a point, change the method to *Key in coordinates*.

4. Enter the *Station interval*. To add the horizontal element, tap *Store*. The start point appears in the graphical view.
5. Tap *Options* to select the *Transition type*.

Note - For more information on supported transition types, see [Transitions](#).

6. To enter the next horizontal element, tap *New*. In the *Entry Method* field, select *Length/Coordinates* and then tap *OK*.
7. Select the *Element* method, enter the required information, and then tap *Store*. The element appears in the graphical view.

Tips

- ◆ Tap the up arrow to access the [map softkeys](#) to navigate around the graphical view.
- ◆ Tap and hold on the pan softkey to make it active and then use the left, right, up, or down arrow keys on the controller to pan around the screen.

7. To enter further elements, see the following:

Line elements

Arc elements

Entry transition/Exit transition elements

8. When you have entered the last element, tap *Accept*.

Notes

- ◆ When you add an element, it appears after the previous element that you added. To insert it at a particular place, highlight the element in the graphical view that you want it to follow. Tap *New* and enter details of the element.
- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other elements.
- ◆ To edit an element, highlight it in the graphical view and tap *Edit*.
- ◆ To delete an element, highlight it in the graphical view and tap *Delete*.

9. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Line elements

If you select *Line* in the *Element* field, the *Start station* field displays the start station value for the line that you are defining. You cannot edit this.

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure
Azimuth and length	In the <i>Azimuth</i> and <i>Length</i> fields, enter values that define the line. The <i>End north</i> and <i>End east</i> fields update with the values entered.
End coordinates	In the <i>End north</i> and <i>End east</i> fields, enter values that define the line. The <i>Azimuth</i> and <i>Length</i> fields update with the values entered.
Select end point	In the <i>Point name</i> field, enter a value. The <i>Azimuth</i> , <i>Length</i> , <i>End north</i> , and <i>End east</i> fields update with the values entered.

Tip - If this line is not the first line to be defined, the *Azimuth* field displays an azimuth calculated from the previous element. To edit the azimuth, select *Edit azimuth* from the pop-up menu in the *Azimuth* field. If the element is non tangential a solid red circle is shown at the start of the element.

Arc elements

If you select *Arc* in the *Element* field, the *Start station* field displays the start station value for the arc that you are defining. You cannot edit this.

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure
Radius and length	Specify arc direction. In the <i>Radius</i> and <i>Length</i> fields, enter values that define the arc.
Delta angle and radius	Specify arc direction. In the <i>Angle</i> and <i>Radius</i> fields, enter values that define the arc.
Deflection angle and length	Specify arc direction. In the <i>Angle</i> and <i>Length</i> fields, enter values that define the arc.
End coordinates	In the <i>End north</i> and <i>End east</i> fields, enter values that define the arc. The <i>Arc direction</i> , <i>Radius</i> , and <i>Length</i> fields update with the values entered.
Select end point	In the <i>Point name</i> field, enter a value that defines the arc. The <i>Arc direction</i> , <i>Radius</i> , <i>Length</i> , <i>End north</i> , and <i>End east</i> fields update with the values entered.
End coordinates and center point	In the <i>End north</i> , <i>End east</i> , <i>Center point north</i> , and <i>Center point east</i> fields, enter values that define the arc. If required select <i>Large arc</i> . The <i>Azimuth</i> , <i>Arc direction</i> , <i>Radius</i> , and <i>Length</i> fields update with the values entered.
Select end and center points	In the <i>End point name</i> and <i>Center point name</i> fields, enter values that define the arc. If required select <i>Large arc</i> . The <i>Azimuth</i> , <i>Arc direction</i> , <i>Radius</i> , <i>Length</i> , <i>End north</i> and <i>End east</i> fields update with the values entered.

Tip - For an arc defined by *Radius and length*, *Delta angle and radius* or *Deflection angle and length*, the *Azimuth* field shows the azimuth as calculated from the previous element. If the element is non tangential a solid red circle is shown at the start of the element. To reload the original azimuth, select *Restore tangency* from the pop-up menu.

Entry transition/Exit transition elements

If you select *Entry transition/Exit transition* in the *Element* field, the *Start station* field displays the start station value for the entry transition or exit transition that you are defining. You cannot edit this.

Specify the arc direction. In the *Start radius*, *End radius* and *Length* fields, enter values that define the transition.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Note - For more information on supported transition types, see [Transitions](#).

Tips

- The *Azimuth* field displays the azimuth as calculated from the previous element. To edit the azimuth, select *Edit azimuth* from the pop-up menu in the *Azimuth* field. If the element is non tangential a solid red circle is shown at the start of the element.
- If the transition type is NSW cubic parabola the computed *Transistion Xc* value is displayed. If the transition is between two arcs the *Transistion Xc* displayed is the value computed for the common tangent point with the smaller of the two arcs.

Entry by End station

To add a horizontal alignment to a tunnel definition by entering end station values, select *Horizontal alignment* and then do the following:

1. Tap *New* to enter the first element that defines the alignment. The *Element* field is set to *Start point*. You cannot change this.
2. Enter the *Start station*.
3. In the *Method* field, choose one of the following options:
 - ◆ *Key in coordinates*
 - ◆ *Select point*

If you choose the *Key in coordinates* method, enter values in the *Start north* and *Start east* fields. If you choose the *Select point* method field, enter a value in the *Point name* field. The *Start north* and *Start east* fields will update with the values for the entered point.

Tip - To edit the *Start north* and *Start east* values when they have been derived from a point, change the method to *Key in coordinates*.

4. Enter the *Station interval*. To add the horizontal element, tap *Store*. The start point appears in the graphical view.
5. To enter the next horizontal element, tap *New*. In the *Entry Method* field select *End station* and then tap *Ok*.
6. Select the *Element* method, enter the required information, and then tap *Store*. The element appears in the graphical view.

Tips

- ◆ Tap the up arrow to access the *map softkeys* to navigate around the graphical view.
- ◆ Tap and hold on the pan softkey to make it active and then use the left, right, up, or down arrow keys on the controller to pan around the screen.

1. To enter further elements, see the following:

Line elements

Arc elements

Entry transition/Exit transition elements

8. When you have entered the last element, tap *Accept*.

Notes

- ◆ When you add an element, it appears after the previous element that you added. To insert it at a particular place, highlight the element in the graphical view that you want it to follow. Tap *New* and enter details of the element.
- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other elements.
- ◆ To edit an element, highlight it in the graphical view and tap *Edit*.
- ◆ To delete an element, highlight it in the graphical view and tap *Delete*.

9. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Tip - Tap *Method* to change the entry method to *Length*.

Line elements

If you select *Line* in the *Element* field, the *Start station* field displays the start station value for the line that you are defining. You cannot edit this.

In the *Azimuth* and *End station* fields, enter values that define the line. The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Tip - If this line is not the first line to be defined, the *Azimuth* field displays an azimuth calculated from the previous element. To edit the azimuth, select *Edit azimuth* from the pop-up menu in the *Azimuth* field. A solid red circle is shown at the start of an element if adjoining elements are non tangential.

Arc elements

If you select *Arc* in the *Element* field, the *Start station* field displays the start station value for the arc that you are defining. You cannot edit this.

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure
--------	-----------

Radius and end station	Specify arc direction. In the <i>Radius</i> and <i>End station</i> fields, enter values that define the arc.
Deflection angle and end station	Specify arc direction. In the <i>Angle</i> and <i>End station</i> fields, enter values that define the arc.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Tip - The *Azimuth* field displays the azimuth as calculated from the previous element. To edit the azimuth, select *Edit azimuth* from the pop-up menu in the *Azimuth* field. A solid red circle is shown at the start of an element if adjoining elements are non tangential or if adjoining elements defining a curve have different radii.

Entry transition/Exit transition elements

If you select *Entry transition/Exit transition* in the *Element* field, the *Start station* field displays the start station value for the entry transition or exit transition that you are defining. You cannot edit this.

Specify arc direction. In the *Start radius*, *End radius* and *End station* fields, enter values that define the transition.

The *End North* and *End East* fields update to display the coordinates at the end of the element just added.

Note - For more information on supported transition types, see [Transitions](#).

Tips

- The *Azimuth* field displays the azimuth as calculated from the previous element. To edit the azimuth, select *Edit azimuth* from the pop-up menu in the *Azimuth* field. A solid red circle is shown at the start of an element if adjoining elements are non tangential or if adjoining elements defining a curve have different radii.
- If the transition type is NSW cubic parabola the computed *Transistion Xc* value is displayed. If the transition is between two arcs the *Transistion Xc* displayed is the value computed for the common tangent point with the smaller of the two arcs.

Entry by PI

To add a horizontal alignment to a tunnel road definition by entering the points of intersection (PI), select *Horizontal alignment* and then do the following:

1. Tap *New* to enter the first element that defines the alignment. The *Element* field is set to *Start point*. You cannot change this.
2. Enter the *Start station*.
3. In the *Method* field, choose one of the following options:
 - ◆ *Key in coordinates*
 - ◆ *Select point*

If you choose the *Key in coordinates* method, enter values in the *Start north* and *Start east* fields. If you choose the *Select point* method field, enter a value in the *Point name* field. The *Start north* and *Start east* fields will update with the values for the entered point.

Tip - The selected entry method will be the default for subsequent elements. To change the entry method, select the *Method* option.

Tip - To edit the *Start north* and *Start east* values when they have been derived from a point, change the method to *Key in coordinates*.

4. Enter the *Station interval*. To add the horizontal element, tap *Store*.
5. To enter the next horizontal element tap *New*. In the *Entry method* field, select *PI* and then tap *OK*.
6. Tap *Options* to select the *Transition type*.

Note - For more information on supported transition types, see [Transitions](#).

7. Tap *New* and select the *Curve type*, enter the required information, and then tap *Store*. For details on supported curve types, see the following:

None

Circular

Transition|Arc|Transition

Transition|Transition

8. When you have entered the last element, tap *Accept*.

Tip - To delete an element, highlight it and tap *Delete*. When you add an element, it appears below the previous element that you added. To insert it at a particular place in the list, highlight the element that you want it to follow. Tap *New* and enter details of the element.

9. Enter the other road components or tap *Store* to store the road definition.

Curve type: None

Define the PI and then select *None* in the *Curve type* field.

Curve type: Circular

Define the PI and then select *Circular* in the *Curve type* field. Enter values defining the *Radius* and *Arc length* and then tap *Store*.

Curve type: Transition|Arc|Transition

Define the PI and then select *Transition|Arc|Transition* in the *Curve type* field. Enter values defining the *Radius*, *Arc length*, *Transition length in*, and *Transition length out* and then tap *Store*.

Note - For more information on supported transition types, see [Transitions](#).

Curve type: Transition|Transition

Define the PI and then select *Transition|Transition* in the *Curve type* field. Enter values defining the *Radius*, *Transition length in*, and *Transition length out* and then tap *Store*.

Note - For more information on supported transition types, see [Transitions](#).

Transitions

The Tunnels software supports the following transition types.

Method	Length	End station	PI
Clothoid spiral	*	*	*
Egg-shaped clothoid spiral	*	*	-
Cubic spiral	*	*	*
Bloss spiral	*	*	*
Korean cubic parabola	*	*	*
NSW cubic parabola	*	*	-

Clothoid

The clothoid spiral is defined by the length of the spiral and the radius of the adjoining arc. The formulae for the 'x' and 'y' parameters in terms of these two values are as follows:

Parameter 'x':

$$x = l * [1 - \frac{l^4}{40R^2 L^2} + \frac{l^8}{3456R^4 L^4} - \dots]$$

Parameter 'y':

$$y = \frac{l^3}{6RL} [1 - \frac{l^4}{56R^2 L^2} + \frac{l^8}{7040R^4 L^4} - \dots]$$

Egg-shaped clothoid

By editing the *Start / End radius* for an *Entry / Exit transition* from *Infinite* to a required radius it is possible to define an egg shaped clothoid. To return to an infinite radius, select *Infinite* from the pop-up menu.

Cubic spiral

The cubic spiral is defined by the length of the spiral and the radius of the adjoining arc. The formulae for the 'x' and 'y' parameters in terms of these two values are as follows:

Parameter 'x':

$$x = l * [1 - \frac{l^4}{40R^2 L^2} + \frac{l^8}{3456R^4 L^4} - \dots]$$

Parameter 'y':

$$y = \frac{x^3}{6RX}$$

Bloss spiral

Parameter 'x':

$$x = l * [1 - \frac{l^6}{14R^2 L^4} + \frac{l^7}{16R^2 L^5} - \frac{l^8}{72R^2 L^6} + \frac{l^{12}}{312R^4 L^8} - \frac{l^{13}}{168R^4 L^9} + \frac{l^{14}}{240R^4 L^{10}} - \frac{l^{15}}{768R^4 L^{11}} + \frac{l^{16}}{6528R^4 L^{12}}$$

Parameter 'y':

$$y = \left[\frac{l^4}{4RL^2} - \frac{l^5}{10RL^3} - \frac{l^{10}}{60R^3 L^6} + \frac{l^{11}}{44R^3 L^7} - \frac{l^{12}}{96R^3 L^8} + \frac{l^{13}}{624R^3 L^9} \right]$$

Korean cubic parabola

This cubic parabola is defined by the length of the parabola and the radius of the adjoining arc. The formulae for the 'x' and 'y' parameters in terms of these two values are as follows:

Parameter 'x':

$$x = l * [1 - \frac{l^4}{40R^2 L^2}]$$

This formula is the same as for the 'x' parameter of the clothoid spiral, reduced to the first term of the series.

Parameter 'y':

$$y = \frac{x^3}{6RX}$$

NSW cubic parabola

The NSW cubic parabola is a special parabola used for rail projects in New South Wales, Australia. It is defined by the length of the parabola and an 'm' value. Refer to http://engineering.railcorp.nsw.gov.au/Civil_EngineeringStandards.asp and see *Track Geometry Stability*, Reference number: *ESC 210* for the formulae for the 'x' and 'y' parameters in terms of these two values.

Vertical Alignment

To add a vertical alignment to a tunnel definition, select *Vertical alignment*. You can enter the alignment using one of the following methods:

- **Vertical Points of Intersection**
- **Start and end points**

Note - The selected entry method applies to all elements defining the vertical alignment.

Tip - If you defined the horizontal alignment for your tunnel from line work in a file, and the line work has elevations, these will be used to define the vertical alignment as a series of *Point* elements. See [Horizontal alignment](#) for further details. The vertical alignment can be edited if required.

Entry by Vertical Points of Intersection (VPI)

To add a vertical alignment to a tunnel definition by entering Vertical Points of Intersection (VPI), select *Vertical alignment* and then do the following:

1. To enter the first element that defines the alignment, tap *New*.
2. In the *Station* and *Elevation* fields, key in the values that define the first vertical point of intersection. The *Element* field is set to *Start point*. You cannot change this.
3. Tap *Store* to add the vertical element record.
4. Tap *New*. In the entry method field select *VPI* and then tap *Ok*.
5. Select the *Element* method, enter the required information, and then tap *Store*.
6. To enter further elements, see the following:

[Point elements](#)

[Circular arc elements](#)

[Symmetric parabola elements](#)

[Asymmetric parabola elements](#)

7. When you have entered the last element, tap *Accept*.

Notes

- ◆ When you add an element, it appears after the previous element that you added. To insert it at a particular place, highlight the element in the list that you want it to follow. Tap *New* and enter details of the element.
- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other elements.
- ◆ To edit an element, highlight it in the list and tap *Edit*.
- ◆ To delete an element, highlight it in the list and tap *Delete*.

8. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Point elements

If you select *Point* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. The *Slope in* field updates to display the calculated slope value. The *Slope out* field updates when the next element is added.

Note - A vertical alignment defined by VPIs must end with a point.

Circular arc elements

If you select *Circular arc* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the radius of the circular arc in the *Radius* field. The *Slope in* field updates to display the calculated slope value. The *Length*, *K factor* and *Slope out* fields update when the next element is added.

Symmetric parabola elements

If you select *Sym parabola* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI and a length for the parabola. The *Slope in* field updates to display the calculated slope value. The *K factor* and *Slope out* fields update when the next element is added.

Asymmetric parabola elements

If you select *Asymmetric parabola* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the VPI. Enter the In and Out lengths of the parabola. The *Slope in* field updates to display the calculated slope value. The *K factor* and *Slope out* fields update when the next element is added.

Note - When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.

Tip - To confirm the entry, use the *Slope in*, *Slope out*, and *K factor* values.

Entry by Start and End Points

To add a vertical alignment to a tunnel definition by entering Start and end points, select *Vertical alignment* and then do the following:

1. To enter the first element that defines the alignment, tap *New*.
2. In the *Station* and *Elevation* fields, key in the values that define the first vertical point of intersection. The *Element* field is set to *Start point*. You cannot change this.
3. Tap *Store* to add the vertical element record.
4. Tap *New*. In the entry method field select *Start and End points* and then tap *Ok*.
5. Select the *Element*, enter the required information and then tap *Store*. For details on supported elements, see the following:

Point elements

Circular arc elements

Symmetric parabola elements

6. When you have entered the last element, tap *Accept*.

Notes

- ◆ When you add an element, it appears after the previous element that you added. To insert it at a particular place, highlight the element in the list that you want it to follow. Tap *New* and enter details of the element.
- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other elements.
- ◆ To edit an element, highlight it in the list and tap *Edit*.
- ◆ To delete an element, highlight it in the list and tap *Delete*.

7. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Point elements

If you select *Point* in the *Element* field, use the *Station* and *Elevation* fields to key in values that define the start point. The *Slope in* field updates to display the calculated slope value. The *Slope out* field updates when the next element is added.

Circular arc elements

If you select *Circular arc* in the *Element* field, use the *Start station*, *Start elevation*, *End station*, *End elevation*, and *Radius* fields to key in values that define the circular arc. The *Length*, *Slope in*, and *Slope out* fields update to display the calculated values.

Symmetric parabola elements

If you select *Sym parabola* in the *Element* field, use the *Start station*, *Start elevation*, *End station*, *End elevation*, and *K factor* fields to key in values that define the parabola. The *Length*, *Slope in*, and *Slope out* fields update to display the calculated values.

Note - When you edit an element, only the selected element is updated. All adjoining elements remain unchanged.

Tip - To confirm the entry, use the *Slope in*, *Slope out*, and *Length* values.

Templates

A template defines the profile of the tunnel and may consist of any number of surfaces. A surface can be defined by any of the following:

- Entering line and arc elements
- Measuring positions within a tunnel
- Copying and then offsetting an existing surface

To define a template for a tunnel definition, select *Templates* and then do the following:

1. Tap *New*, enter a template name and then tap *Add*.

Tips

- ◆ To edit an existing template, highlight the template name and tap *Edit*. Highlight the surface to edit and tap *Edit*. Then, from the graphical template view select the element and then tap *Edit*.
- ◆ Use the *Copy from* option to copy an existing template definition, either from the current tunnel or from a previously defined tunnel, into the current template.
- ◆ To create a template library, define a tunnel that only contains templates.

2. From the *Select a surface* screen tap *New*, enter a surface name and then tap *Add*.

Tip - Use the *Copy from* option to copy an existing surface by a specified offset.

3. Tap *New* to enter the start point element defining the surface.

Tip - Use the *Measure* softkey to measure positions within a tunnel to define elements in a surface. If no surface elements have been defined, tap *Measure* to define the *Start point*. If the surface consists of one or more elements, tap *Measure* to define the end point of a line element. To use this option, you must start a survey.

4. In the *Horizontal offset* and *Vertical offset* fields, enter the values that define the *Start point* and then tap *Store*. The element appears in the graphical view.

Tap the up arrow to access the *map softkeys* to navigate around the graphical view.

5. To enter further elements, tap *New*, select the *Element* and *Method* and then enter the required information. For details on supported elements and entry methods, see the following:

Line elements

Arc elements

6. When you have entered the last element, tap *Accept*.

Notes

- ◆ Templates must be defined in a clockwise direction.
- ◆ When you add an element, it appears after the previous element that you added. To insert it at a particular place, highlight the element in the graphical view that you want it to follow. Tap *New* and enter details of the element.
- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other elements.
- ◆ To edit an element, highlight it in the graphical view and tap *Edit*.
- ◆ To delete an element, highlight it in the graphical view and tap *Delete*.
- ◆ Surfaces can be open or closed.

7. To save the surface, tap *Accept*.

Tip - To rename a surface, highlight it and then tap *Rename*. To delete a surface, highlight it and then tap *Delete*.

8. To save the template, tap *Accept*.

Tip - To rename a template, highlight it and then tap *Rename*. To delete a template, highlight it and then tap *Delete*.

9. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Line elements

To add a line to the template definition, select *Line* in the *Element* field.

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure
Cross slope and offset	In the <i>Cross slope</i> and <i>Offset</i> fields, enter values that define the line. To change the way a cross slope value is expressed, tap <i>Options</i> and then change the <i>Grade</i> field as required.
Delta elevation and offset	In the <i>Delta elevation</i> and <i>Offset</i> fields, enter values that define the line.
End point	In the <i>Horizontal offset</i> and <i>Vertical offset</i> fields, enter values that define the end point of the line.

Arc elements

To add an arc to the template definition, select *Arc* in the *Element* field.

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure

End point and Radius	In the <i>Horizontal offset</i> and <i>Vertical offset</i> fields, enter values that define the end point of the arc. Enter the <i>Radius</i> . Select <i>Large arc</i> , if required.
Alignment and Delta angle	Specify the <i>Delta angle</i> for the arc. The center point for the arc is defined by the horizontal and vertical alignments.
Center point and delta angle	In the <i>Horizontal offset</i> and <i>Vertical offset</i> fields, enter values that define the center point of the arc. Enter the <i>Delta angle</i> for the arc.

Tip - On page two the parameters defining the arc are displayed.

Template Positions

To define the position of templates in a tunnel definition, specify the station at which the Tunnels software starts to apply each template. For station values between applied templates, the template element values are interpolated. Two interpolation methods are supported:

- [Norwegian interpolation](#)
- [Linear interpolation](#)

Note - The templates applied must have the same number of elements.

Norwegian interpolation method

This method maintains the radii of the first and last arcs (referred to as wall arcs), as well as the radii of the second and fourth 'transition' arcs when present, and computes a new radius for the central (or roof) arc. It uses interpolation of the arc angles rather than the radii values.

This method is automatically used if the templates applied at the previous and next stations fulfill the following requirements:

- Each template consists of 3 or 5 arcs in sequence joined tangentially
- There is no 'tilt' to the defined section (template)

If the above requirements are not met the [Linear interpolation](#) method is used.

Linear interpolation

For this method, the template element values are interpolated linearly (applied on a pro rata basis), from a template applied at the previous station to the station where the next template is applied.

This method is used if the requirements for the *Norwegian method* are not met.

Template positioning

To define the template positioning:

1. Select *Template positioning*.

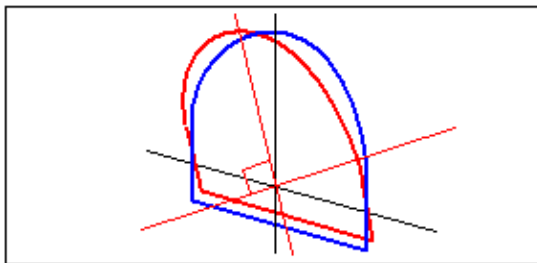
2. Tap *New*.
3. In the *Start station* field, specify the start station for the template(s).
4. Select the templates to apply. The options in the drop-down list for the *Template* field are:
 - ◆ <None> - no template is assigned. Use this option to create a gap in the tunnel definition.
 - ◆ Templates - defined using the *Define / Templates* option.
5. The surfaces making up the selected template are displayed. Select the surface you want to use.
6. Tap *Store* to apply the template.
7. Tap *New* to enter more templates at other positions.
8. When all template positions are entered tap *Accept*.

Notes

- ◆ Use the *Start*, *Prev*, *Next* and *End* softkeys to view other template positions.
 - ◆ To edit a template position, highlight it in the list and tap *Edit*.
 - ◆ To delete a template position, highlight it in the list and tap *Delete*.
9. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

For more information, see the [example alignment](#) with the associated table. That topic describes how to use the template assignments, including the <None> template, and the *Surface to use* option to achieve the required tunnel definition.

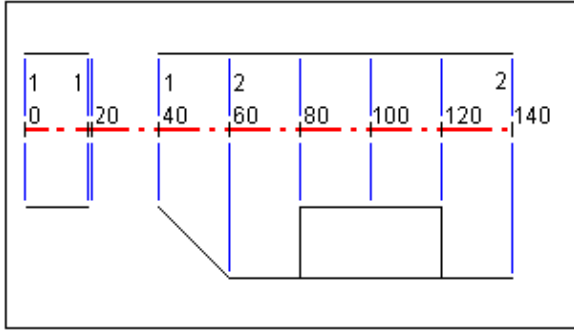
Note - Tap the *Options* softkey to specify if the templates are applied *Vertical* or *Perpendicular* to the vertical alignment. See the following diagram where the red linework indicates the template applied perpendicular and the blue linework a template applied vertically.



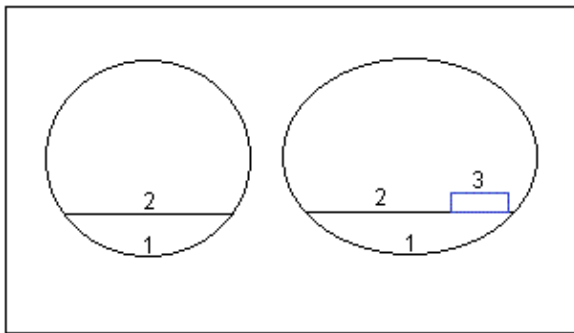
The station and offset display of points relative to a tunnel using *Point manager* or *Review job* are only calculated vertical to the alignment. If the templates were applied perpendicular in Tunnel positioning then the station and offsets will be different.

Example Alignment

The following discussion explains how the template assignments, including the <None> template, and the *Surfaces to use* option can be used to control a tunnel definition. See the plan in the following figure where the tunnel is a consistent width from station 0 to 20, has a gap between stations 20 and 40, widens from station 60 to 80 and then is a constant width to station 140.



See also the two templates in the following figure where template 1 (on the left side in the figure) has two surfaces and template 2 has three surfaces:



To define this design you need to assign the templates with the appropriate surfaces selected as shown in the following table:

Start station	Templates	Surface 1	Surface 2	Surface 3
0.000	Template 1	On	On	-
20.000	Template 1	On	On	-
20.005	<None>	-	-	-
40.000	Template 1	On	On	-
60.000	Template 2	On	On	Off
80.000	Template 2	On	On	On
120.000	Template 2	On	On	Off
140.00	Template 2	On	On	Off

Rotation

Use rotation to tilt or rotate a tunnel template and associated setout positions around an origin point. Rotation is mainly used around a horizontal curve to represent superelevation. However, it can be used anywhere in the tunnel alignment provided that there is a valid horizontal alignment, vertical alignment, and template assigned.

To define rotation:

1. From the *Define* tunnel menu, select *Rotation*.
2. Tap *New*.
3. Enter the *Start station* for the rotation.
4. Enter the *Rotation* value.
 - If the tunnel is to rotate to the left, enter a negative value.
 - If the tunnel is to rotate to the right, enter a positive value.
 - If you are defining the start of the rotation, enter a rotation value of 0%.
5. Enter the *Horizontal offset* and *Vertical offset* of the *Pivot position*.
 - If the rotation pivots around the alignment, leave the offsets as 0.000.
6. Tap *Store* to apply the rotation.
7. Tap *New* to enter a new rotation value at another station.
8. To edit an existing rotation value, highlight the record and then tap *Edit*.
9. To delete an existing rotation value, highlight the record and then tap *Delete*.
10. When all rotation values are entered, tap *Accept*.
11. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Note - The following describes the order that templates of different shapes, with rotation applied, are computed before interpolation of intermediate stations takes place:

1. Construct the first template and apply rotation
2. Construct the second template and apply rotation
3. Interpolate between the two resolved templates

Set out positions

Set out positions typically define bolt holes within a tunnel. They are defined by station and offset values and a method.

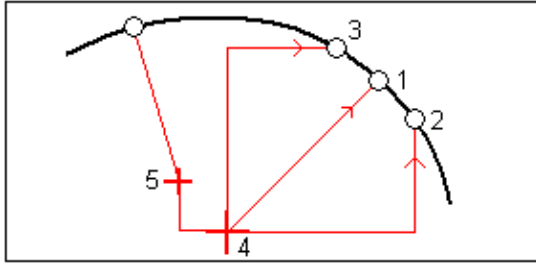
To define set out positions:

1. Select *Set out positions*.
2. Tap *New*.
3. In the *Start station* field, specify the start station for the position to be set out.
4. In the *End station* field, specify the end station for the position to be set out.

Tip - Leave the *End station* field blank if the set out position is to apply to all stations.

5. Select the *Method* to define the set out position.

The following diagram and table describes the three methods.



1	Set out position defined radial	4	Alignment
2	Set out position defined vertical	5	Offset center for radial method
3	Set out position defined horizontal	-	-

The following table shows the available methods and the fields that appear when you select each one.

Method	Procedure
Radial	In the <i>Start station</i> and <i>End station</i> fields and the <i>Horizontal offset</i> and <i>Vertical offset</i> fields, enter values that define the position to be set out.
Horizontal	In the <i>Start station</i> and <i>End station</i> fields and the <i>Vertical offset</i> field, enter values that define the position to be set out. Select the horizontal <i>Direction</i> the offset is applied.
Vertical	In the <i>Start station</i> and <i>End station</i> fields and the <i>Horizontal offset</i> field, enter values that define the position to be set out. Select the vertical <i>Direction</i> the offset is applied.

Tip - For all three methods, the horizontal and vertical offsets are relative to the alignment. For the radial method, to define a new center offset from the alignment, enter *Horizontal offset* and *Vertical offset* values in the *Radial center offsets* group box.

For all methods, you can specify a *Code*.

Tip - The annotation entered in the *Code* field is assigned to the end of the position and is displayed when setting out the position.

6. Tap *Store* to apply the set out position.
7. Tap *New* to enter more set out positions.

Tips

- ◆ To copy a highlighted entry, tap *Copy*.
 - ◆ To delete a highlighted entry, tap *Delete*.
8. When all set out positions are entered, tap *Accept*.
 9. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Station Equations

Use *Station equations* to define the station values for an alignment.

To define an equation:

1. Select *Station equations*.
2. Tap *New*.
3. In the *Back station* field, enter a station value.
4. In the *Ahead station* field, enter a station value. The *True station* value will be calculated.
5. Tap *Store*.

The values entered in the *Back station* and *Ahead station* fields are shown: The zone is indicated by a number after the colon in each field. The calculated *Progression*, indicating whether the station value increases or decreases after the station equation, is also shown.

Note - The zone up to the first station equation is zone 1.

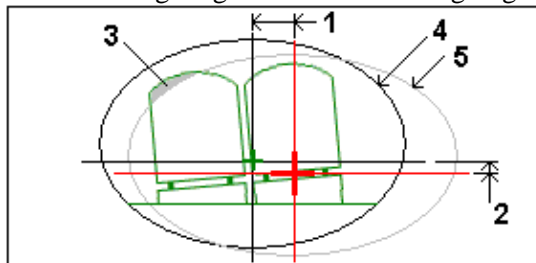
Tip - To change the progression for the last station equation, tap *Edit*.

6. To add further equations, tap *New*. To delete an equation, tap *Delete*. To accept the entered equations, tap *Accept*.

Alignment Offsets

Use alignment offsets to offset the horizontal and / or vertical alignment. Alignment offsets are typically used at horizontal curves in a rail tunnel to ensure that carriage clearance is maintained when the track is superelevated. However, they can be used anywhere along the tunnel alignment provided there is a valid horizontal alignment, vertical alignment, and template assigned.

The following diagram illustrates using alignment offsets to avoid carriage conflict with the design tunnel.



1	Horizontal offset	4	Offset tunnel
2	Vertical offset	5	Design tunnel
3	Carriage conflict	-	-

To define alignment offsets:

1. From the *Define tunnel* menu, select *Alignment offsets*.
2. Tap *New*.
3. Enter the *Start station* for the offsets.
4. Enter the *Horizontal offset* and / or *Vertical offset*.
5. Tap *Store* to apply the offsets.

6. Tap *New* to enter offsets at another station.
7. To edit an existing offset, highlight the record and then tap *Edit*.
8. To delete an existing offset, highlight the record and then tap *Delete*.
9. When all offsets are entered, tap *Accept*.
10. Enter the other tunnel components, or tap *Store* to store the tunnel definition.

Import

You can convert a LandXML file that defines a tunnel to a Trimble txl file for use in the Tunnels software. The LandXML file is converted using the [ASCII File Generator] utility program available on www.trimble.com.

Before you can convert a LandXML file, you must copy the [LandXML To TunnelXML.xsl] file from www.trimble.com to the [\\Custom ASCII Files] folder on your office computer.

To convert a LandXML file to a txl file:

1. On the office computer, select [Start / Programs / Trimble Data Transfer / ASCII File Generator] to start the [ASCII File Generator] utility program.
2. From the *Source JobXML or Job file* field, select *Browse*. Set the *File of type* field to *All files*. Browse to the appropriate folder and then select the LandXML file to convert.
3. From the *Output format* field, select the [LandXML To TunnelXML] style sheet.
4. Select *OK*.
5. From the *User Value Input* screen, select the tunnel surface to be converted.
6. Select *OK*.
7. Confirm the *Save in* folder and *File name* for the txl file and then select *Save*.
8. When done, select *Close*.

Use the ActiveSync technology to copy the txl file to the controller.

Tip - To create txl files for other surfaces in the LandXML file, repeat steps 1 through 8.

Survey Tunnels

Survey

Use Survey to:

- [Auto scan cross sections](#)
- [Manual measure positions](#)
- [Measure positions relative to a tunnel](#)
- [Set out positions](#)
- Measure surface - select this option to access the *Define* option. This enables you to define template surface elements from positions measured in a tunnel.















Survey Settings

When starting a survey you will be asked to select a survey style. To learn more about survey styles and related connection settings from the Trimble Access menu tap *Settings* and then tap:

- *Survey styles* to edit or define a survey style. Survey Styles define the parameters for configuring and communicating with your instruments, and for measuring and storing points.
- *Connect / GNSS contacts* to create or configure a cellular modem dial profile
- *Connect / Auto connect* to configure your auto connect options
- *Connect / Radio settings* to configure the Radio channel and Network ID on a Trimble VX Spatial Station or Trimble S Series total station. These settings are used with a conventional instrument in robotic mode.
- *Connect / Bluetooth* to establish a connection to other devices using Bluetooth wireless technology.

Icons

The icons that appear when surveying a tunnel are shown below.

Icon - plan view	Description	Icon - cross section view	Description
	Station available for selection		Scanned position within tolerance
	Station unavailable for selection		Scanned position outside of tolerance
	Selected station (Auto scan)		Stored set out position
	Scanned station within tolerance		Set out position
	Scanned station with positions outside of tolerance		Selected set out position
	Current station		Alignment axis
	High-power laser pointer active		High-power laser pointer active

-	-	+	Offset alignment axis / Rotated alignment axis
-	-	+	Current position

Notes

- The Tunnels software defaults to tracking mode when scanning and measuring in a tunnel. If you select standard mode, you achieve better quality but slower measuring times.
- The Tunnels software *Survey / Tunnel* option supports Trimble VX/S Series instruments.

Auto Scanning Positions

Auto scan measures points at a defined scan interval for selected stations. The resulting positions are compared to the design template surface for that station.

To auto scan positions in a tunnel:

1. Tap *Survey*, select a survey style and start a survey.

From the Trimble Access menu tap *Settings / Survey styles* to edit an existing style or to define a new style.

2. Tap *Autoscan*.
3. Select a tunnel from the list.

Tip - To add files from another folder to the list, tap *Add*, navigate to the required folder and then select the file(s) to add.

The plan view displays the horizontal alignment of the tunnel, the instrument position, and the current direction. A black open circle indicates each station as defined by the station interval.

4. To define the scan station range, use one of the following methods to select stations to scan:
 - ◆ Key values into the *Start station* and *End station* fields.
 - ◆ In the *Start station* and *End station* fields, select *List* from the pop-up menu and then select values from the list.
 - ◆ Highlight the *Start station* field, point the instrument to the required start point of the scan and then tap *Measure*. Repeat the process for the *End station*.
5. In the *Station interval* field, enter the required station interval for the scan. From the pop-up menu in *Station interval*, make sure that the correct interval method is selected. The options are *0 based* and *Relative*.
 - ◆ The 0 based method is the default method and gives station values that are multiples of the station interval. For example, if the start station is 2.50 and the station interval is 1.00, the 0 based method produces stations at 2.50, 3.00, 4.00, 5.00, and so on.
 - ◆ The Relative method gives station values relative to the start station. For example, if the start station is 2.50 and the station interval is 1.00, the Relative method produces stations at 2.50, 3.50, 4.50, 5.50, and so on.

6. Select the template surface to scan.
7. Tap *Next* to view the selected station range in the plan view. The plan view automatically zooms to the defined range.

Tip - To add a station that is not defined by the station interval, tap and hold on the screen and then select *Add station* from the menu.

Selected stations defining a scan are indicated as solid blue circles.

Tap a station to deselect it. Alternatively, tap and hold on the screen and then select *Clear selection* to clear all stations. The tap and hold menu also features a *Station list* from which you can select or deselect stations within the station range.

Note - Stations shown greyed out have no vertical alignment or no template assigned and cannot be selected for scanning.

Tip - As an alternative to defining a scan from the plan view, you can view a station to scan from the cross section view, tap and hold on the screen and then select *Scan current station*.

8. Tap *Next* to view the cross section of the first selected station. The selected template surface is highlighted.
9. If there are areas of the tunnel that cannot be scanned or need to be excluded from the scan, or if you want to scan only part of the tunnel profile, you can define scan zones to do this. Tap and briefly hold on the screen and then select *Add scan zone* from the pop-up menu.
10. Tap *Start* and then set the *Start point* name, *Point code*, *Scan interval*, and *EDM timeout* from the *Scan / Manual settings* screen. Points to be scanned are defined by the scan interval, and include the start and end points that define each element in the template surface.

Tip - You can reduce the EDM timeout to improve performance. If the instrument struggles to get a measurement due to, for example, reflective or dark surfaces, increase the EDM timeout.

Use the *On station adjustment* option to control where the position will be measured when the tunnel surface does not match the design. If selected, *Auto OS* appears at the top left of the screen. You must specify a station tolerance if using this option. See step 6 below.

If you are using a Trimble VX Spatial Station, select the *VX scanning* option for improved scanning performance.

To display guide lines in the cross section view select the *Display vertical center line* and the *Display spring line* options. The vertical line displays as a green line that runs vertically through the centerline. The spring line displays as a horizontal green line through the centerline and can be offset vertically relative to the centerline.

11. Tap *Accept* and then set the *Station*, *Overbreak*, and *Underbreak* tolerances and the number of *Iterations* from the *Scan / Manual tolerances* screen.
12. Tap *Accept*. The Tunnels software begins scanning the first station.

For each scanned point, the point name overbreak / underbreak and delta station values are displayed. Each scanned position appears as a green circle (if within tolerance) or a red circle (if not within tolerance).

If using a Trimble S Series total station, tap *Pause* to pause the scan; tap *Continue* to resume scanning; and tap *Stop* to end the scan before it is completed. While paused, you can select any scanned position to view the deltas.

If using a Trimble VX Spatial Station, tap *Stop* to stop the scan. Tap *Start* and Tunnels continues scanning the remaining points.

Once all points for the current station are scanned, the Tunnels software automatically advances to the next station until all selected stations are scanned.

Tip - When in the cross section view, tap the up arrow (next station) or tap the down arrow (previous station), to review other stations while still scanning. The station being scanned is indicated in the top left of the screen. The station being viewed is indicated at the top center of the screen.

13. Once all points for all selected stations are scanned, results show which stations have errors. You can expand stations with errors to see the number of points scanned, the number skipped, and the number of points outside tolerance. You can expand this last record to see the number of overbreak, underbreak, and delta station points.

Tip - The plan view shows the scanned stations. Stations with no errors appear as solid green circles, while those with errors appear as solid red circles.

14. Tap *Close* to finish.

Tip - After a scan is completed, you can do the following:

- ◆ To review a summary for each station, return to the plan view, tap and hold on the screen and then select *Results*.
- ◆ To see details for the current station, return to the cross section view, tap and hold on the screen and then select *Details*. See also [Review tunnel](#).
- ◆ To edit the tolerance values from either the plan or cross section view, tap and hold on the screen and then select *Tolerances*. The *Station*, *Overbreak*, and *Underbreak* deltas are updated to reflect the new tolerance values.

Notes

- Auto scan defaults to tracking mode for each scan but will work in standard mode.
- When a scan starts, the DR target height and prism constant are automatically set to 0.00.
- When scanning with *On station adjustment* selected and using a Trimble S Series total station, each point is scanned until it is found within tolerance.
- When scanning with *On station adjustment* selected and using a Trimble VX Spatial Station, fifty points will be scanned at a time. The scan is repeated for those points that were not within tolerance.
- If the number of iterations is exceeded or the EDM times out, the point is skipped.

Tip - During a conventional survey, you can use the tap and hold menu in the map to quickly measure a check point. If there are no points selected, *Check backsight* is available; if one point is selected *Check shot* is available.

Alternatively, to measure a check shot from any screen, press [CTRL + K] on the controller.

Scan Zones

Use scan zones when parts of the tunnel profile either do not require measuring or cannot be measured (for example, areas behind ventilation ducts).

Only points within the scan zone will be measured.

You can have multiple scan zones on the same profile.

Scan zones are applied to the entire length of the defined station range.

To define scan zones:

1. Follow steps 1 through 7 of performing an auto scan.
2. Tap and hold briefly on the screen, or press the space key and then select *Add scan zone*.
3. Point the instrument to where you want the scan zone to start. The instrument ray appears as a solid red line on screen. Tap *Accept* or press *Enter* to store the scan zone start point.

Note - Scan zones must be defined in a clockwise direction.

Tip - If you define the start of the scan zone in the wrong place, tap *Back* or press Escape to go back and redefine it.

4. Point the instrument to where you want the scan zone to end. The instrument ray appears as a solid red line on screen and the scan zone start appears as a red dashed line. Tap *Accept* or press *Enter* to store the scan zone end point.

The auto scan profile view appears. Points outside the scan zone are greyed out and will not be measured.

5. To define another scan zone, select *Add scan zone* again from the tap and hold menu.

To delete the scan zones, tap and hold briefly on the screen, or press the space key and then select *Delete scan zones*. All scan zones are deleted.

Manually Measuring Positions

Use manual measurement to:

- **Measure** a position that could not be measured by a scan.
- **Delete** a scanned or manually measured position.

Manual measurement

To perform a manual measurement:

1. Follow the procedure for performing an [Auto scan](#).

The plan view displays the horizontal alignment of the tunnel, the instrument position, and the current direction. A black open circle indicates each station as defined by the station interval.

Tip - Tap the pan softkey and then use the left, right, up, and down arrow keys on the controller keyboard to pan around the screen.

2. Tap and hold briefly on the screen, or press the *Space* key and then select *Manual measure* from the pop-up menu.

The selected mode, *Manual*, is shown at the top left of the screen. To change modes, tap and hold briefly on the screen and then select the required mode from the pop-up menu.

Tip - From the tap and hold menu, select *Settings*. From the *Manual measure* group, select the [Apply target height perpendicular to profile](#) option when measuring with a prism. This option enables a position to be measured perpendicular to the tunnel profile when using a prism by entering the prism radius as the target height.

3. Select a station to measure using one of the following methods:
 - ◆ Tap an up or down arrow on the controller keyboard.
 - ◆ Tap an individual station.
 - ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.

The selected station appears as a red circle.

4. Tap *Next* to view the cross section and measure.
5. Tap the location that you want to measure; the instrument automatically turns to that position. Alternatively, manually aim the instrument at the position you want to measure. When a measurement is received, the *Station*, *Underbreak*, *Overbreak* and *Delta station* values are shown. Tap *Store* to store the position.

Tip - If the instrument struggles to get a measurement due to, for example, reflective or dark surfaces, increase the EDM timeout.

Note - If the *Start point* name has not been defined, the *Settings* screen appears. Complete the required fields and then tap *Accept*.

If the tolerances have not been defined, the *Tolerances* screen appears. Complete the required fields and then tap *Accept*.

Stations with no errors appear as solid green circles, while those with errors appear as solid red circles.

Tip - During a conventional survey, you can use the tap and hold menu in the map to quickly measure a check point. If there are no points selected, *Check backsight* is available; if one point is selected *Check shot* is available.

Alternatively, to measure a check shot from any screen, press [CTRL + K] on the controller.

Deleting points

To delete a measured position:

1. From the cross section view, tap a point to select it. The selected point is indicated with a black circle.

To deselect the point, tap off it. Alternatively, tap and hold on the screen and then select *Clear selection*.

2. Tap *Delete*.

Tip - To restore deleted points, tap and hold on the screen and then select *Restore deleted points*.

Note - When you select a point for deletion, the instrument target will be the design position for that point. If you select *Store* immediately after deleting the point, the instrument remeasures the design position for the deleted point.

Position in Tunnel

Use Position in Tunnel to:

- Measure a position at any station within the Tunnel.
- Compare the position with the design parameters of the tunnel.

To use Position in Tunnel:

1. Tap *Survey*, select a survey style and start a survey.

From the Trimble Access menu tap *Settings / Survey styles* to edit an existing style or to define a new style.

2. Tap *Position in Tunnel*.
3. Select a tunnel from the list.

Tip - To add files from another folder to the list, tap *Add*, navigate to the required folder and then select the file(s) to add.

The instrument is automatically set to DR tracking mode with the laser pointer on. The cross section for the current position is displayed on screen.

Tip - To disable DR mode, set a target height, or make other changes to the instrument setting, tap the arrow at the right of the screen to access the status bar.

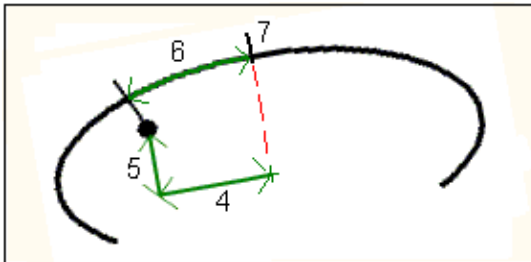
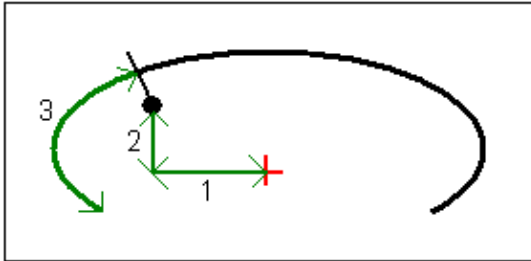
4. Tap the template surface to measure relative to.

Tip - Alternatively use the tap and hold menu to select the surface from a list.

5. Point the instrument at the position you want to measure.

Information on the current position and its relationship to the selected template surface appears at the bottom of the screen.

To scroll through the values, tap the arrow to the left of the text. See the following diagrams and table for details on what is available:



Number	Value	Description
-	Station	The station of the current position in terms of the tunnel design.
-	Under/Overbreak	The underbreak or overbreak of the current position in terms of the selected template surface. Appears in red if it is out of tolerance.
-	Rotation	The rotation value of the cross section at the current position.
1	Hx. offset	The horizontal offset of the current position from the tunnel centerline (shown as a red cross).
2	Vt. offset	The vertical offset of the current position from the tunnel centerline (shown as a red cross). Maybe either perpendicular or true vertical, depending on the template position options in the Tunnel design.
3	Profile dist.	The profile distance of the current position measured along the selected template surface from its start point.
4	Hx. off. (rot)	The horizontal offset of the current position from the rotated tunnel centerline (shown as a green cross) and rotated with the tunnel.
5	Vt. off. (rot)	The vertical offset of the current position from the rotated tunnel centerline (shown as a green cross) and rotated with the tunnel. May be either perpendicular or true vertical, depending on the template position options in the tunnel design.
6	Dist. to vertex	The profile distance from the vertex (7) to the current position. The vertex (shown as a black line) is defined by the intersection of a perpendicular line from the rotated centerline (shown as a green cross)

		to the tunnel roof.
-	Northing	Northing of the current position.
-	Easting	Easting of the current position.
-	Elevation	Elevation of the current position.

6. Tap *Store* to record the current position in the job's database.

Tap and Hold menu

The following options are available:

- Settings - use this to configure the *Point name* and *Point code*. Select the *Apply target height perpendicular to profile* option when measuring with a prism. This option enables a position to be measured perpendicular to the tunnel profile when using a prism by entering the prism radius as the target height.

To display guide lines in the cross section view select the *Display vertical center line* and the *Display spring line* options. The vertical line displays as a green line that runs vertically through the centerline. The spring line displays as a horizontal green line through the centerline and can be offset vertically relative to the centerline.

- Tolerances - use this to set the *Overbreak tolerances* and *Underbreak tolerances*.

3R Laser Pointer

If you are using a Trimble S8 total station equipped with the high-power laser pointer, before storing the point, tap *3R Laser* to enable the high-power laser pointer and show the mark on the tunnel surface. An icon appears at the bottom right of the screen to show that the laser is active.

Tap *Measure* to measure the position and then tap *Store* to record the current position in the job's database.

Notes

- Even though the high-power laser pointer is not coaxial with the telescope, the instrument can automatically turn to measure to the laser pointer location. When you tap *3R Laser*, a preliminary measurement is taken to determine the vertical angle to turn the instrument so that the distance is measured to where the high-power laser pointer is pointing. When you tap *Measure*, the instrument automatically turns to that location and takes the measurement. The instrument then turns so that the high-power laser again points to the measured position. The preliminary measurement is not stored.
- The calculation of the vertical angle to turn to assumes the horizontal distance to the preliminary measurement is similar to the distance to the high-power laser pointer location. To measure to the high-power laser point when it is near the upper or lower edge of an object, consider using face 1 to take measurements at the lower edge of an object, and face 2 to take measurements at the upper edge of an object so that the preliminary measurement does not overshoot the object you are measuring to.

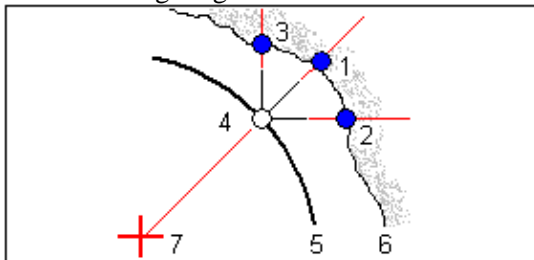
WARNING - The high power laser is a class 3R laser that emits laser radiation - do not stare into the beam or view directly with optical instruments.

Setting Out Positions

Use *Tunnel / Set out* to set out predefined positions in a tunnel. To define set out positions in a tunnel, see [Tunnel set out positions](#).

Note - When setting out positions Tunnels will attempt to navigate you to the defined position. Often this will not be possible and the software will instead locate a position on the tunnel surface that is on the selected station. The location of this position depends on the method used to define the set out position. For more information on the three methods of defining a set out position in a tunnel, see [Tunnel set out positions](#).

The following diagram and table describes the effect of the three methods at set out.



1	Set out position defined radial	5	Design surface
2	Set out position defined horizontal	6	Tunnel surface
3	Set out position defined vertical	7	Center for radial position
4	Design position	-	-

To set out previously defined positions in a tunnel:

1. Tap *Survey*, select a survey style and start a survey.

From the Trimble Access menu tap *Settings / Survey styles* to edit an existing style or to define a new style.

2. Tap *Set out*.

3. Select a tunnel from the list.

Tip - To add files from another folder to the list, tap *Add*, navigate to the required folder and then select the file(s) to add.

4. To define the scan station range, use one of the following methods to select stations to scan:
 - ◆ Key values into the *Start station* and *End station* fields.
 - ◆ In the *Start station* and *End station* fields, select *List* from the pop-up menu and then select values from the list.
 - ◆ Highlight the *Start station* field, point the instrument to the required start point of the scan and then tap *Measure*. Repeat the process for the *End station*.
5. In the *Station interval* field, enter the required station interval for the scan. From the pop-up menu in *Station interval*, make sure that the correct interval method is selected. The options are *0 based* and

Relative.

- ◆ The 0 based method is the default method and gives station values that are multiples of the station interval. For example, if the start station is 2.50 and the station interval is 1.00, the 0 based method produces stations at 2.50, 3.00, 4.00, 5.00, and so on.
- ◆ The Relative method gives station values relative to the start station. For example, if the start station is 2.50 and the station interval is 1.00, the Relative method produces stations at 2.50, 3.50, 4.50, 5.50, and so on.

6. Tap *Next* to view the selected station range in the plan view. The plan view automatically zooms to the defined range.

The plan view displays the horizontal alignment of the tunnel, the instrument position, and the current direction. A black open circle indicates each station as defined by the station interval.

Tip - Tap the pan softkey and then use the left, right, up, and down arrow keys on the controller keyboard to pan around the screen.

7. Select a station to measure using one of the following methods:

- ◆ Tap an up or down arrow on the controller keyboard.
- ◆ Tap an individual station.
- ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.

The selected station appears as a red circle.

8. Tap *Next*.

9. From the cross section view, do one of the following to select a position to set out:

- ◆ Tap an individual set out position.
- ◆ Use the left and right arrow on the controller keyboard.

Set out positions are displayed as a hollow black circle with a line that is defined by the origin of the position.

10. Tap *Auto* to set out the selected position.

Note - If the *Start point* name has not been defined, the *Settings* screen appears. Complete the required fields and then tap *Accept*.

If the *Position tolerance* has not been defined, the *Tolerances* screen appears. Complete the required fields and then tap *Accept*.

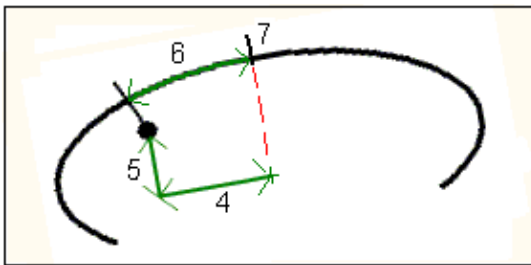
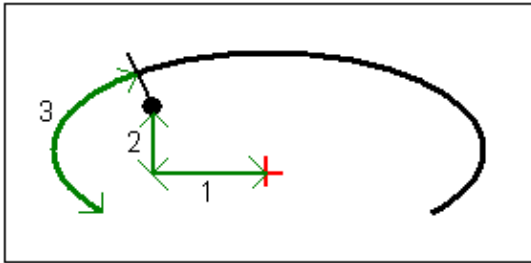
Tip - If the instrument struggles to get a measurement due to, for example, reflective or dark surfaces, increase the EDM timeout.

The instrument automatically turns to the selected position by an iterative process indicated by the progress bar at the top left of the screen. When the position is found you are instructed to mark the point.

If the position cannot be found within the position tolerance, the software shows *Failed* above the delta display.

Information on the current position and its relationship to the selected set out position appears at the bottom of the screen.

To scroll through the values, tap the arrow to the left of the text. See the following diagrams and table for details on what is available:



Number	Value	Description
-	Delta station	The station of the current position in terms of the tunnel design.
-	Delta offset	The radial difference between the measured position and the set out position. Appears in red if it is greater than the <i>Position tolerance</i> .
-	Rotation	The rotation value of the cross section at the current position
1	Hx. offset	The horizontal offset of the current position from the tunnel centerline (shown as a red cross).
2	Vt. offset	The vertical offset of the current position from the tunnel centerline (shown as a red cross). Maybe either perpendicular or true vertical, depending on the template position options in the Tunnel design.
3	Profile dist.	The profile distance of the current position measured along the selected template surface from its start point.
4	Hx. off. (rot)	The horizontal offset of the current position from the rotated tunnel centerline (shown as a green cross) and rotated with the tunnel.
5	Vt. off. (rot)	The vertical offset of the current position from the rotated tunnel centerline (shown as a green cross) and rotated with the tunnel. Maybe either perpendicular or true vertical, depending on the template position options in the tunnel design.
6	Dist. to vertex	The profile distance from the vertex (7) to the current position. The vertex (shown as a black line) is defined by the intersection of a perpendicular line from the rotated centerline (shown as a green cross) to the tunnel roof.
-	Northing	Northing of the current position.
-	Easting	Easting of the current position.
-	Elevation	Elevation of the current position.

Tip - If you want to manually locate the set out position, use the *Turn* softkey to point the instrument at the selected set out position and then fine tune the position manually. Tap the *Store* softkey to record the measured position.

If you are using a Trimble S8 total station equipped with the high-power laser pointer, tap *3R Laser* to enable the high-power laser pointer and to show the mark on the tunnel surface. An icon appears at the bottom left of the screen to show that the laser is active. Tap *Store* to record the current position in the job's database.

Notes

- ◆ Even though the high-power laser pointer is not coaxial with the telescope, the instrument can automatically turn to measure to the laser pointer location. When you tap *3R Laser*, a preliminary measurement is taken to determine the vertical angle to turn the instrument to point the high-power laser at the setout position. The instrument then automatically turns to the setout position and the high-power laser pointer is enabled. When you tap *Store*, the high-power laser pointer is disabled, the instrument turns back to the setout position, and the position is stored. The preliminary measurement is not stored.
- ◆ The calculation of the vertical angle to turn to assumes the horizontal distance to the preliminary measurement is similar to the distance to the high-power laser pointer location. To measure to the high-power laser point when it is near the upper or lower edge of an object, consider using face 1 to take measurements at the lower edge of an object, and face 2 to take measurements at the upper edge of an object so that the preliminary measurement does not overshoot the object you are measuring to.

WARNING - The high power laser is a class 3R laser that emits laser radiation - do not stare into the beam or view directly with optical instruments.

Tip - During a conventional survey, you can use the tap and hold menu in the map to quickly measure a check point. If there are no points selected, *Check backsight* is available; if one point is selected *Check shot* is available.

Alternatively, to measure a check shot from any screen, press [CTRL + K] on the controller.

11. Tap *Store* to record the measured position. The stored position is indicated by a solid black circle.

Tip - After a scan is completed, you can do the following:

- ◆ To review a summary for each station, return to the plan view, tap and hold on the screen and then select *Results*.
- ◆ To see details for the current station, return to the cross section view, tap and hold on the screen and then select *Details*. See also [Review tunnel](#).

Machine positioning

To position a machine relative to a tunnel:

1. Tap *Position*, select a survey style and start a survey.

From the Trimble Access menu tap *Settings / Survey styles* to edit an existing style or to define a new style.

2. Select a tunnel from the list.

Tip - To add files from another folder to the list, tap *Add*, navigate to the required folder and then select the file(s) to add.

3. From the *Machine positioning* screen enter the *Nominal station* of the tunnel face by either:

- ◆ Keying in a value.
- ◆ Measuring a station by selecting *Measure*.

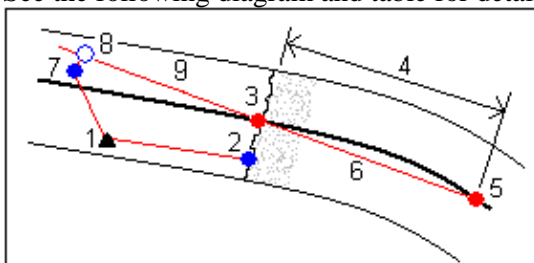
4. Enter a *Drill depth*.

Notes

- ◆ The Tunnels calculates positions on the tunnel centerline at the nominal station and at the station defined by the drill depth. A reline is calculated using these two positions.
 - ◆ The reline cannot be calculated if the:
 - ◇ nominal station is before the start of the tunnel
 - ◇ drill depth is zero
 - ◇ drill depth results in a station beyond the end of the tunnel
5. Optionally, enter *Construction offsets*. Two offsets can be specified:
 - ◆ *Transverse offset* - offset the reference line left or right of its computed position
 - ◆ *Vertical offset* - offset the reference line up or down from its computed position
 6. Tap *Next*.
 7. The calculated station and elevation values and coordinates for the two positions defining the reline are displayed along with the azimuth and grade of the reline. Use these values to confirm the reline.
 8. Tap *Next*.
 9. The transverse and vertical offsets from a measured point to a position calculated perpendicular onto the reline are displayed, along with the longitudinal offset from the calculated position on the reline to the calculated position at the tunnel face.

Use these deltas to position the machine.

See the following diagram and table for details.



1	Instrument position	6	Refline
2	Nominal station at tunnel face	7	Measured point
3	Calculated position on tunnel centerline projected from 2	8	Calculated position on refline projected from 7
4	Drill depth	7 to 8	Transverse and Vertical offsets
5	Calculated position on tunnel centerline at drill depth	9	Longitudinal offset

9. Tap *Finish*.

Tip - Tap *Back* to return to the *Refline definition* screen to confirm the definition or *Back* again to confirm the nominal station and / or drill depth.

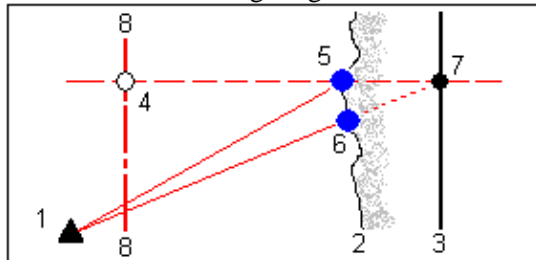
Tip - During a conventional survey, you can use the tap and hold menu in the map to quickly measure a check point. If there are no points selected, *Check backsight* is available; if one point is selected *Check shot* is available.

Alternatively, to measure a check shot from any screen, press [CTRL + K] on the controller.

On station adjustment

From the *Settings* screen use the *On station adjustment* option to control the position that will be measured when the tunnel surface does not match the design, that is, the surface is in either underbreak or overbreak.

Refer to the following diagram and table that illustrates an underbreak situation.



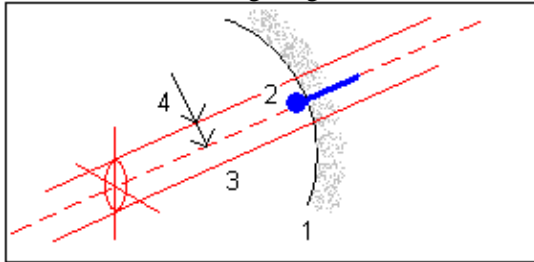
1	Instrument position	5	Measured position when <i>On station adjustment</i> is selected
2	Tunnel surface	6	Measured position when <i>On station adjustment</i> is not selected
3	Tunnel design	7	Design position
4	Station	8	Tunnel center line

The overbreak is similar to the underbreak situation.

Set Out Position Tolerance

The *Position tolerance* is defined as the radius of a cylinder that passes through the axis of the set out position. If the measured point is within this cylinder the point is within tolerance.

Refer to the following diagram and table.



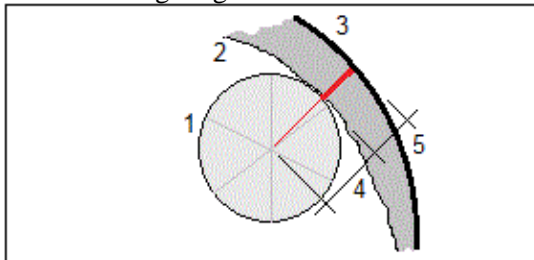
1	Tunnel surface	3	Axis of cylinder
2	Set out position	4	Radius of cylinder

Measuring a Position with a Prism

To measure a position perpendicular to the tunnel profile using a prism:

1. From the tap and hold menu, select *Settings*.
2. Select the *Apply target height perpendicular to profile* option.
3. Tap *Accept*.
4. From the status bar, enter the prism radius as the target height.

The following diagram and table describes this option.



1	Prism
2	Tunnel surface
3	Design tunnel
4	Target height (prism radius)
5	Overbreak

Review Tunnels

Review

Use *Review* to see the survey results for:

- [Scanned](#) and manually measured points
- [Set out](#) points

Scanned points

To review a tunnel scan:

1. Tap *Review* select a tunnel from the list, and then tap *OK*. The plan view of the tunnel appears.

Stations with no scan points outside tolerance appear as solid green circles, while those with errors appear as solid red circles.

Tip - Tap the pan softkey and then use the left, right, up, and down arrow keys on the controller keyboard to pan around the screen.

2. By default the first station is selected. To select another station to review, do one of the following:
 - ◆ Tap an up or down arrow on the controller keyboard.
 - ◆ Tap an individual station.
 - ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.

The selected station appears as a red circle.

3. To view a summary for each station, select *Results* and then expand the station that you want to review.
 - ◆ To view the number of points scanned, the number of points within tolerance, and the number of points outside tolerance, expand the *Scanned points* record.
 - ◆ To view the number of points in overbreak, underbreak, and delta station, expand the *Points outside tolerance* record.

Tip - If you edit the tolerance values, the deltas are updated. To do this, tap and hold on the screen and then select *Tolerances*.

4. Tap *Close*.
5. To view the cross section for the current station, select the icon at the bottom right of the screen or press the **Tab** key. From the cross section view, tap and hold on the screen and then select *Scanned points*. The selected mode, *Scan*, is shown at the top left of the screen.

Each scanned position appears as a green circle if it is within tolerance or as a red circle if it is not within tolerance.

6. The point name, overbreak / underbreak, and delta station values appear for the current position. Tap other points to view their delta values. To deselect a point, tap off the point. Alternatively, tap and hold on the screen and then select *Clear selection*.
7. To view details for a selected point, tap *Details*. Expand the point that you want to review: The Offsets (true), Offsets (rotated), Grid coordinates, Underbreak / Overbreak, and Delta station values are shown for each point.
 - ◆ To view the horizontal and vertical offsets from the intersection of the horizontal and vertical alignments to the scanned position, expand the *Offsets (true)* record.
 - ◆ To view the rotated horizontal and vertical offsets from the intersection of the rotated horizontal and vertical alignments to the scanned position, expand the *Offsets (rotated)* record.
 - ◆ To view the north, east, and elevation values for the measured positions, expand the *Grid* record.

8. Tap *Close*.

Tip - If you edit the tolerance values, the deltas are updated. To do this, tap and hold on the screen and then select *Tolerances*.

9. Select another station to review using one of the following methods:
 - ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.
 - ◆ Tap an individual station.
 - ◆ Tap an up or down arrow on the controller keyboard.
10. To delete a selected point, tap the backspace key. Alternatively, tap and hold on the screen and then select *Delete point*. To restore deleted points, tap and hold on the screen and then select *Restore deleted points*.
11. Tap *Esc*.

Note - All scanned and measured points are face 1 measurements and are stored in the database. To review them, go to *Jobs / Review job*.

Set out points

To review set out points:

1. Select *Review* select a tunnel from the list, and then tap *OK*. The plan view of the tunnel appears.

Tip - Tap and hold on the pan softkey to use the left, right, up, and down arrow keys to pan around the screen.

2. By default the first station is selected. To select another station to review, do one of the following:
 - ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.
 - ◆ Tap an individual station.
 - ◆ Tap an up or down arrow on the controller keyboard.

The selected station appears as a red circle.

3. To view a summary for each station, select *Results*, and expand the station that you want to review.

- ◆ To view the number of points setout and the number of points within tolerance expand the *Set out points* record.
4. Tap *Close*.
 5. To view the current cross section showing the design tunnel and set out positions, select the icon at the bottom right of the screen or press the **Tab** key. From the cross section view, tap and hold on the screen and then select *Set out points*. The selected mode, *Set out*, is shown at the top left of the screen.

Measured set out positions are indicated by a solid black circle.

6. The point name, horizontal and vertical offsets are displayed for the current position. Tap other points to view their delta values.
7. To view details for a selected point, tap *Details*. Expand the point that you want to review. For each point, the Offsets (true), Offsets (rotated), Grid coordinates, and Delta station values are displayed.
 - ◆ To view the horizontal and vertical offsets from the intersection of the horizontal and vertical alignments to the measured position, expand the *Offsets (true)* record.
 - ◆ To view the horizontal and vertical offsets from the intersection of the rotated horizontal and vertical alignments to the measured position, expand the *Offsets (rotated)* record.
 - ◆ To view the north, east, and elevation values for the measured positions, expand the *Grid* record.
8. Tap *Close*.
9. To select another station to review, do one of the following:
 - ◆ Tap and hold on the screen and then select a station from the list in the *Select stations* field.
 - ◆ Tap an individual station.
 - ◆ Tap an up or down arrow on the controller keyboard.

The selected station appears as a red circle.

10. Tap *Esc*.

Note - All set out points are face 1 measurements and are stored in the database. To review the points, go to [Jobs / Review job](#).


File Transfer

Report - Export Custom Format Files

Use the *Report* option to create custom ASCII files on the controller while in the field. Use the predefined formats or create your own custom formats. With custom formats, you can create files of almost any description. Use these files to check data in the field, or to produce reports, which you can transfer from the field to your client or to the office for further processing with the office software.

You can modify a predefined format to meet your specific requirements, or use it as a template to create a completely new custom ASCII export format.

To create a report of survey data:

1. Open the job that contains the data to export.
2. From the Tunnels menu, tap *Report*.
3. In the *File format* field, specify the type of file to create.
4. Tap  to select an existing folder or create a new one.
5. Enter a filename.

By default, the *File name* field shows the name of the current job. The filename extension is defined in the XSLT style sheet. Change the file name and extension as required.

6. If more fields are displayed, complete them.

You can use the XSLT style sheets to generate files and reports based on parameters that you define. For example, when generating a Stakeout report, the *Stakeout horizontal tolerance* and the *Stakeout vertical tolerance* fields define acceptable stakeout tolerances. When generating the report you can stipulate the tolerances, then any stakeout delta greater than the defined tolerances appears in color in the generated report.

7. To automatically view the file after you create it, select the *View created file* check box.
8. To create the file, tap *Accept*.

Note - When the selected XSLT style sheet is applied to create the custom export file, the processing is all carried out in the program memory available on the device. If there is not enough memory to enable the creation of the export file, an error message will be displayed and no export file will be created.

Four factors will affect whether the export file can be created

1. The amount of program memory available to the device.
2. The size of the job being exported.
3. The complexity of the style sheet being used to create the export file.
4. The amount of data being written to the export file.

If it is not possible to create the export file on the controller, download the job as a JobXML file to a computer.

To create the export file from the downloaded JobXML file using the same XSLT style sheet, use the ASCII File Generator utility program (available from www.trimble.com).