



GeoCOGO Operation Manual

Version 2021.11.22

GeoLab-Compatible **CO**ordinate **GeO**metry Tool

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Introduction

The GeoCOGO tool is designed as a 3D calculator to facilitate geometrical computations between new and existing points.

The tool has four main functions in this regard:

1. Set new points based on known observations.
2. Determine the geometry (inverse) between existing points (such as in an adjusted network) for quality control against known geometry.
3. Find the geometrical misclosure in a traverse loop, given known points and field observations.
4. Find the geometrical surface area and volume of a closed loop, given known points and an Earth ellipsoid.

Using COGO point-setting tools, field and survey plan observations can be used to create an accurate visual map of the locations of surveyed monuments, and much more.

Overview

Usage

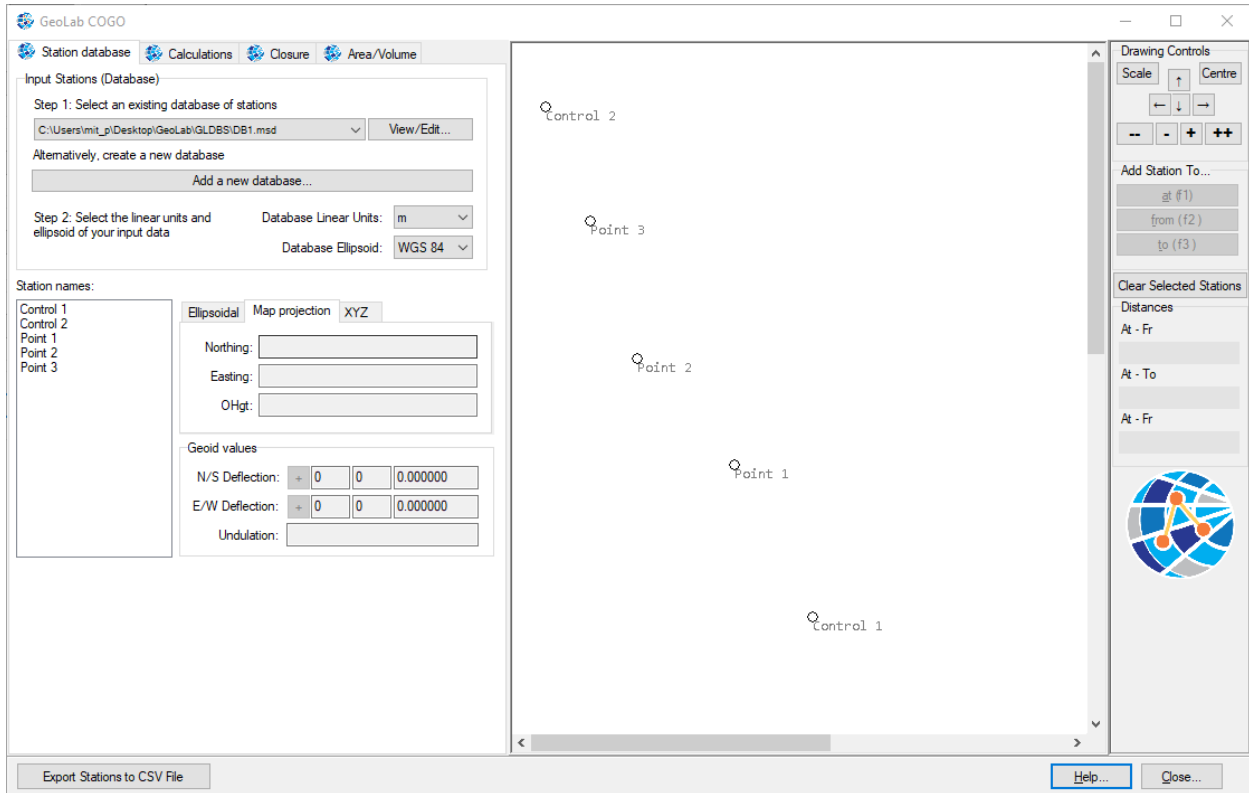
The GeoCOGO tool has a simple design with all relevant tools visible on each relevant dialog, and none hidden away in complicated popup menus.

GeoCOGO has four main tabs used to access its various functions:

1. **Station Database:** Select a “database” to work with and load in any existing points if applicable; select the linear units and ellipsoid that apply to this input data
2. **Calculations:** Set new points by a variety of geometrical functions, and inverse to determine these same function values between existing points
3. **Closure:** Load a GeoLab adjusted network and use the input observations taken between existing points to determine the misclosure values in selected traverse loops
4. **Area/Volume:** Find the square surface and planimetric area values for a selected loop of points in your database, alongside the cubed volume above and below given cut heights

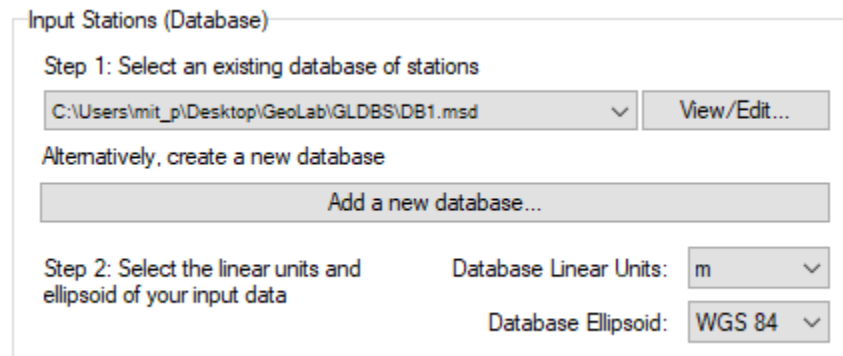
Features and Usage

Station Database Tab



In order to properly use the **Calculations** and **Area/Volume** tabs, there must be an active station database with at least one point loaded into it.

Active Station Database



GeoCOGO will automatically load the most recently used station database and its points will be displayed in the drawing panel. The **Station database** dropdown displays the currently active database, and drops down to show any previously loaded databases.

The **View/Edit...** button opens the [Station Database Dialog](#) which allows you to select a database from some other location on your computer, create a new database, or add to and edit stations in the current database.

Alternatively, the **Add a new database...** button will bring up a dialog allowing you to quickly add and select a new database and fill it with stations.

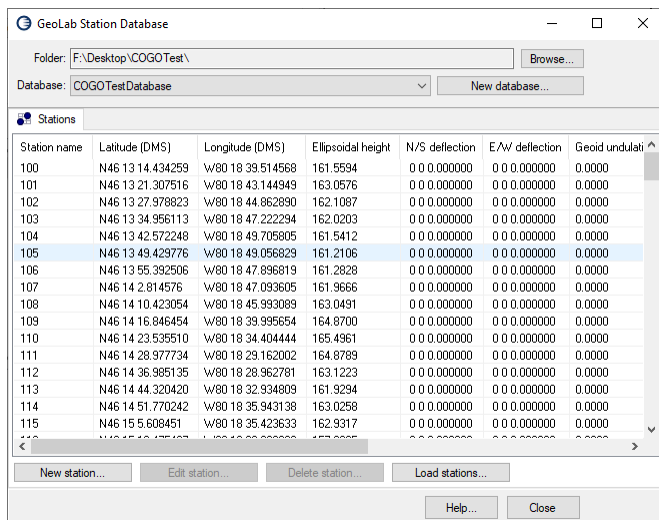
Change Station Database Datum

The **Database Linear Units** toggle sets the linear units of the points loaded in. Since points are loaded in as Latitude-Longitude-Ellipsoidal Height, this only applies to the ellipsoidal heights. This value will typically be in meters (m).

The **Database Ellipsoid** toggle sets the ellipsoid reference from which the ellipsoidal heights are derived. This will vary depending on the reference datum of the source that produced the ellipsoidal heights.

It is important that the input linear units and ellipsoid be correct, in order to provide accurate COGO results.

Edit Station Database



This dialog will look in the selected **Folder** for all existing databases and load them into the **Database** dropdown. Select a database to make it the active database.

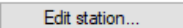
Clicking the **Browse...** button will allow you to change the active folder and search for station databases in another location on your computer.

The **New database...** button will create a new station database in the active folder.

The **Stations Tab** list view below these options shows all stations inside the active database.

These stations can carry a variety of detailed information, including pictures.

Edit a Station

 Click the **Edit Station...** button with a station active to view and edit this information (alternatively, click the **Edit Station** tab)

The **Edit Station Tab** contains the following information:

- Station Name
- Latitude
- Longitude
- Ellipsoidal Height

The above values are mandatory, as they convey the geographical information of a point. The remaining information is optional:

- Project Name
- Party Chief
- Point Description
- N/S deflection

- E/W deflection
- Undulation
- Date/Time
- Company
- Station Bitmap Drawing

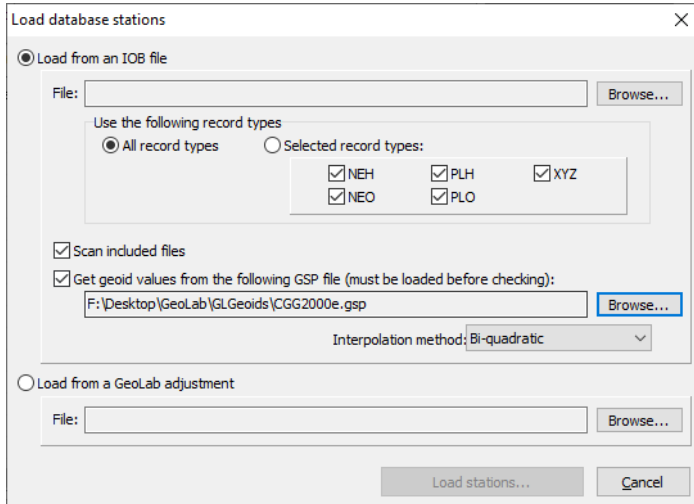
Add or Remove Stations

New station... Clicking the **New station...** button will bring up a blank **Edit Station** dialog, allowing you to manually add an individual new station.

Delete station... Clicking the **Delete station...** button will simply delete the selected station from the station database.

Load Multiple Stations

Load stations... The **Load stations...** button brings up the Load Database Stations dialog, which allows you to import multiple stations at a time from a GeoLab .IOB file or a GeoLab adjusted network.



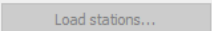
Load from an IOB file:

Use this option to load initial stations of selected types from a given IOB file, and optionally, any included IOB files.

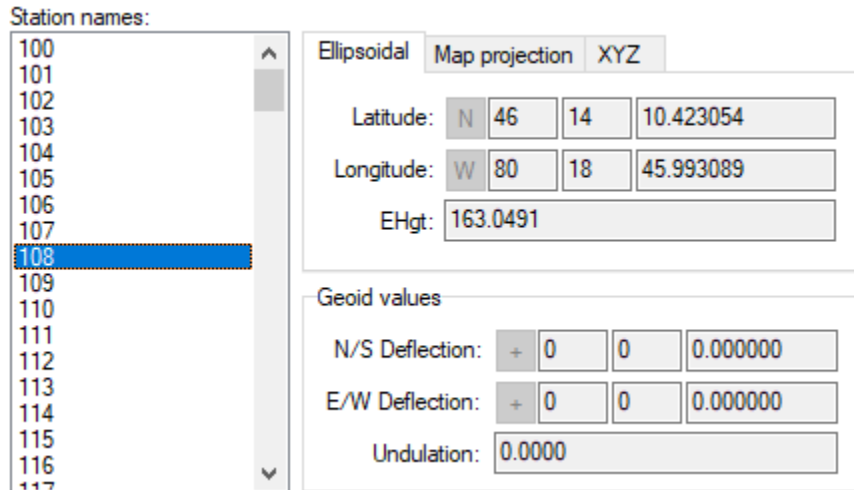
Since this does not load in adjusted stations, you can optionally interpolate geoid values from a geoid specification (.gsp) file.

Load from a GeoLab adjustment:

This option will load all stations from a GeoLab adjusted network, including any geoid data provided during the adjustment.

 Select the appropriate method you would like to use to import your stations, click the **Browse...** buttons to select the files containing the points and geoid if applicable, and click the **Load Stations...** button.

Station View

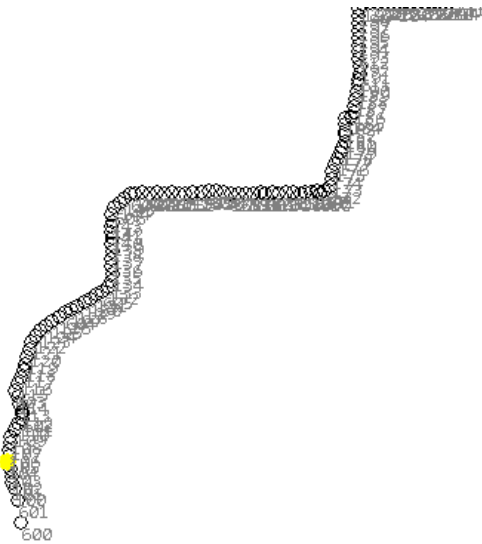


All the stations in the active database will be loaded into the **Station names** box.

Click a station to display its geographical information and geoid values, in either **Ellipsoidal**, **Map Projection**, or **XYZ** reference.

Double-click a station to open the active database and view/edit its stations.

The Drawing



The Drawing is common throughout each of the four COGO functions (**Station Database, Calculations, Closure, Area/Volume**), though with a slightly different function in each.

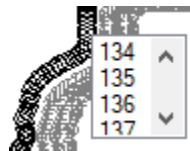
All the stations from the active database are projected onto a flat plane and drawn on this portion of the dialog.



When a station on the **Station Database** tab is clicked, **The Drawing** will center to that station and highlight it in yellow.

Conversely, clicking on a point on the drawing will highlight that point in the **Station names** box and display its geographical and geoid values.

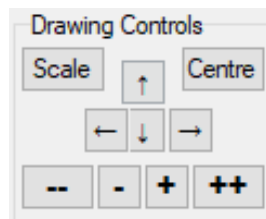
Multi-Select



If you click a point on the drawing at a scale where the individual point cannot be determined, a selection box will be presented with all the potentially clicked points.

Click a point in this box to select it.

Drawing Controls



Scale

Click on the **Scale** button to “scale to fit” the drawing, so that all points are visible in the drawing window.

Centre

The **Centre** button will center the drawing around the network’s median point.

Pan

The arrow key buttons will pan the drawing up, left, right, or down.

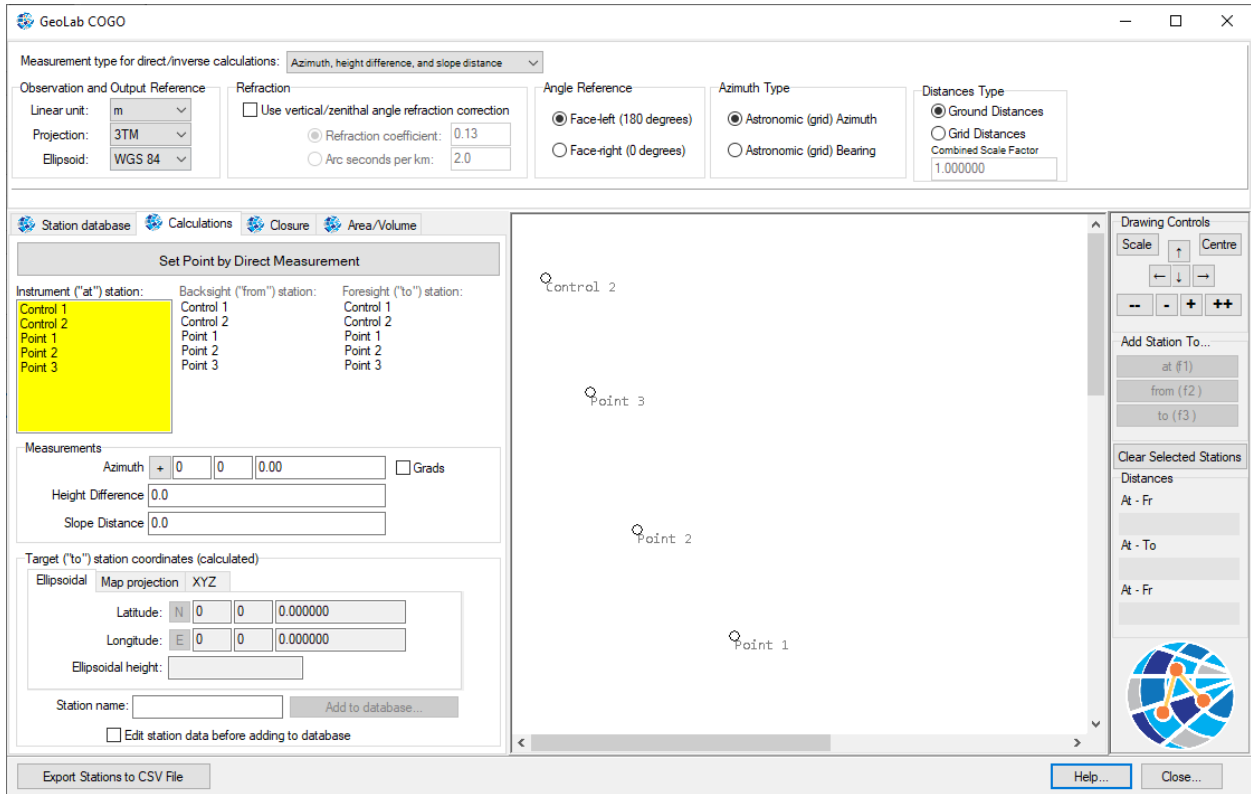
Alternatively, you can use the mouse to drag the drawing in any of these directions with a “drag and drop” motion.

Zoom

Use the +/- and ++/-- buttons to zoom and super-zoom in and out of the drawing’s median point, respectively.

Alternatively, you can use the mouse wheel to zoom in and out of the cursor position or hold the control function key (Ctrl) and use the mouse wheel to super-zoom in and out of the cursor position.

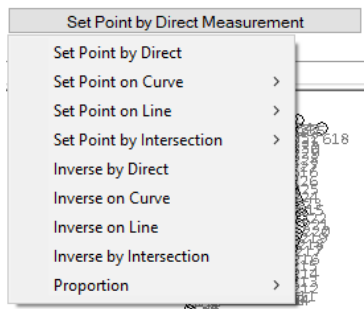
Clear Selected Stations To clear the selected point from the drawing, either click the **Clear Selected Stations** button or click a blank section of the drawing.



Calculations Tab

The **Calculations Tab** is used to add new points to your database using 3D or 2D geometrical observations, or to determine the 3D and 2D geometrical observations between existing points.

*Important note: to use this tab, you need to have stations loaded through the **Station database tab***



First, select the COGO function you would like to use.

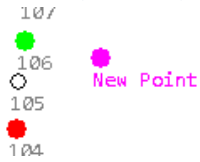
Click the button near the top-left portion of this dialog, which may say “Set Point by Direct Measurement” by default; this will provide a pop-up menu from which you can choose your COGO function of choice:

COGO Measurement Types

Quite note: 3D functions work by measuring directly along the ellipsoid in a 3D reference frame, while 2D functions work by measuring along a 2D plane at the height of the reference point.

For these reasons, there may be some loss in accuracy when using 2D functions such as the intersection functions alongside reference points with a large change in height. In normal use, this should not be an issue.

Set Point by Direct (3D)



This function allows you to directly set a new point from an existing reference point via one of the following **3D** observation types:

- Azimuth, height difference, slope distance
- Azimuth, vertical angle, slope distance
- Azimuth, zenithal angle, slope distance
- Horizontal angle, height difference, slope distance
- Horizontal angle, vertical angle, slope distance
- Horizontal angle, zenithal angle, slope distance
- Delta X, Y, Z cartesian

Set Point on Curve (2D)



Set a new point along a 2D curve beginning at a reference point and centered around a second reference point, based on one of the following:

- Horizontal angle
- Chord length
- Arc length

Optionally, specify an offset value to offset the new point towards or away from the center point.

Set Point along Line (3D)

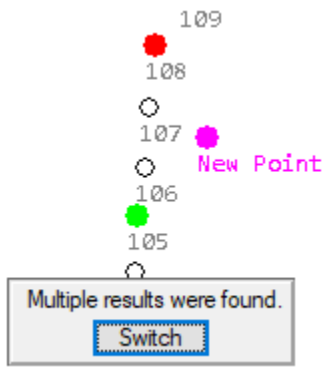


Set a new point along a 3D line beginning at a reference point and ending at a second reference point, based on one of the following:

- Distance along line
- Percentage along line

Optionally, specify an offset value to offset the new point perpendicular to this line.

Set Point by Intersection (2D)



Set a new point at the intersection between two reference points, based on one of the following:

- Distance/distance
- Distance/azimuth
- Azimuth/distance
- Azimuth/azimuth

In the case that there are two intersections found, a dialog will allow you to switch between the two results before confirming the new point.

This function looks for the intersection assuming it occurs on a flat plane surrounding the first reference point (2D).

Inverse by Direct (3D)



Select one of the following observation types and select the appropriate number of reference points to determine the measurement quantities between them:

1. Azimuth, vertical angle, slope distance
2. Azimuth, zenithal angle, slope distance
3. Horizontal angle, height difference, slope distance
4. Horizontal angle, vertical angle, slope distance
5. Horizontal angle, zenithal angle, slope distance
6. Delta X, Y, Z cartesian

Inverse along Curve (2D)



Select two reference points and a curve point to determine the following:

- Angle along curve
- Chord along curve
- Arc along curve
- Offset of point from curve

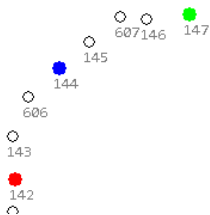
Inverse along Line (3D)



Select two reference points and a target point to determine the following:

- Distance along line
- Percentage along line
- Offset of point from line

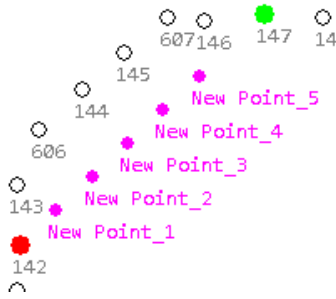
Inverse Intersection between Points (2D)



Select two reference points and a target point to determine the following:

- Azimuth from 1st
- Azimuth from 2nd
- Distance from 1st
- Distance from 2nd

Proportion along Line (3D)

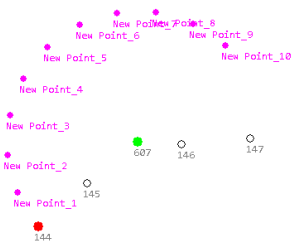


Set a given number of new points along a 3D line between two points by the following:

- Number of points to set
- Distance between points

Optionally, specify a maximum distance to reach along the line with the proportioned points (ie. stop proportioning new points halfway) and/or specify an offset value for each of the new points

Proportion along Curve (2D)



Set a given number of points along a 2D curve starting at a reference point and centered at another by the following:

- Number of points to set
- Angle between points
- Arc distance between points
- Chord distance between points

Optionally, specify a maximum angle (between 0° and 360°) to reach along the curve with the proportioned points, and/or specify an offset value for each of the new points.

Other Calculations Controls

Measurement type for direct/inverse calculations: Azimuth, height difference, and slope distance ▼

<p>Observation and Output Reference</p> <p>Linear unit: m ▼</p> <p>Projection: 3TM ▼</p> <p>Ellipsoid: WGS 84 ▼</p>	<p>Refraction</p> <p><input type="checkbox"/> Use vertical/zenithal angle refraction correction</p> <p><input checked="" type="radio"/> Refraction coefficient: 0.13</p> <p><input type="radio"/> Arc seconds per km: 2.0</p>	<p>Angle Reference</p> <p><input type="radio"/> Face-left (180 degrees)</p> <p><input checked="" type="radio"/> Face-right (0 degrees)</p>
---	--	---

Measurement type for direct/inverse calculations

Measurement type for direct/inverse calculations: Horizontal angle, zenithal angle, and slope distance ▼

Select the measurement type for setting a new point via direct measurement or inverting to determine direct measurements (only available with **Set Point by Direct** or **Inverse by Direct**).

Observation and Output Reference

Observation and Output Reference

Linear unit: m ▼

Projection: 3TM ▼

Ellipsoid: WGS 84 ▼

Select the linear units, map projection, and ellipsoid used for all the calculations on this tab. This applies to the display values of the points and the measurement quantities provided. Custom definitions created in GeoLab's Tools tab will also be available here.

Refraction

Refraction

Use vertical/zenithal angle refraction correction

Refraction coefficient: 0.13

Arc seconds per km: 2.0

Apply a vertical and zenithal angle correction based on refraction values provided via a refraction coefficient or arcseconds per km. This only applies to **Set Point by Direct** when a zenithal or vertical angle is being used.

Angle Reference

Angle Reference

Face-left (180 degrees)

Face-right (0 degrees)

Modifies the backsight reference for **Set Point by Direct** and **Inverse by Direct** computations; this affects the following:

- Horizontal angle zero-reference will start at 0° in face-right, and 180° in face-left
- Zenith reference will start at 90° in face-right and 270° in face-left
- Vertical angle reference will start at 0° in face-right and 360° in face-left

This is a useful feature when working with total station data that was taken in face-right and face-left configurations, removing the need to manually bring all the data to one configuration first.

Azimuth Type

Azimuth Type

Astronomic (grid) Azimuth

Astronomic (grid) Bearing

Select the angle type for azimuths (horizontal absolute angles).

Azimuth type is a measurement clockwise from North when positive, and counterclockwise from North when negative.

Bearing type is an angle measurement specified as an angle relative to two grid bearing references, for example N 25 10 2 E representing 25 degrees, 10 minutes, 2 seconds East starting from North.

Distances Type

Distances Type

Ground Distances

Grid Distances

Combined Scale Factor

1.000000

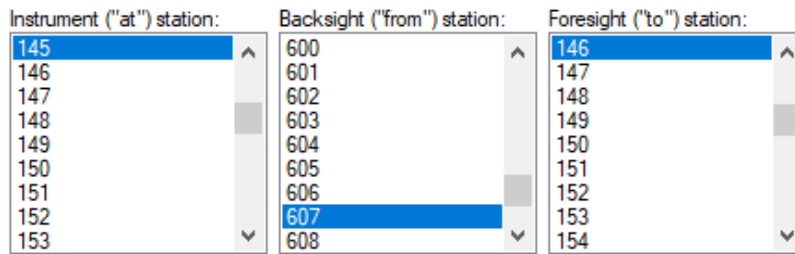
Select the measurement type for distances.

Ground distances are observations that have been taken on the ground, which can be seen as the real observations as could be seen in real life or observed with a tape measure.

Grid distances are observations that have been taken on the Grid, which is a 2D representation of the Earth's surface such as a map projection. Grid distances are converted to real (ground) observations using a scale factor. These are observations that may have been taken with a survey instrument or converted from previous ground distances for other purposes.

For GeoCOGO's purposes, the combined scale factor is used which is a combination of the elevation and grid scale factors.

Station Controls



Depending on the COGO function being used, between one to three stations will need to be selected.

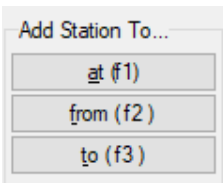
Their use will be specified in the title (eg. Instrument "at" station).

Each of these boxes will contain all the stations in the active database; select a station in an active box to highlight it and center on it in **The Drawing**. Conversely, click to select a station on **The Drawing** and add it as an active station to select it in the appropriate box.

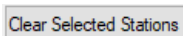
The highlights on **The Drawing** will always be shown as such:



- Red = "at" station
- Green = "from" station
- Blue = "to" station
- Yellow = current selected point (not yet active)



Click one of the appropriate buttons or the function hotkeys (f1, f2, f3) to add a station selected on the drawing as one of the three required active stations for the current function.



Click the **Clear Selected Stations** button to clear all stations selected as active stations in a function, including the current highlighted point.

Stn	604
Lat	46.272529
Lon	-80.289579
EHgt	166.006700

When a station has been selected in one of the selection boxes, or by clicking it on **The Drawing**, its information will be shown at the bottom of **The Drawing** in a concise list.

The format of this information will follow the selected format in the **Target ("to") station coordinates (calculated)** box (Ellipsoidal, Map Projection, XYZ) and the **Output and Observation Reference** values.

Distances	
125 - 126	259.2363
125 - 604	519.4979
126 - 604	260.9136

When more than one station is selected as an active station, the distances between each of them will be displayed in the selected linear units.

Measurement Quantities

Measurements					
Horizontal Angle	+	176	48	28.99	<input type="checkbox"/> Grads
Zenith Angle	+	269	26	40.50	<input type="checkbox"/> Grads
Slope Distance	454.4150				

When using any one of the inverse functions, the results of the inverse computation will be shown in the **Measurements** group.

Measurements					
Horizontal Angle	+	45	0	0.00	<input type="checkbox"/> Grads
Zenith Angle	+	90	0	0.00	<input type="checkbox"/> Grads
Slope Distance	500				

When using any of the point-setting functions, the **Measurements** group is used to provide the observations used to derive the new point(s).

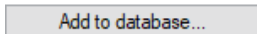
Target ("to") station coordinates (calculated)				
Ellipsoidal	Map projection	XYZ		
Latitude:	N	46	18	17.221354
Longitude:	W	80	14	0.096969
Ellipsoidal height:	174.6175			
Station name:	My Point		Add to database...	
<input type="checkbox"/> Edit station data before adding to database				

In this case, the **Target ("to") station coordinates (calculated)** group will show the geographical coordinates of the new point.



My Point

This point will be shown highlighted in fuchsia on **The Drawing**, alongside the name you specify. Change the name accordingly.



Click the **Add to database...** button to add this new point to the active point database.

Edit station data before adding to database If you wish to edit the detailed information of this new point via the **Edit Station Tab**, check off the **Edit station data before adding to database** checkbox before adding the point.

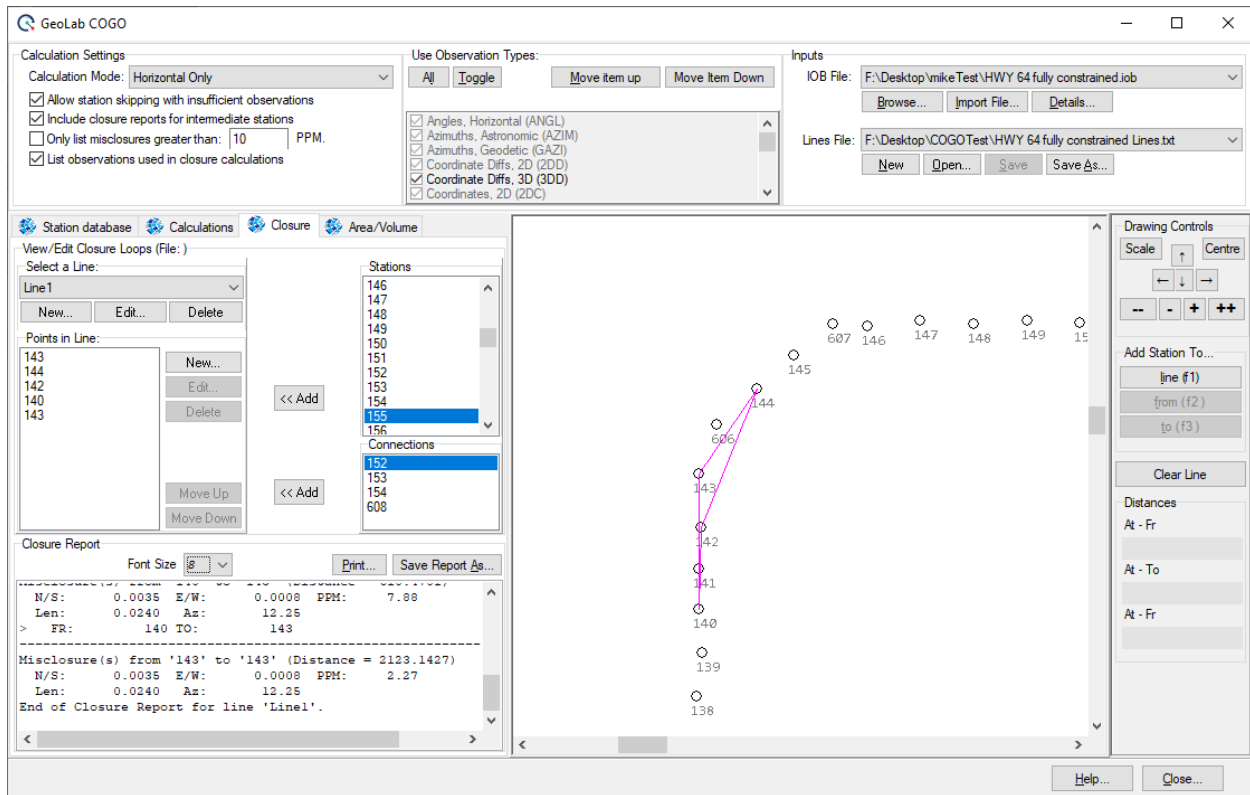
Message Dialog

No intersection; distances must add up to at least 1244.394828m

At the top of **The Drawing**, you will see a small box pop-up when there is a message the program needs to display. These messages typically contain the following:

- Error messages pertaining to intersection, set along curve, and other such functions
- Offset values and other secondary information derived from certain inverse functions, such as the inverse along curve function

Closure Tab



The **Closure Tab** is used to determine the geometrical closure values. This is done by finding the theoretical value of a station's location based on the field observations and comparing this against the adjusted location of that station.

Because of this, only two stations are needed to find the misclosure values of that second station. As you add more stations to a misclosure line, the various errors will propagate and the misclosure values will increase.

To check the misclosure values for a traverse loop, simply add each of the points in this traverse to a closure line and ensure that there are observations between each of the points; the larger the traverse, the larger the final misclosure is likely to be.

At each section of the closure calculation, a PPM value is provided based on the cumulative misclosure values and the distance between the two points at that section. The final section of the closure loop will provide a PPM value based on the cumulative misclosures and total distance of the loop.

Important note: to get started with Closure, ensure that you have an IOB file (top-right) loaded as well as a Lines File (top-right) loaded with an active Line (mid-left).

Closure uses separate stations from COGO/Area Volume as it requires observations to be loaded from an IOB file as well as stations.

Inputs

The **Closure Tab** is different from the remaining tabs in the GeoCOGO program in that it requires point locations and field observations to work.

This means that the **Closure Tab** contains a separate network than the other three tabs,

which must be loaded through the **Inputs** section.

While any source can theoretically be used to generate the COGO network (including COGO calculation tools), a GeoLab adjusted network must be used to generate the Closure network.

If you wish to find the misclosure between points created with the COGO tools, you will need to survey between those points and run an adjustment through the GeoLab program.

IOB File

The **IOB File** dropdown requires you to select an existing IOB file via the **Browse...** button, or a previously loaded file in the dropdown.

The IOB file you load **must be the main IOB file for the given project**; the adjusted network will then be loaded alongside its stations and observations. This is a necessary step before any misclosures can be found.

Importing IOB Files

You can easily import files from a variety of popular formats such as Trimble Business Center with the **Import File** button.

Alternatively, you can make use of GeoLab's GLIImports custom import tool to import delimited and fixed-column text files of your choice and formatting with the **GLIImports** button.

Lines File

The **Lines File** is a plaintext file that needs to be loaded or created; all closure lines/loops are saved in this file and used to generate **Closure Reports**.

You will generally only need one Lines File for each project, and you can create multiple individual closure lines within that one file.

It is important to click the **Save** button here whenever you make changes to the closure lines within the file, do that your changes are saved for the next time you load the file.

Calculation Settings

Calculation Settings

Calculation Mode: Horizontal Only

Allow station skipping with insufficient observations

Include closure reports for intermediate stations

Only list misclosures greater than: PPM.

List observations used in closure calculations

The **Calculation Settings** group allows you to change the settings relating to the misclosure calculations and the **Closure Report** in the bottom-left of this tab.

Calculation Mode relates to the type of misclosure calculation, and can be one of the following:

- Vertical (height) only; **1D**
- Horizontal only; **2D**
- Horizontal and vertical; **3D**
- X, Y, Z cartesian; **3D**

Each calculation mode requires enough observation data to make its corresponding misclosure calculations; if there is not enough information available between any given stations in the closure loop, a message will be shown in the **Closure Report**.

This will usually occur if there are no observations or the proper type between stations, such as if two stations contain only leveling observations between them and the desired calculation mode is **3D**.

Allow station skipping with insufficient observations

Allow station skipping with insufficient observations will tell the closure computation to continue and skip a given station if it does not have sufficient observations to and from it, allowing closure computations to be generated for the remainder of the loop.

Include closure reports for intermediate stations

Include closure reports for intermediate stations will display all misclosures generated for the entire closure loop, not just the final quantity; this includes all misclosures between each set of stations and their respective PPM values.

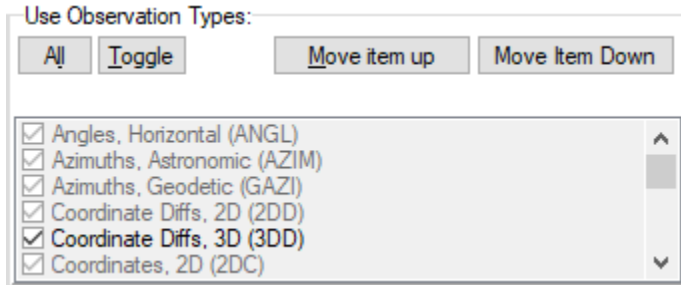
Only list misclosures greater than: PPM.

The **Only list misclosures greater than** option will limit the misclosures shown in the **Closure Report** to only those greater than the given PPM value. This is useful when including closure reports for intermediate stations.

List observations used in closure calculations

List observations used in closure calculations will give a brief summary of the observation types used in the closure calculations between each set of intermediate stations. This becomes more useful when working with mixed networks with many different observation types.

Observation Types



The **Use Observation Types** group controls which types of observations are to be used in **Closure Report** calculations.

When a point is selected on **The Drawing**, this will also control which secondary and tertiary points are displayed as connected by field observations.

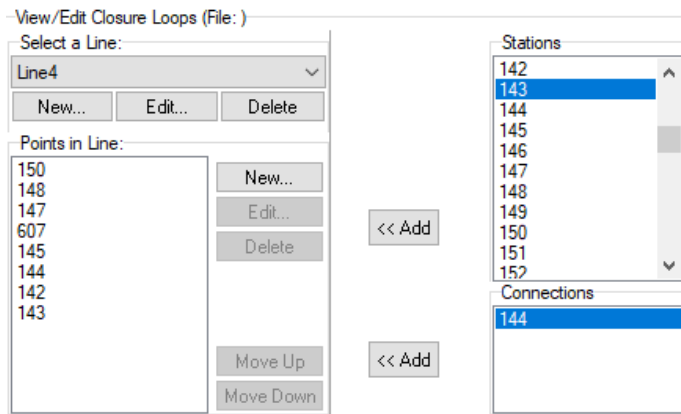
When a network is loaded, all observation types contained in that network will be shown as active while all other types will be grayed out.

When a **Closure Report** is generated, only the selected active observation types between each of the stations in a closure loop will be used for calculations; this means that it is important to have the desired observation types active when creating a loop, to ensure the stations are connected.

If your stations should be connected but the **Closure Report** is saying there are not enough observations between stations, try using more observation types (check each or click **All**) and ensuring you are using the correct **Calculation Mode**.

To make it easier to access your most commonly used observation types, you can use the **Move item up** and **Move Item Down** buttons to move the observation types of choice to the top of the list.

View/Edit Closure Loops (Lines)

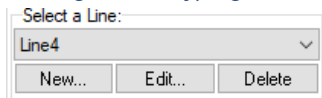


In order to generate a **Closure Report**, you must specify a line containing all the points in that closure line.

In order to create a line, you must first have a **Lines File** opened and an **IOB File** network loaded.

You can create any number of closure loops within a given **Lines File**.

Adding or Modifying a Line



The **Select a Line** box allows you to select the active line from which to load and add points and generate the **Closure Report**.

The **New...** button here will create a new line in the **Lines File** with the specified name.

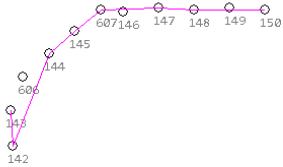
The **Edit...** button will rename the selected line.

The **Delete...** button will delete the selected line.

Any changes made here can be saved by clicking the **Save** button underneath the **Lines File**.

Generating the Closure Report

When a line contains two or more points, the **Closure Report** will be automatically generated based on the **Observation Types** selected and contained between the points in the closure loop.



As you add points to a line, the **Closure Report** will be updated and the loop will be shown on **The Drawing** in fuchsia.

You can add, remove, and modify the position of points within the selected line with the buttons to the right of the **Points in Line** box, however this is not generally recommended as it may affect the connectedness of the points within the line.

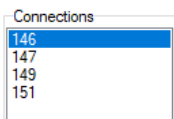
Adding Points

The goal of adding stations to a line is to have all stations connected to one another throughout the line, so that no stations need to be skipped when generating the **Closure Report**.



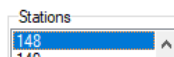
Click on a station in the **Stations** box to select, pan to, and highlight it in yellow on **The Drawing**.

Alternatively, you can select a point and highlight it in the **Stations** box by clicking it on **The Drawing**.



When a point has been selected, all points it is connected to via the selected **Observation Types** will be highlighted in green. These connected points will also be populated in the **Connections** box.

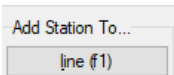
To add the selected point to the loop, you can do one of several things:



Double-click the point in the **Stations** box



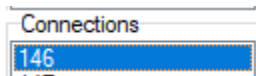
Select the point (either by clicking it in the **Stations** box or on **The Drawing**) and click the << **Add** button



With the point selected, click the **Add Station To... line (f1)** button or press the **f1** function key

Connected Points

After adding a point to the line, you should then add a connected point so that the **Closure Report** can be calculated properly.



Double-click a point in the **Connections** box to add it to the current line; this will also highlight the point and show its connections.

Alternatively, you can select one of the connected points by clicking it on **The Drawing** or in the **Stations** box and adding it with the above method.



When working with a network containing sporadic connections between its points, it may be useful to peek ahead at the connections of a point's connected points to ensure you can close your loop properly.

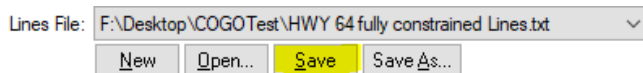
You can view these "tertiary" points by single-clicking a point in the **Connections** box; this will put a small navy blue highlight over the selected connection and show all its connections in purple.

Removing Points

Delete As mentioned earlier, you can click the **Delete** button next to the **Points in Line** box to remove the selected station from the active line, thereby updating the **Closure Report**.

Clear Line You can also click the **Clear Line** button at the right side of the window to remove all points from the selected line.

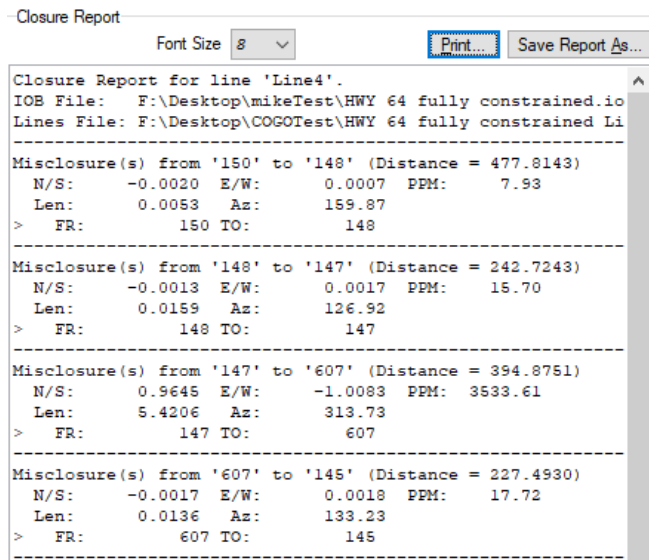
Saving Changes to a Line



Any changes you make to a **Lines File**, including adding **Closure Loops (Lines)** or modifying the

Stations within these lines, can be saved by clicking the **Save** or **Save As...** buttons below the selected **Lines File**.

Closure Reports



The **Closure Report** is automatically generated whenever the active **Closure Loop (Line)** is updated and contains at least 2 stations.

The content of the report depends on the other controls on the **Closure Tab**, including:

- **Loaded Network (IOB File)**
- **Selected Line and Points in Line**
- **Calculation Settings**
- **Observation Types**

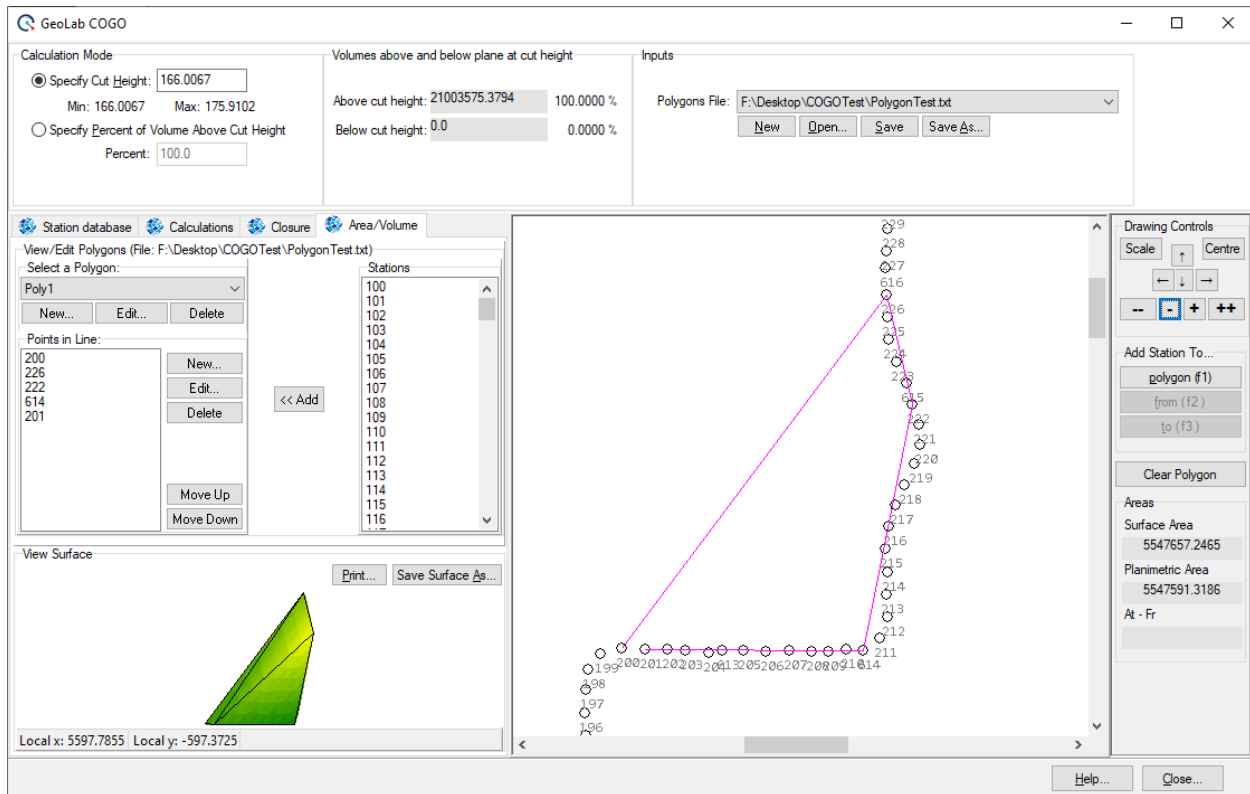
Font Size You can change the display size of the **Closure Report** with the **Font Size** dropdown menu.

Print... **Save Report As...** The **Print...** and **Save Report As...** buttons allow you to send a report to a connected printer and save it as a plaintext file, respectively.

The **Misclosure** values in the **Closure Report** depend on the **Calculation Type** and also the number of points in a given line, as the longer a line is the more propagated error there will be in the misclosure values.

This is important to keep in mind, as although the final PPM value may be low due to the length of a line the absolute misclosure values may be high enough to be of concern.

Area/Volume Tab



The **Area/Volume Tab** is used to determine the geometrical area and volume of a section of your COGO network, based on a few factors:

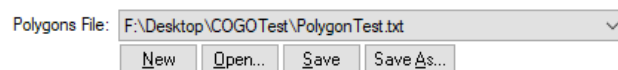
- Output linear units
- Output reference ellipsoid
- Network ellipsoidal heights

After at least three stations are contained in the polygon, a **Triangulated Irregular Network (TIN)** is generated using the station 3D coordinates and the ellipsoidal model of the Earth's surface.

This TIN is used to determine the 2D Surface and Planimetric areas of the specified area, as well as the 3D volumes above and below a designated cut height. If this cut height is set at the lowest height in the TIN, then the volume of the entire TIN will be calculated.

*Important note: to use this tab, you must have stations loaded through the **Station database** tab as well as a polygon file (top-right) loaded and an active polygon within it (mid-left)*

Inputs

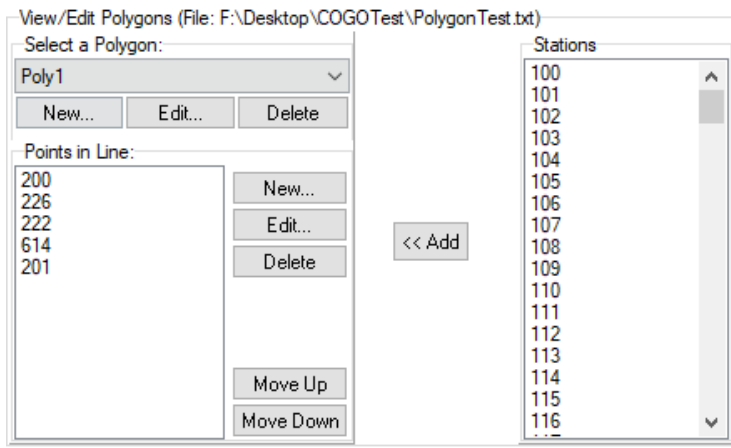


Similarly to the **Closure Tab**, area/volume calculation is done on one polygon at a time.

Polygons are held within a **Polygons File**, which can hold as many polygons as desired.

You can select an existing **Polygons File** or create a new one with the controls on the **Inputs** section. Since this tab makes use of the COGO network of points and does not need field measurements, it is not necessary to load a separate network here as with the **Closure Tab**.

View/Edit Polygons

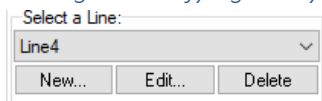


In order to generate an **Area/Volume Report**, you must specify a line containing all the points in that polygon.

In order to create a line, you must first have a **Polygons File** selected.

You can create any number of polygons within a given **Polygons File**.

Adding or Modifying a Polygon



The **Select a Polygon** box allows you to select the active polygon from which to load and add points and generate the **Area/Volume Report**.

The **New...** button here will create a new line in the **Polygons File** with the specified name.

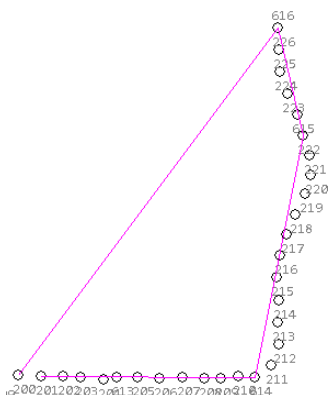
The **Edit...** button will rename the selected line.

The **Delete...** button will delete the selected line.

Any changes made here can be saved by clicking the **Save** button underneath the **Polygons File**.

Generating the Area/Volume Report

When a line contains three or more points, the **Area/Volume Report** will be automatically generated based on the 3D locations of the specified points and the datum (Earth ellipsoid, linear units).

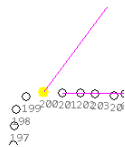
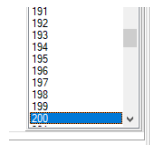


As you add points to a Polygon, the **Area/Volume Report** will be updated and the polygon will be shown on **The Drawing** in fuchsia.



Additionally, a visualization of the **TIN** will be updated and shown in the **View Surface** window.

Adding Points

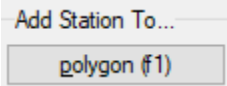


Select a point by clicking it in the **Stations** box or on **The Drawing**; this will highlight the point in yellow and pan to it.

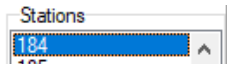
You can add a point to the polygon in one of three ways:



Select it and click the << **Add** button

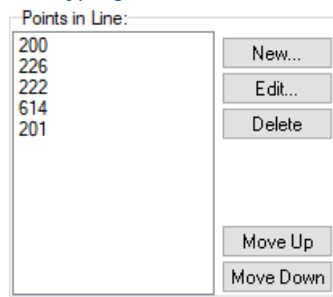


Select it and click the **Add Station To...** **polygon (f1)** button or press the **f1** function key



Double-click it in the **Stations** box

Modifying the Points in a Polygon



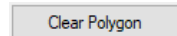
As you modify the polygon, the **TIN** and **Area/Volume Report** will be updated.

You can click the **New...** button to add a point manually by name, which is similar to the methods of adding a point as discussed above.

The **Edit...** button will allow you to modify the name of a point in a polygon.

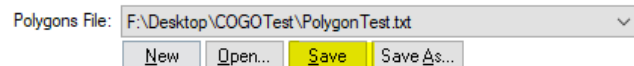
Deleting Points

The **Delete...** button will remove the selected point from the active polygon.



Additionally, you can click the **Clear Polygon** button at the right side of the window to clear all the stations from the selected polygon.

Saving Changes

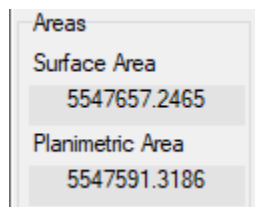


Any time a **Polygons File** is modified by adding or removing **Polygons**, or by adding or removing

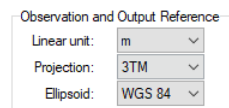
Stations from its polygons, it should be saved with the **Save...** or **Save As...** buttons underneath the **Polygons File** dropdown.

Area/Volume Report

Area Results



The results of the surface area computation are shown at the right side of the dialog, under the **Surface Area** and **Planimetric Area** labels.



These results are shown according to the **Observation and Output Reference** Linear Unit and Ellipsoid settings, which can be modified by going back to the **Calculations Tab**.

The **Ellipsoid** will affect the total surface/planimetric area and volume as each Ellipsoid models the Earth's surface differently, however the **Linear Unit** will only change the display units and not the actual values.

ie. Half a cubed kilometer ($0.5km^3$) in volume will display as $500,000,000m^3$, which may be more confusing to look at.

However, it is important to keep in mind that smaller units will provide a higher level of accuracy.

The TIN (View Surface)



The **View Surface** window shows the **TIN**, which is used to calculate the areas and volumes.

The **Print...** button will print an image of this surface to a connected printer.

The **Save Surface As...** button will instead save the surface as an image.

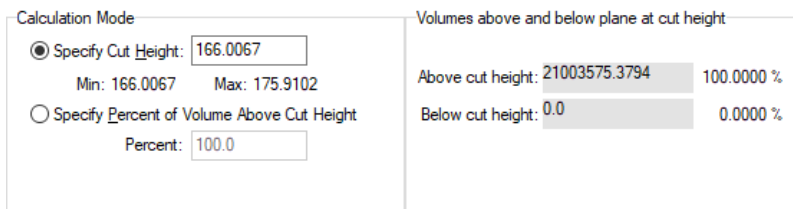
The **TIN** will show high areas in yellow and low areas in green, and any areas in-between the lowest and highest points will be on a gradient between these two colors.

Triangle area: 2018469.1373 Hover the mouse over each triangle portion of this TIN to show the surface area of that individual section.



If you wish to remove a portion of the TIN from the area and volume calculations, you can click it and it will turn red. Click this same section again to re-enable it, and it will go back to its original colors.

Volume Results



The results of the volume calculation will always default to show the volume of the entire TIN, with the cut height being set at the lowest point.

By Cut Height

You can change the cut height by specifying a different value between the automatically populated minimum and maximum ellipsoidal height values; this will update the **Volumes above and below plane at cut height** values, which show the volume in selected linear units and by percentage of the total volume.

By Percent of Volume Above Cut Height

You can instead specify the percentage of total volume contained above the cut height. This will display the amount of volume, in linear units, contained within that upper percentage and in the percentage below.

Exporting Stations

At any point, you can click the “Export Stations to CSV File” button to export the current stations loaded in and modified through the COGO Calculations to a CSV file.

If you have any suggestions for new features, questions, or problems with using the software, please feel free to reach out to the following:



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