

# Release Notes

**Version 5.90**

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## Welcome to Survey Office

Survey Office (SO) provides a complete office software solution for survey professionals. Having the ability to work in a single software environment streamlines operational efficiency while minimizing the costs of data management, software maintenance, and training.

**Important Note!** This version of Survey Office is available to:

- Perpetual license users whose current warranty expiration date is **May 1, 2023** or later. (If your perpetual license warranty expires prior to this date and you proceed with the installation, licensed features will not be available.)
- Subscription license users whose subscription is currently active.

If necessary, you can contact your distributor to purchase a warranty extension or renew your subscription. In the SO ribbon, select Support > License Manager to view your warranty or subscription expiration date.

## New features

Following are the new features included in this version of Survey Office. To view context-sensitive help at any time while using SO, press **F1**.

### Miscellaneous

- **Select objects by layer group** - In the Select by Layer command, you can now select all of the objects on the layers in a layer group by pressing the [Shift] key when checking the box for one of the layers. All layers (and the objects that reside on them) in that layer's group will be selected. If the selected layer is not assigned to a layer group, there is no effect; only the individual layer is selected.

### Data exchange

- **Tag (rename) imported files** - The Project Explorer lists all data files you bring in alphabetically under the Imported Files node. If an imported file naming convention is not ideal, such as when you import field data, you can now use the Tag property in the Properties pane to 'rename' and reorder imported file names by:
  - adding a prefix before the file name
  - adding a suffix after the file name
  - adding both a prefix and suffix around the file name
  - overwriting the file name with your own text
  - adding hidden metadata for the file (e.g., a station range covered by the data)

This feature lets you, for example, group topo files together, cross-sections together, etc.

- **RINEX 4 support** - SO can import and process files from the latest RINEX version 4.00. This version of RINEX is a major revision of the format document to modernize the Navigation message files to be able to accommodate the new navigation messages from all the GNSS constellations, as well as system data messages, such as ionospheric corrections, earth orientation parameters and system time offsets. The Observation file format remains the same with some added QZSS signals and tracking codes to fully support the upcoming L1 C/B signal. The Meteo file format also remains the same. All RINEX file types also have new optional header lines to support FAIR data usage: Finding, Accessible, Interoperable and Reusable data.
- **Support for new Perpendicular Target Height method used in Trimble Access** - Import and process Trimble Access survey data that includes the newly added Perpendicular Target Height method for measuring a total station target when performing an object-oriented station setup.
- **Import secondary design data for stakeout line points** - Secondary design data can now be imported into SO for stakeout points that have a second line design.

## Coordinate System

- **Improved management of EPSG IDs** - When connecting to a third-party GIS database or WMS service, you can now verify you are using the correct zone, datum, and geoid model by viewing their EPSG IDs for the selected coordinate system in SO Project Settings > Coordinate System, just as you can do when viewing coordinate systems in the Coordinate System Manager. The IDs are automatically updated when there is a change to the datum or geoid. And every ID is a clickable link to the EPSG website where you can find more information about it. In addition, the JXL importer has been enhanced to ensure EPSG IDs are not "lost" between the field software and SO.
- **Updated Coordinate System Database** - The newest Coordinate System Database installed with SO v5.90 includes the following enhancements:
  - Added accurate support of NAD27 and old realizations of NAD83 using NADCON 5 grid files
  - Added support for old realizations of California Spatial Reference System (CSRS Epoch 2004, 2007, 2009 & 2011)
  - Added support for SIRGAS-ROU98 datum and zones for Uruguay
  - Added coordinate system zones for Guam
  - Added coordinate systems for Austria: EPSG 31257, 31258, 31259
  - Added Kinematic Datum IGS20 & RTX20 considered same as ITRF2020
  - Added support for SIRGAS-Ecuador (2016.4) datum and zones for Ecuador

*Note:* It is recommended that you use Trimble Coordinate Database version 106 with SO 5.90 and later. You can check your software and database versions in the Coordinate System Manager by selecting Help > About. You can upgrade to the latest software version 3.9.13 and database version 106 by selecting Help > Check for Updates.

- **Improved interoperability with the latest Coordinate System Database** - SO has been enhanced as follows to take full advantage of the latest Coordinate System Database (CSD):
  - The Trimble Coordinate System Database and Change Coordinate System Wizard have been enhanced to improve search by EPSG ID, enabling users to find UTM zones on NAD83(2011) or US state plane zones in feet.
  - Users can now change the Horizontal Datum when they click the Change button in Project Settings / Coordinate System / Datum Transformation.
  - The Geodetic Library has been updated to support Displacement Models with logarithmic terms required for Argentina.
  - An update was made to the global reference epoch used for Japanese Datum JGD2011, which is really 2011.395 or 1997, depending on the location.

## Survey and COGO

- **COGO enhancements** - The Create COGO command, which enables you to create a COGO collection of linework in your project that you can use to create parcels, compute parcel closure, and generate legal descriptions, has been enhanced as follows:
  - **Create COGO collections from existing linework** - If your project already contains boundary CAD linework, you can simply select the linework to automatically create a COGO collection.
  - **Create nested COGO parcels** - You can create a parcel that is completely enclosed (*nested*) within another parcel, allowing you to handle more complex land boundary situations. In the Map Check Report, nested parcel areas are treated as transparent holes in the outer parcels in which they are enclosed, and they do not contribute to the outer parcel's area. The Legal Description Writer has also been enhanced to support nested parcels with new *Jump to Nested Area* parameters in the default template.
  - **Custom reference start points for COGO collections** - When creating COGO linework, you have the option to start the creation of a new "absolute" COGO line segment (a line segment whose definition is not relative to the previous line segment) from a different reference start point than the last created point, which is the default. This provides added flexibility when creating COGO linework.

- **Streamlined COGO linework creation workflow** - When you enter a line, point, or arc command line (excludes start, line/arc extend, and sideshot-type commands), the command type controls stay open until you select to enter a different type of command. This streamlines the COGO creation process when entering multiple command lines of the same type.
- **Format and edit parcel names** - Each parcel name is now saved as a CAD multiline text object. When the Create COGO command pane is closed, you can select the text to display icons in the Plan View that allow you to move, resize, and/or rotate the text to fit appropriately within the parcel boundaries. You can also select the text, right-click, and select Properties to display the Properties pane where you can change the text and various text properties.
- **South azimuth in Create COGO command** - The Create COGO command now supports south azimuth coordinate systems. If your project is set up for a south azimuth orientation, the new “Azimuths point to the south” check box is checked by default on the "Options" tab when you create a new COGO collection, ensuring points and lines are created with a south azimuth orientation. Otherwise it is unchecked, indicating points and lines are created with a north azimuth orientation. You can check or uncheck this setting at any time if necessary.

*Note:* If you created a COGO collection in a project in an earlier version of SO, this check box is disabled when you open the project in SO 5.90.)

- **Grant Boundary/Compass COGO adjustment** - The Create COGO command has been enhanced to enable you to perform a Grant Boundary or Compass (Bowditch) adjustment automatically to re-establish lost boundary corners. To do this, you simply enter one of the new COGO line commands—End Coordinate or End Point—to specify a different end location for the selected boundary linestring based on an imported measured point or coordinate. The adjustment is performed automatically by rotating and scaling the linework that defines the entire boundary based on the new measured corner point, which is fixed during the adjustment. Using the new COGO Adjust tab, you can select the type of adjustment to perform and whether to display the legacy linework on a different layer than the new adjusted linework so it can easily be hidden or displayed in a different color. Information about the adjustment is displayed on the Adjust tab as well, including the legacy and adjusted boundary line lengths, misclosure between the legacy and adjusted end points, applied rotation, and applied scaling factor.
- **Support for WMS background maps** - Use the new Web Map Service command to connect to a WMS server and display geo-registered background map images (for example, JPEG or PNG) from one or more distributed geospatial databases according to the Open Geospatial Consortium (OGC) specification. After selecting a WMS server, simply select the area you want to cover and the coordinate system to apply, select the resolution and transparency to apply, and select the layers to display. This is a powerful tool for overlaying data and providing additional visual context in your Plan View.

- **GVX file exporter** - The GVX (GNSS Vector Exchange) file exporter, used to export GNSS vectors derived from varying GNSS survey methods and manufacturer hardware, has been enhanced to support the export of receiver and antenna serial numbers and firmware version, ensuring necessary metadata is included in the exported file.
- **IGS20 reference frame support** - SO supports the latest IGS20 reference frame for using precise orbits when processing baselines.  
*Note: SO automatically downloads the first version (version 0) of the applicable IGS20 precise orbit data file. If a newer version is available (for example, version 1), you can download it by clicking the Manual button in the Internet Download pane and logging in the IGS website using your own personal login. Then you can import the file using the TBC import dialog or with the drag-and-drop method.*
- **Higher-performance kinematic baseline processor** - SO has updated its kinematic baseline processor to provide (1) much higher performance when dealing with difficult environments and (2) the ability to process all modern signals, including Beidou 3.
- **Create points by station offset** - The new Create Points by Station Offset command enables you to quickly and easily create multiple points along a user-defined baseline by first specifying the station and offset for each point you want to create and then running the command to create them all at once automatically. You specify the point ID and feature code for each of the points, which are organized into collections in the Project Explorer.
- **Integrate points into geometry** - Use the Integrate Points into Geometry command to automatically convert vertex coordinates for linestring-based polygonal objects and COGO parcels into points.

## CAD

- **Enhanced SketchUp support** - SketchUp support has been enhanced as follows:
  - Import and export SketchUp files (SKP/.skp) using the latest SKP library, enabling access to the most current functionality.
  - The origin point coordinates for an exported model can now be retained in the SKP export file so that if the file is re-imported back into SO, the model is imported at the correct location instead of 0,0,0.
- **Enhanced object/entity selection option** - Options > General > Display now includes an option allowing you to specify to include the elevation for each CAD object/entity when your initial selection in a graphic view displays multiple objects in a selection list. This enables you to more easily discern and select the one you want (for example, for snapping or exporting). This option is turned on by default.
- **Automatically divide an area** - Use the new Divide Area command to easily divide the area of a 2D polygonal feature into subareas based on any of the following criteria:
  - A specified number of equal-sized subareas

- One or more subareas of a specified size
- One or more subareas at a specified distance from a division baseline (which defaults to the selected edge of the polygon, but can be customized)
- **Use a bearing as a deflection angle for linestring segments** - When creating a segment in a linestring using a deflection, you can now use the Specified angle option to enter a bearing.
- **Enhanced IFC exporter** - The IFC exporter has been updated to incorporate the newest Trimble Tekla libraries and includes the following enhancements when exporting Industry Foundation Classes files (.ifc):
  - Duplicate geometry definitions have been removed from the export to save file space.
  - A simplified interface supports any BIM input, not just existing data blocks.

## Drafting

- **Include feature attributes in point labels** - The Properties pane has been enhanced to allow you to quickly and easily specify which attributes to display in point feature labels.

## GIS

- **Support for Trimble Access rectangular feature control coding** - SO now supports processing of feature line control codes that specify a rectangular shape using a width parameter that is consistent with usage within Trimble Access. Prior to this release, the width parameter had to be included on the first rectangle feature corner point of two consecutive corners. Now the width can instead be included on the second feature corner point, as is typically done in Trimble access. SO will process the rectangular feature correctly either way.
- **Filter features from a GIS data source** - The Read Features from GIS command now allows you to click two points to define a selection box in the Plan View just around the area from which you want to import features (instead of importing from the entire area covered by the data source). Then you can click the Preview button to see a list of features included in the box (and straddling its border) that can be imported. This helps you avoid unnecessarily long download times and the need for a large amount of disk storage space.

- **Display geographical features using a Web Feature Service (WFS)** - Use the new OGC Service Manager command (Open Geospatial Consortium) to connect to a Web Feature Service (WFS) server, which supports the querying and retrieval of geographical features to temporarily display in your project. After connecting to a WFS server, simply select the area you want to cover and the coordinate system to apply; then select the features to display. This is a powerful tool for overlaying temporary geographical feature data (which can be snapped to) and providing additional visual context in your Plan View. (Note: You can also connect to a Web Map Service (WMS) server to display background maps in your project using the new OGC Service Manager command.)
- **Exchange attachments with a GIS data source** - When you exchange feature data with a GIS data source that includes feature attributes with attached files (for example, a photo JPG file), the attached files are now included in the exchange. This ensures a more complete transfer of feature data to be shared with others.

*Note:* In previous versions of SO, it was possible to export attachments to the data source, but not import them from the data source.

- **Exchange data with PostGIS** - SO now supports the exchange of geometry and GIS data with PostGIS, a spatial database extender for PostgreSQL object-relational databases. PostGIS provides support for geographic objects, allowing location queries to be run in SQL. Use the GIS Connection Manager to easily connect to a Postgres database. Then, optionally select an STC configuration file (generated by QGIS Desktop for STDM) to use for the exchange of features and/or attributes and to populate the project's Feature Definition Library as necessary. You also have the option of selecting to merge GIS coordinates into points in SO to ensure points are referenced within the geometry along with coordinates.
- **Exchange data with Trimble Penmap for Android** - You can now import and export Penmap project data contained in a Penmap PDT compressed file that includes all required template files, geometry data, measured GNSS points, and GIS data records. Optionally, you can select to export only template data from SO: either the template itself, or a compressed file containing all of the related template files and a geometry styles file, symbol definitions file, feature system file, and GIS schema file.
- **Exchange data with an Esri feature service** - SO now supports the exchange of feature data with an Esri feature service either internal to your organization or anywhere on the Web. Use the GIS Connection Manager to select and connect to the service.

*Note:* The import of true curves is not fully supported at this time, but they can be converted to straight lines on import.)



## Surfaces

- **Create a composite surface** - You can now create a single, combined surface from two or more other surfaces without having to completely rebuild (continually retriangulate) a merged surface model. There are few steps in creating a composite surface, saving you time and preventing errors. Composite surfaces are continuously updated to show the current state of the project as you change the contributing surfaces. A composite surface can be viewed, edited, and used like any other surface, e.g, it can be referenced, sliced, and used to calculate volumes for takeoffs and reports.

## Corridors and Alignments

- **Use reference alignment stationing** - You can now apply alignment stationing based on the stationing of another alignment (usually where a design alignment is slightly different from the as-built alignment).

## Point Clouds

- **Trimble X12 support** - Import and process scan data and images collected with the new Trimble X12 3D laser scanning system, which provides unparalleled ease of use and exceptional quality of point clouds and imagery. The Trimble X12 provides two files for import into SO for processing: a .tos file containing 3D points, and a .toi file containing images for point cloud colorization.
- **Shape-based feature extraction** - Use the new Extract Geometry command to draw or select an existing 2D closed CAD object whose shape and size you want to use as a template to locate and extract features of the same shape and size (for example, painted arrows on a roadway). You can select whether or not "found" features may be rotated or mirrored (flipped) from the selected shape's orientation.
- **Scan inspection enhancements** - The Scan Inspection command, which enables you to create customizable "heat map" overlays and reports that display positioning variations between point clouds and 3D and surface objects, has been enhanced as follows:
  - **Select mesh faces on 3D objects** - You can use the new "Internal Select" mode to easily select one or more mesh faces on a selected 3D object (not just the entire object mesh as before) to compare to a selected point cloud region, giving you more precise control over your inspection deliverables.
  - **Select multiple 3D or surface objects** - You can now select more than one 3D or surface object to compare to a selected point cloud region, ensuring a more efficient and faster way of creating highly usable inspection deliverables.

- **Extract manhole features from point clouds** - The Extract Point Feature command has been enhanced to enable you to extract closed manhole cover features from a point cloud manually or automatically and assign feature attributes. To help ensure the best results, you can specify whether data was collected using photogrammetry or laser scanning. When performing an automatic extraction, a handy slider control allows you to filter the extraction results to remove false findings by increasing or decreasing the extraction "confidence" level, ensuring the most accurate extractions.
- **Point cloud classification enhancements** - The Extract Classified Point Cloud Regions command is now based on deep learning technology to provide overall more accurate extractions and classifications. It also includes more outdoor class types to choose from for terrestrial scans. And to help ensure the highest accuracy with difficult outdoor (terrestrial) extractions, a new Refinement option allows you to run an enhancement for Ground, Poles, Signs, and/or Buildings classes as necessary to obtain optimal classification results.
- **Extract stockpiles from a point cloud** - Use the new Extract Stockpile command to quickly and easily extract one or more stockpiles from a point cloud, save them in your project, and compute their base and slope areas and volumes. Simply click each stockpile you want to extract and specify a few parameters to automatically generate a boundary around it. The new (or a specified existing) boundary is then used to automatically extract the stockpile (including the automatic generation of initial/base and final/slope surfaces) and calculate its area and volume. You can then create a formatted report and/or CSV file showing the results of the extraction. Each extracted stockpile is represented by an individual node in Feature Extraction > Stockpiles in the Project Explorer, allowing you to select it and view its properties, and generate surfaces associated with it.
- **Point Clouds ribbon enhancement** - The Point Clouds ribbon has been reorganized to better group and display related commands, making it easier to perform each of the various point cloud-related workflows provided in SO.
- **Selectively assign feature codes during automatic point extraction** - When using the automatic mode for feature point extraction, during the QA/QC process you can now specify a different feature code or additional feature codes for each extracted feature as necessary, instead of assigning the same default feature code to all of them. This enhancement combines the speed of automatic point extraction with the flexibility to assign appropriate features codes to varying extracted features when necessary.
- **Drape a CAD line on a point cloud** - Use the new Drape Objects on Point Cloud command to elevate each of the vertices in a 2D or 3D CAD linear or closed object or alignment to a point or group of points in a point cloud using any of a variety of strategies, each of which is based on a specified search radius and the projection of the vertex through the point cloud along a Z axis.

- **Enhanced Ambient Shading mode for point clouds** - The new Enhanced Ambient Shading mode is similar to Ambient shading mode except that it applies anti-aliasing to give a more aesthetic visualization, typically darkening the points but revealing more detail in the scene. Since enhanced ambient shading applies to all datasets (it does not require normal information, intensity, or color), this is the recommended mode for most situations, combined with your favorite color and visibility options.
- **Extract geometry automatically from multiple features at the same time** - The Extract Geometry command, which allows you to use a template to locate and extract geometry for features of the same shape and size displayed in a point cloud (for example, painted arrows on a roadway), has been enhanced to support multiple extractions at the same time. So now you can either select each feature for which you want to extract geometry individually, or you can select an area with multiple matching features in which multiple automatic extractions can occur. In the multiple extraction mode, a handy slider bar allows you to adjust the confidence level for the automatic extraction to obtain optimal results by filtering out false positive shapes in the area of interest and increasing the detection rate of shapes that are difficult to identify due to, for example, worn or faded paint.
- **Trimble X9 laser scanner support** - SO fully supports the import and processing of data collected with the new Trimble X9 laser scanner, which provides PPM corrections and uses a new TZF export format that provides better compression than previous TZF files.

## Photogrammetry

- **Import and process frame-based aerial image data from any UAS camera** - The UAS Importer has been enhanced to allow you to import geotagged aerial image data from any UAS camera regardless of the maker and model. SO includes an extensive list of predefined camera specifications that can be automatically applied when you perform the import (drag-and-drop or via Import UAS in the menu). In case UAS cameras are not stored in SO, you can easily import data by manually entering required specifications (sensor focal length and sensor pixel size) directly into fields provided in the Import UAS Data pane. These custom specifications can be saved and re-applied when image data is again imported from the same UAS camera. data is again imported from the same UAS camera.

Additionally, the Import UAS Data command pane now:

- Displays the camera maker and model along with the sensor size in pixels (if provided in the image's EXIF metadata).
- Includes an Advanced setting that allows you to specify that the GNSS used to capture the data is of high quality, which enables an absolute orientation adjustment to be performed without the need to process baselines or measure GCPs.

- **Improved deliverables boundary creation** - In previous versions, if you did not select an existing boundary when creating photogrammetry deliverables, the flight block plan was automatically used for the boundary. For this version, a new boundary is now automatically generated that more accurately and efficiently defines the area to be included in the deliverables creation process.
- **Digital Surface Model enhancements** - The DSM elevation type deliverable has been enhanced as follows:
  - Moving objects are removed from the model.
  - Buildings have sharper edges.
  - Radiometric corrections are performed on overexposed or underexposed image areas by taking the scene illumination and sensor influence into consideration.

Also, in this version of SO, the generation of DSM is based only on the Semi-Global-Matching algorithm (in the previous versions called Digital Surface Model Highest Quality), which is the basis for the generation of high-quality True-Orthophotos.

In addition, the Create Deliverables command now includes an Advanced option to select a different file location (for example, on an external drive) for the possibly large volume of temporary files created during the DSM creation process.

- **Height shift for low quality GNSS data** - The new Set Height Shift command enables you to perform a GNSS height shift when GNSS quality is low and the EXIF height values from the imported drone images are incorrect (for example, due to the wrong coordinate system being used). If necessary, you can use the Inverse command in the 3D View to measure between the drones and ground control points to determine the correct height shift value to apply using the new command.

## Tunnels

- **Volume property added for tunnel design and as-built mesh** - Compare and verify your tunnel design and as-built tunnel mesh by viewing the new Volume property value for each in the Properties pane. (Note that average cross-sections are used when calculating volumes.) This allows tunnel construction and survey professionals to generate fast analytics on the construction activities for processes such as shotcrete volumes.
- **Create CAD tunnel cross-section diagrams** - Use the new Create CAD Tunnel Cross-Sections command to automatically generate 2D and 3D CAD cross-section diagrams from tunnel inspection maps. Simply select the inspection map you want to reference, enter the range of stations you want to include and the station interval, and specify layout properties for the diagrams. 2D cross-section diagrams display information in both images and text tables. 3D cross-section diagrams display information in images only. The diagrams help reduce the time required to create CAD-based deliverables from tunnel survey data, such as for construction verification and documentation of excavation, shotcrete, and final lining.

- **Specify the direction of arcs in tunnel shapes** - When creating or editing a tunnel shape, the new Arc Direction property enables you to select to "draw" an arc segment either in a *Standard* direction (the arc curves inward toward the tunnel alignment centerline) or in an *Inverted* direction (the arc curves outward from the tunnel alignment centerline). This option provides additional flexibility when creating tunnel designs such as for soft-ground sequential excavation projects where the tunnel excavation profile is performed in multiple stages. (Note: To include Arc Direction properties in an exported tunnel design TXL file, be sure to use the latest version of the TXL exporter. The resulting TXL file cannot be imported into earlier versions of SO.)
- **Add pipe set outs for tunnel designs** - Properties have been added to the tunnel Shape Editor that enable you to define a new pipe set out type. (A *pipe umbrella* system is a pre-support measure used in weak ground conditions in conventional as well as mechanized tunneling.) Properties include horizontal/vertical offset, end horizontal/vertical offset, and length along the alignment. (Note: To include pipe set out properties in an exported tunnel design TXL file, be sure to use the latest version of the TXL exporter. The resulting TXL file cannot be imported into earlier versions of SO.)
- **Mesh-comparison delta values in the Tunnel Inspection View and report** - To better meet user's needs, the deviation values formerly displayed on a tab in the Tunnel Inspection View and in the Tunnel Inspection Report have been replaced by delta values.
- **Tunnel Inspection Report (with geological overprofile)** - The Tunnel Inspection Report command now includes a new report template: *Tunnel Inspection Report (with geological overprofile)*. This version of the report includes all of the information contained in the standard *Tunnel Inspection Report* template along with the following geological overprofile information for drill and blast headings and tunnel boring machine (TBM) headings:\*
  - Geological overprofile area for each station
  - Geological overprofile volume for each station

Total geological overprofile volume for all stations Computations are based on offset values you specify when running the report \* In accordance with Swiss underground construction and tunnel Norm SIA198.

- **Delta histogram and statistics added to the Tunnel Inspection Report** - The Tunnel Inspection Report now includes on the first page of the report a histogram plot showing the distribution of delta values (overbreak/underbreak) based on the width interval used to aggregate delta values on the x axis of the histogram and the less-than/more-than delta range to include, both of which you specify before running the report. In addition, the Summary table now includes a new "Statistics of Inspection" section that includes key delta statistical values (number of delta values, average delta value, standard deviation, and delta value variance) along with the percentage of delta values within a range you specify before running the report. This enhancement enables surveyors and contractors to meet key project requirements when providing quality control of tunnel construction for shotcrete and excavation analysis. (For example, "80% of the shotcrete layer must be within thickness values of 10 to 15 cm".)
- **Enhanced tunnel inspection maps** - The tunnel inspection map has been enhanced to include all comparison delta values (within specified tolerances), regardless of whether the comparison mesh is closed along its bottom.

## Important notes and known issues

See the SO Help for a complete, up-to-date list of important notes and known issues related to SO.

## System requirements

<b>Microsoft operating system:</b>	Windows® 10 (64-bit version) Windows 11 (64-bit version)
<b>Processor:</b>	Dual-core 1.80 GHz or better recommended  Quad-core 2.80 GHz or better (additional cores with hyper-threading support highly recommended for Aerial Photogrammetry, Mobile Mapping, and Scanning modules)  <b>Important!</b> Because components of SO make use of Intel-only multi-thread processing, <b>AMD Ryzen processors are not supported.</b>
<b>Random access memory (RAM):</b>	4 GB or more recommended  32 GB or more recommended for Aerial Photogrammetry, Mobile Mapping, and Scanning modules

<b>Hard disk space available:</b>	<p>30 GB or more recommended</p> <p>100 GB or more on solid-state drive required for Aerial Photogrammetry, Mobile Mapping, and Scanning modules</p> <p>The recommended SSD overall hard drive capacity is 500GB or more for Aerial Photogrammetry, Mobile Mapping, and Scanning modules</p>
<b>Monitor:</b>	<p>1280 x 1024 or higher resolution with 256 or more colors (at 96 DPI)</p>
<b>I/O Ports:</b>	<p>USB 2.0 port required if HASP hardware key is used</p>
<b>Graphics:</b>	<p>DirectX 11 compatible graphics card with 512 MB memory or more</p> <p>OpenGL version 3.2 or later required when working with point cloud data (latest version recommended)</p> <p>8 GB or higher graphics card (for example, NVIDIA Quadro P4000) recommended when working with Aerial Photogrammetry, Mobile Mapping, and Scanning modules</p> <p><b>Note:</b> 4 GB or higher NVIDIA graphics card with CUDA compute capability (5.0 or higher) required when working with point cloud classification.</p>
	<p><b>Note:</b> If you are using a laptop computer with both an integrated (on-board) graphics card and a discrete NVIDIA graphics card enabled via Optimus technology, your computer must allow you to select to disable the integrated graphics card and use only the discrete graphics card when working with point cloud data. See "Disabling a laptop integrated graphics card" in the "Important Notes" topic in the SO Help.</p>

***Important!***

**It is critical that you keep your graphics driver(s) updated if you are working with point cloud data.**

Whether your computer has one or multiple graphics cards installed, you must ensure each has been updated with the latest driver provided by the card's manufacturer. The best way to determine if your driver needs to be updated and, if so, perform the update is to visit the card manufacturer's website. For more information, see "Update and Configure Your Graphics/Video Driver" in the online Help.

(If, instead, you decide to update your driver using the Windows Device Manager and the "Search automatically" option, the program may suggest using a Microsoft-approved WHQL version of the driver. However, to ensure you have the latest bug fixes and new features for your graphics card, it is recommended that you use the latest manufacturer version instead.)