TECHNICAL NOTES

Trimble Business Center

AI-Powered Feature Extraction

TRIMBLE BUSINESS CENTER OFFICE SOFTWARE
September 2024

Enhancing the value of collected data and transitioning the surveyor's role to overseeing AI processes with the feature extraction capabilities of Trimble Business Center software.

Add value to collected data by transforming it into actionable information for confident decision-making with AI-powered classification, feature extraction and analysis capabilities within Trimble® Business Center (TBC). Discover a library of pre-trained 3D deep learning-based classifiers, automated feature extraction tools and comprehensive industry workflows. Unleash the full power of AI for customization of your feature extraction workflows with easy-to-use tools for training your own 3D deep learning models. Unlock the full potential of your point clouds and images from mobile mapping, 3D laser scanning, aerial LiDAR or photogrammetry data.

Find out more at:
www.trimble.com/tbc

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AI-based feature extraction: More than just a buzzword

Trimble Business Center offers a toolkit for transforming your point cloud data into information. This includes very basic operations such as filtering and down-sampling, as well as point cloud classification for more comprehensive visualization of your data. This lays a solid base for extraction and analysis workflows, extraction of vector data with geometric attributes that represent real-world assets, and of course analysis workflows for 360 degree information including decision aids.

TBC is one platform that delivers the tools for a complete workflow.

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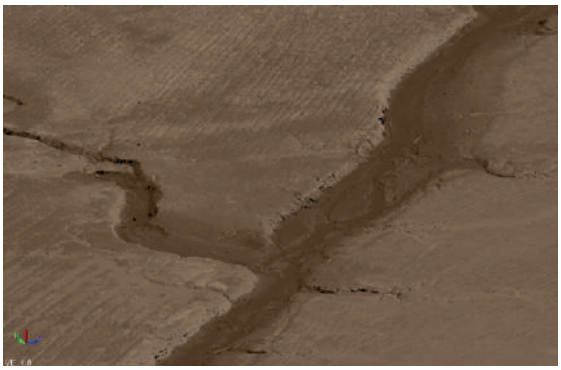
Supporting basic point cloud operations

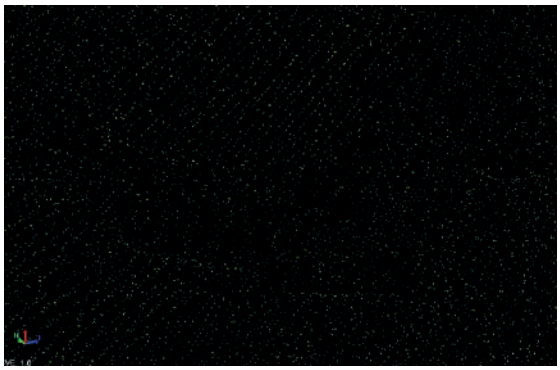
Advanced point cloud filtering

Elevation-based filtering that leaves one point per sampling cell of a user-defined size. Choose whether a point with maximum, minimum or median height stays in the cell. Avoid point cloud noise with outlier removal.

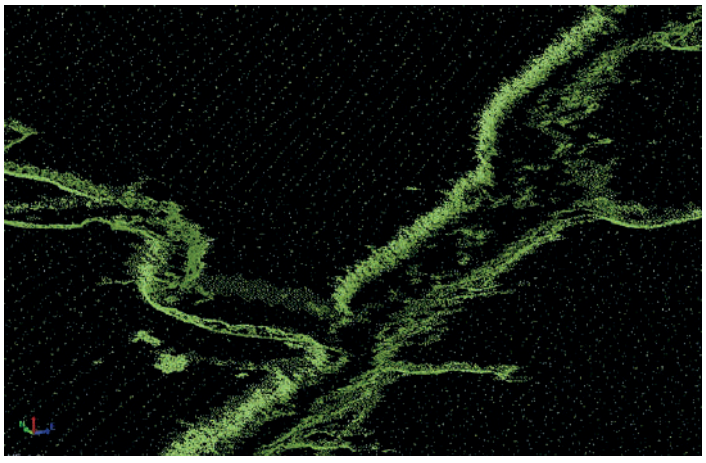
- Smart downsampling of dense point clouds.
- Ensures you remove only redundant information and preserve the details such as curbs, hills and ditches with dynamic cell size. The cell size automatically shrinks when encountering significant change in slope to make sure the important natural and artificial terrain features are not filtered out.
- Bare ground filter: remove low grass from the ground, delivering a perfect finish for 3D deep learning-based classification.



Original density



Downsampled



Downsampled with smart filter

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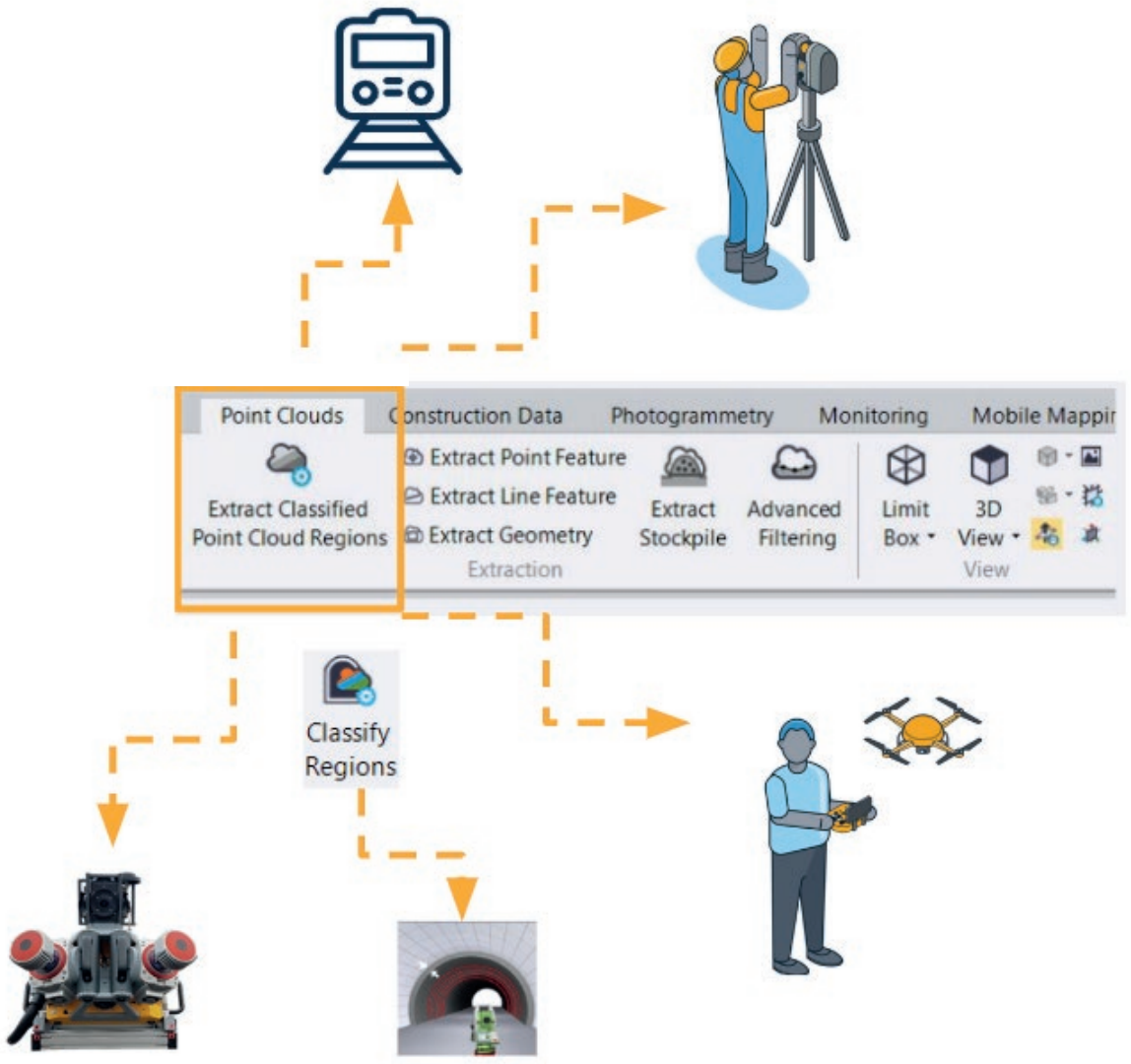
Classification: the first step in any point cloud workflow

Classification is a basic step in almost any point cloud workflow. This is the first step that allows you to understand your data better by categorizing each collected point into a certain class.

TBC has a library of pre-trained classifiers that serve a large variety of industries including transportation, utilities, civil construction, mining, tunneling and more.



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The library of pre-trained classifiers includes:

- **Outdoor (Terrestrial):** Classifier for any point cloud from any mobile mapping system or terrestrial scanner. Classifies point clouds into ground, buildings, high or medium vegetation, power lines, poles, traffic signs, noise (people, vehicles, scanning artifacts), steps, dividers (walls, fences, jersey barriers, guard rails) and other. This classifier is based on a 3D deep learning model powered by automatic algorithm-based refinement tools that enhance classification of ground, buildings, poles and traffic signs.
- **Outdoor (Aerial):** 3D deep learning-based classifier for any point cloud from aerial LiDAR or generated from aerial imagery (photogrammetry). Classifies each point into one of the following classes: ground, high or medium vegetation, buildings, poles, power lines, stockpiles, noise (people, vehicles, scanning artifacts) or dividers (walls, fences, jersey barriers, guard rails). This classifier is powered with automated 3D deep learning-based refinement tools to enhance the appearance of ground, buildings and stockpiles.
- **Indoor:** Classifier based on traditional algorithm. Classifies each point into one of the following classes: floor, walls, grated floor or ceiling.
- **Railway:** 3D deep learning-based classifier for railways. Classifies each point into rail, sleeper, ballast. The Railway classifier is specifically optimized for data collected with mobile mapping systems and GEDO track measurement trolleys, but can also be used for aerial point clouds.
- **Tunneling (Tunneling license required):** 3D deep learning-based classifier for tunnels. Classifies each point into one of the following classes: rock, shotcrete, rebar mesh, rock bolt or ground.

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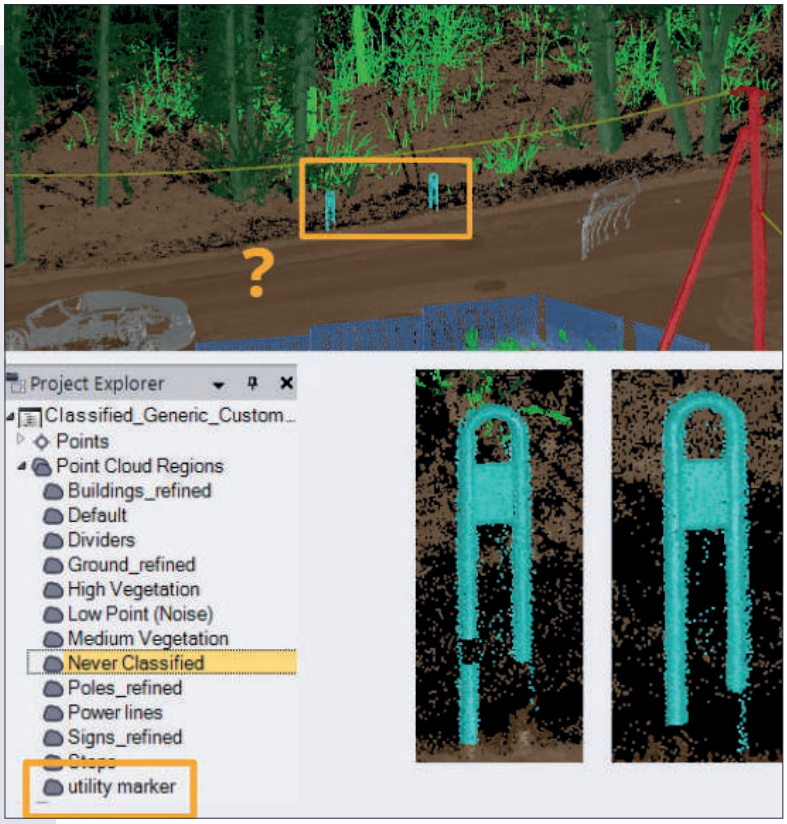
Classification: the first step in any point cloud workflow

TBC enables users to customize point cloud classification to their application domain by facilitating them training their own 3D deep learning classification models. Classification of any object can be automated and fully project-specific.

This accessible workflow, designed for surveying professionals, opens up access to Trimble deep learning model architecture. Without programming skills and without extensive knowledge of AI, users can classify any region of interest simply by providing sample data. Trained models are then a property of that user and can then be easily shared within the organization for company-wide efficiency.



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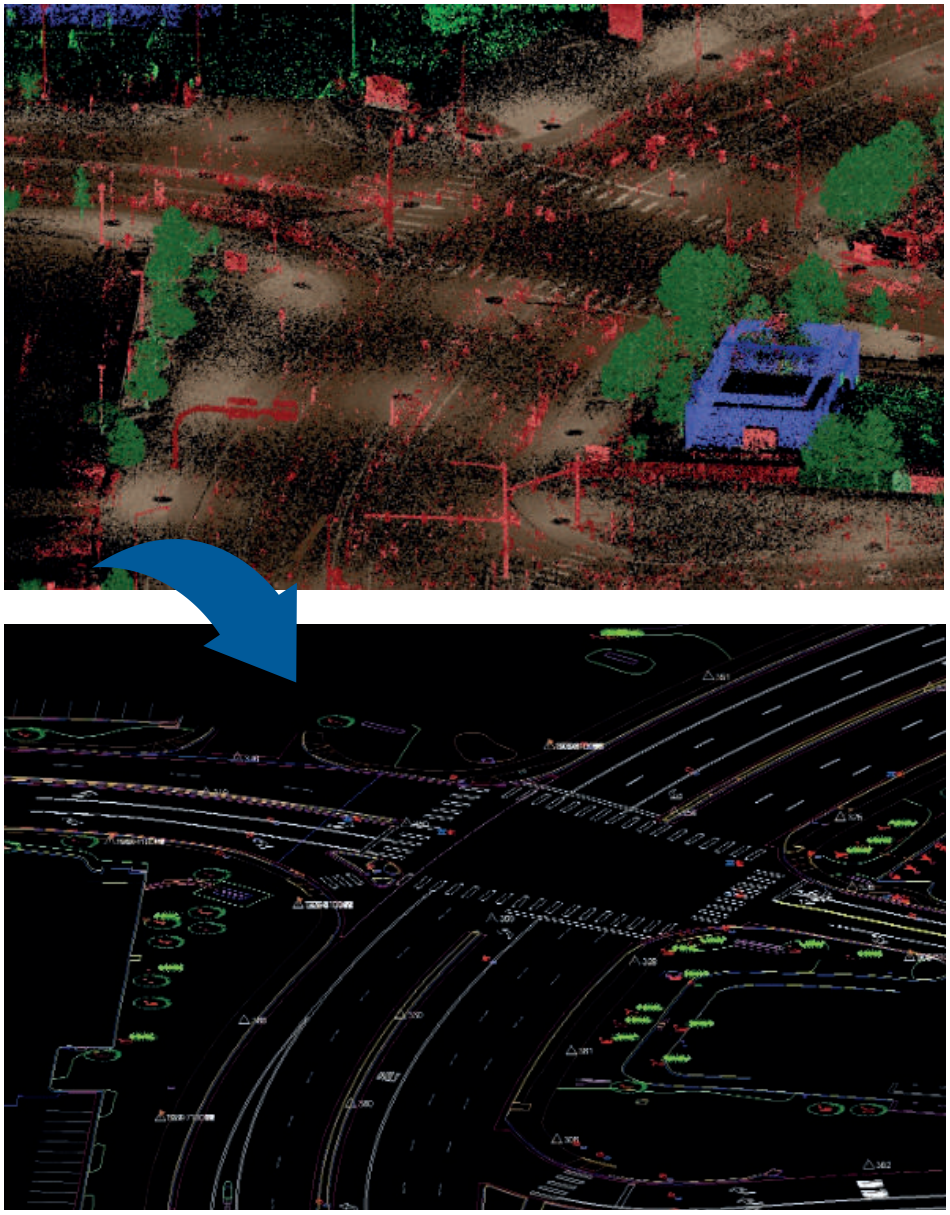
From classification to actual information extraction

Classification is just the first step that makes further data analysis, whether it is automated or manual, easier and faster. Ultimately, a surveyor needs features and their geometric attributes, not classified points.



TBC offers a library of commands for automation of asset management tasks for transportation, utilities and more that allow you to keep your asset databases up to date.

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Point extraction

Automated extraction of CAD point and geometric attributes for each traffic sign, pole, manhole and tree in your point cloud. Convenient QA/QC tools for supervision of automated outputs.

Tree extraction

Quickly extract location, height, trunk diameter and crown spread for each tree in the point cloud with this algorithm-based tool. The command works best for urban areas with well-separated trees.

Sign extraction

Find the location of each traffic sign in your data. Additionally, add more information to it such as height and inclination of each found asset.

Pole extraction

This command extracts each pole in your point cloud data, including its height and inclination.

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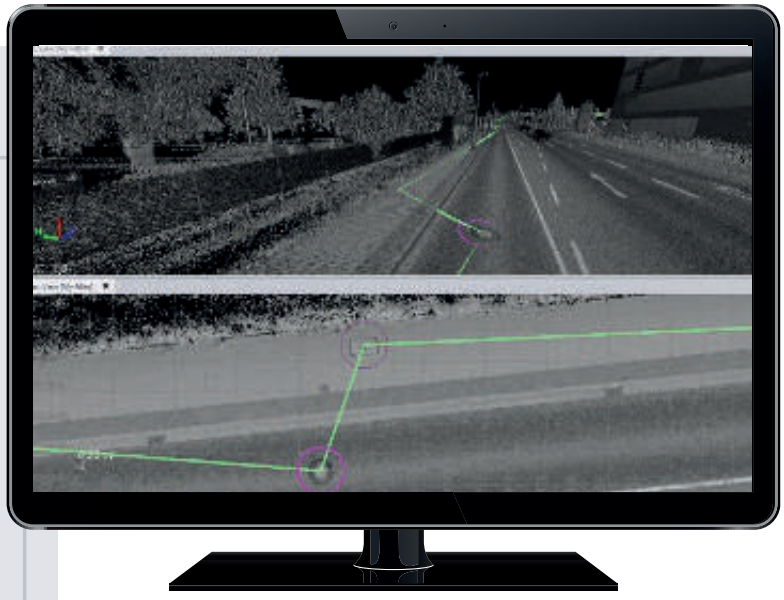

Manhole extraction

This deep learning-based command allows the extraction of a precise location of each manhole and its diameter. Two modes are available: laser scanning for static scanners, mobile mapping systems and aerial LiDAR, and photogrammetry for point clouds generated from aerial imagery with no intensity available.

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Line extraction

Semi-manual extraction of linework from point clouds with minimal user interaction.

Lane line extraction

Pavement markings are one of the most valuable road assets. This command enables extraction of the linestring that is placed in the exact center of each lane line whether it is solid, dashed or double. The functionality relies on the intensity values of the pavement markings, meaning that point clouds need to have intensity values to ensure the correct behavior of the command.

Overhead lines extraction

Extraction of power lines as line vectors from the point cloud.

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Curb and gutter extraction

Extraction of linework for curbs. The command works for jersey barrier extraction as well.

Extraction of polygons

Pavement markings go beyond lane lines. They also include crosswalks, arrows and more. Extract geometry can quickly extract pavement markings as polygons based on user-defined templates. This functionality relies on the intensity values of the pavement markings, meaning that each point needs to have an intensity value to ensure the correct behavior of the command.

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From simple feature extraction to comprehensive workflows and automated data analysis

Many times a surveyor requires more than just a collection of points, lines and polygons with geometric attributes. TBC provides commands that can complete full workflows and go beyond simple feature extraction. Completing complex tasks that require extraction of vectors and attributes, calculation and reporting from A to Z without closing a single command.

Stockpile extraction

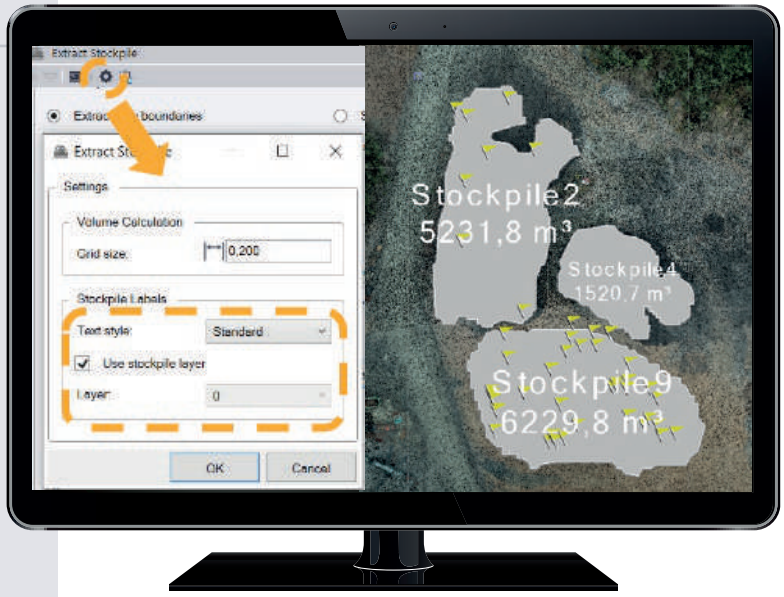
Streamlined workflow for stockpile extraction, volume calculation and reporting.

Extract stockpiles with one click

With the stockpile picker, you can click anywhere on the stockpile and the boundary around it will be auto-generated. Replace tens of clicks with a single click to create a boundary needed for volume computation.

Volume measurements that you can trust

Volume calculation is based on the grid difference between base and slope surfaces. The grid size can be controlled by the user to find balance between processing speed and required accuracy. The base and slope surfaces are auto-generated based on the stockpile boundary. Boundaries are 3D linestrings, which account for undulations at the base of stockpiles, and calculate correct volumes for stockpiles located on slopes. Optionally, users can input their custom base surfaces for maximum computational flexibility and accuracy.



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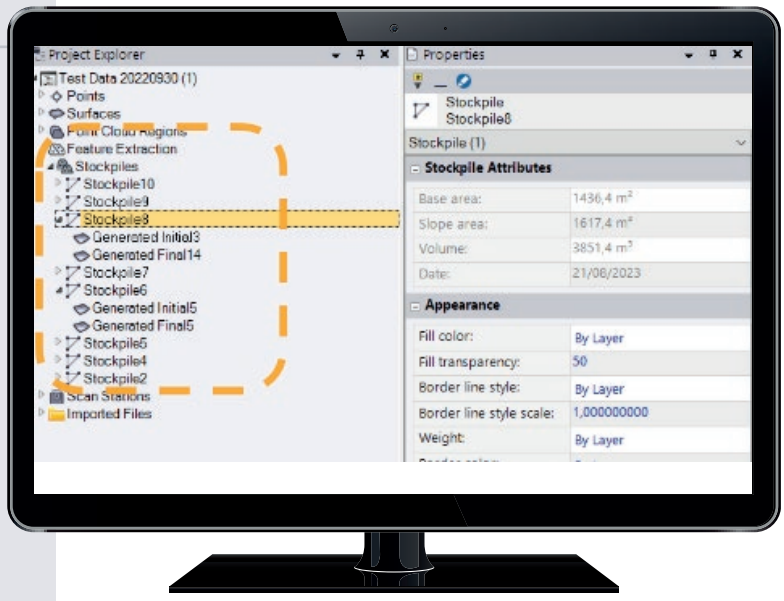
More than just volumes

In addition to the volume calculation, TBC auto-generates the base and slope surfaces for each selected stockpile, and calculates the areas of these surfaces.

Clear overview of the earthwork site data

In addition to the detailed report in CSV and PDF formats, TBC provides an overview of outputs for each stockpile in the site in the Project Explorer tree. All your boundaries and surfaces are organized in the Feature Extraction > Stockpiles container. The selection of any item in the container is synced with the selection in the View in TBC where each stockpile is labeled with its name and its volume.



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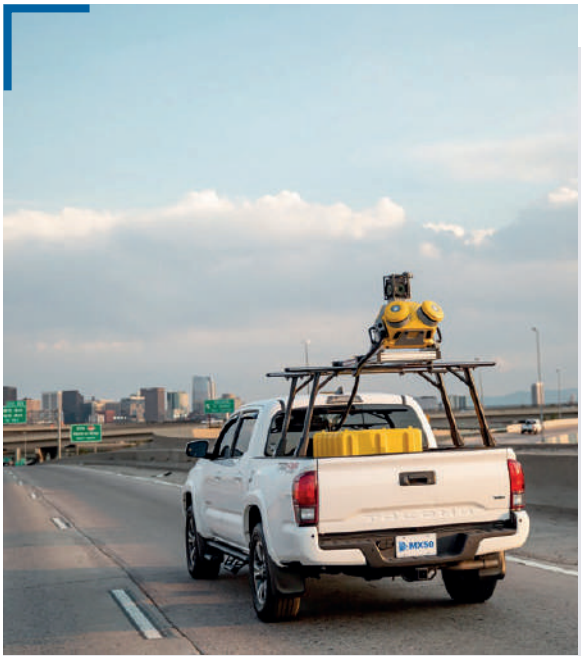


Pavement inspection

Pavement is the most expensive roadway asset and requires continuous monitoring and maintenance. Rapid collection of high-quality data at large scale made possible with Trimble MX mobile mapping systems is now complemented by a comprehensive pavement inspection workflow for automated extraction of pavement distresses and assessment of their severity.

This ensures timely pavement monitoring for cost-effective maintenance and can be used by a wide range of customers from the public and private sectors.

Why mobile mapping for pavement and asset inspection?

Remove subjectivity from pavement analysis

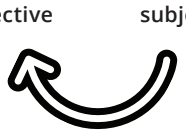
Algorithms replace subjective judgments to extract truly objective information

Matching software for automated analysis & asset management

Efficient information extraction from collected data in Trimble Business Center

Frequent information update for proactive response

Evaluation of pavement at scale and granularity that were previously not feasible



Remove subjectivity from pavement analysis

Algorithms replace subjective judgments to extract truly objective information

Employee safety

Provide risk-free work environment for your employees

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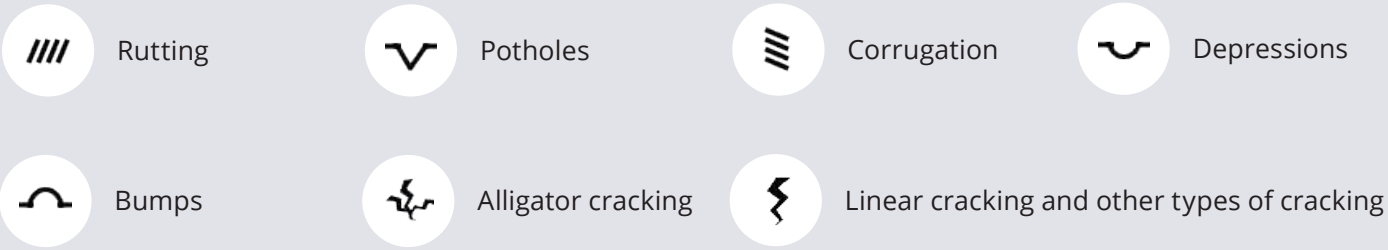
What pavement distresses can the command find?



Cracking is identified using backward camera imagery, therefore it is available only for Trimble mobile mapping systems with backward cameras.

Who can use the command?

Trimble mobile mapping customers.

What technology do we use?

Traditional algorithms are used to find rutting, corrugation, depressions, bumps and potholes.
2D deep learning is used to identify cracking from the backward camera imagery.

What deliverables can the command generate?

- Vector polygons for each: bump pothole, depression, rutting, alligator cracking
- Vector lines for each: linear and other type of cracking
- Automatically extracted geometric attributes for each identified and classified pavement distress and its severity level (severity levels are user-definable)
- Pavement Condition Index score based on ASTM D6433 standard
- Detailed PDF and Excel reports

Why is IRI important?

Calculate the International Roughness Index (IRI) to evaluate the smoothness of your pavement. IRI calculation is particularly critical to ensure adequate ride quality for construction acceptance as well as for checking the condition of the road for maintenance purposes.

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System requirements

Operating system

- Microsoft® Windows® 11 (64-bit version)
- Microsoft Windows 10 (64-bit version)

Processor

- Quad-core Intel 2.80 GHz or better recommended (additional cores with hyper-threading support highly recommended)
- AMD Ryzen processors are not supported

Random-access memory (RAM)

- 32 GB or more recommended

Disk space

- 100 GB free or more on solid-state drive (SSD) where project data and system's temporary folder are located
- Overall capacity of 1 TB SSD or more recommended for multiple projects

Graphics

- DirectX 11 compatible graphics card
- OpenGL version 3.2 or later required when working with point cloud data (latest version recommended)
- 8 GB graphics card or higher (NVIDIA Quadro P4000 or similar) required

Monitor

- 1920 × 1080p or higher resolution with 256 or more colors (at 96 DPI)

Supported languages

- Chinese (Simplified)
- Czech
- Danish
- Dutch
- English US
- English UK
- Finnish
- French
- German
- Italian
- Japanese
- Korean
- Norwegian
- Polish
- Portuguese
- Russian
- Spanish
- Swedish

Learning resources

Interested in TBC but wondering where to start? Want to learn more? We offer a variety of helpful resources to make you productive quickly. Learning TBC has never been easier.

Website:

Your home for everything TBC: downloads, support information and bulletins, as well as customer testimonials and videos:
www.trimble.com/tbc

Learn Platform:

Complete free self-paced workflow-based courses with hands-on guided software experiences:
learn.trimble.com/pages/422/trimble-business-center-tbc

Trimble Community page:

Join your fellow TBC users and ask questions, showcase a project and learn from peers in this open online forum:
community.trimble.com/groups/tbc-group

Power Hours:

A live monthly session where a Trimble or industry expert showcases a workflow in TBC. All sessions available afterwards and on-demand, for free:
geospatial.trimble.com/webinars/trimble-business-center

Tutorials:

Follow along with sample data and PDF instructions as we explain and illustrate specific workflows and introductions to TBC:
geospatial.trimble.com/trimble-business-center-tutorials

YouTube channel:

Watch and learn as our team explains how a specific function works or what's new in our latest release:
www.youtube.com/user/TBCSurvey

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