

User Manual

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BMX BlastPlanner



**User Manual
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Introduction

BMX BlastPlanner is a software component for planning the geometric parameters of a blast site on the computer. The basis for the measurement is a 3D model enhanced by *Blast Site (Marker) Elements*. *BMX BlastPlanner* is used before drilling (pre-profiling) and after drilling. For pre-profiling the user generates a *Drill Pattern* by entering basic parameters on the planned pattern. The system delivers profiles in front of the boreholes, sectional areas, minimum burden diagrams, etc. and a plan view of the *Blast Site* for staking out. If the boreholes are checked after drilling by borehole probes and/or GPS rovers, these data are importable and updates the planned boreholes including all related items such as profiles, or burden diagrams.

Within the *BMX BlastPlanner* overall geometric information on the *Blast Site* is available. *BMX BlastPlanner* serves the determination of profiles and burdens, drilling patterns and borehole attitudes and enables calculations of the *Blast Site* volume. In addition, the *BMX BlastPlanner* supports a customized import of borehole survey data from down-the-hole probe and corresponding measure while drilling (MWD) data. The import of major rock mass structures (discontinuities) from the *JMX Analyst* (".jms" file) allows to combine geological mapping with blast analysis and allows next to a visualization the localization of intersections with boreholes in the minimum burden diagrams.

This user manual addresses all topics related to the *BMX BlastPlanner*. The covered topics include installation, background, definitions, user interface, features, operation and analysis of *BMX BlastPlanner*. Let us know if we can support you, and give us your valuable feedback. Only this way it remains possible to keep the systems both, flexible enough for broad usage and sufficiently specific for your applications.

We wish you success with the *BMX BlastPlanner*.

The Team of 3GSM

Graz, October 2024

2 General

The *BMX BlastPlanner* is part of the *BlastMetriX* software package and is not available as a stand-alone program. The installation takes place during the installation of *BlastMetriX* and is described in the corresponding user manual.

Note:

SMX software components are used under this name in *ShapeMetriX* and *BlastMetriX*, i.e. there are no dedicated *BMX* versions for e.g. *SMX Referencer*.

Attention:

Blast Site files (“*.smb*”) generated with *BMX BlastPlanner v4.9* are not fully supported by previous versions. *Design parameters* specified in the current version cannot be read by versions older than 4.5, they have to be specified once again. However, the current version reads input files from former versions.

3 Background

3.1 Elements of the Blast Site

3D model

The 3D model represents the surveyed model of the bench face. It is an accurate and detailed description of the bench face geometry and enhanced by image information. Borehole measurements towards the free surfaces are derived from the 3D model. A 3D model comprises a 3D point cloud, a triangulation between 3D points forming an irregular surface, and a set of photos draped onto the surface. This leads to a photorealistic representation of the bench face.

Reference elements

- *Terrestrial imaging*
Reference elements include *Range Poles* and *Delimiters*. *Range Poles* are used to scale and orientate the 3D model. *Delimiters* are used to define the location of the *Top Level Surface* and the lateral border planes. They also define a *Reference Line* which relates the 3D model and the boreholes (see Figure 1). As an option, additional markers can be used to define the upper boundary of the *Blast Site*. *Top Level Surface Markers (TLS Markers)* are used to define the (uneven) shape of the *Top Level Surface*. *(Borehole) Collar Markers* can be added to the *Blast Site* at an arbitrary number, which define borehole collars. Reference elements and markers are positioned in the *BMX BlastSiteGenerator* (see corresponding user manual).
- *Aerial imaging*
Reference elements include *Delimiters*, *Floor Level Markers* and (optionally) *Range Poles*. *Delimiters* are used to define the lateral border planes and the *Reference Line* which relates the 3D model and the boreholes (see Figure 1). The *Floor Level Markers* limits the geometry of the *Blast Site* at its bottom. The *Top Level Surface* is automatically generated from the 3D points of the *Top Level Area*, no additional markers are needed. Elements are positioned in the *BlastSiteGenerator3D* (see corresponding user manual). *(Borehole) Collar Markers* can be added to the *Blast Site* at an arbitrary number, which define borehole collars. *Collar Markers* are positioned directly on the 3D model in the *BXM BoreholeFinder* (see corresponding user manual). Optionally, *Range Poles* can be used to scale and orientate a generic 3D model (see *SMX Normalizer* and *BMX BlastSiteGenerator* user manual).

Border planes

Border planes limit the extent of the *Blast Site*. They are initially defined by the positions of *Range Poles*, *Floor Level Markers* and *Delimiters*. The *Left* and the *Right Border Planes* as well as the *Floor Level Plane* but can be relocated in the *BMX BlastPlanner* (Chapter 7.3.). The *BMX BlastPlanner* has following planes:

- *Face Plane*
The *Face Plane* is the best-fit plane to the bench. It considers the central part of the bench between the *Delimiters*. The *Face Plane* is automatically determined and cannot be modified.
- *Left and Right Border Planes*
The *Left* and *Right Border Plane* limit the *Blast Site* laterally. They strike perpendicular to the strike of the *Face Plane*. The *Left Border Plane* is located at the *Left Delimiter* while the *Right Border Plane* at

the *Right Delimiter*. When generating a *Drill Pattern*, the boreholes are located within the boundaries of the *Left* and *Right Border Plane*.

- *Floor Level Plane*

The *Floor Level Plane* limits the *Blast Site* at its bottom. It is defined by two or three points (*Floor Level Markers*; see *BMX BlastSiteGenerator* and *BMX BlastSiteGenerator 3D* user manual). In the case of two points the *Floor Level Plane* strikes perpendicular to the strike of the *Face Plane*. In the case of three points the plane is defined by the three toe positions of the *Floor Level Markers*. The *Floor Level Plane* forms the lower boundary of the volume of the *Blast Site*. The volume of subdrilling of boreholes is counted below the *Floor Level Plane*. The elevation of the plane can be adjusted in *BMX BlastPlanner* (see Chapter 7.3.)

- *Top Level Plane*

The *Top Level Plane* is defined by two or three points (position of the *Delimiters* see *BMX BlastSiteGenerator* and *BMX BlastSiteGenerator 3D* user manual). In the case of two point the *Top Level Plane* strikes perpendicular to the strike of the *Face Plane*. In the case of three points the plane is defined by the three positions of the *Delimiters*. The *Top Level Plane* forms the basis for the local UVW coordinate system for boreholes, i.e. it contains the u and v axis. Consequently, borehole which are not contained in the *Top Level Plane* have a non-zero w value.

Top Level Surface (TLS)

The *TLS* limits the *Blast Site* at its top. It is an irregular surface and capable to model uneven crests. The *TLS* is also the upper limit for the volume of the *Blast Site*. Boreholes are forced to follow the *TLS* when generating a *Drill Pattern*.

Note:

The *TLS* is defined by toe points of the *Delimiter*, *Top Level Surface Points* and *Borehole Collars* when using markers (*BlastSiteGenerator 2D*, terrestrial imaging), whereas the *TLS* is automatically generated from the top level 3D data when using the *BlastSiteGenerator 3D* (aerial imaging with UAV).

Note:

The boreholes follow the *Top Level Surface* rather than the *Top Level Plane*.

Boreholes

Boreholes form the limits of the *Blast Site* within the rock mass. They consist of the collar and the trajectory. Boreholes can be straight or curved. In the planning stage, boreholes can be relocated (position, inclination, azimuth, etc.). Borehole collars and trajectories which have been surveyed by third-party devices can be imported into *BMX BlastPlanner*. Imported borehole parameters cannot be modified. Boreholes can be assigned to rows or be unassigned.

Rows

Rows organise boreholes logically and geometrically. They form a logical chain of boreholes and they also connect the boreholes with an irregular surface. Row information is used for subsequent *Blast Site* analysis. Volume calculation considers only boreholes assigned to rows. Boreholes are automatically organised in rows using the "Generate Drill Pattern" command. Imported boreholes have to be assigned manually to rows.

Borehole Volume

The borehole volume is the volume of rock mass supposed to be blasted by a single borehole. This volume is defined by the trajectory of the borehole, the distance and shape of the free surface in front of the borehole and the new surface generated by the blasting process. The volume of the *Blast Site* is a volumetric body determined by 3D model, the boreholes, the *Top Level Surface (Top Level Plane)* and the *Floor Level Plane*. It is a prediction of volume for designing blasts.

Note:

The volume of subdrilling of boreholes is counted below the *Floor Level Plane*.

Annotations

Mesh Borders

Mesh Borders (see Chapter 9.3) outline the upper and lower boundary of the mesh (triangulated surface) of the bench face.

Muck Lines

Muck Lines (see Chapter 9.6) are used to define areas of pre-existing heap in front of the rock wall. Those areas are excluded from volume calculation of the bank

Face Area

The *Face Area* (see Chapter 9.4) defines the best-fit plane of the face. It is considered between the *Delimiters* in the center of the bench.

Attention:

Mesh Borders are automatically determined but must be checked for correctness. For volume calculation it is necessary to have consistent and correct *Mesh Borders*.

3.2 Definitions

Boreholes

Boreholes are defined by the collar position, the orientation of the trajectory, the length, and the diameter. The collar position is defined by the distances u along and v across the *Reference Line*. In a geo-referenced survey the collar position is also defined by the co-ordinates E (Easting), N (Northing), and H (Height). The orientation of the trajectory is defined by two angles. The first one is the inclination and it is the borehole angle measured from vertical. The second one is the horizontal direction of the hole which is either given by alpha or azimuth:

- Alpha is measured counter-clockwise from the *Reference Line*
- Azimuth is measured clockwise from North to geo-referenced surveys

Subdrilling is defined as the vertical distance of the intersection point between *Floor Level Plane* and borehole and the toe of the borehole. Subdrilling and length are mutually dependent.

Figure 1 shows the parameters defining boreholes in *BMX BlastPlanner*. It shows the parameters for collar position and borehole orientation.

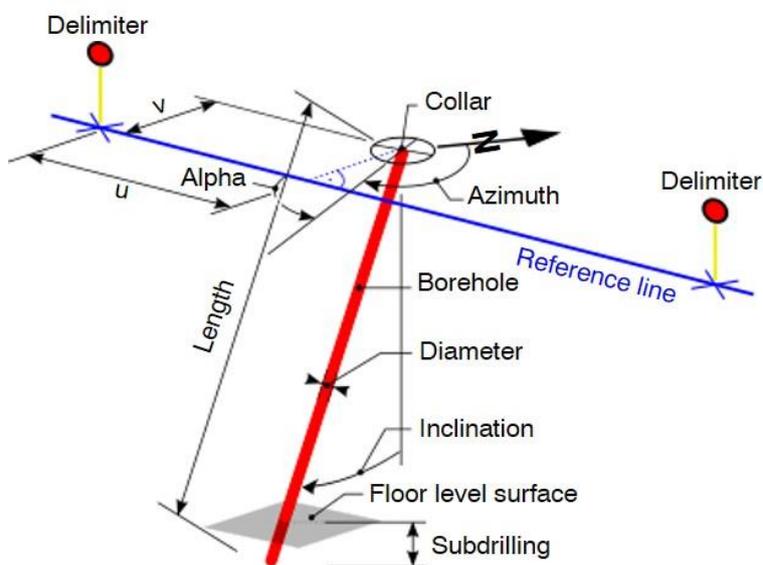


Figure 1: Borehole definitions

Drill Pattern

The *Drill Pattern* consists of boreholes which are placed individually and/or organised in rows. The *Drill Pattern* is defined by the number of rows, the side spacing of boreholes within rows, the distance between rows and the shift between rows. Rows have an arbitrary direction relative to the *Reference Line*. Boreholes which are assigned to rows are connected by a surface. The existence of the surface is indicated also by a dashed line between collars. Boreholes which are not assigned to rows are called *Unassigned Boreholes*. Figure 2 shows the definitions of the *Drill Pattern*, its relation to the *Reference Line*, boreholes assigned to rows and *Unassigned Boreholes*.

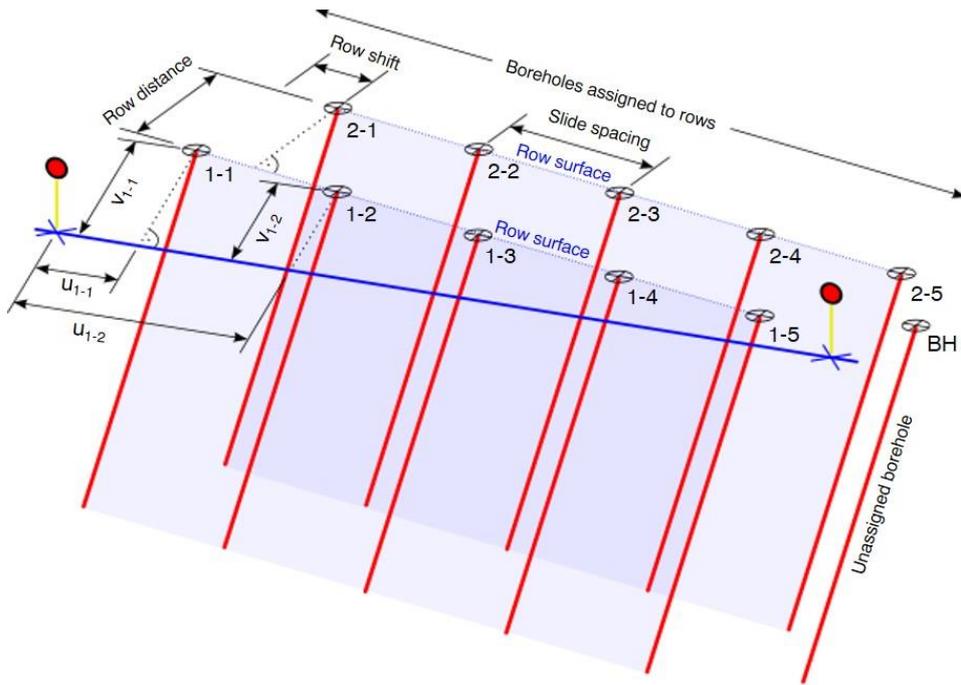
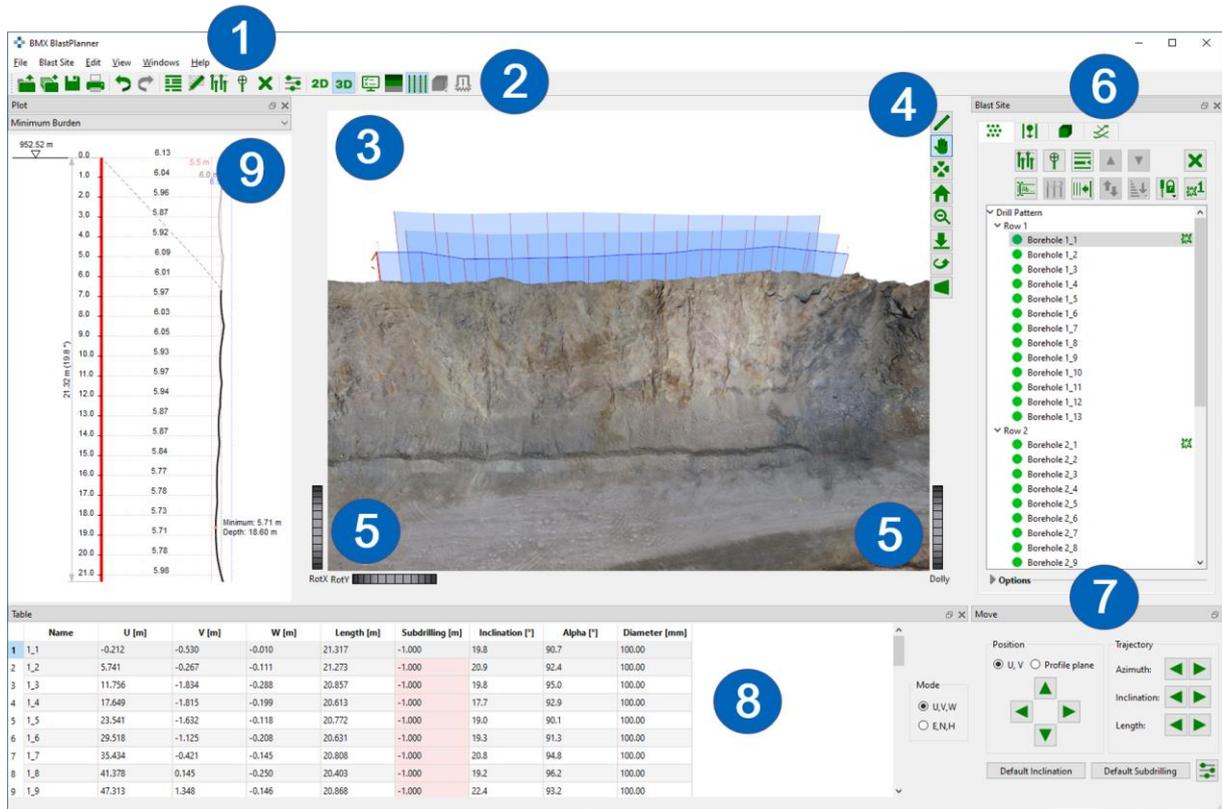


Figure 2: Drill Pattern definitions

4 User interface and features

The user interface of the *BMX BlastPlanner* (Figure 3) comprises the menu bar, the toolbar, the 2D and 3D viewer, navigation bar, thumb wheels, and several detachable panes.



- 1 Menu bar
- 2 Toolbar
- 3 3D viewer
- 4 Navigation bar
- 5 Thumb wheels
- 6 *Blast Site* pane
- 7 *Move* pane
- 8 *Table* pane
- 9 *Plot* pane

Figure 3: User interface of the *BMX BlastPlanner*

4.1 Viewers

The viewer is permanently connected to the *BMX BlastPlanner* window. The user can switch between the 3D viewer (3D model together with *Blast Site Elements*) and 2D display (plan view with contour lines and boreholes) by clicking the “2D” **2D** or “3D” **3D** icons, respectively in the menu bar.

3D viewer

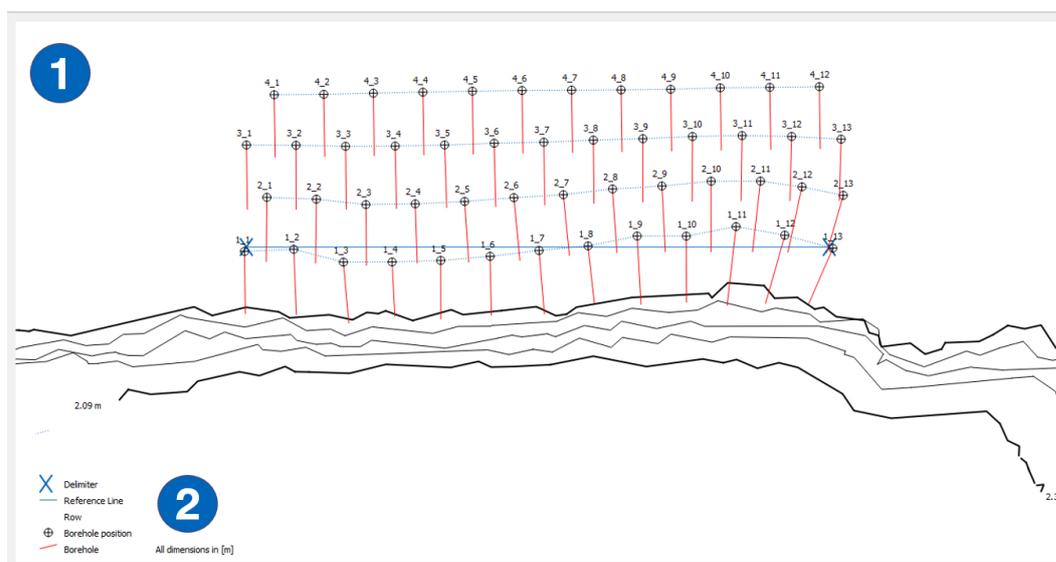
The 3D viewer (Figure 3) serves for displaying the 3D models. Each 3D viewer comprises the context menu, the navigation bar and three thumb wheels for rotation and zooming. The context menu (*Navigate* mode) of the 3D

viewer allows the change in the display of the 3D model. It is opened by a click on the right mouse button in the viewer. Following options can be chosen:

<i>Draw as is</i>	The 3D topography is completely overlaid by the digital photograph (3D model)
<i>Wireframe</i>	A Triangulated red coloured point cloud is forming the topography
<i>Wireframe Overlay</i>	The 3D model and a red coloured overlay of the wireframe is forming the topography
<i>Points</i>	The point cloud of the scene according to the topography is shown
<i>All Points</i>	All available points of the 3D model according to the photograph are shown
<i>Fullscreen</i>	Switches between the fullscreen display and the windowed display.
<i>Show Texture</i>	Displays the 3D model with texture in the viewer
<i>Show Axes</i>	Turns the co-ordinate axes on and off
<i>Show Bounding Box</i>	Turns the bounding box surrounding of the 3D model on and off
<i>3D View Options</i>	Opens the options dialog at the <i>General</i> tab

2D viewer

The 2D viewer (Figure 4) displays the plan view of the blast including contour lines, boreholes with collars and reference elements (i.e. *Delimiter* and *Reference Line*). *Plan View* options are opened by using “*Edit | Options*” in the menu bar or by selecting the corresponding command “*Plan View Options*” in the context menu (see Chapter 6.2).



1 2D viewer

2 Legend

Figure 4: 2D viewer with plan view of the 3D model and Blast Site Elements

4.2 Menu bar

The menu bar comprises six main menus. The menu commands are accessible using the mouse cursor. The following paragraphs describe the structure and commands of the five main menus (*File, Blast site, Edit, View, Windows and Help*)

Menu File

<i>Open 3D Model</i>	Opens a 3D model (".jm3" file)
<i>Export 3D Model</i>	
<i>Export as DXF</i>	Exports the 3D geometry (triangulation) to a ".dxf" file
<i>Export as OBJ</i>	Exports the 3D geometry (triangulation) to an ".obj" file
<i>Generate Screenshot</i>	Generates a user-defined screenshot
<i>Print Report</i>	Prints a report of the drill pattern to a connected printer
<i>Export Report as PDF</i>	Writes a report of the drill pattern directly to a ".pdf" file
<i>Export Plan View as PDF</i>	Exports the plan view to a ".pdf" file
<i>Show Reconstruction Report</i>	Opens the <i>SMX MultiPhoto</i> reconstruction report (available since <i>SMX MultiPhoto v4.0</i> ; not available for 3D models generated by the <i>SMX ReconstructionAssistant</i>)
<i>Exit</i>	Closes the <i>BMX BlastPlanner</i>

Menu Blast Site

<i>Load Blast Site</i>	Loads a <i>Blast Site</i> (".smb" file)
<i>Save Blast Site</i>	Saves the <i>Blast Site</i> including boreholes to the current ".smb" file
<i>Save Blast Site as</i>	Saves the <i>Blast Site</i> including boreholes to a new ".smb" file
<i>Import</i>	
<i>Import Generic Probe Data</i>	Imports borehole deviations recorded by down-the-hole-probes from a text file
<i>Import Pulsar Data</i>	Imports borehole deviations recorded with a <i>Pulsar</i> probe. 3D model and borehole collar are required to be geo-referenced.
<i>Import Pulsar Interactively</i>	Imports borehole deviations recorded with a <i>Pulsar</i> probe. Borehole data is interactively assigned to borehole positions. This also opens the <i>Pulsar</i> dialog.
<i>Import Boretrak Data</i>	Imports borehole deviations recorded with a <i>Boretrak</i> probe. 3D model and borehole collar are required to be geo-referenced.
<i>Import Boretrak Interactively</i>	Imports borehole deviations recorded with a <i>Boretrak</i> probe. Borehole data is interactively assigned to borehole positions. This also opens the <i>Boretrak</i> dialog.

<i>Import Renishaw CSV Interactively</i>	Imports borehole deviations recorded with a <i>Renishaw</i> probe. Borehole data is interactively assigned to borehole positions. This also opens the <i>Renishaw CSV</i> dialog.
<i>Import Surveyed Drill Pattern from CSV</i>	Imports positions of the borehole collar from a “.csv” file. Positions (local or geo-referenced) cannot be modified
<i>Import Designed Drill Pattern from CSV</i>	Imports positions of the borehole collar from a “.csv” file. Positions (local or geo-referenced) can be modified
<i>Import Top Level Surface Points</i>	Imports positions of surveyed points of the <i>Top Level Surface</i> from a “.csv” file. Positions can be local or geo-referenced.
<i>Import Mapping</i>	Imports structural geologic data (<i>Traces, Areas and Discontinuities</i>) from a “.jms” file generated by the <i>JMX Analyst</i>
<i>Custom / Import Drill Pattern from IREDES</i>	Imports borehole and MWD data according to the IREDES standard (“.xml” file.) via the <i>Import IREDES</i> dialog.
Export	
<i>Export to SHOTPlus5 Premier</i>	Exports the 3D model and the <i>Blast Site</i> data to a “.spx” file which is compatible to the software SHOTPlus5 Premier
<i>Export Drill Pattern as CSV</i>	Exports the geometric parameters of the drill pattern to a “.csv” file (readable by spreadsheet programs)
<i>Export Borehole Profiles and Minimum Burden Distances as CSV</i>	Exports borehole profiles and minimum burden distances to a “.csv” file
<i>Export Borehole Volumes as CSV</i>	Exports the borehole volumes to a “.csv” file
<i>Export Delimiter as CSV</i>	Exports the position of the Right and Left Delimiter to a “.csv” file
<i>Custom</i>	<i>Export Drill Pattern as IREDES DRPlan</i> <i>Export Drill Pattern as Atlas Copco CSV</i>
Statistics	Shows basic parameters of the <i>Blast Site</i> including geometry, design parameters and drill pattern analysis
<i>Entitle Blast Site</i>	Allows defining and editing names for the <i>Blast Site</i>
<i>Generate Drill Pattern</i>	Opens a dialog for generating a <i>Drill Pattern</i>
<i>Add Borehole</i>	Adds a borehole to the current row of the <i>Drill Pattern</i>
<i>Remove Borehole</i>	Removes the currently selected borehole(s)
Menu Edit	
<i>Undo</i>	Revokes the previously executed commands step by step
<i>Redo</i>	Redoes the commands revoked by the <i>Undo</i> function step by step
<i>Options</i>	Opens the <i>Options</i> dialog. In this dialog general parameters for the visualisation, printing, navigation, and operation can be modified.

Menu View

<i>2D</i>	Switches to 2D display (Plan view)
<i>3D</i>	Switches to 3D display (3D model)
<i>Show Burden</i>	Shows/hides the colour-coded overlay of burden
<i>Show Top Level Surface</i>	Shows/hides the <i>Top Level Surface (TLS)</i>
<i>Show Row Surfaces</i>	Shows/hides the row surfaces
<i>Show Volume</i>	Shows/hides the calculated volume of the <i>Blast Site</i>
<i>Show MWD Analysis</i>	Shows/hides MWD analysis (colour code) of individual boreholes

Menu Window

<i>Reset Layout</i>	Resets the layout of <i>BMX BlastPlanner</i> with the <i>Move</i> , <i>Blast Site</i> , <i>Plot</i> , and <i>Table</i> pane enabled.
<i>Plot</i>	Shows/hides the <i>Plot</i> pane (<i>Profiles / Minimum Burden</i> diagram)
<i>Table</i>	Shows/hides the <i>Table</i> pane (borehole parameters)
<i>Blast Site</i>	Shows/hides the <i>Blast Site</i> pane (<i>Drill Pattern, Geometry and Volume</i> tab)
<i>Move</i>	Shows/hides the <i>Move</i> pane (control of borehole position and angles)
<i>Interhole Distances</i>	Opens a plan view for displaying distances between individual boreholes at variable heights
<i>MWD Plot</i>	Shows/hides the <i>MWD Plot</i> pane that displays drilling data based on the IREDES standard
<i>MWD Analysis</i>	Shows/hides the <i>MWD Analysis</i> pane that displays analysis of the drilling data based on the IREDES standard

Menu Help

<i>User Manual</i>	Opens the manual of the software component
<i>Units</i>	Displays the units used by the software
<i>About BlastPlanner</i>	Displays version and release information of the software component

4.3 Toolbar

The toolbar has a dynamic layout depending on whether the 3D or 2D viewer is enabled.

Toolbar with 3D viewer enabled



Toolbar with 2D viewer enabled



Open 3D Model



Opens a 3D model (".jm3" file)

Load Blast Site



Loads a *Blast Site* (".smb" file)

Save Blast Site



Saves the current *Blast Site*

Print Report



Prints the report

Undo



Revokes the previously executed commands step by step

Redo



Redoes the commands revoked by the *Undo* function step by step

Entitle Blast Site



Opens a dialog for entitling *Blast Site*

Generate Drill Pattern



Opens a dialog for generating a *Drill Pattern*

Add Borehole



Adds a borehole to the current row of the *Drill Pattern*

Remove Borehole



Removes the currently selected borehole(s)

Options



Opens the *Options* dialog

2D View



Switches to 2D visualisation (plan view)

3D View



Switches to 3D visualisation (3D model)

Render options



Opens a dialog to modify settings in the display view

Render Options (Left: aerial imaging; Right: terrestrial imaging)

<p>Top level area</p> <p><input checked="" type="checkbox"/> Show Top Level Surface</p> <p><input checked="" type="checkbox"/> Show top level 3D data</p> <p>Face area</p> <p><input checked="" type="checkbox"/> Show face 3D data</p> <p>Floor level area</p> <p><input checked="" type="checkbox"/> Show floor level 3D data</p> <p>Augment</p> <p><input checked="" type="checkbox"/> Augment Boreholes</p> <p>3D data opacity</p> <p>Annotation size</p>	<p>Top level area</p> <p><input checked="" type="checkbox"/> Show Top Level Surface</p> <p>Face area</p> <p><input checked="" type="checkbox"/> Show face 3D data</p> <p>Augment</p> <p><input type="checkbox"/> Augment Boreholes</p> <p>3D data opacity</p> <p>Annotation size</p>
---	--

Show Top Level Surface



Shows/hides the *Top Level Surface*

Show Top Level 3D Data (aerial imaging)



Shows/hides the *Top Level Area* (3D model)

Show Face 3D Data



Shows/hides the *Face Area* (3D model)

Show Floor Level 3D Data (aerial imaging)



Shows/hides the *Floor Level Area* (3D model)

Augment Boreholes



Enlarges the boreholes in the viewer

3D Data Opacity



Slider to change stepwise the transparency of the 3D model

Annotation Size



Adjusts the size of markers in the 3D model

Visualise Burden Over the Whole Area



Shows/hides the colour-coded overlay of burden

Show Row Surfaces



Shows/hides the row surfaces

Show Volume



Shows/hides the calculated volume of the *Blast Site*

Show Volume



The icon changes, if volume settings have been changed

Show MWD Analysis



Shows the results of MWD analysis in the 3D viewer (colour coded marking of the boreholes)

4.4 Navigation bar

Hint:

The *BMX BlastPlanner* toggles between the *Edit* and *Navigate* mode by pressing the “*ESC*” key.

Edit



Performs actions within the 3D model such as marking annotations, etc. (active = blue)

Navigate



Controls the motion and inspection of a 3D model (active = blue)

Seek to a Selected Point



Zooms towards the selected location on the 3D model

Move to Home Position



Sets the viewer to its initial position

Zoom out / Zoom in



Zooms out from the current view. Zooms to the previous view again.

Top Down View



Orientates the 3D model from the camera view (top down).

Auto Rotate (fixed or view)



Rotates the 3D model from a fixed point (top down) or from the current point of view

Toggle Perspective/Parallel Projection



Toggles between perspective and parallel projection

Thumb wheels

The thumb wheels are used for rotation and zooming

4.5 Navigation mode

The devices used in the *Navigate* mode are the mouse and/or the keyboard.

Mouse navigation

- Rotation: The left mouse button rotates the 3D model. Just keep the left button pressed and move the mouse around to see the 3D model rotating.
- Context menu: The right mouse button opens a context menu where the representation of the 3D model can be influenced.
- Panning: The middle mouse button is used to pan the 3D model. The same can be done by pressing “Ctrl” or “Shift” and using the left mouse button.
- Zooming: Pressing the left and middle mouse button at the same time is used to zoom. The same can be done by pressing “Ctrl” and “Shift” and using the left mouse button. When turning the wheel of a wheel mouse the 3D model is also zoomed.

Hint:

It is preferred to have a mouse with 3 buttons, or a wheel mouse. Usually the wheel acts as the third mouse button.

Keyboard navigation

- Straight motion is performed by pressing the corresponding arrow key “Left”, “Right”, “Up” or “Down”.
- Zooming is performed by pressing “Shift” simultaneously with the arrow key “Up” for zooming in and the arrow key “Down” for zooming out.

- Rotation of the 3D model in a desired direction is performed by pressing “Ctrl” simultaneously with the corresponding arrow key “Left”, “Right”, “Up” or “Down”.

4.6 Scrolling mechanism

The scrolling mechanism is a fast and easy way to change parameter values with the wheel of the computer mouse. Move the mouse cursor over the input field of the corresponding parameter and turn the mouse wheel. The entered numbers are highlighted and increase or decrease according to the spin of the wheel. Changed values are instantly updated.

4.7 File management

The *BMX BlastPlanner* software deals with two files:

1. The “.jm3” file, which contains all information on the 3D model and its generation. It is generated by the *SMX ReconstructionAssistant* or by the *SMX MultiPhoto*, respectively. The file cannot be modified by the *BMX BlastPlanner*.
2. The “.smb” file, which defines the geometric borders of the *Blast Site*. It is generated by the *BMX BlastSiteGenerator* (terrestrial imaging) or by the *BMX BlastSiteGenerator3D* (aerial imaging), respectively. The *BMX BlastPlanner* modifies (e.g. adjustment of *Blast Site* borders) and extend (e.g. *Drill Pattern*, *Muck Lines*) the file.

For file management follow the steps below:

- Open a 3D model by clicking “Open 3D Model”  icon in the toolbar or using “File | Open 3D Model” from the menu bar: A dialog pops up asking for defining a “.jm3” file.
- Open a *Blast Site* by clicking the “Load Blast Site”  icon in the toolbar or using “Blast Site | Load Blast Site”. A dialog pops up asking for defining a “.smb” file.
- Save the *Blast Site* by clicking the “Save Blast Site”  icon in the toolbar or using “Blast Site | Save Blast Site (as)” from the menu bar.
- Exit *BMX BlastPlanner* by using “File | Exit” from the menu bar.

Hint:

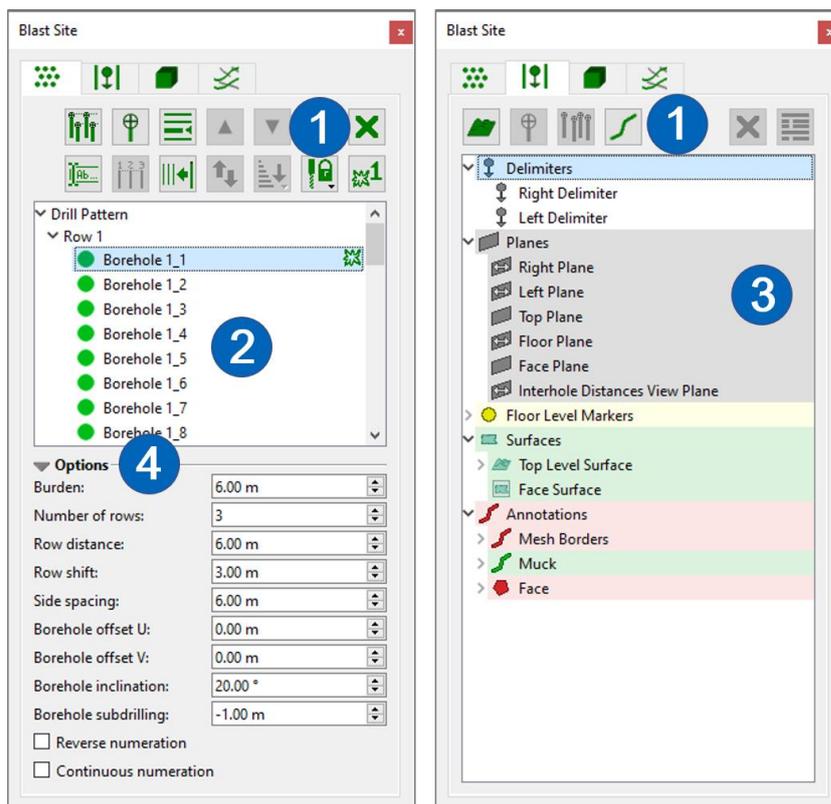
The *Blast Site* (“.smb” file”) is automatically loaded by the *BMX BlastPlanner*, if it has the same file name as the 3D model (“.jm3”).

5 Detachable panes

BMX BlastPlanner has seven panes (*Plot, Table, Blast Site, Move, Interhole Distances, MWD Plot and MWD Analysis*), which can be attached and detached from the interface window. For instruction regarding *Interhole Distances* and *Measure While Drilling* please refer to Chapter 11 and Chapter 12.

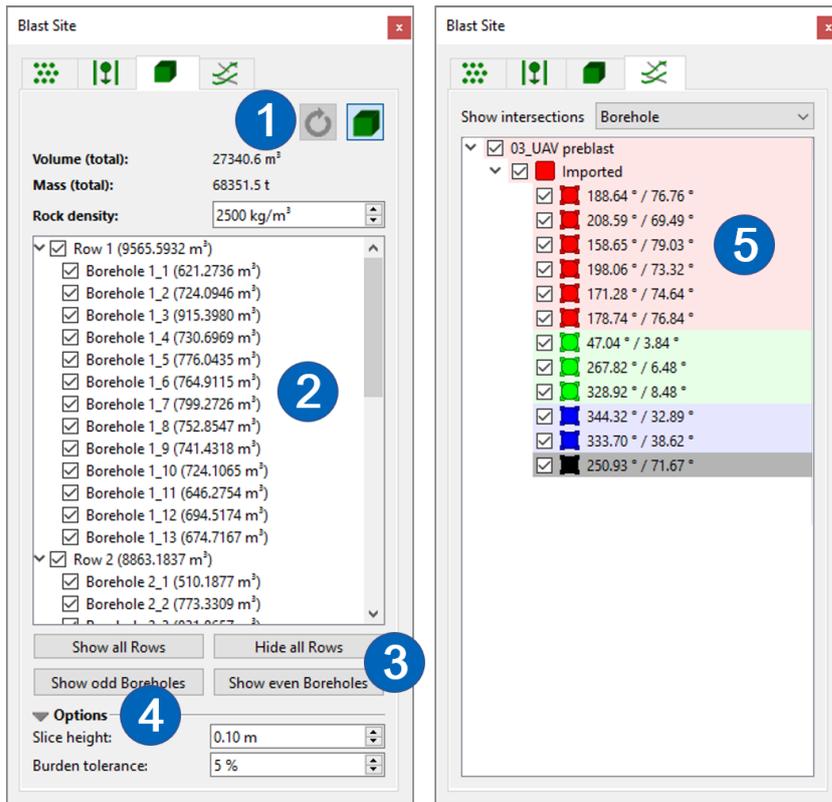
5.1 Blast Site pane

The *Blast Site* pane comprises the dock bar and four tabs (Figure 5 and Figure 6), i.e. *Drill Pattern* tab, *Geometry* tab, *Volume* tab and the *Geology* tab, which can be switched. The *Drill Pattern* tab comprises the *Drill Pattern* list, the toolbar and options. The *Geometry* tab comprises the list of *Blast Site Elements* and the toolbar. The *Volume* tab comprises the list of row volumes, the toolbar and options. The *Geology* tab comprises the imported structural geologic data from the *JMX Analyst* (see Chapter 10).



- 1 Tab-specific toolbar
- 2 *Drill Pattern* list (rows, boreholes)
- 3 Blast Site Elements
- 4 Options

Figure 5: Blast Site pane: *Drill Pattern* tab (left) and *Geometry* tab (right)



1 Tab-specific toolbar
 2 Volumes (rows and single boreholes)
 3 View options for volumes
 4 Options
 5 Imported structural geologic data
 Figure 6: Blast Site pane: Volume tab (left) and Geology tab (right)

Drill Pattern tab – Toolbar



Generate Drill Pattern



Opens a dialog for generating a *Drill Pattern*

Add Borehole



Adds a borehole to the current row of the *Drill Pattern*

Insert Row



Inserts a row directly behind the current row. Inserts a row at the first position if *Drill Pattern* is selected

Move Row Forward



Moves the current row one level forward

Move Row Backward



Moves the current row one level backward

Remove



Removes the currently selected items (*Drill Pattern*, row(s), borehole(s)) from the *Drill Pattern*

Rename



Opens a dialog for renaming the current borehole or row (borehole and row prefixes are preserved)

Auto Rename



Auto-renames the rows and/or boreholes according to the specified row and borehole order

Assign to Row



Assign the selected borehole(s) from the current row to another row

Reverse Borehole Order



Switches the order of boreholes

Pull-down menu "Sort by..."



Sort by U

Sorts the boreholes with ascending u co-ordinate

Sort by V Sorts the boreholes with ascending v co-ordinate

Pull-down menu “Subdrilling”



Lock Subdrilling Locks subdrilling for selected boreholes

Unlock Subdrilling Unlocks subdrilling for selected boreholes

Set as Initial Blast Borehole



Sets the selected borehole as initial *Borehole* to blast

Context menu of Drill Pattern elements

A click on the right mouse button on the entry “*Drill Pattern*” in the *Drill Pattern* list opens a pop up window and several options can be chosen:

- Auto Rename* Auto-renames the row and /or boreholes according to the specified row and borehole order
- Reverse Borehole Order* Switches the order of the boreholes
- Sort by U* Sorts the boreholes with ascending u co-ordinate
- Sort by V* Sorts the boreholes with ascending v co-ordinate
- Lock Subdrilling* Locks subdrilling for all boreholes of the *Drill Pattern*
- Unlock Subdrilling* Unlocks subdrilling for all boreholes of the *Drill Pattern*
- Remove* Removes the selected element from the list
- Add Borehole* Adds a borehole to the current row of the *Drill Pattern*
- Insert Row* Inserts a row to the *Drill Pattern*
- Export as PDF* Writes a report of the drill pattern directly to a “.pdf” file
- Print* Prints a report of the drill pattern to a connected printer

A click on the right mouse button on the entry “*Row*” in the *Drill Pattern* list opens a pop up window and several options can be chosen:

- Rename* Opens a dialog for renaming the current row (row prefixes are preserved)
- Auto Rename* Auto-renames the row according to the specified row order
- Reverse Borehole Order* Switches the order of the boreholes
- Sort by U* Sorts the boreholes with ascending u co-ordinate
- Sort by V* Sorts the boreholes with ascending v co-ordinate
- Lock Subdrilling* Locks subdrilling for all boreholes of the *row*

<i>Unlock Subdrilling</i>	Unlocks subdrilling for all boreholes of the <i>row</i>
<i>Remove</i>	Removes the selected element from the list
<i>Add Borehole</i>	Adds a borehole to the current row of the <i>Drill Pattern</i>
<i>Insert Row</i>	Inserts a row to the <i>Drill Pattern</i>
<i>Move Row Forward</i>	Moves current row one level forward
<i>Move Row Backward</i>	Moves current row one level backward
<i>Export as PDF</i>	Writes a report of the drill pattern directly to a “.pdf” file
<i>Print</i>	Prints a report of the drill pattern to a connected printer

A click on the right mouse button on the entry “*Borehole*” in the *Drill Pattern* list opens a pop up window and several options can be chosen:

<i>Rename</i>	Opens a dialog for renaming the current borehole (borehole prefixes are preserved)
<i>Assign to Row</i>	Assign the selected borehole(s) from the current row to another row
<i>Lock Subdrilling</i>	Locks subdrilling for the individual borehole
<i>Unlock Subdrilling</i>	Locks subdrilling for the individual borehole
<i>Remove</i>	Removes the selected element from the list
<i>Add Borehole</i>	Adds a borehole to the current row of the <i>Drill Pattern</i>
<i>Insert Row</i>	Inserts a row to the <i>Drill Pattern</i>
<i>Set as Initial Blast Borehole</i>	Define the selected borehole as the initial one to blast
<i>Export as PDF</i>	Writes a report of the selected borehole directly to a “.pdf” file
<i>Print</i>	Prints a report of the selected borehole to a connected printer

Drill Pattern tab – Options

Options of the *Drill Pattern* tab (Figure 7) are unfold with a click on the left triangle of the *Options* entry. For definitions see Chapter 3.2 (Figure 1 and Figure 2) and Figure 23.

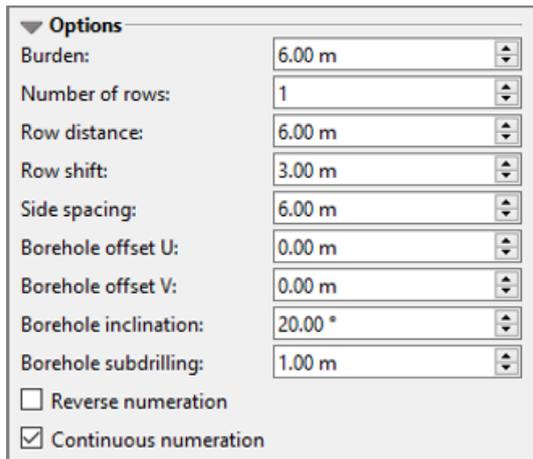


Figure 7: Options of the Drill Pattern tab

<i>Burden</i>	Design burden (crest burden) for generation of the <i>Drill Pattern</i> , burden analysis and volume calculation
<i>Number of rows</i>	Specifies the number of rows
<i>Row distance</i>	Distance between rows for generation of the <i>Drill Pattern</i> , burden analysis and volume calculation
<i>Row shift</i>	Offset of holes between adjacent rows in case of a staggered pattern
<i>Side spacing</i>	Hole-to-hole distance within a row for the generation of the <i>Drill Pattern</i>
<i>Borehole offset U</i>	Offset from the active borehole in u-direction when adding a new borehole
<i>Borehole offset V</i>	Offset from the active borehole in v-direction when adding a new borehole
<i>Borehole inclination</i>	Inclination of boreholes from vertical for generation of the <i>Drill Pattern</i>
<i>Borehole subdrilling</i>	Vertical distance between floor plane and bottom of boreholes for the generation of the <i>Drill Pattern</i>
<i>Reverse numeration</i>	Reverses the order of the boreholes (1-1, 1-2, 1-3,... to 1-3, 1-2, 1-1)
<i>Continuous numeration</i>	Renames borehole by applying a continuous numeration (1-1, 1-2, 1-3,... to 1, 2, 3,... ongoing)

Geometry tab – Toolbar



Show Top Level Surface



Shows/hides the *Top Level Surface*

Add Borehole



Adds a borehole at the currently selected *TLS Marker* or *(Borehole) Collar* markers

Add Boreholes at All Collars



Adds boreholes at all *(Borehole) Collar* markers

Add Muck Line



Adds a *Muck Line*

Delete



Deletes the currently selected *TLS Marker* or *(Borehole) Collar* markers

Properties



Reveals properties of the selected item

Geometry tab – Blast Site Elements

Geometry tab (Figure 8) comprises the elements of the *Blast Site*:

- *Delimiters*
 - *Right Delimiter*
 - *Left Delimiter*
- *Planes* (partly editable; see Chapter 7.3)
 - *Right (Border) Plane*  (editable)
 - *Left (Border) Plane*  (editable)
 - *Top Level Plane*
 - *Floor Level Plane*  (editable)
 - *Face Plane*
 - *Interhole Distances View Plane*  (editable)
- *Floor Level Markers*
- *Surfaces* (editable; see below and Chapter 7.4)
 - *Top Level Surface*
 - *Face Surface*

- Annotations (editable; see Chapter 9)
 - *Mesh Borders*
 - *Upper Mesh Border*
 - *Lower Mesh Border*
 - *Muck Lines*
 - *Face Area*

Properties of the *Top Level Surface* are opened by selecting *Surfaces/Top Level Surfaces* in the list and clicking the “*Properties*” icon  in the toolbar. Following options are provided:

<i>Use Delimiter Position</i>	Defines the <i>TLS</i> by the position of the <i>Delimiter</i>
<i>Use surveyed borehole positions</i>	Defines the <i>TLS</i> by surveyed positions of boreholes
<i>Use surveyed TLS positions</i>	Defines the <i>TLS</i> by surveyed points on the surface

The *Face Surface* is generated by the software automatically and support volume calculations. Properties of the *Face Surface* are opened selecting *Surfaces/Face Surface* in the list and by clicking the corresponding icon  in the toolbar. Following options are provided:

<i>Horizontal influence</i>	Horizontal extent of the area for determining the orientations of the dynamic projections
<i>Vertical influence</i>	Vertical extent of the area for determining the orientations of the dynamic projections
<i>Max. inclination</i>	Maximum vertical inclination allowed for dynamic projections
<i>Prevent overhang</i>	If enabled, overhanging dynamic projections are inhibited and limited with 0°

Note:

The *Face Surface* is not visualized in the *BMX BlastPlanner*. The properties of the *Face Surface* should be adapted only, if volume calculations (see Chapter 9) or automatic placement of boreholes (*Minimum Burden* mode; see Chapter 7.2) fail.

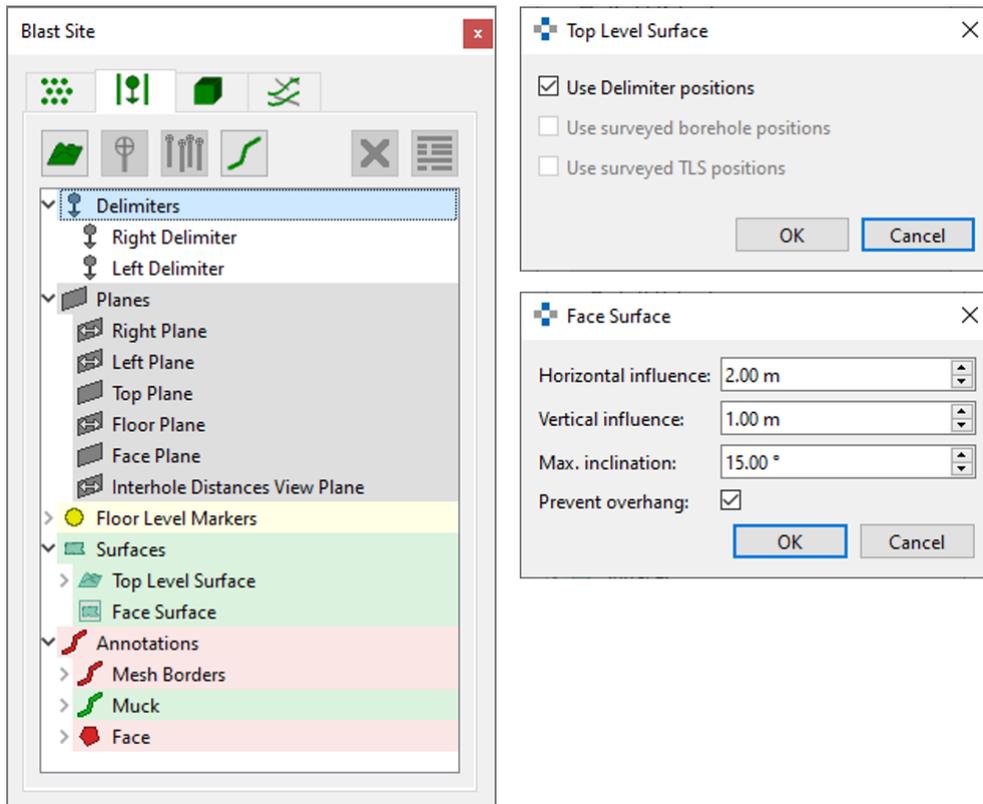


Figure 8: Blast Site Element list of the Geometry tab with the corresponding Top Level Surface and Face Surface dialog

Volume tab – Toolbar



Update Volume



Calculates or updates the volume to blast

Show Volume



Shows/hides the calculated volume of the *Blast Site*

Show Volume



The show volume icon changes, if volume settings have been changed. The “Update Volume” icon gets enabled in order to update the volume.

Volume (total)

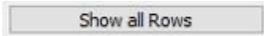
Displays the (total) blast volume from design

Mass (total)

Displays the (total) mass

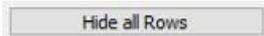
Rock density Defines the rock density used for total mass calculations

Show all Rows



Shows all borehole rows of the *Blast Site*

Hide all Rows



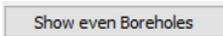
Hides all borehole rows of the *Blast Site*

Show odd Boreholes



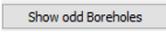
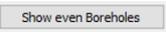
Shows odd *Boreholes* of the *Blast Site*

Show even Boreholes



Shows even *Boreholes* of the *Blast Site*

Volume tab – Volume of rows and boreholes

The *Volume* tab (see Figure 5/5) lists the volume of rows and single boreholes. The volume for rows or single boreholes can be shown or hidden by enabling/disabling the checkboxes in the row volumes list. In addition, the following buttons allows for an individual visualization of the results: “*Show all Rows*” , “*Hide all Rows*” , “*Show odd Boreholes*” , and “*Show even Boreholes*” .

Note:
The total volume as well as the total mass is not affected by changes in the list. Enabling or disabling rows only affects the viewer’s display.

Volume tab - Options

Options of the *Volume* tab (

Figure 9) are unfold when clicking the triangle left of the *Options* entry. For definitions see also Figure 1, Figure 2, and Figure 24.

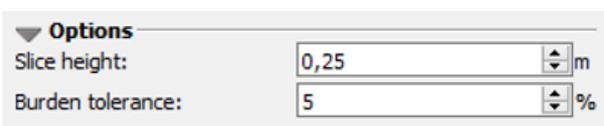


Figure 9: Options of the Volume tab

Slice height Height of one slice for the volume calculation

Burden tolerance Excess percentage of design burden allowed when generating the volume model

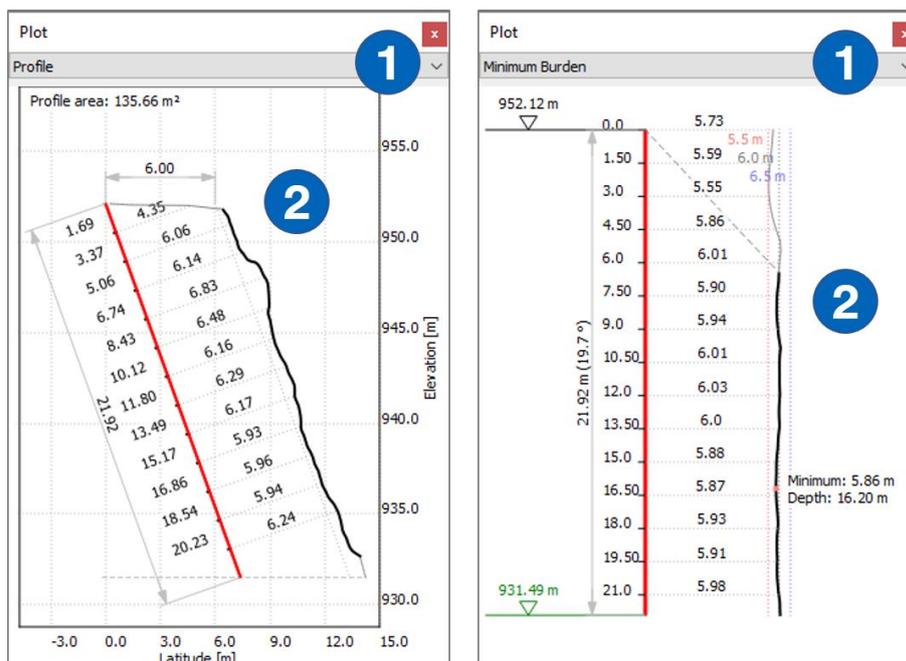
Geology tab

Show intersections Shows/hides imported *Discontinuities* from the *JMX Analyst* in the *Plot* pane (*Profile* and *Minimum Burden* diagram)

- *All* Shows all *Discontinuities* (positions and intersections)
- *Borehole* Shows *Discontinuities* intersecting boreholes only
- *Profile* Shows *Discontinuities* intersecting the *Profile* only
- *Profile and Borehole* Shows *Discontinuities* intersecting boreholes and the *Profile*

5.2 Plot pane

The *Plot* pane displays the *Profile* or *Minimum Burden* diagram the active borehole (Figure 10). See Chapter 8 for detailed information.



- 1 Pull-down menu (*Profile* or *Minimum Burden*)
- 2 Plot area

Figure 10: Plot pane for displaying the *Profile* or *Minimum Burden* diagram of a borehole

5.3 Table pane

The *Table* pane shows the geometric parameters of all boreholes on an editable spreadsheet (Figure 11).

Table									
	Name	U [m]	V [m]	W [m]	Length [m]	Subdrilling [m]	Inclination [°]	Alpha [°]	Diameter [mm]
1	1_1	-0.212	-0.530	-0.010	21.317	-1.000	19.8	90.7	100.00
2	1_2	5.741	-0.267	-0.111	21.273	-1.000	20.9	92.4	100.00
3	1_3	11.756	-1.834	-0.288	20.857	-1.000	19.8	95.0	100.00
4	1_4	17.649	-1.815	-0.199	20.613	-1.000	17.7	92.9	100.00
5	1_5	23.541	-1.632	-0.118	20.772	-1.000	19.0	90.1	100.00
6	1_6	29.518	-1.125	-0.208	20.631	-1.000	19.3	91.3	100.00
7	1_7	35.434	-0.421	-0.145	20.808	-1.000	20.8	94.8	100.00
8	1_8	41.378	0.145	-0.250	20.403	-1.000	19.2	96.2	100.00
9	1_9	47.313	1.348	-0.146	20.868	-1.000	22.4	93.2	100.00
10	1_10	53.265	1.333	-0.091	20.739	-1.000	21.6	90.3	100.00
11	1_11	59.287	2.499	-0.110	21.262	-1.000	25.6	83.7	100.00

- 1 Spreadsheet (editable)
- 2 Switch mode (u,v,w into (E)x,(N)y,(H)z co-ordinates)

Figure 11: Table pane showing the geometric parameters of the boreholes in an editable spread sheet

5.4 Move Pane

The Move pane comprises buttons for controlling the position, size and orientation of selected boreholes (Figure 12). Further details are found in Chapter 7.3.

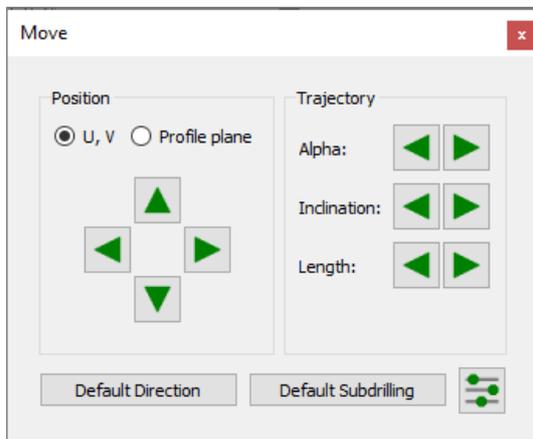


Figure 12: Move pane with control area

5.5 Attaching and detaching panes

Attaching and detaching panes serves for individually designing the appearance of the BMX BlastPlanner and arranging panes with different functionality at your personal preference. A detachable pane has a dock bar at the top of its window (see e.g. Figure 5).

Attaching panes:

1. Drag the window of the detached pane close to your desired dock position.
2. A blue placeholder opens. Two options are possible:
 - a. The placeholder can open a non-overlapping field (Figure 13)
 - b. The placeholder can overlap with another view (Figure 14)

- Once you release the left mouse button, the pane will dock to the place holder. In case of overlapping panes a flag at the pane's bottom appears allowing switching between the panes.

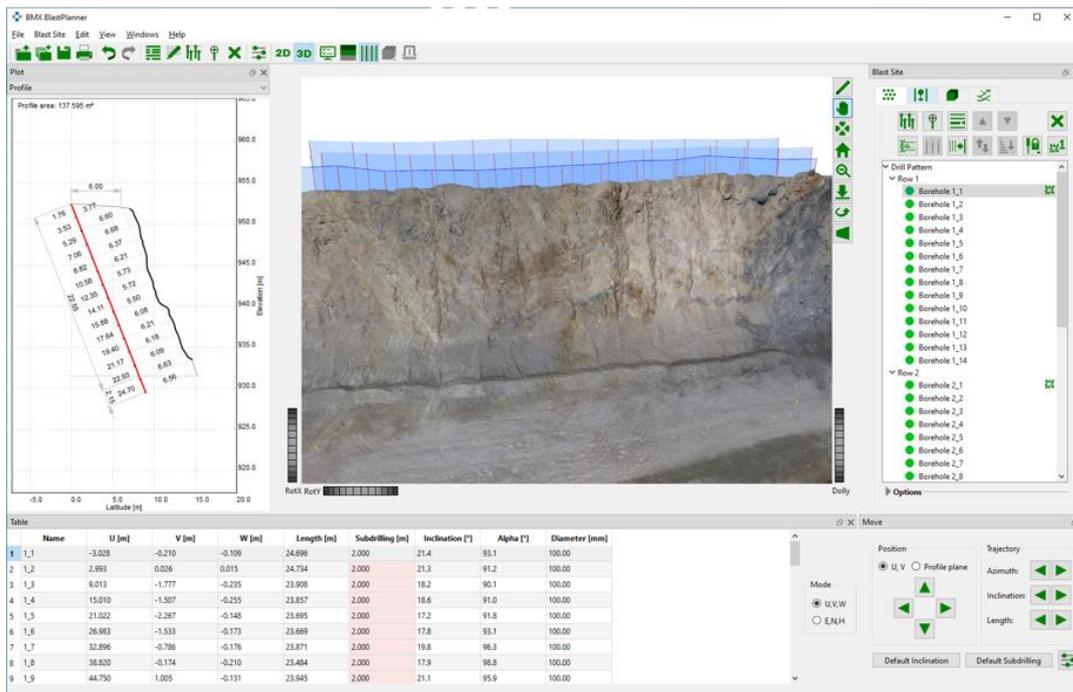
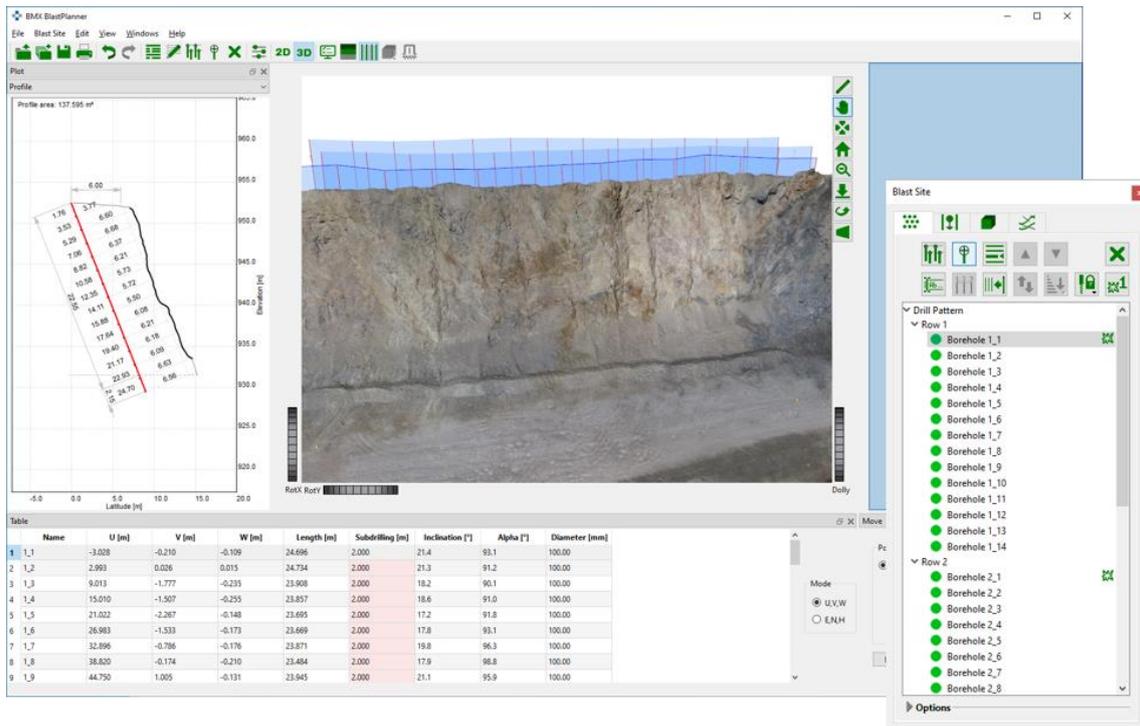


Figure 13: Attaching a pane into a non-overlapping placeholder. The pane docks and takes the shape of the placeholder after releasing the mouse button.

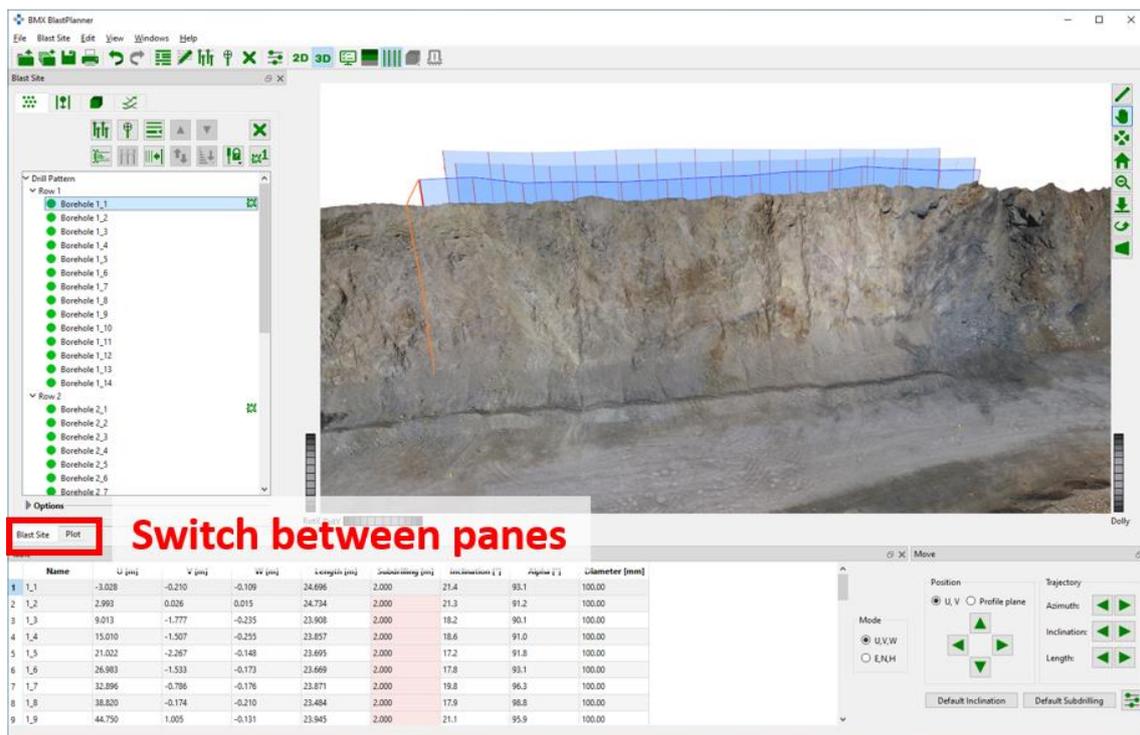
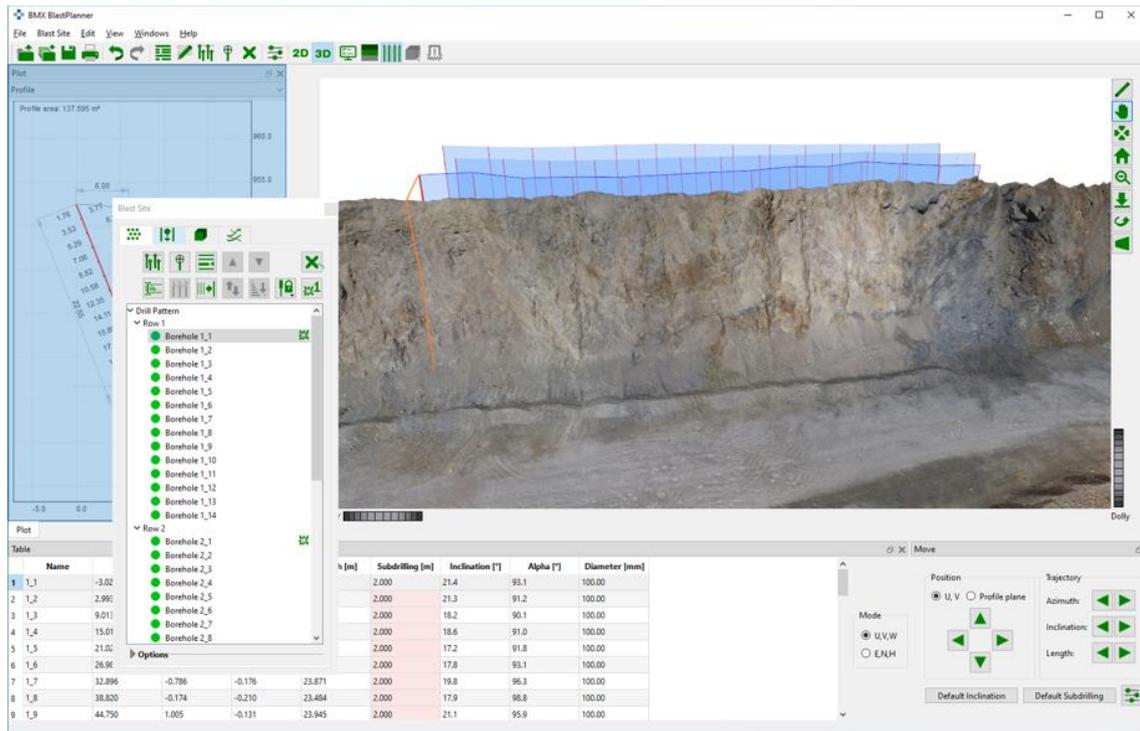


Figure 14: Attaching a pane into a placeholder overlapping with another pane. The pane docks and takes the shape of the placeholder after releasing the mouse button. A flag appears at the bottom of the view, which allows to switch between the overlapping panes.

Detaching panes (Figure 15):

1. Click with the left mouse button on the dock bar.
2. Drag the view to the desired position while holding the left mouse button.

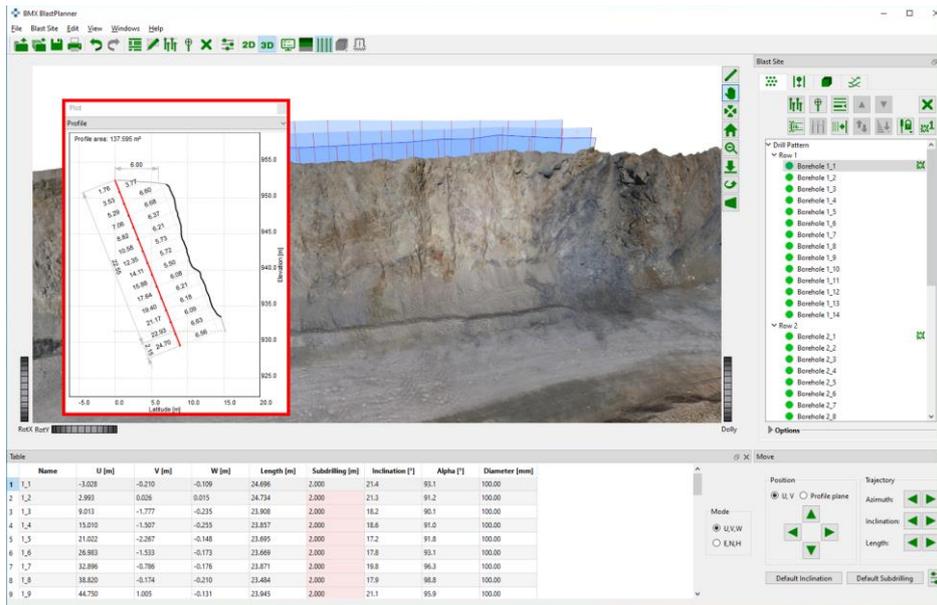


Figure 15: Detaching a pane with the mouse cursor in the dock bar while holding the left mouse button

Additional properties:

- Panes are shown or hidden through the menu *Windows* by selecting the corresponding entry in the menu (i.e. *Plot*, *Table*, *Blast Site* and *Move*).
- The size and shape of the panes can be adjusted with the mouse (see Figure 16)
- Undocked views can be placed on different screens.
- The layout of the user interface can be reset with selecting the menu "*Windows | Reset Layout*". The viewer and the panes are arranged to its original layout.

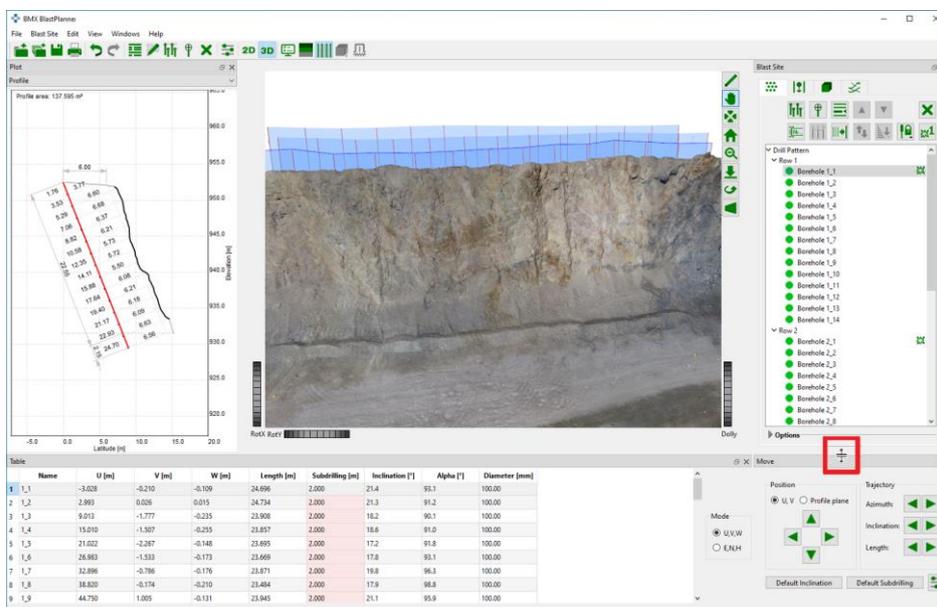


Figure 16: Change the size and shape of a pane with the mouse by clicking at the pane's boundary. The mouse cursor turns into a double arrow.

6 General Options

The *Options* dialog is called by clicking “*Edit | Options*” or by clicking the “*Options*”  icon in the toolbar. The dialog can be directly called from the context menu of the 3D viewer (see Chapter 4.1) It comprises the *General* tab, the *Plan View* tab and the *Step Size* tab.

6.1 General tab

The *General* tab (Figure 17) customizes the valid burden distance and the general view of the loaded model.

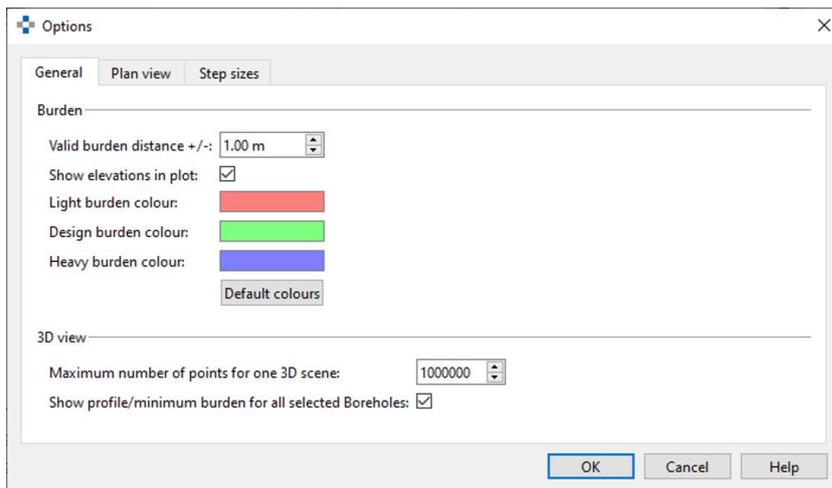


Figure 17: General tab of the Options dialog

Following options are provided:

- Burden
 - *Valid burden distance +/-*
Tolerance margin for acceptable burden values (linked to the green areas in the colour-coded burden visualisation). Boundaries are also shown in the minimum burden diagram.
 - *Show elevations in plot*
Displays the altitude at the borehole collar and at the floor level in the minimum burden diagram.
 - *Light burden colour*
Defines the colouring of light burden areas
 - *Design burden colour*
Defines the colouring of design burden areas
 - *Heavy burden colours*
Defines the colouring of design burden areas
 - *Default colours*
Resets the burden colours to the default colours
- 3D view:

- *Maximum number of points for one 3D scene*
Reducing this value facilitates smooth motion of the 3D model also on less powerful computers. A reduced number of plotted points is only used for visualisation and does not influence the internal measurement accuracy.
- *Show Profile/Minimum Burden for all selected boreholes* *Enabled:*
Shows the *Profile* or *Minimum Burden* for all selected boreholes in the 3D model. *Disabled:*
Shows the *Profile* or *Minimum Burden* for the first selected borehole in the 3D model.

6.2 Plan View tab

The *Plan View* tab (Figure 18) customizes the plan view by showing or hiding individual parameters.

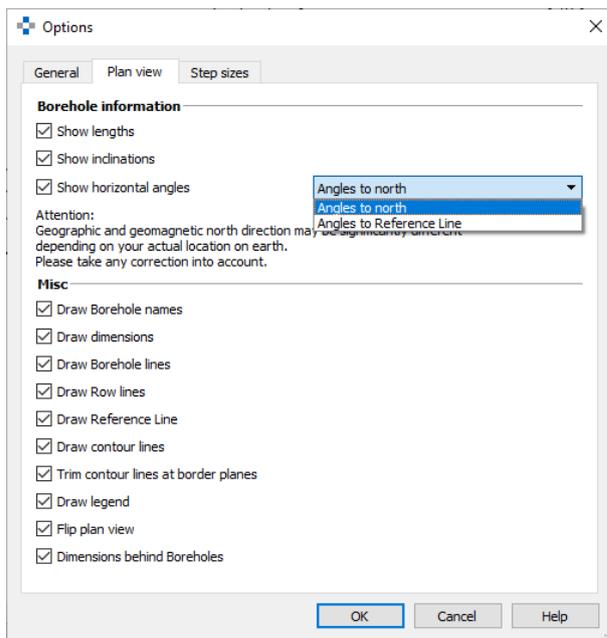


Figure 18: Plan View tab of the Options dialog

Following options are provided:

- Borehole information
 - Lengths
 - Inclinations
 - Horizontal angles to north
Geographic and geomagnetic north direction may be significantly different depending on your actual location on earth, Please take any correction into account.
 - Horizontal angles to the *Reference Line*
- Misc
 - Borehole names

- Dimensions
- Borehole lines (shaft)
- Row lines
- *Reference Line*
- Contour lines
- Trim contour lines at *Border Planes*
- Legend
- Flip the plan view
- Draw dimensions behind Boreholes

6.3 Step Size tab

A click on the arrow buttons in the *Move* pane (Figure 12) causes an adjustment of the boreholes.

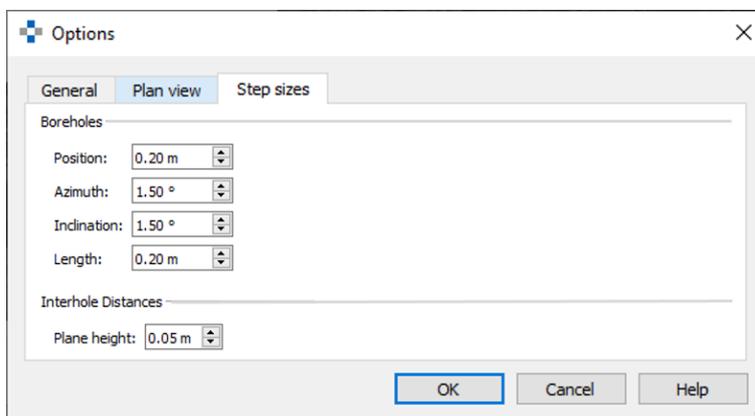


Figure 19: Step Size tab of the Options dialog

In the *Step Size* tab (Figure 19) the increments for one click are defined by the following parameters:

- *Boreholes*
 - *Position*: Increment for the position of the borehole along (U) and across (V) the *Reference Line*
 - *Azimuth*: Increment for the borehole azimuth
 - *Inclination*: Increment for the borehole inclination
 - *Length*: Increment for the borehole length
- *Interhole Distances*
 - Increment for the plane height

7 Operations

The basic procedure for designing a *Drill Pattern* is described in Chapter 7.1. Detailed description of the operation features (e.g. generation, editing, import of files etc.) are found in Chapters 7.2 to 7.7.

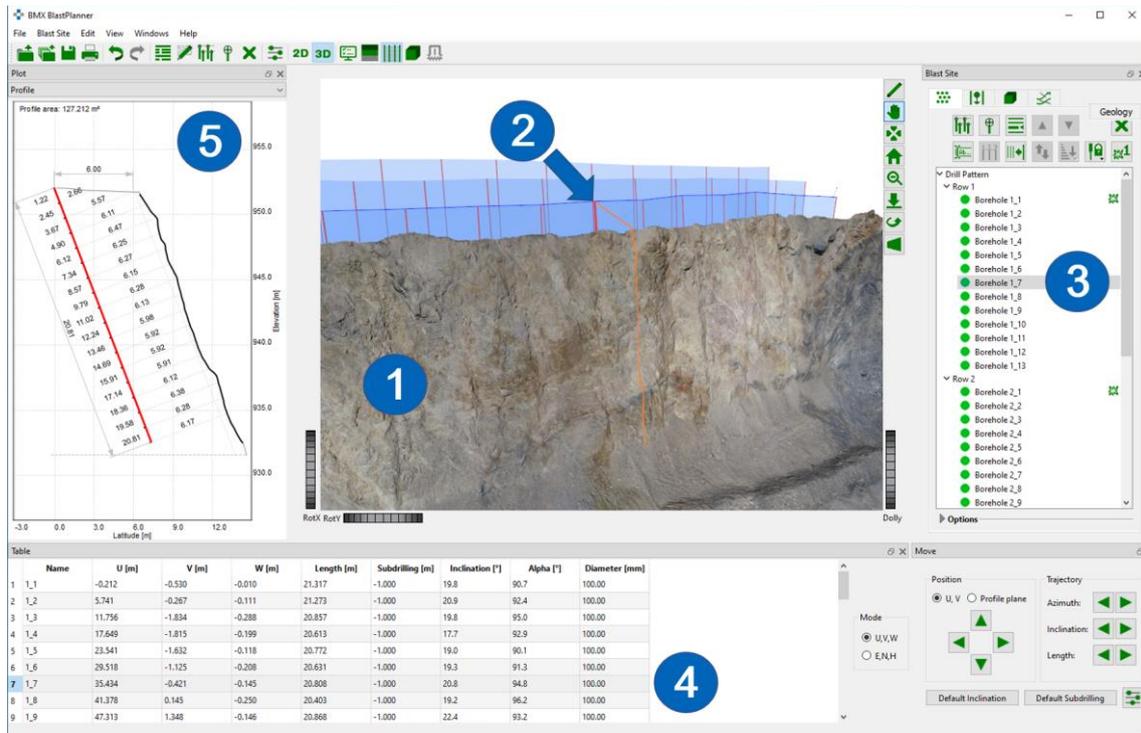
7.1 Standard operation procedure

1. Load the 3D model of the bench face by clicking “*File | Open 3D Model*” in the menu bar or by clicking the corresponding  icon in the toolbar and choose the intended file with extension “.jm3”.
2. Load the *Blast Site* file by clicking “*Blast Site | Load Blast Site*” in the menu bar or by clicking the corresponding icon  in the toolbar and choose the intended file with extension “.smb”.

Hint:

The *Blast Site* (“.smb” file) is automatically loaded by the *BMX BlastPlanner*, if it has the same file name as the 3D model (“.jm3”).

3. Generate a *Drill Pattern* by clicking “*Edit | Generate Drill Pattern*” in the menu bar or by clicking the corresponding icon  in the toolbar and specify the intended geometric parameters of the *Blast Site* in the dialog window. Currently, three modes are offered and described in Chapter 7.2.
4. Confirm the dialog window by clicking the “OK” button and the software generates the *Drill Pattern*. It assigns borehole locations accordingly and generates a hierarchical list in the *Drill Pattern* tab of the *Blast Site* pane. The boreholes are instantly displayed within the 3D viewer as red cylinders (Figure 20). To display the row surfaces in the viewer click “*View | Show Row Surfaces*” in the menu bar or click on the corresponding icon  in the toolbar.
5. Click on one of the boreholes either in the 3D viewer, the plan view, the *Table* pane or the *Drill Pattern* tab. The corresponding *Profile* or *Minimum Burden* diagram appears in the *Plot* pane. The entries corresponding to the selected borehole in the *Drill Pattern* tab and the *Table* pane are highlighted. The selected borehole is highlighted red in the plan view. An example of a *Drill Pattern* with an active borehole is shown in Figure 20.
6. If required, adjust the position, inclination, azimuth, or length of the borehole using the control buttons in the *Move* pane.
7. Switch between *Profile* or *Minimum Burden* diagram to check the burden of the borehole.
8. Switch to 3D display and turn on the colour-coded burden overlay to check the resulting overall burden situation by clicking “*Visualize Burden Over The Whole Area*”  icon in the toolbar. For further details see Chapter 8.



1 3D model
 2 Drill Pattern with boreholes (red) and row surfaces (blue)
 3 Drill Pattern list with highlighted active borehole
 4 Table pane with highlighted active borehole
 5 Profile plot of the active borehole
 Figure 20: Display of the 3D model and the planned boreholes. The blue arrow marks the active borehole.

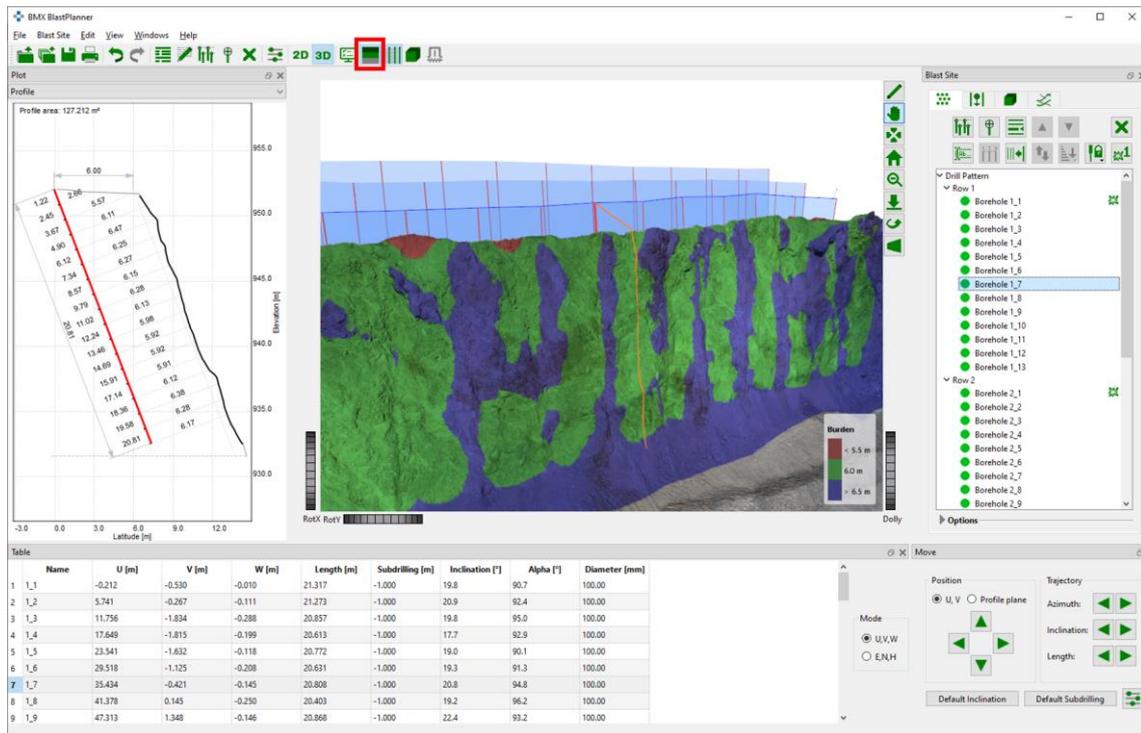


Figure 21: Display of the 3D model and the planned boreholes with visualized burden situation

9. Repeat steps 5 - 8 for all boreholes until you are satisfied with the *Drill Pattern* and the *Profiles* and/or *Minimum Burden* diagrams.
10. Calculate the volume to blast by the specified *Drill Pattern* by clicking the “Update Volume”  icon in the *Volume* tab of the *Blast Site* pane. For further details see Chapter 9.
11. A window with the geometric properties of the *Blast Site* appears when clicking on “*Blast Site | Statistics*” (see Figure 22). The values can be exported in a text file by clicking on the “Export” button. (“.csv” format; this can be read by spreadsheet programs like MS Excel).

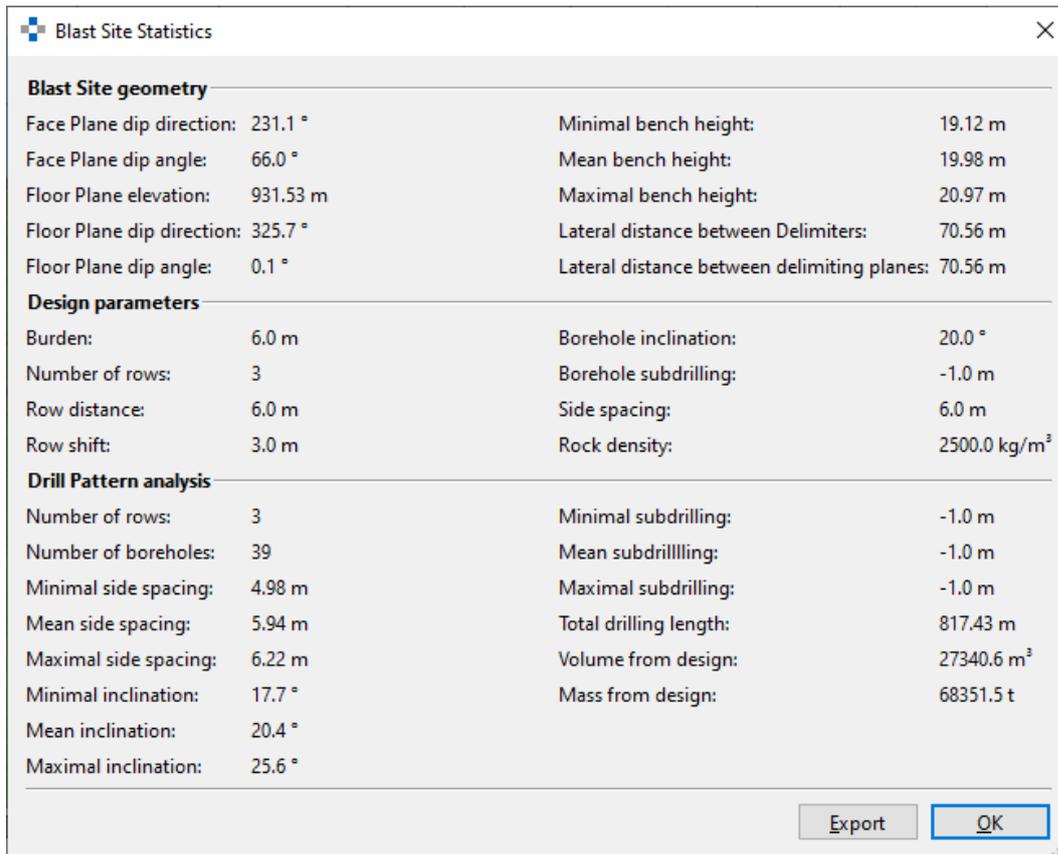


Figure 22: Statistics

12. Save the *Blast Site* by clicking “*Blast Site | Save Blast Site (as)*” in the menu bar or clicking the corresponding icon  in the toolbar.
13. In order to produce a report, click “*File | Print Report*” in the menu bar or the corresponding icon  in the toolbar. By choosing the appropriate output device the results are printed into a “.pdf” file (preferred mode) or directly send to a connected printer. For further information see Chapter 13.

Hint:

Reports are independent from any printer settings if the „Export Report as PDF” feature in the menu bar is used (see Chapter 13).

7.2 Generate a Drill Pattern

The dialog for generating a *Drill Pattern* is called by “*Edit | Generate Drill Pattern*” from the menu bar or clicking the corresponding icon  in the toolbar. Three different modes are available:

Alternative A: Mean Burden mode (borehole line parallel to Face Plane)

The *Mean Burden* tab allows to specify the *Drill Pattern* parameters of the *Blast Site* (Figure 23). These parameters are:

- Burden
- Row parameters
 - number of rows
 - side spacing
 - row distance
 - row shift
- Borehole parameters
 - diameter
 - inclination
 - subdrilling
- General
 - reverse numeration
 - continuous numeration
 - add to existing *Drill Pattern*
- Trim contour lines at border planes

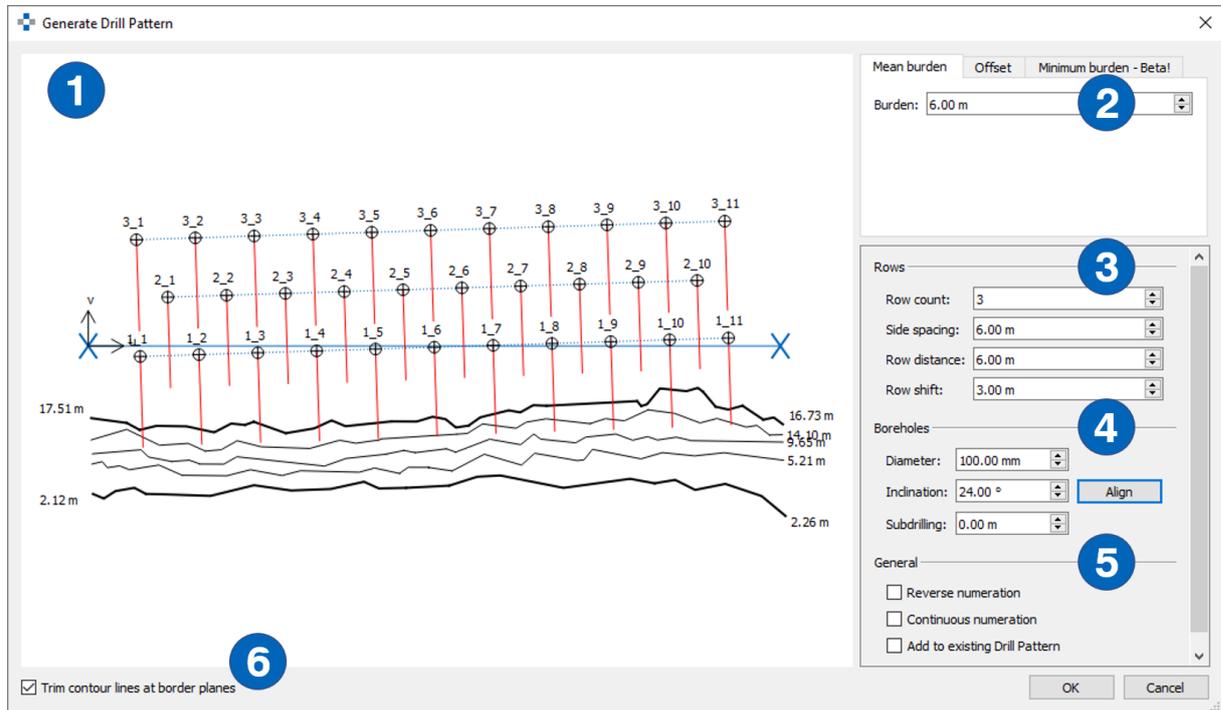
By clicking the “*Align*” button, the borehole inclination is set to the mean dipping of the bench face, i.e. it complies the defined burden as good as possible. All holes get the same inclination. The order of boreholes are reversed by a click on the “*Reverse numeration*” checkbox. A continuous numeration of the boreholes (i.e. 1, 2, 3, ongoing) is applied by activating the checkbox “*Continuous numeration*”. The *Drill Pattern* is added to an existing one by activating the “*Add to existing Drill Pattern*” checkbox. By enabling the checkbox “*Trim contour lines as border planes*” the plan view is limited to the area between the border planes (see Chapter 3.1 and 7.3). Enabling this feature does not affect the generation of the drill pattern. It serves for the optimized visualization of the *Drill Pattern* in the plan view.

Hint:

After generating the *Drill Pattern* each hole is movable and inclinable individually using the *Move* pane.

Hint:

In this dialog burden means horizontal crest burden counted from the intersection of the *Face Plane* with the *Top Level Plane* (Figure 24).



- 1 Instant preview of *Drill Pattern*
- 2 Design burden
- 3 Row parameters
- 4 Borehole parameters
- 5 General options
- 6 Trim contour lines at border planes

Figure 23: Dialog window for entering the geometric parameters of a blast. Mean Burden mode: Borehole lines parallel to the mean bench face plane.

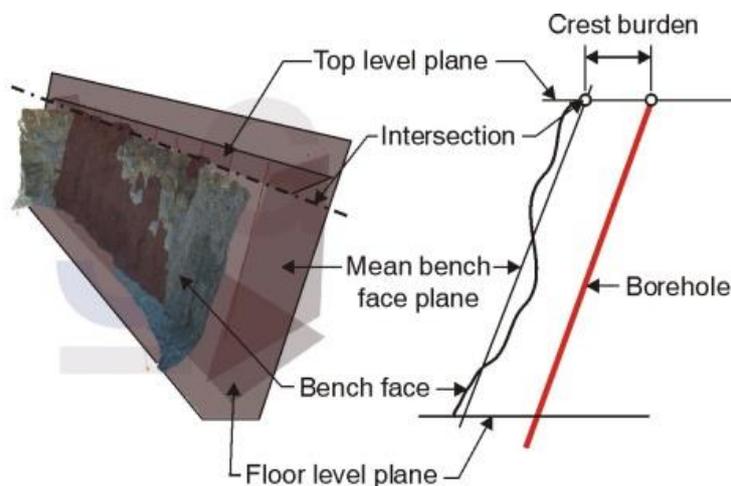


Figure 24: Definition of the mean burden as a crest burden. The burden is measured from the intersection line between mean bench Face Plane and Top Level Plane.

Alternative B: Offset mode (free choice of borehole lines)

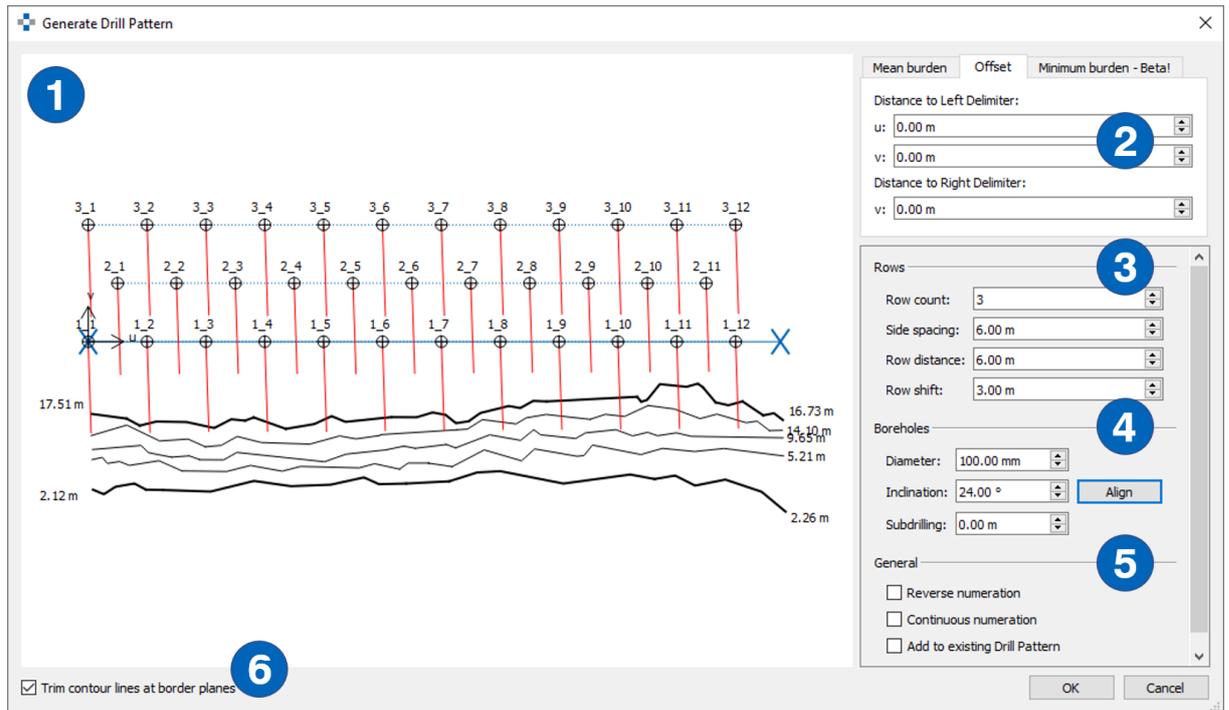
The *Offset* tab allows to specify the *Drill Pattern* parameters of the *Blast Site* (Figure 25). These parameters are:

- Offset parameters of the borehole line
 - u and v distances to the *Left Delimiter*
 - v distance to the *Right Delimiter*
- Row parameters
 - number of rows
 - side spacing
 - row distance
 - row shift
- Borehole parameters
 - diameter
 - inclination
 - subdrilling
- General
 - reverse numeration
 - continuous numeration
 - add to existing *Drill Pattern*

The borehole line (connection between first and last borehole) is defined freely by specifying values along and across the *Reference Line*. The coordinate along the *Reference Line* is u while across it is v. The first two values define the position of the first borehole related to the *Left Delimiter*. The third value specifies at which distance of the borehole line passes the *Right Delimiter*. Using the given side spacing the line of holes is defined and instantly drawn.

By clicking the “Align” button, the borehole inclination is set to the mean dipping of the bench face, i.e. it complies the defined burden as good as possible. All holes get the same inclination. The order of boreholes are reversed by a click on the “Reverse numeration” checkbox. A continuous numeration of the boreholes (i.e. 1, 2, 3, ongoing) is applied by activating the checkbox “Continuous numeration”. The *Drill Pattern* is added to an existing one by activating the “Add to existing *Drill Pattern*” checkbox. By enabling the checkbox “Trim contour lines as border planes” the plan view is limited to the area between the border planes (see Chapter 3.1 and 7.3). Enabling this feature does not affect the generation of the drill pattern. It serves for the optimized visualization of the *Drill Pattern* in the plan view.

Hint:
After generating the *Drill Pattern* each hole is movable and inclinable individually using the *Move* pane.



- 1 Instant preview of *Drill Pattern*
- 2 Offset of the borehole line
- 3 Row parameters
- 4 Borehole parameters
- 5 General options
- 6 Trim contour lines at border planes

Figure 25: Dialog window for entering the geometric parameters of a blast. Offset mode: Free choice of borehole lines

Alternative C: Minimum Burden mode (automatic placement of boreholes)

The *Minimum Burden* tab (Figure 26) allows to specify the following parameters:

- Burden
- Row parameters
 - number of rows (row count)
 - side spacing
 - row distance
 - row shift
- Borehole parameters
 - Diameter
 - inclination
 - subdrilling
- General

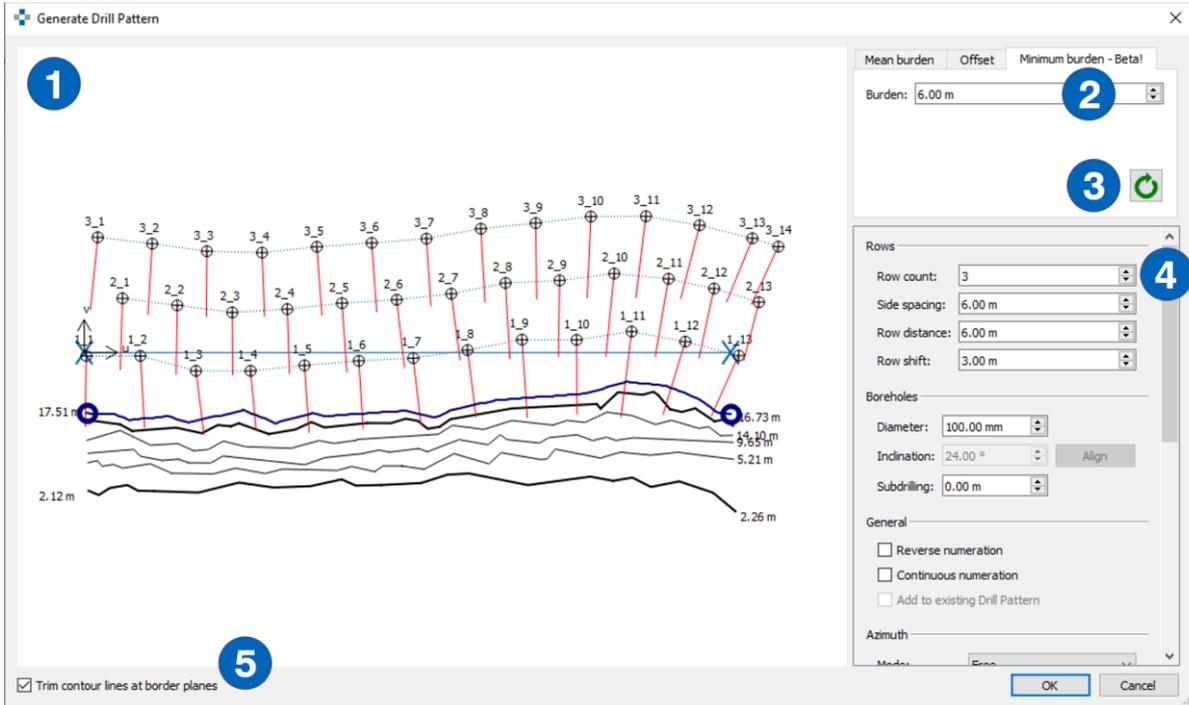
- reverse numeration
 - continuous numeration
 - add to existing *Drill Pattern*
- Azimuth
 - mode (fix, limited or free)
 - angle
 - minimum angle
 - maximum angle
- Inclination
 - mode (fix, limited or free)
 - angle
 - minimum angle
 - maximum angle
- Position
 - minimum distance
 - maximum distance
- Straighten last row
 - parallel to the *Reference Line*
 - target inclination

The position of the boreholes is calculated automatically after clicking the “*Place Boreholes*” button. The order of boreholes are reversed by a click on the “*Reverse numeration*” checkbox. A continuous numeration of the boreholes (i.e. 1, 2, 3,... ongoing) is applied by activating the checkbox “*Continuous numeration*”. The azimuth and the inclination can be limited or fixed by selecting the corresponding mode from the pull down menu. Depending upon the mode the minimum, maximum or fixed angle can be specified. In addition the minimum and maximum distance between boreholes (lower end of boreholes) can be entered.

By enabling the checkbox “*Trim contour lines as border planes*” the plan view is limited to the area between the border planes (see Chapter 3.1 and 7.3). Disabling this feature allows to adapt the range of the *Drill Pattern* by dragging the blue circle in the plan view along the projected crest of the bench (blue line) by holding the mouse button pressed (see Figure 27).

Note:

Check the geometry of the blast site (mesh borders, face plane and face surface) if the automatic placement of boreholes fails. See Chapter 5.1 and Chapters 9.3 to 9.5 for further details.



- 1 Instant preview of *Drill Pattern*
- 2 Design burden
- 3 Place boreholes
- 4 Settings (Rows, Boreholes, General, Azimuth, Inclination, Position, straighten last row)
- 5 Trim contour lines at border planes

Figure 26: Dialog window for entering the geometric parameters of a blast. Minimum Burden mode: Automatic placement of boreholes

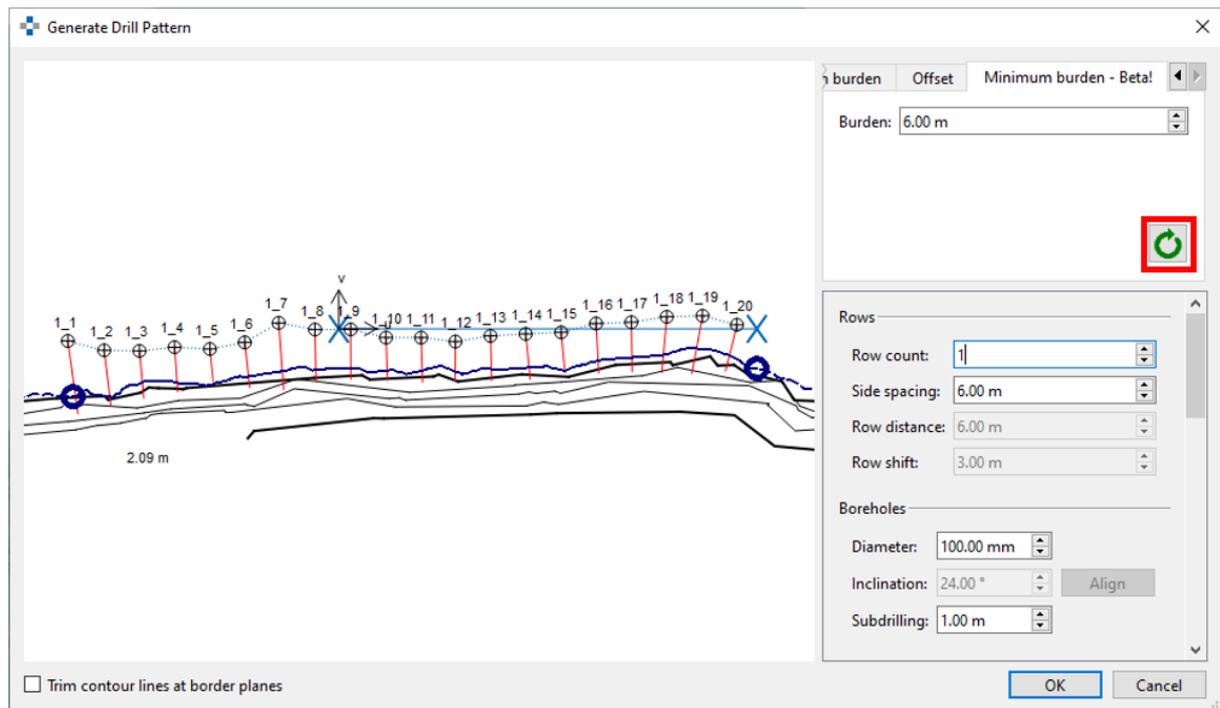
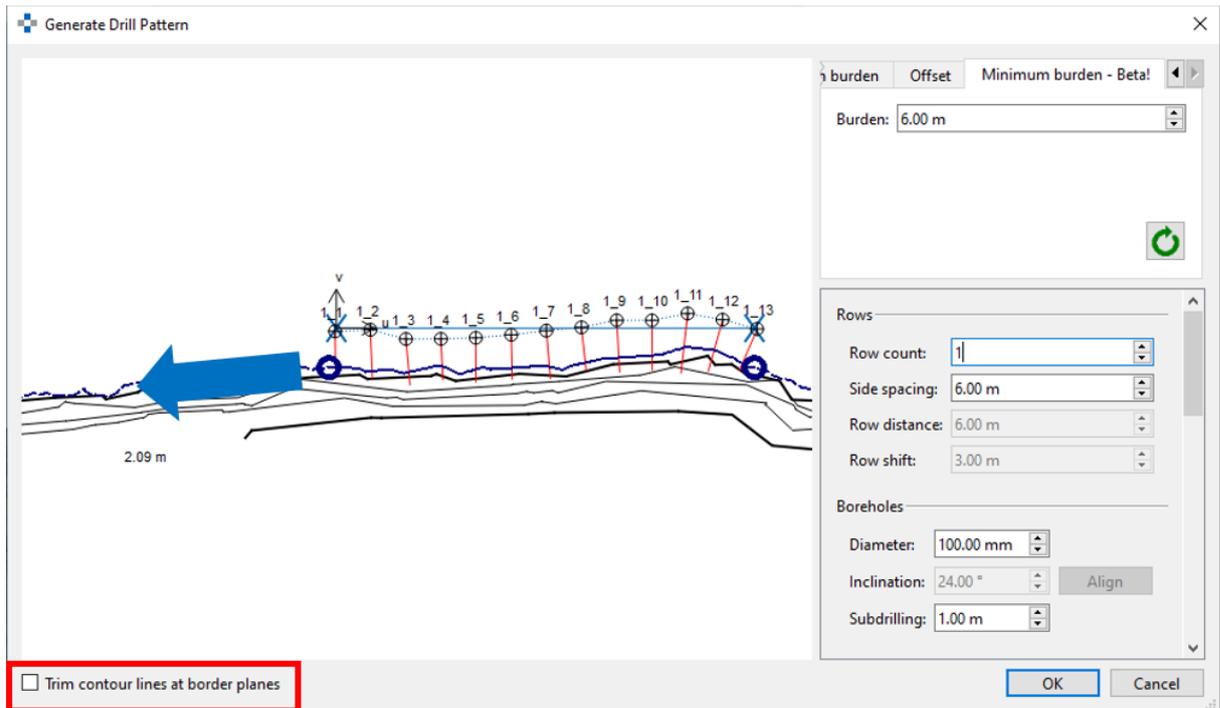


Figure 27: Adjustment of the border planes

7.3 Editing a Drill Pattern

Once the *Drill Pattern* has been generated, it can be edited using the different panes. The entire *Blast Site* is inspected in the 3D viewer. The plan view of the *Blast Site* is shown in the 2D viewer. The *Plot* pane shows *Profiles* and *Minimum Burden* charts of single boreholes. The *Blast Site* pane and *Table* pane show general and geometric data of the *Blast Site* and the boreholes. Using the *Move* pane boreholes are edited (position, angles, etc.). The individual panes are shown in Chapter 5.

Subdrilling

Subdrilling is locked for all boreholes by default when generating a *Drill Pattern*. Subdrilling can be unlocked by using the command “*Unlock Subdrilling*” in the context menu of the *Drill Pattern* element.

Note:

Subdrilling and borehole length are mutually dependent. Changing the length of the borehole effects the lengths of subdrilling, applied also for “locked” boreholes.

Adding and removing boreholes

A single borehole is added by using “*Edit | Add Borehole*” from the menu bar or by clicking the corresponding icon  in the toolbar. The icon is also found in the *Drill Pattern* tab in the *Blast Site* pane. The position of the new borehole is at the position of the active borehole modified by the borehole offset.

Hint:

Every borehole will be assigned to the row to which the active borehole has been assigned. It will be inserted in the *Drill Pattern* list right after the active borehole entry.

Any selected borehole can be deleted by using “*Edit | Remove Borehole*” from the menu bar or by clicking the corresponding  icon in the toolbar. The icon is also found in the *Drill Pattern* tab in the *Blast Site* pane. All or several boreholes are removed by

- selecting all or several borehole entries in the *Table* pane
- **or** selecting all or several boreholes in the plan view
- **or** selecting all or several boreholes in the 3D view
- **or** selecting all or several boreholes in the *Drill Pattern* tab in the *Blast Site* pane
- **and** clicking the “*Remove Borehole*”  icon in the toolbar of the *Drill Pattern* tab in the *Blast Site* pane.

Moving boreholes

Stepwise adjustment using the Move pane

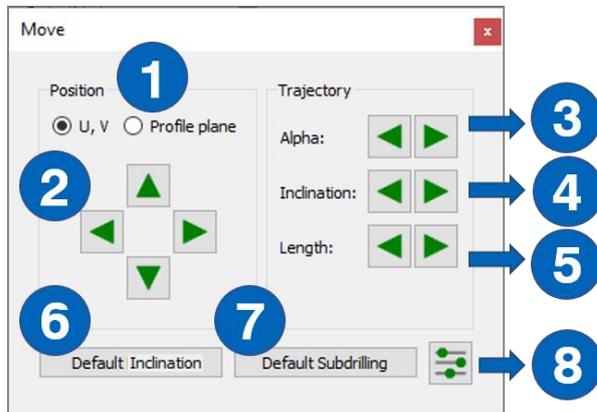
Boreholes are modified step by step using the *Move* pane. Following adjustment are provided:

- position
 - U-direction and V-direction, i.e. along and across the *Reference Line*
 - the position along and across the plane of the *Profile* (see also Chapter 8)
- trajectory
 - alpha
 - inclination
 - lengths

Boreholes are adjusted by clicking on the ► buttons (Figure 28). Clicking on the “Default Subdrilling” button corrects the length of the borehole to the specified subdrilling (level). Clicking on the “Default Inclination” button applies the value set in the options of the *Drill Pattern* tab. Adjustments are applied for all selected boreholes.

Hint:

Step sizes for one mouse click can be defined in the options of the *Step Size* tab (see Figure 19).



- 1 Options for moving borehole positions
- 2 Move borehole position
- 3 Turn borehole azimuth (alpha)
- 4 Change borehole inclination
- 5 Change borehole length
- 6 Set borehole inclination to default value
- 7 Set borehole to default subdrilling
- 8 Open the *Options* dialog

Figure 28: Buttons for adjusting the borehole positions, inclinations and length in the *Move* pane

Direct adjustment using the *Table* pane

The *Table* pane shows geometric borehole parameters (Figure 29) including the name, the position of the collar (depending on the used co-ordinate system in UVW or XYZ / ENH values), the length, the subdrilling, the inclination and the azimuth (alpha in case the angle is related to the *Reference Line*).

General hints:

- All values in the table are editable by selecting the according cell and entering the new values.
- Multiple boreholes are selected by moving the mouse cursor over the corresponding cells with the left mouse button clicked. Selected boreholes / cells are marked and highlighted in the *Drill Pattern* preview in green.
- Multiple boreholes in neighbouring rows are selectable by individual clicks with the left mouse button while the “*Shift*” key is pressed.
- Multiple boreholes in non-neighbouring rows are selectable by individual clicks with the left mouse button while the “*Ctrl*” key is pressed.
- All values can be copied and pasted with the mouse (context menu) or keyboard (“*Ctrl+C*” and “*Ctrl+V*” keys).

- A copied value can be pasted into several cells by marking them simultaneously with the “Shift” and/or “Ctrl” key.
- The actually shown co-ordinate system is switchable between “UVW” (relative to Reference Line) and “XYZ” (local; relative to camera) / ENH (geo-referenced by Easting, Northing, and Height).

Table										
	Name	E [m]	N [m]	H [m]	Length [m]	Subdrilling [m]	Inclination [°]	Azimuth [°]	Diameter [mm]	
1	1_1	-107459.373	266975.793	952.455	23.622	1.000	21.4	230.1	100.00	
2	1_2	-107455.576	266971.112	952.512	23.661	1.000	21.3	232.0	100.00	
3	1_3	-107453.415	266965.215	952.195	22.855	1.000	18.2	233.1	100.00	
4	1_4	-107449.606	266960.576	952.109	22.802	1.000	18.6	232.2	100.00	
5	1_5	-107446.611	266955.307	952.149	22.649	1.000	17.2	231.4	100.00	
6	1_6	-107442.453	266950.975	952.058	22.619	1.000	17.8	230.1	100.00	
7	1_7	-107438.312	266946.689	951.990	22.808	1.000	19.8	226.9	100.00	
8	1_8	-107434.272	266942.313	951.890	22.433	1.000	17.9	224.4	100.00	
9	1_9	-107429.775	266938.271	951.903	22.874	1.000	21.1	227.3	100.00	
10	1_10	-107426.265	266933.426	951.847	22.698	1.000	20.4	231.6	100.00	
11	1_11	-107421.313	266929.723	951.881	23.711	1.000	26.0	236.5	100.00	
12	1_12	-107418.259	266924.554	951.636	23.197	1.000	24.9	243.5	100.00	

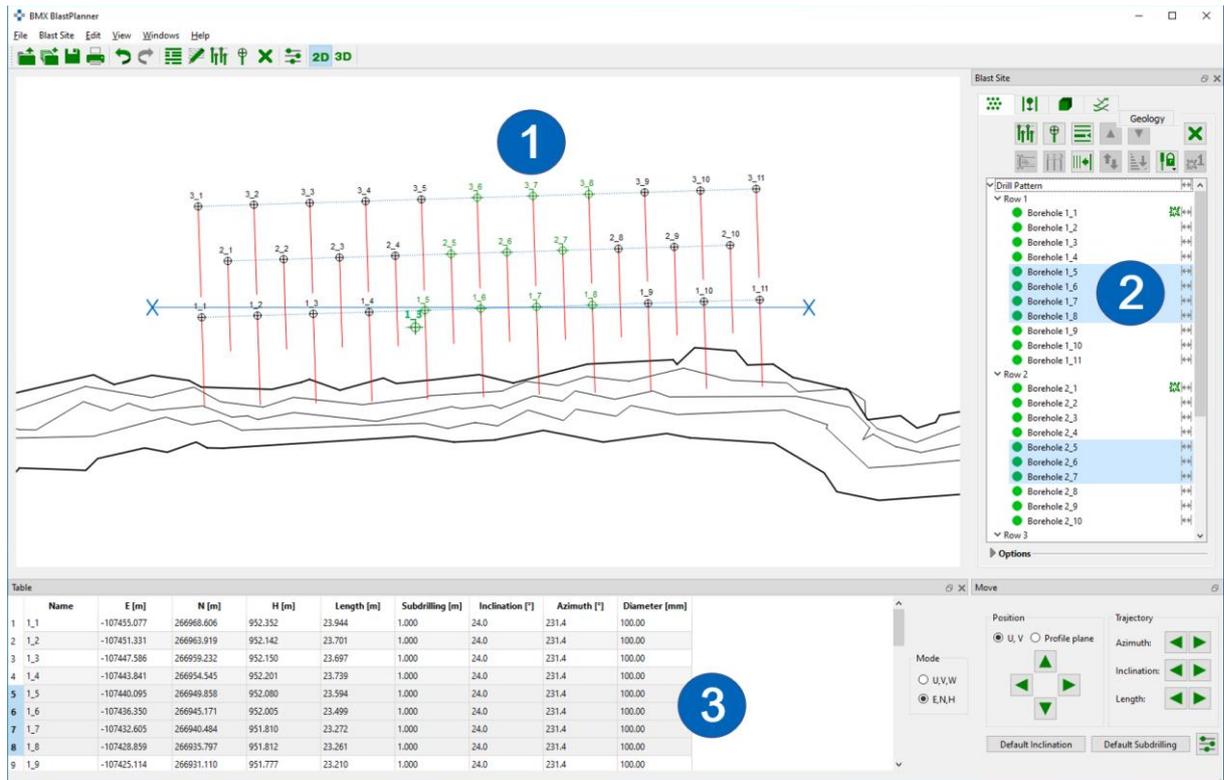
- 1 Marked cells of a borehole
- 2 Switch between UVW and ENH

Figure 29: Geometric borehole parameters in editable cells in the Table pane

Adjustment in the plan view

The plan view is activated by using “View / 2D” from the menu bar or by clicking the corresponding **2D** icon in the toolbar. Boreholes can be adjusted after selecting them in the viewer by the features provided in the Move pane. General hints:

- Single boreholes are selected by a click with the left mouse button on the borehole symbol.
- Multiple boreholes are selected by:
 - a. clicking with the left mouse button on the borehole symbol while keeping the “Shift” and/or “Ctrl” key pressed (neighbouring / non-neighbouring holes). Selected boreholes are highlighted in green. See Figure 30.
 - b. moving the mouse cursor over the area of the desired boreholes while keeping the left mouse button pressed. A red polygon grows instantaneously when moving the mouse. After releasing the left mouse button boreholes enclosed by the polygon are selected and are highlighted in green. See Figure 30.



- 1 Borehole pattern - selected boreholes in green
- 2 Selected boreholes in the *Drill Pattern* list
- 3 Selected boreholes in the *Table* pane

Figure 30: Multiple borehole selection and adjustment of boreholes in the plan view

Adjusting the order of the Drill Pattern

The order of the *Drill Pattern* refers to the order of the rows relative to the 3D model and the order of the boreholes within a row. For a reasonable design and analysis the order of rows and boreholes must follow a certain order.

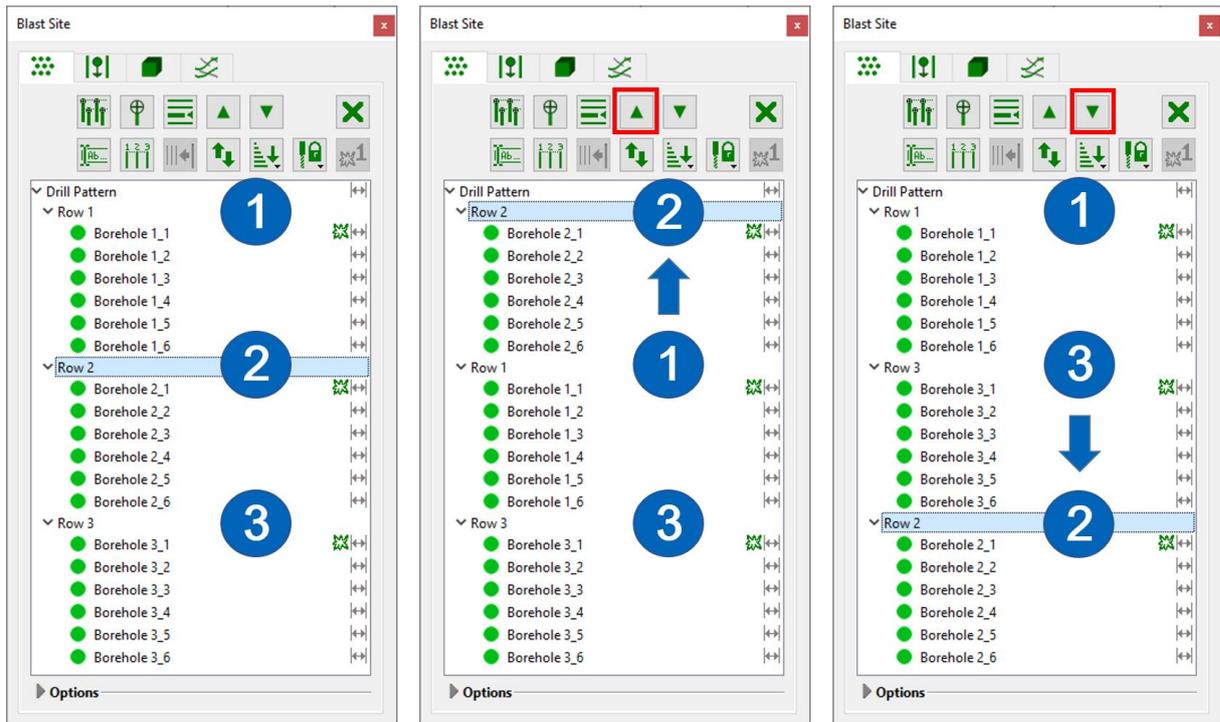
Adjusting the row order

The row order affects the volume calculation and the auto-rename functionality. General hints:

- Select the row entry in the *Drill Pattern* list (Figure 31 left)
- Click the “Move Row Forward” ▲ icon in the toolbar of the *Drill Pattern* tab for moving the row logically one step closer to the 3D model, i.e. up in the list (Figure 31 middle).
- Click the “Move Row Backward” ▼ icon in the toolbar of the *Drill Pattern* tab for moving the row logically one step back, i.e. down in the list (Figure 31 right).

Important:

The rows will keep their names and geometric position. They will only change their logical order.



- 1 First row
- 2 Second row
- 3 Third row

Figure 31: Adjusting the row order by selecting the row (left), and clicking the “More Row Forward” (middle) or “Move Row Backward” (right) button

Adjusting the borehole order

The borehole order affects the volume calculation, the row surfaces, and the auto-rename function. General hints:

- Boreholes within a row can be logically rearranged using drag and drop of the borehole entries. Drag and drop is described in the section “Assigning boreholes to rows” below.
- Boreholes within a row can be sorted for selected rows according to their ascending u co-ordinates by clicking the “Sort by U” icon in the toolbar of the *Drill Pattern* tab or choosing the command from the row’s context menu (Figure 32).
- Likewise, boreholes within a row can be sorted for selected rows according to their ascending v co-ordinates by clicking the “Sort by V” icon in the toolbar of the *Drill Pattern* tab or choosing the command from the row’s context menu.
- The borehole order within a row can be reversed for selected rows by clicking the “Reverse Borehole Order” icon in the toolbar of the *Drill Pattern* tab or choosing the command from the row’s context menu.

Important:

The boreholes will keep their names and geometric position. They will only change their logical order!

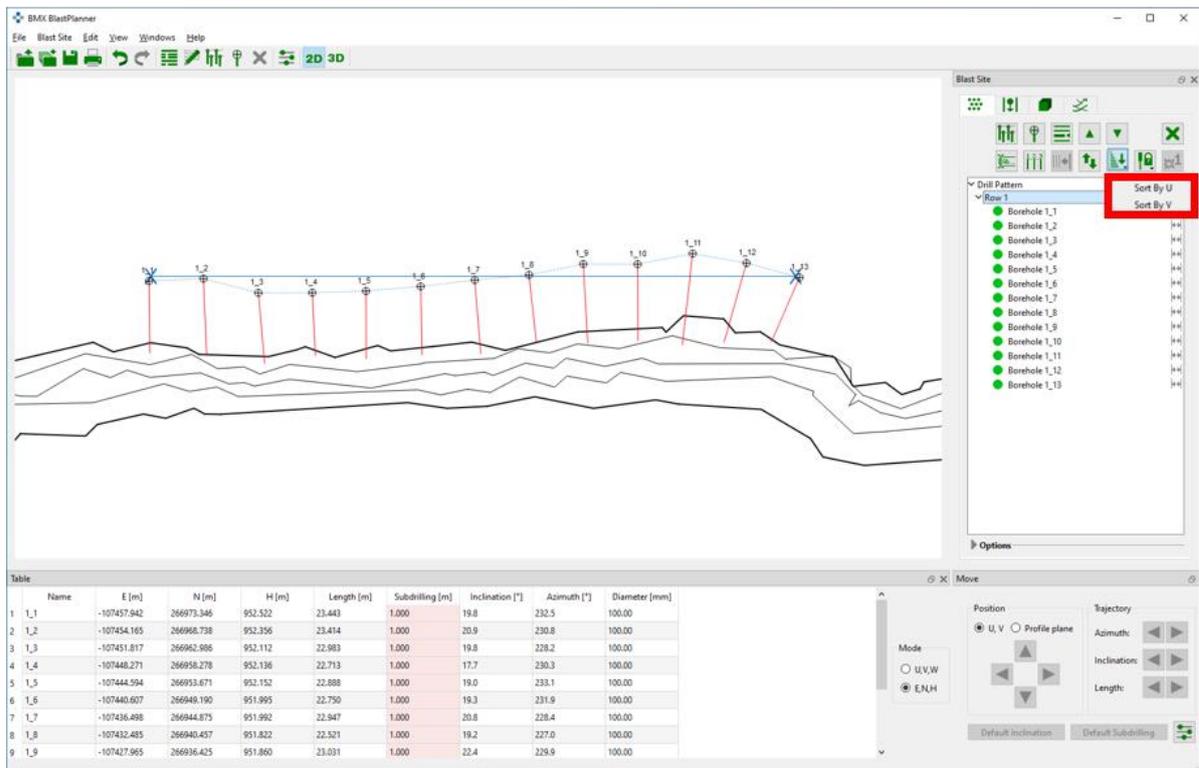
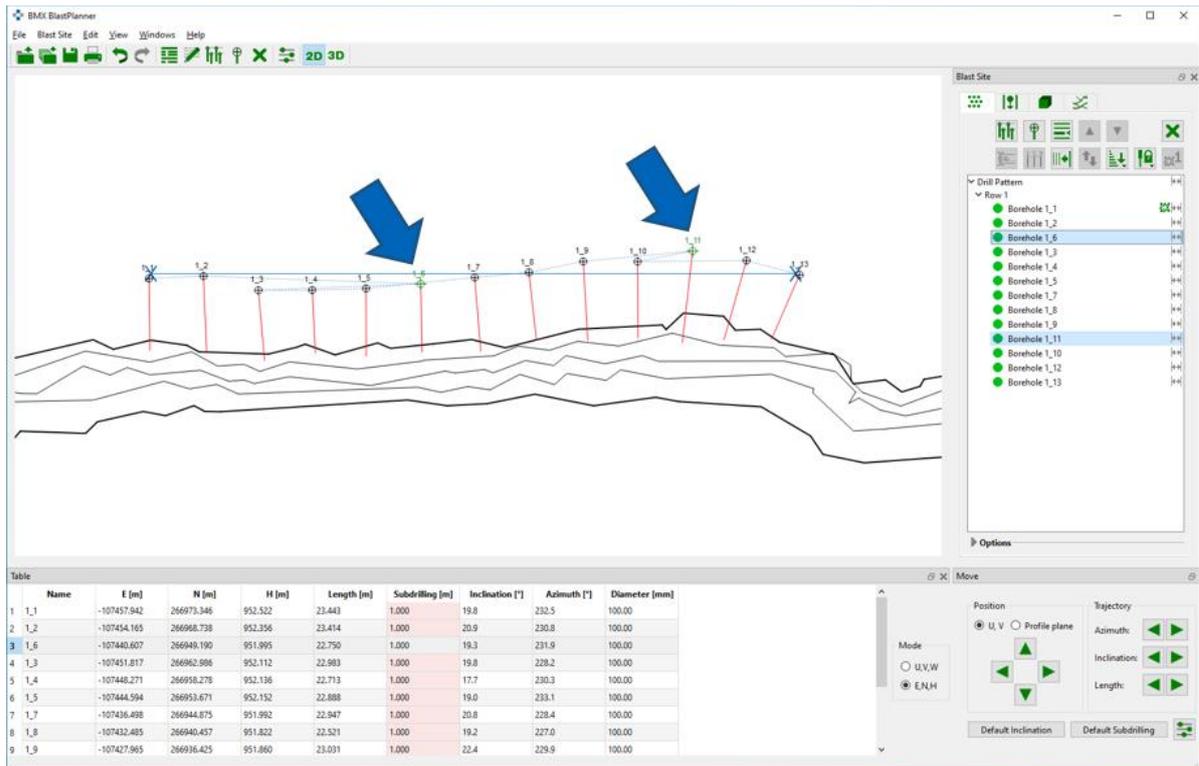


Figure 32: Left: Borehole order with multiple inconsistencies (see blue polygons marked with the arrows and note the order in the Drill Pattern list). Right: Borehole order sorted by ascending u co-ordinate after clicking “Sort by U” (red box).

Assigning boreholes to rows

Selected boreholes are assigned to a certain row by

- dragging and dropping the borehole selection at the target borehole or row entry,
- clicking the “Assign to Row” icon in the toolbar of the *Drill Pattern* tab and choose the target row, or
- choosing “Assign to Row” from the context menu and choose the target row

Boreholes can be selected in the *Drill Pattern* list in the 2D viewer or in the 3D viewer. General hints:

- A borehole selection may include boreholes from different rows (Figure 33)
- Boreholes are inserted in the same logic order (Figure 33)
- If boreholes are dragged, they are inserted after the target borehole (Figure 33), or at the top of the row if dropped at the row entry.
- In all other cases boreholes are inserted at the bottom of the row
- If a borehole selection is dropped at the *Drill Pattern* entry, the boreholes are assigned to the *Unassigned* row (Figure 34)

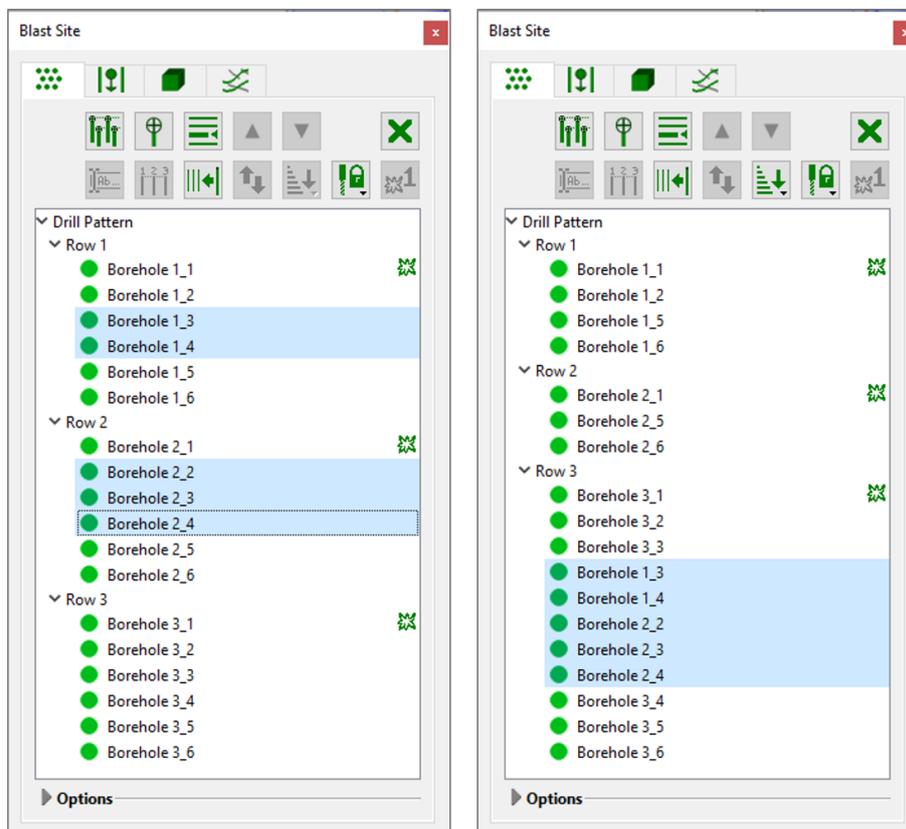


Figure 33: Assigning a borehole selection to a row by drag and drop. The selection originates from different rows and has been dropped at borehole 3_3 in row 3.

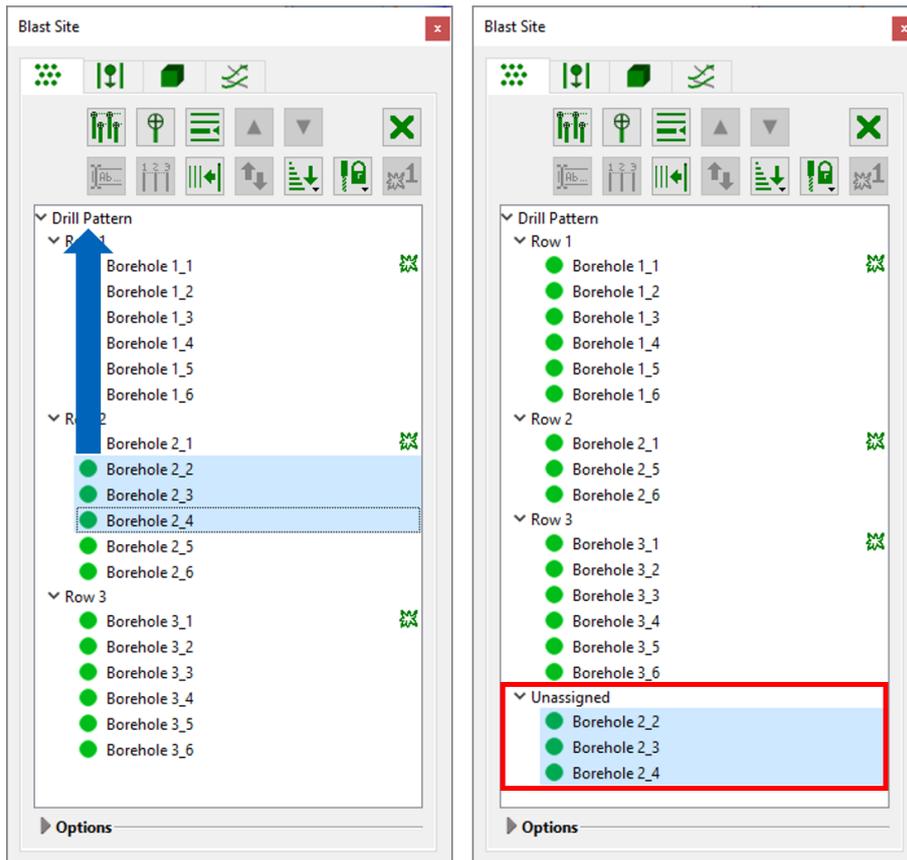


Figure 34: Dragging a borehole selection to the Drill Pattern entry forms an unassigned row at the bottom at the list

Renaming rows and boreholes

General hints:

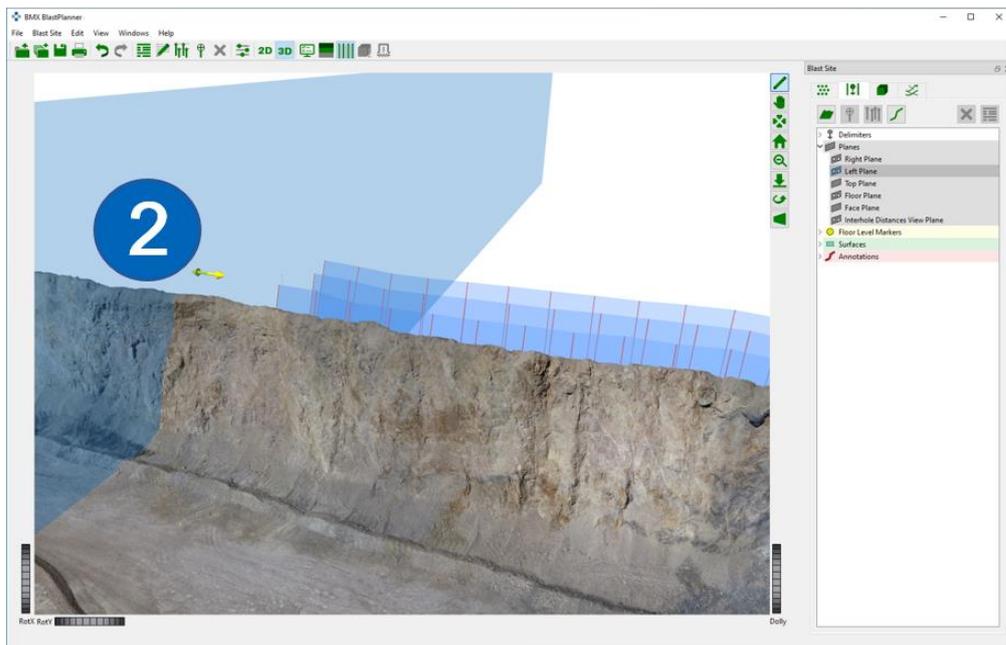
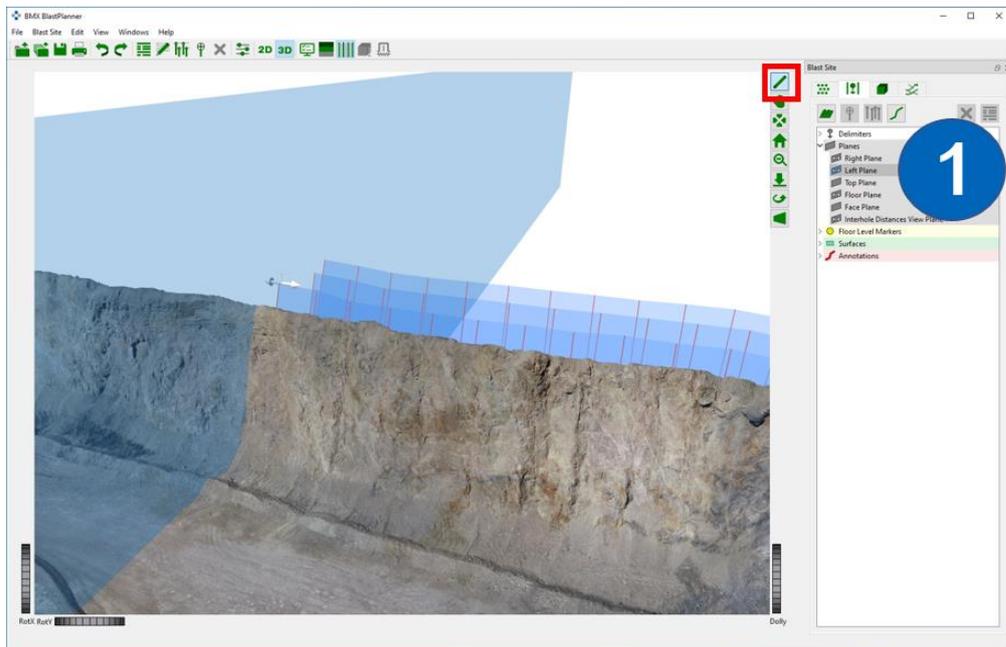
- Single rows and single boreholes can be renamed by clicking the “Rename”  icon in the toolbar of the *Drill Pattern* tab or choosing the command from the context menu (open with a right mouse click at the selected row or borehole).
- A selection of boreholes can be automatically renamed according to the current logic order by clicking the “Auto Rename”  icon in the toolbar of the *Drill Pattern* tab or choosing the command from the context menu (open with a right mouse click at the selected row or borehole).
 - a. All boreholes of a row by selecting the corresponding row entries (use “Ctrl” key).
 - b. All boreholes AND rows by selecting the *Drill Pattern* entry.

Adjusting Border Planes

Adjusting *Border Planes* is available for the *Right* and the *Left Plane*, and the *Floor Plane* as well. Lateral border planes (*Right* and *Left Border Planes*) can be moved e.g. for extending the blast area beyond the position of the *Delimiters*. Changing the level of the *Floor Level Plane* allows constructing an intermediate bench, e.g. subdividing a double bench.

For moving the *Border Planes* follow the following steps:

1. Switch to the *Edit* mode
2. Mark the *Left Border Plane / Right Border Plane / Floor Level Plane* in the *Geometry* tab of the *Blast Site* pane. The selected plane is highlighted and an arrow appears (Figure 35).
3. Drag the plane at the new position by clicking with the left mouse button on the arrow and move the mouse
4. Switch to the *Navigate* mode



- 1 Mark planer in the *Drill Pattern* list (*Geometry* tab in the *Blast Site* pane)
- 2 Drag plane to new position using the arrow

Figure 35: Adjusting the position of a lateral Border Plane

7.4 Top Level Surface and Borehole Collars

The *TLS* is used to model an irregular uneven crest (see Chapter 3.1). The *TLS* can be switched on and off in the 3D viewer by clicking the “Show Top Level Surface”  icon in the dialog “Render Options”  in the menu bar. The “Show Top Level Surface”  icon is also found in the toolbar of the *Geometry* tab. Positions of *Borehole Collars* are saved in the “.smb” file in the *BMX BlastSiteGenerator* (terrestrial imaging) or in the *BMX BoreholeFinder* (aerial imaging with UAV), respectively.

Properties of the *Top Level Surface*:

- The *TLS* is a triangulated irregular network passing through the *Top Level Surface* points.
- The borehole collars follow the *TLS*.
- The borehole collars follow the *TLS* when moving a borehole position.
- *TLS* points are displayed as green spheres, while (*Borehole*) *Collar Markers* are displayed as blue spheres.
- A *TLS* point / (*Borehole*) *Collar Marker* is highlighted when selected in the *Blast Site Elements* list (Figure 37).
- A *TLS* point / (*Borehole*) *Collar Marker* can be removed by selecting the *TLS* point / (*Borehole*) *Collar Marker* in the *Blast Site Elements* list, and clicking the  icon or choosing “Delete” from the context menu.
- Boreholes can be added to *TLS* points / (*Borehole*) *Collar Markers* by selecting the point in the *Blast Site Elements* list and by clicking “Add Borehole”  icon in the toolbar or choosing the command from the context menu. Boreholes are added according to the defined settings. Borehole at all (*Borehole*) *Collar Markers* are set by clicking the “Add Boreholes at All Collars”  icon in the *Geometry* tab.
- The position of the *TLS* point / (*Borehole*) *Collar Marker* is displayed when selecting the item in the list (Figure 37).
- It is possible to enable or disable certain *TLS* point groups in the *Top Level Surface* by clicking the “Properties”  icon on the *Geometry* tab. Groups include toe points of *Delimiter*, surveyed borehole positions, and surveyed *TLS* positions. Figure 38 shows the dialog for enabling or disabling *TLS* point groups.

Note:

A multiple selection of *TLS* points is supported with the computer mouse after activating the *Edit* mode in the navigation bar. *TLS* points are selected by dragging the cursor across the surface while keeping the left mouse button pressed. After releasing the mouse the selected *TLS* points are highlighted.

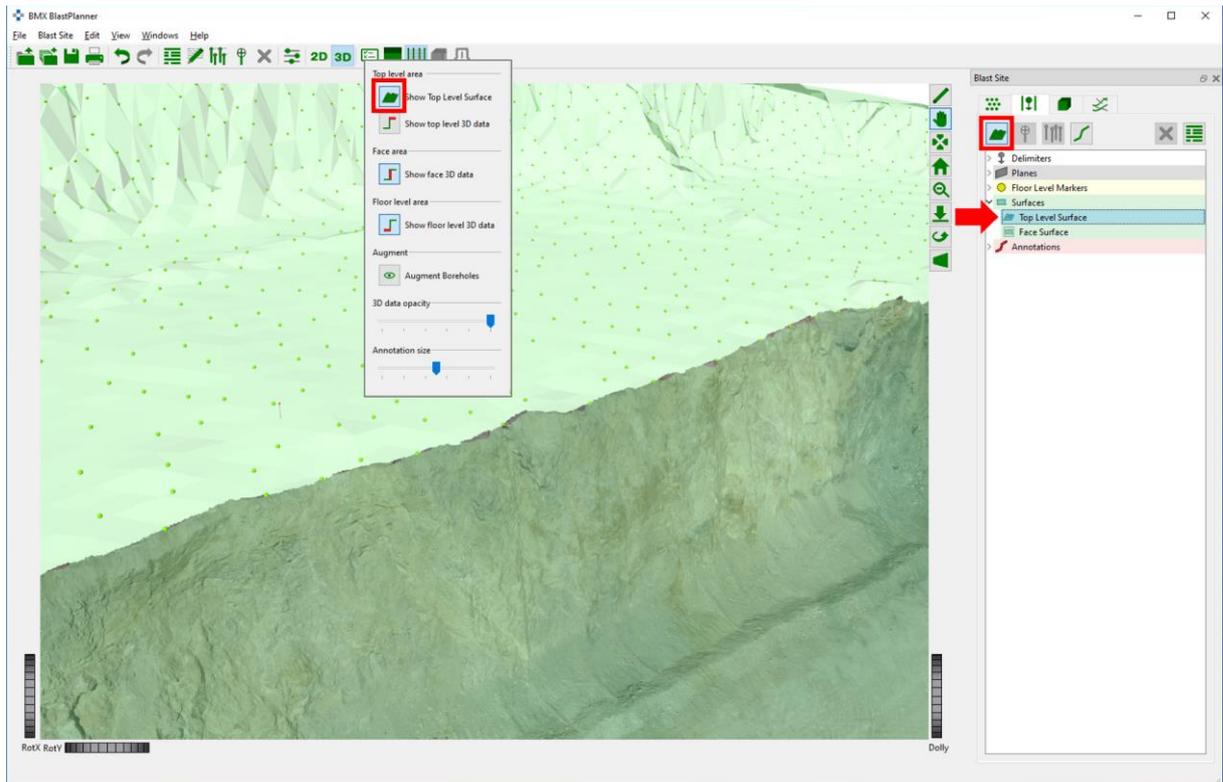


Figure 36: Blast Site with enabled Top Level Surface

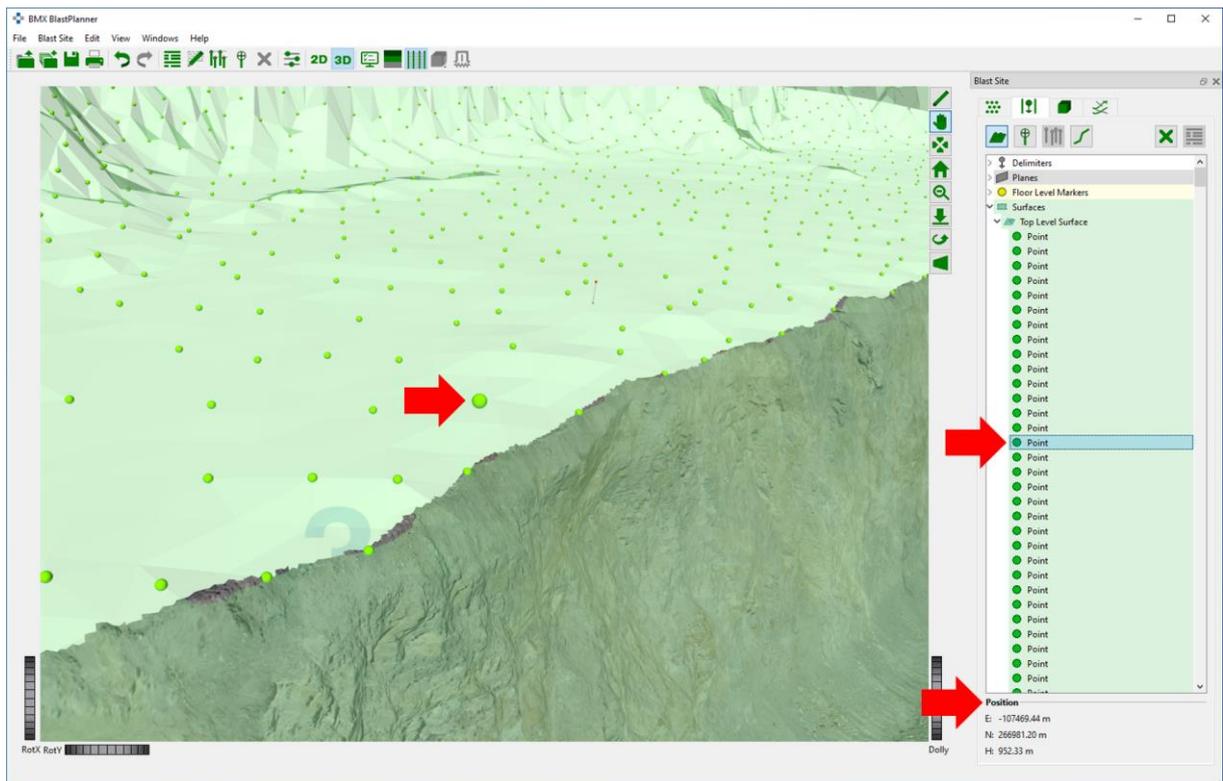


Figure 37: Highlighted TLS point

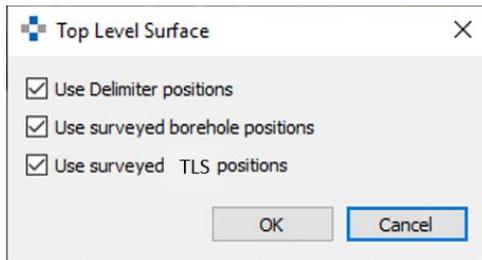
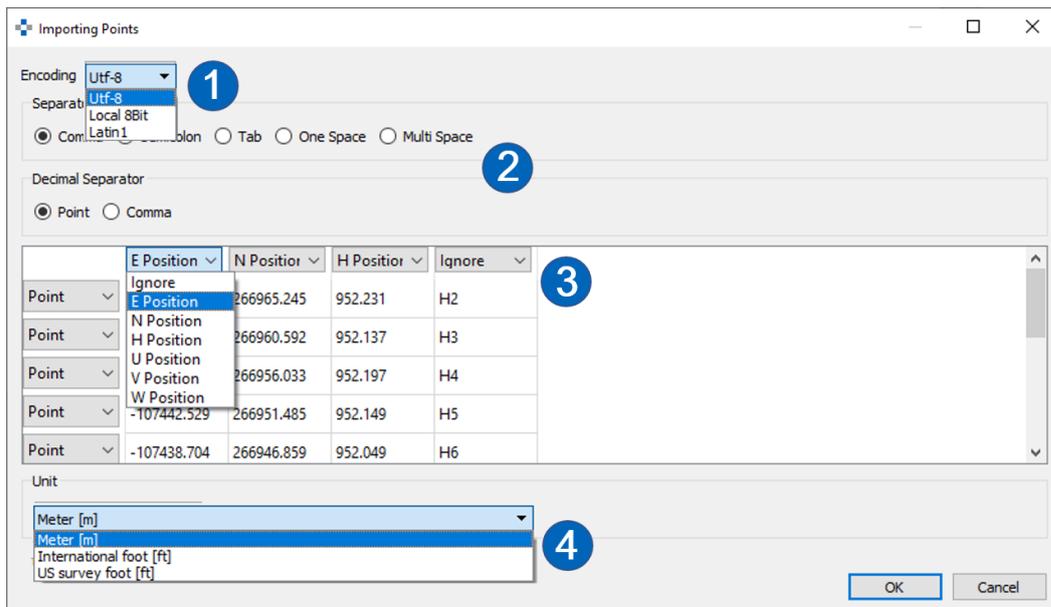


Figure 38: Dialog for selecting TLS point groups considered in the TLS

Importing surveyed Top Level Surface points

Co-ordinates of *Top Level Surface Points* can be provided in a “.csv” or other text based files (e.g. “.txt”, “.prt”, “.dat”). The format has to be defined correctly during the import process. Co-ordinates can be either local (UVW) or global (ENH). Procedure:

1. Select “BlastSite | Import | Import Top Level Surface Points” in the menu bar.
2. A dialog window (Figure 39) appears requiring following inputs:
 - a. Character encoding
 - b. Used separator
 - c. Data classification (E/N/H or U/V/W)
 - d. Units (millimeter [mm], meter [m], inch [in], international foot [ft], US survey foot [ft])
3. Click the “OK” button to import *Top Level Surface Points*. Imported TLS points appear as grey spheres and are highlighted in yellow in the list (Figure 40).



- 1 Character encoding
- 2 Separators
- 3 Data
- 4 Unit

Figure 39: Import Top Level Surface Points dialog for “.csv” files

Examples for “.csv” files

Point – Comma

```
XX.XXX,YY.YYY,ZZ.ZZZ
9453674.75,456235.21,248.45
```

Comma – Semicolon

```
XX,XXX;YY,YYY;ZZ,ZZZ
9453674.75;456235.21,248;45
```

Point – Space

```
XX.XXX YY.YYY ZZ.ZZZ
9453674.75 456235.21 248.45
```

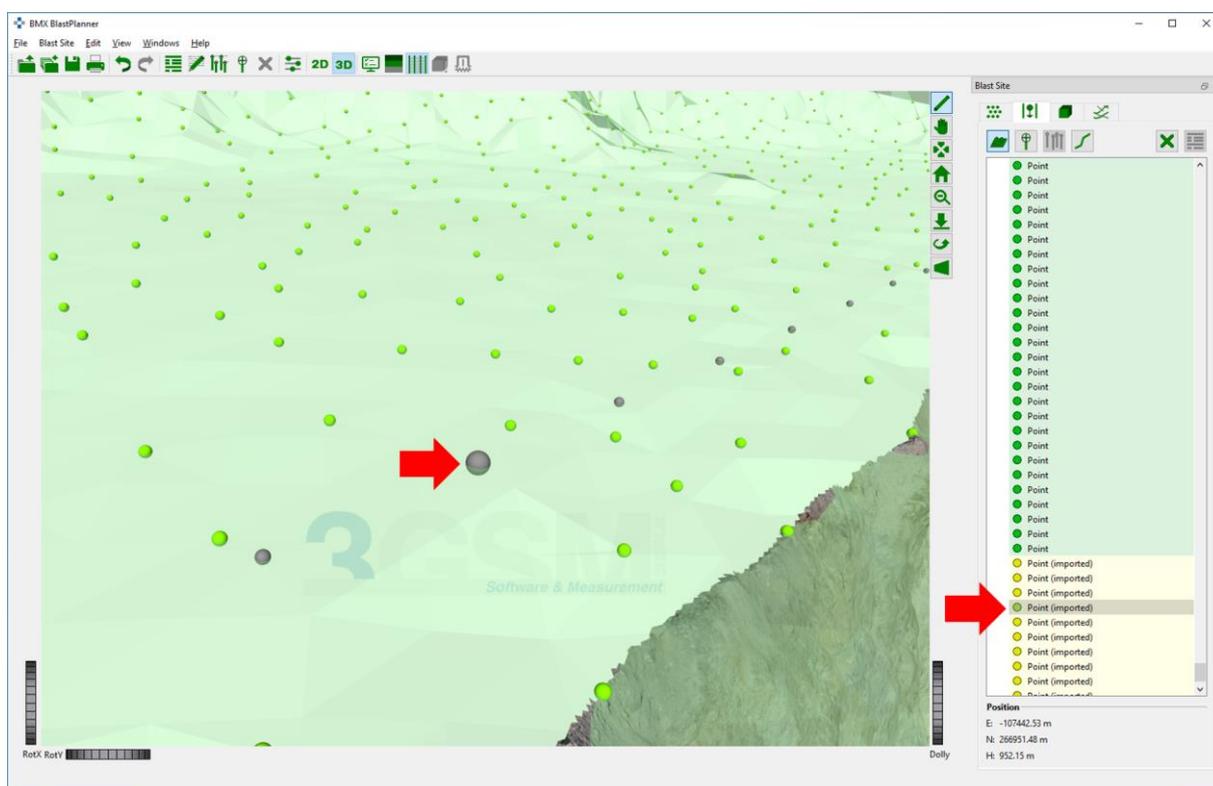


Figure 40: Detail of imported TLS point (grey spheres)

7.5 Import co-ordinates of borehole collars

Co-ordinates of borehole collars can be imported into the *BMX BlastPlanner* using a “.csv” or other text based files (e.g. “.txt”, “.prt”, “.dat”). This is especially applicable with GPS surveys or other geo-referenced surveys, or if co-ordinates are provided digitally. Borehole co-ordinates are imported by using following commands in the menu bar:

- “BlastSite | Import | Import Surveyed Drill Pattern from CSV”

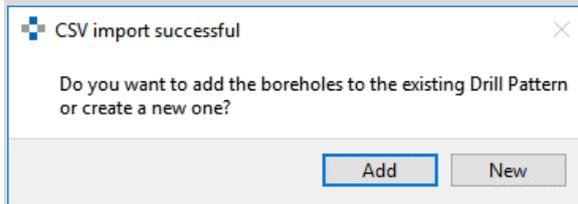
Imported borehole collars will be locked to the imported position, i.e. it is not possible to edit the borehole position

- “BlastSite | Import | Import Designed Drill Pattern from CSV”
Editing of imported borehole positions is possible

The borehole angles and lengths are generated according to the settings for inclination and subdrilling in the *Drill Pattern* tab options. Azimuth depends on the *Face Plane*. The supported file formats are described in the subsequent sections.

Note:

Imported borehole collars are used to create a new *Drill Pattern* or can be added to an existing *Drill Pattern* by clicking “Add” or “New” in the appearing dialog.



Attention:

For a complete blast design and corresponding analysis it is necessary to assign boreholes to rows after the import.

Supported “.csv” files formats

The file format has to be defined correctly during the import process. Co-ordinates can be either local (UVW) or global (ENH):

- Local co-ordinate systems (UVW)
Boreholes will be placed according to the U, V, and W co-ordinates. *The Top Level Surface* will contain the collars.
 U: Offset from the left *Delimiter* along the *Reference Line*
 V: Offset across the *Reference Line*
 W: Vertical offset of borehole collar from the *Top Level Plane*
- ENH Format (geo-referenced)
Boreholes will be placed according to the Easting, Northing, and Height. The *Top Level Surface* will contain the collars.

Procedure:

1. Select “Blast Site | Import | Import Surveyed Drill Pattern from CSV” or “Blast Site | Import | Import Designed Drill Pattern from CSV” in the menu bar.
2. A dialog window (Figure 39) appears requiring following inputs:
 - a. Character encoding
 - b. Used separator

- c. Data classification of E/N/H or U/V/W
Optional: E/N/H directions or U/V/W directions, lengths, inclination, angle to the *Reference Line*, angle to north. For further information see subsequent section and Chapter 14.
 - d. Units (millimeter [mm], meter [m], inch [in], international foot [ft], US survey foot [ft])
3. Click the “OK” button to import the co-ordinates

Examples for “.csv” files

Point – Comma

XX.XXX,YY.YYY,ZZ.ZZZ
9453674.75,456235.21,248.45

Comma – Semicolon

XX,XXX;YY,YYY;ZZ,ZZZ
9453674.75;456235.21,248;45

Point – Space

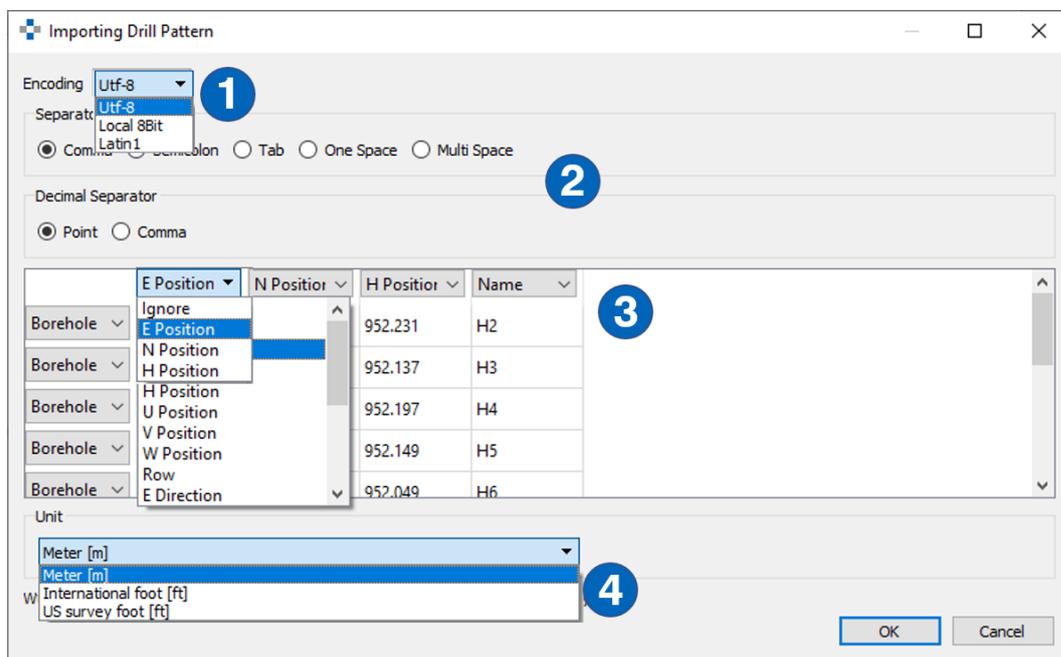
XX.XXX YY.YYY ZZ.ZZZ
9453674.75 456235.21 248.45

Example without borehole names

2.579,1.631,0.2
7.578,1.561,0.2
12.578,1.49,0.21

Example with borehole names

2.579,1.631,0.2,BH_01
7.578,1.561,0.2,BH_02
12.578,1.49,0.21,BH_03



- 1 Character encoding
- 2 Separators

- 3 Data
- 4 Unit

Figure 41: Import Drill Pattern dialog for “.csv” files

File import of the “.csv” file exported from BMX BlastPlanner

Drill Pattern files with the extension “.csv” which have been exported from BMX BlastPlanner can be imported. It is necessary to define the file format during the import process (Figure 41). The structure of the “.csv” file is shown in Chapter 14. Boreholes are assigned to rows according to the “.csv” file entry.

Attention:
Imported boreholes will be completely locked, i.e. it is not possible to edit the borehole parameters.

Attention:
BMX BlastPlanner supports “.csv” files from previous version of the software. Boreholes won’t be assigned to rows. Assignment to rows has to be done by the user.

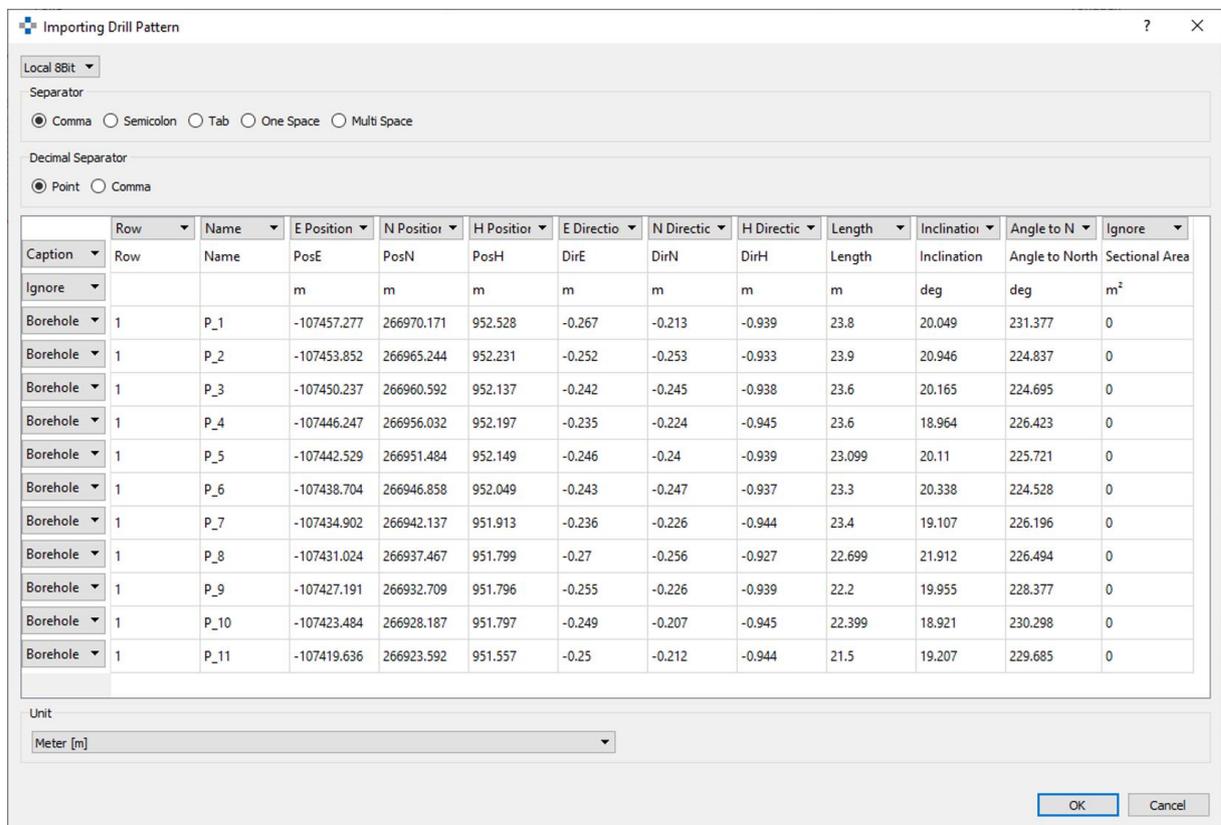


Figure 42: Example of a “.csv” file import from a Drill Pattern which have been exported from BMX BlastPlanner

7.6 Import borehole trajectories from down-the-hole probes

BMX BlastPlanner supports importing borehole survey data from down-the-hole probes. The current version supports:

- *Pulsar* data
- *Boretrak* data; cabled and rodded
- *Renishaw* data
- Custom data meets the *IREDES* standard

The *Pulsar* data import requires geo-referenced co-ordinates of the 3D model (*SMX Referencer* software component required) and the borehole collar, while the *Boretrak* data import supports the interactive assignment of borehole trajectories to borehole positions. Generic probe data imports borehole deviations recorded by down-the-hole-probes from a text file (".json" and ".dth" files). For further detail contact 3GSM under support@3gsm.at.

Properties of surveyed borehole trajectories

- Boreholes cannot be edited with the *Table* pane nor with the *Move* pane.
- The geo-referenced import locks the borehole completely, i.e. neither the collar position nor the orientation and length can be edited.
- The interactive import locks the trajectory only, i.e. the collar position can be edited while the orientation and length are locked.
- There is only the *Minimum Burden* diagram available for surveyed borehole trajectories. Surveyed borehole trajectories are in general curved. Therefore no reasonable unique section is defined which means no profile exists mathematically.

Hint:

Currently, data from borehole probes is interpreted only in metric units (SI) independent from the set units.

Attention:

Boreholes imported with the geo-referenced import are typically not assigned to rows. The user is required to assign the boreholes to rows if necessary.

Import Pulsar blasthole probe data (geo-referenced)

Procedure:

1. Open the 3D model (".jm3") and the *Blast Site* (".smb") as described in Chapter 7.1

2. Select “Blast Site | Import | Import Pulsar Data” in the menu bar. A dialog window (Figure 43): appears requiring several inputs:
 - “.rhd” file (raw hole data): File provided by the Pulsar blasthole system containing the borehole deviations
 - “.hxy” file (position of borehole collar): File provided by the Pulsar blasthole system containing the positions of the borehole collar.
 - Probe length: Length of the probe adjusts the depth of borehole according to the deepest reading
 - Azimuth correction: Corrects the magnetic azimuth readings from the Pulsar blasthole system to the geo-referenced co-ordinate system

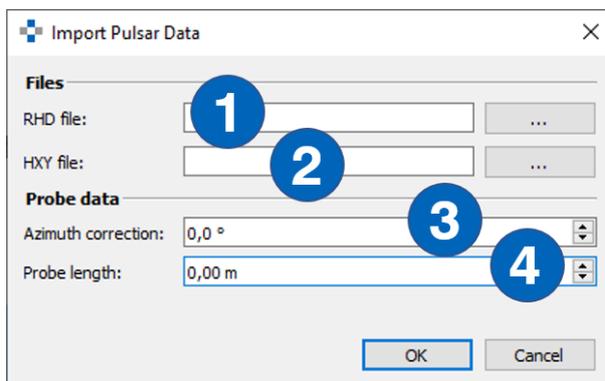
Hint:

The azimuth correction depends on your geographic position and varies with time. For your current azimuth correction contact 3GSM under support@3gsm.at.

Attention:

The azimuth correction applies only if the 3D model has been geo-referenced in a geographic co-ordinate system. If the 3D model has been north-corrected using compass data, the azimuth correction does not apply.

3. Click on the “OK” button. The measured boreholes are imported and instantly displayed in the 3D viewer. (Figure 44 and Figure 45).



- 1 Define “.rhd” file
- 2 Define “.hxy” file
- 3 Define probe length
- 4 Define azimuth correction

Figure 43: Dialog window for importing data from Pulsar blasthole probes

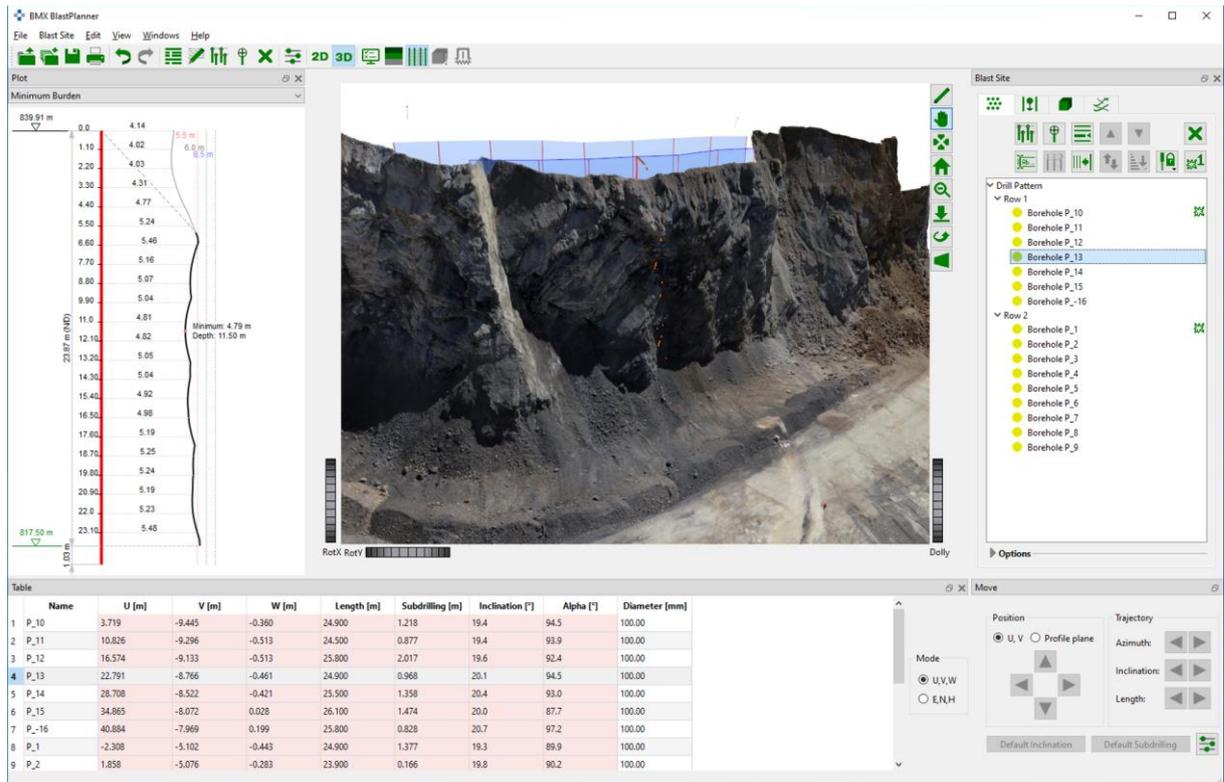


Figure 44: Measured boreholes displayed in the 3D viewer

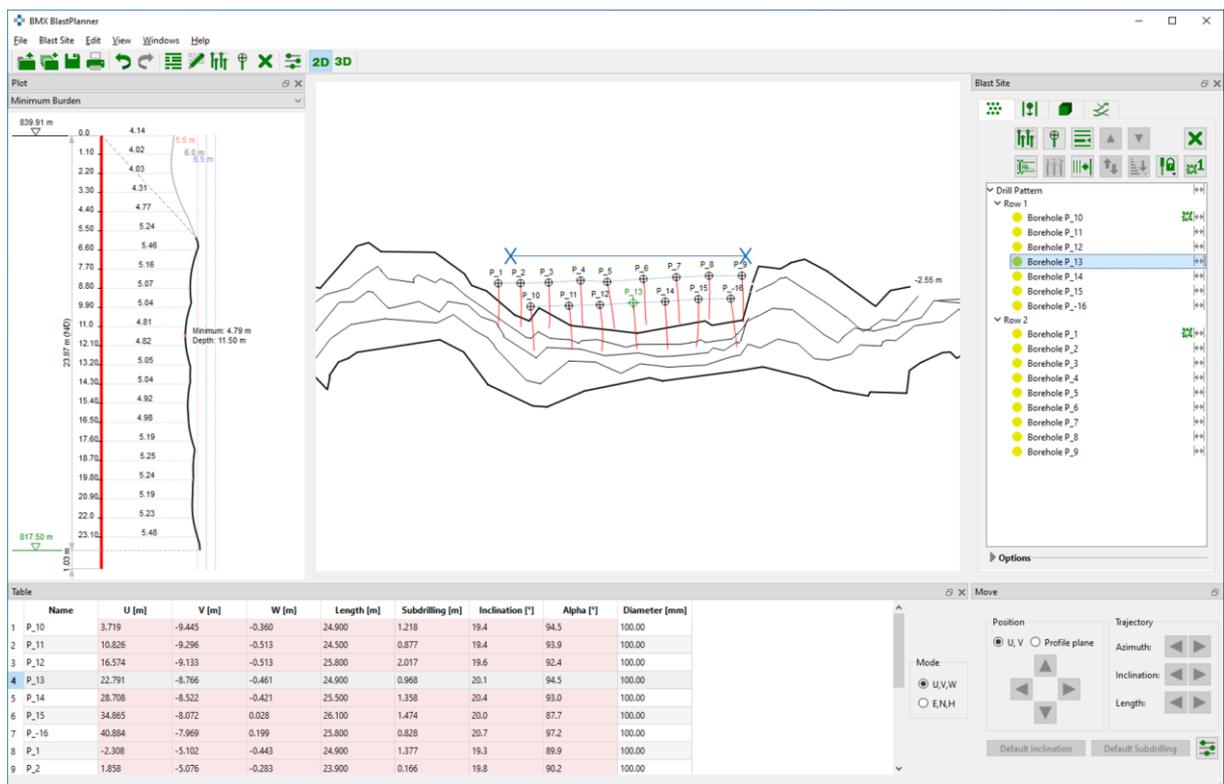


Figure 45: Measured boreholes in the plan view

Import Pulsar probe data (interactively)

The interactive import of Pulsar probe data requires the specification of the raw hole data file (".rhd", ".dm4").

Procedure:

1. Open the 3D model (".jm3") and the *Blast Site* (".smb") as described in Chapter 7.1
2. Define the borehole positions (if not already stored in the ".smb" file) using one of the following possibilities:
 - Enter borehole positions manually in the *Table* pane (Chapter 7.3)
 - Import borehole positions from a ".csv" file (Chapter 7.5)
 - Use planned borehole positions (for instance, using the "Generate Drill Pattern" function; see Chapter 7.2)
3. Select "Blast Site | Import | Import Pulsar interactively" in the menu bar
4. The *Pulsar* dialog appears requiring several inputs (Figure 46):
 - Raw hole data file (".rhd", ".dm4"): File provided by the Pulsar system containing the borehole deviations. Click in the "Import" button and select the raw hole data file. The borehole trajectories are identified and listed in the *Pulsar* dialog.
 - Azimuth correction: Corrects the magnetic azimuth readings from the Pulsar system to the coordinate system of the 3D model
 - Probe length: Length of the probe adjusts depth of borehole according to the deepest reading

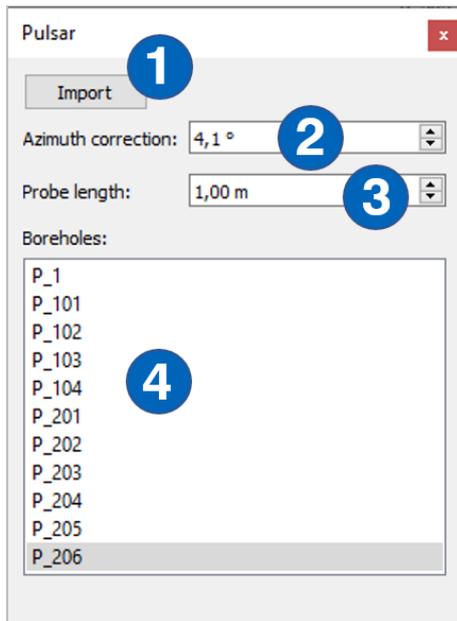
Hint:

The azimuth correction depends on your geographic position and varies with time. For your current azimuth correction contact 3GSM under support@3gsm.at.

Attention:

The azimuth correction applies only if the 3D model has been geo-referenced in a geographic co-ordinate system. If the 3D model has been north-corrected using compass data, the azimuth correction does not apply.

5. Switch to 2D representation (plan view)
6. Click with the left mouse button on an entry in the list of borehole trajectories in the *Pulsar* dialog
7. Drag it to the corresponding target hole (Figure 47). Holes may be the
 - collars in the plan view
 - corresponding row in the *Table* pane
8. Upon releasing the mouse button, the borehole trajectory is allocated to this position. The red straight line changes to a curved line.



- 1 "Import" button for defining the raw hole data file (".rhd", ".dm4")
- 2 Defining the azimuth correction
- 3 Defining the probe length
- 4 List of borehole trajectories contained in the raw hole data file

Figure 46: Pulsar dialog for interactively importing borehole surveys made with a Pulsar probe

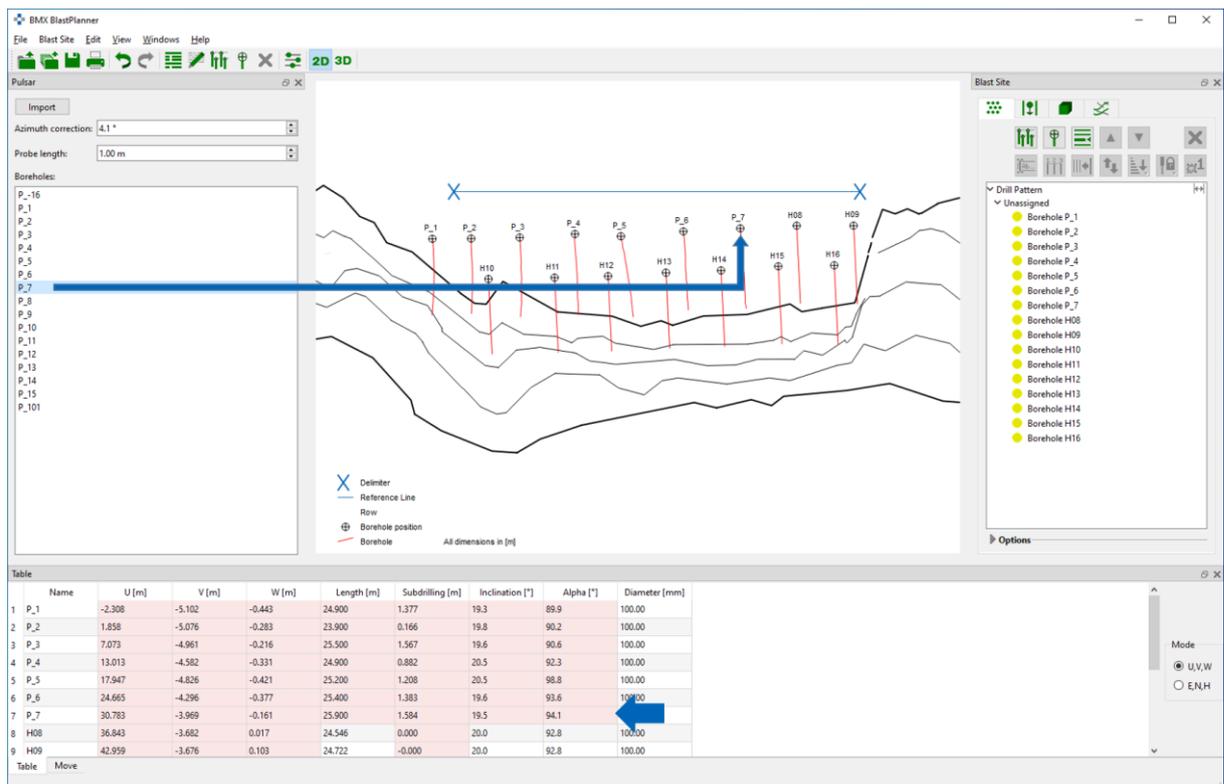


Figure 47: Allocating borehole trajectories to positions in the BMX BlastPlanner

Import Boretrak data (geo-referenced)

Procedure:

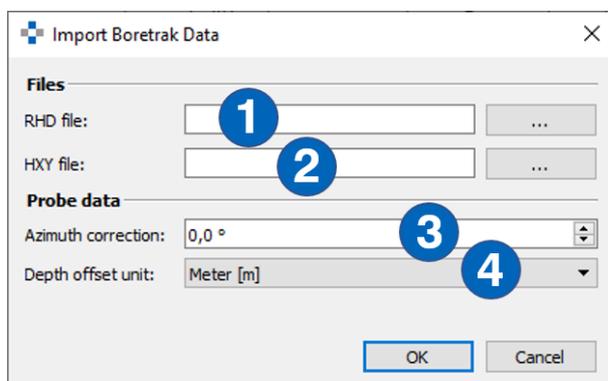
1. Open the 3D model (“.jm3”) and the *Blast Site* (“.smb”) as described in Chapter 7.1.
2. Select “*Blast Site | Import | Import Boretrak Data*” in the menu bar. A dialog window (Figure 43): appears requiring several inputs:
 - “.rhd” file (raw hole data): File provided by the Boretrak® system containing the borehole deviations
 - “.hxy” file (position of borehole collar): File provided by the Boretrak® system containing the positions of the borehole collar
 - Azimuth correction: Corrects the magnetic azimuth readings from the Boretrak® system to the geo-referenced co-ordinate system
 - Depth offset unit: Setting of the unit of the depth offset independent of the general unit setting in *BlastMetriX*, It must coincide with the units used when entering the depth offset in the Boretrak device
3. Click on the “OK” button. The measured boreholes are imported and instantly displayed in the 3D viewer. (Figure 44 and Figure 45).

Hint:

The azimuth correction depends on your geographic position and varies with time. For your current azimuth correction contact 3GSM under support@3gsm.at.

Attention:

The azimuth correction applies only if the 3D model has been geo-referenced in a geographic co-ordinate system. If the 3D model has been north-corrected using compass data, the azimuth correction does not apply.



- 1 Define “.rhd” file
- 2 Define “.hxy” file
- 3 Define azimuth correction
- 4 Define unit of depth offset as set on the Boretrak PDA

Figure 48: Dialog window for importing data from Boretrak probes

Import Boretrak probe data (interactively)

The interactive import of Boretrak probe data requires the specification of the raw hole data file (".rhd").

Procedure:

1. Open the 3D model (".jm3") and the *Blast Site* (".smb") as described in Chapter 7.1
2. Define the borehole positions (if not already stored in the ".smb" file) using one of the following possibilities:
 - Enter borehole positions manually in the *Table* pane (Chapter 7.3)
 - Import borehole positions from a ".csv" file (Chapter 7.5)
 - Use planned borehole positions (for instance, using the "Generate Drill Pattern" function; see Chapter 7.2)
3. Use "Blast Site | Import | Import Boretrak Interactively" in the menu bar
4. The *Boretrak* dialog appears requiring several inputs (Figure 49):
 - Raw hole data file (".rhd", ".dm4"): File provided by the Boretrak system containing the borehole deviations. Click in the "Import" button and select the raw hole data file. The borehole trajectories are identified and listed in the *Boretrak* dialog.
 - Azimuth correction: Corrects the magnetic azimuth readings from the Boretrak system to the co-ordinate system of the 3D model

Hint:

The azimuth correction depends on your geographic position and varies with time. For your current azimuth correction contact 3GSM under support@3gsm.at.

Attention:

The azimuth correction applies only if the 3D model has been geo-referenced in a geographic co-ordinate system. If the 3D model has been north-corrected using compass data, the azimuth correction does not apply.

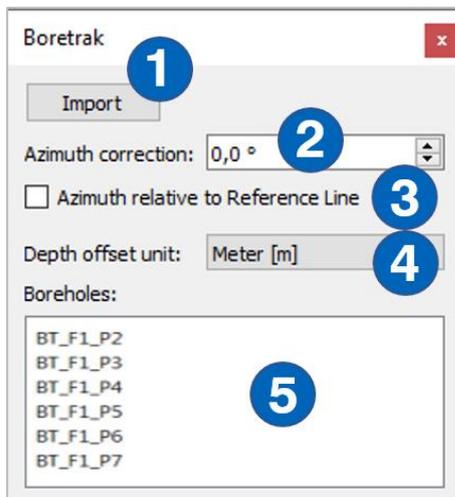
- Azimuth relative to *Reference Line*
 - If the box is selected, azimuth zero is in direction of the reference line
 - If the box is unselected, azimuth zero is in direction of the used co-ordinate system (local or geo-referenced)

Note:

Cabled Boretrak: It has to be calibrated to the *Reference Line*. Refer to the user manual of the Boretrak. *Rodded Boretrak*: For zero azimuth it is assumed that the rod stack is perpendicular to the *Reference Line*. For other orientation of the rod stack use *Azimuth Correction* to compensate the deviation.

5. Switch to 2D representation (plan view)

6. Click with the left mouse button on an entry in the list of borehole trajectories in the *Boretrak* dialog
7. Drag it to the corresponding target hole (see Figure 47) Holes may be the
 - collars in the plan view
 - corresponding row in the *Table* pane
8. Upon releasing the mouse button, the borehole trajectory is allocated to this position. The red straight line changes to a curved line.



- 1 “Import” button for defining the raw hole data file (“.rhd”)
- 2 Defining the azimuth correction
- 3 Define whether the azimuth shall be calculated relative to the *Reference Line*
- 4 Define unit of depth offset as set on the Boretrak PDA
- 5 List of borehole trajectories contained in the raw hole data file

Figure 49: Boretrak dialog for interactively importing borehole surveys made with a Boretrak probe

Import Renishaw CSV (interactively)

The interactive import of Renishaw probe data requires the specification of the raw hole data file (“.csv”).

Procedure:

1. Open the 3D model (“.jm3”) and the *Blast Site* (“.smb”) as described in Chapter 7.1
2. Define the borehole positions (if not already stored in the “.smb” file) using one of the following possibilities:
 - Enter borehole positions manually in the *Table* pane (Chapter 7.3)
 - Import borehole positions from a “.csv” file (Chapter 7.5)
 - Use planned borehole positions (for instance, using the “Generate Drill Pattern” function; see Chapter 7.2)
3. Use “Blast Site | Import | Import Renishaw CSV Interactively” in the menu bar
4. The *Renishaw CSV* dialog appears requiring following inputs:

- Raw hole data file (“.csv”): File provided by the Renishaw system containing the borehole deviations. Click in the “Import” button and select the raw hole data file. The borehole trajectories are identified and listed in the *Renishaw CSV* dialog.
 - Azimuth correction: Corrects the magnetic azimuth readings from the Renishaw system to the co-ordinate system of the 3D model
5. Switch to 2D representation (plan view)
 6. Click with the left mouse button on an entry in the list of borehole trajectories in the *Renishaw CSV* dialog
 7. Drag it to the corresponding target hole (see Figure 47). Holes may be the:
 - collars in the plan view
 - corresponding row in the *Table* pane
 8. Upon releasing the mouse button, the borehole trajectory is allocated to this position. The red straight line changes to a curved line.

The “csv” file has to be defines as follows:

- columns “Hole ID, E, N, H, Heading, Inclination Depth”
- hole number in the first column
- no header
- “.” As decimal and “,” as separator

Examples for “.csv” file:

```
1,1000.000,1000.000,100.000,0.000,0.000,0.000
1,1000.038,1000.627,98.101,3.500,18.300,2.000
1,1000.037,1001.245,96.199,359.900,17.990,4.000
...

```

```
2,1005.031,1000.803,98.169,2.200,23.690,2.000
2,1005.063,1001.607,96.337,2.300,23.720,4.000
2,1005.092,1002.401,94.502,2.100,23.420,6.000
...

```

Hint:

The azimuth correction depends on your geographic position and varies with time. For your current azimuth correction contact 3GSM under support@3gsm.at.

Attention:

The azimuth correction applies only if the 3D model has been geo-referenced in a geographic co-ordinate system. If the 3D model has been north-corrected using compass data, the azimuth correction does not apply.

Custom import (MWD data)

A customized import (“.xml” format) of borehole survey data from down-the-hole probes is possible by using the command in the menu bar: “File | Import | Custom | Import Drill Pattern from IREDES. The visualization of the measure while drilling data (MWD) is provided in a separate dialog. Please refer to Chapter 12.

Attention:

The required data format is according to the IREDES standard.

7.7 Basic procedure for importing an already drilled Drill Pattern

1. Load the 3D model of the bench face by clicking “File | Open 3D Model” in the menu bar or by clicking the corresponding icon  in the toolbar and choose the intended file with extension “.jm3”.
2. Load the *Blast Site* by clicking “Blast Site | Load Blast Site” in the menu bar or by clicking the corresponding icon  in the toolbar and choose the intended file with extension “.smb”.

Hint:

If there is a *Blast Site* with the same file name as the 3D model, it is automatically loaded.

3. Import borehole collars and/or trajectories as described in Chapters 7.5 and 7.6. The boreholes are displayed within the 3D viewer as red cylinders Figure 20.
4. Organise the imported boreholes in rows (see section “Adjusting borehole order” and “Assigning boreholes to row” in Chapter 7.3):
 - Add the necessary number of rows
 - Assign the boreholes to the corresponding rows
 - If necessary, rearrange the borehole order
 - If necessary, rearrange the row order
5. Click on the first borehole either in the plan view, the *Table* pane, or the *Drill Pattern* tab. The corresponding *Profile* or *Minimum Burden* diagram appears in the *Plot* pane. The entries corresponding to the selected borehole in the *Drill Pattern* tab and the *Table* pane are highlighted. The selected borehole is highlighted red in the plan view.
6. Switch between *Profile* and *Minimum Burden* diagram to check the burden of the borehole.

Attention:

For boreholes with an imported borehole trajectory only the *Minimum Burden* diagram is available. The *Profile* is disabled.

7. Switch to 3D display and turn on the colour-coded burden overlay by clicking “Visualize Burden Over the Whole Area”  icon in the menu bar to check the resulting overall burden situation.
8. Calculate the volume to blast by the specified *Drill Pattern* by clicking the “Update Volume”  icon in the *Volume* tab of the *Blast Site* pane.
9. A window with the geometric properties of the *Blast Site* appears when clicking on “Blast Site | Statistics”. The values can be exported in a text file by clicking on the “Export” button. (“.csv” file format, which can be read by spreadsheet programs like MS Excel).
10. Save the *Blast Site* by clicking “Blast Site | Save Blast Site (as)” in the menu bar or by clicking the corresponding  icon in the toolbar.
11. In order to produce a report, click “File | Print Report” in the menu bar or by clicking the corresponding icon  in the toolbar. A dialog window arises where settings for the report are entered (see Figure 104).
12. By choosing the appropriate output device the results are printed into a “.pdf” file (preferred mode) or directly on a connected printer.

Hint:
 Reports are independent from any printer settings if the “Export Report as PDF” feature is used.

7.8 Blast Site statistics

Overview on the basic parameters of the Blast Site

By clicking “Blast Site | Statistics” a status window opens providing the current parameters of the geometry of the *Blast Site*, drill pattern design parameter and drill pattern analysis (see Figure 50).

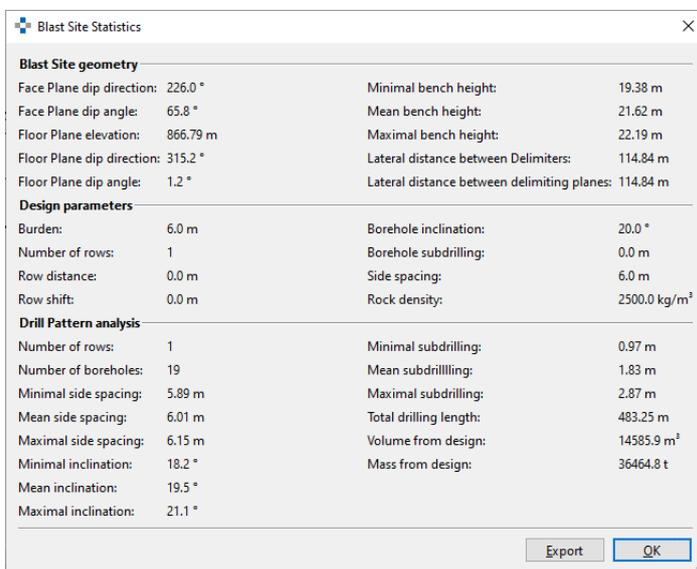


Figure 50: Basic information on the Blast Site

Naming the Blast Site

If the *Blast Site* was not yet named (e.g. during processing with the *BMX BlastSiteGenerator*), then the according dialog window can be used by clicking “*Blast Site | Entitle Blast Site*”. The dialog window (Figure 51) corresponds with the one within the *BMX BlastSiteGenerator* component.

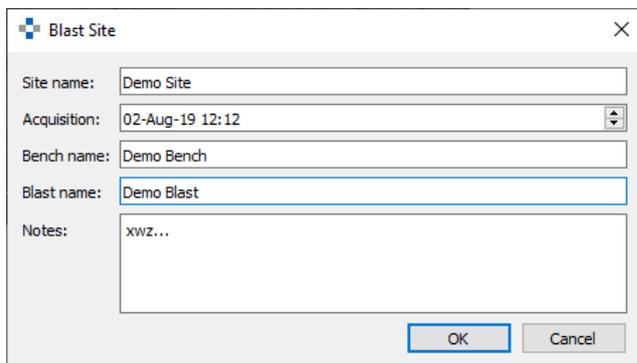


Figure 51: Dialog window for providing a denomination for the survey

7.9 Transformation of a Blast Site

When loading a *Blast Site* into the *BMX BlastPlanner* a consistency check between the 3D model and the *Blast Site* is performed. If the files are not consistent, a warning message appears (see Figure 52).

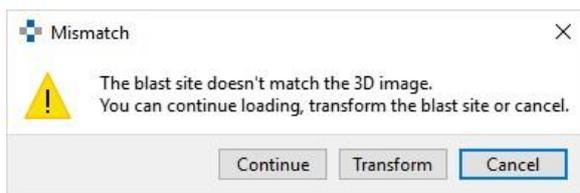


Figure 52: Warning if the *Blast Site* (“*.smb*”) does not match the 3D model (“*.jm3*”)

Inconsistencies occur if the 3D model has been re-scaled, re-orientated or geo-referenced after generating the *Blast Site* (the *Blast Site* then has a different coordinate system than the 3D model). The user can choose to continue loading, cancel loading, or transform the *Blast Site* to the 3D model. The transformation requires the original 3D model (“*.jm3*”), the original *Blast Site* (“*.smb*”) and the altered (transformed) 3D model. The files are selected with the dialog “*Transform Blast Site*” (Figure 53). It is also necessary to define a file name for the transformed *Blast Site* to be generated (“*.smb*”).

The transformation performs a Helmert transformation which recalculates positions, orientations, and sizes for all elements of the *Blast Site*. Externally surveyed *Blast Site Elements* (e.g. borehole probe data) shall be deleted after transformation and re-imported in order to preserve the original measurements.

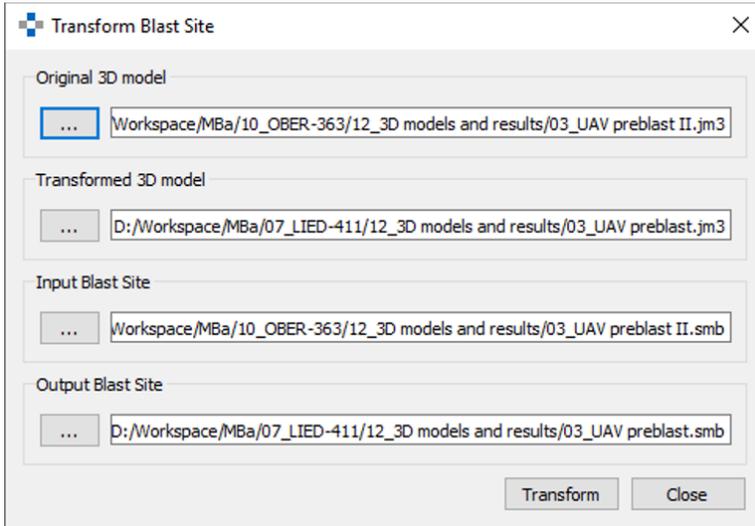


Figure 53: Dialog for defining the Blast Site transformation

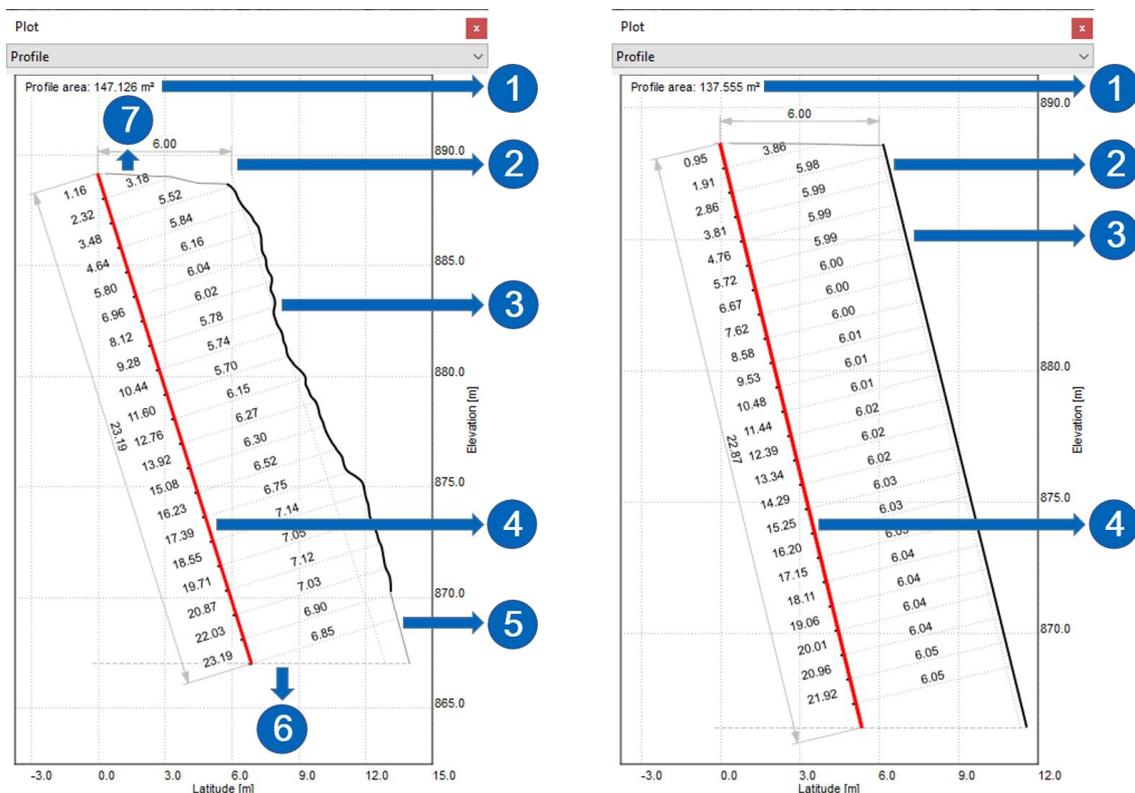
8 Burden analysis

The burden as the distance between the borehole and the free surface can be analysed in terms of *Profiles*, *Minimum Burden* diagrams and colour-coded burden visualisation on the 3D model.

8.1 Profile

Profiles (Figure 54 and Figure 55) are the vertical planar sections which include a borehole and the section through the 3D model or the row surface. *Profiles* include the borehole, the measured profile (to the 3D model or row surface), the *Top Level Surface*, the *Floor Plane*, the projected profile (if calculated), the design burden, and dimensions. The borehole is drawn with its true inclination. The measured profile is drawn as a bold solid line while modelled surfaces are drawn as thin solid or dashed lines.

Attention:
Profiles are not available for imported borehole trajectories from down-the-hole survey



- 1 Measured profile area
- 2 Design burden
- 3 Measured profile
- 4 Borehole
- 5 Projected profile
- 6 Floor Level Plane
- 7 Top Level Surface

Figure 54: Elements of the Profile plot. Left: front row profile. Right: internal row profile.

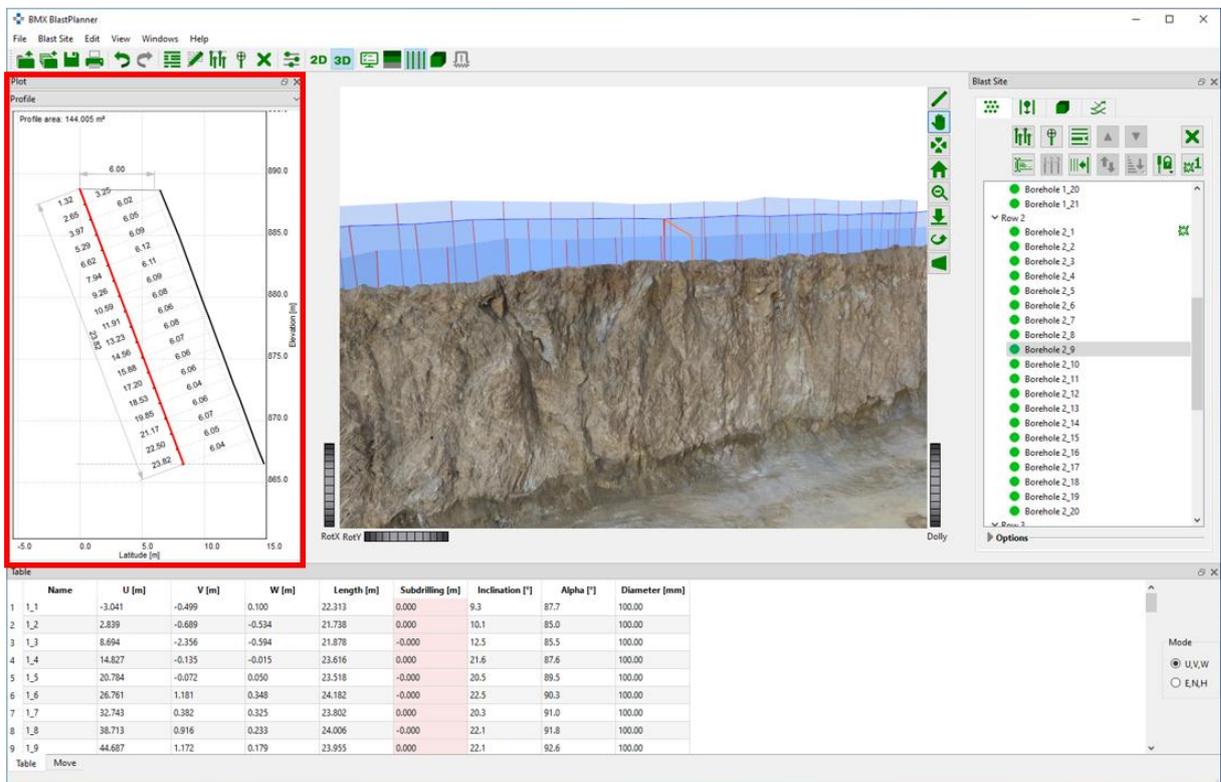
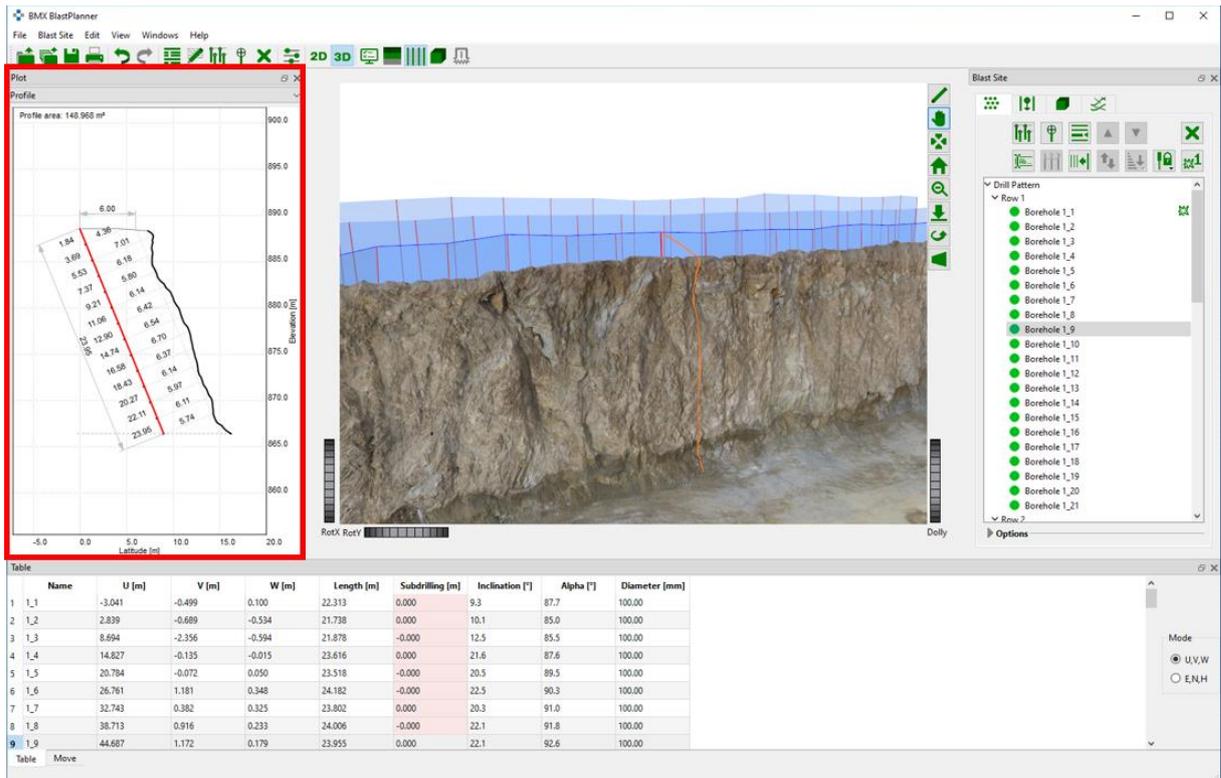
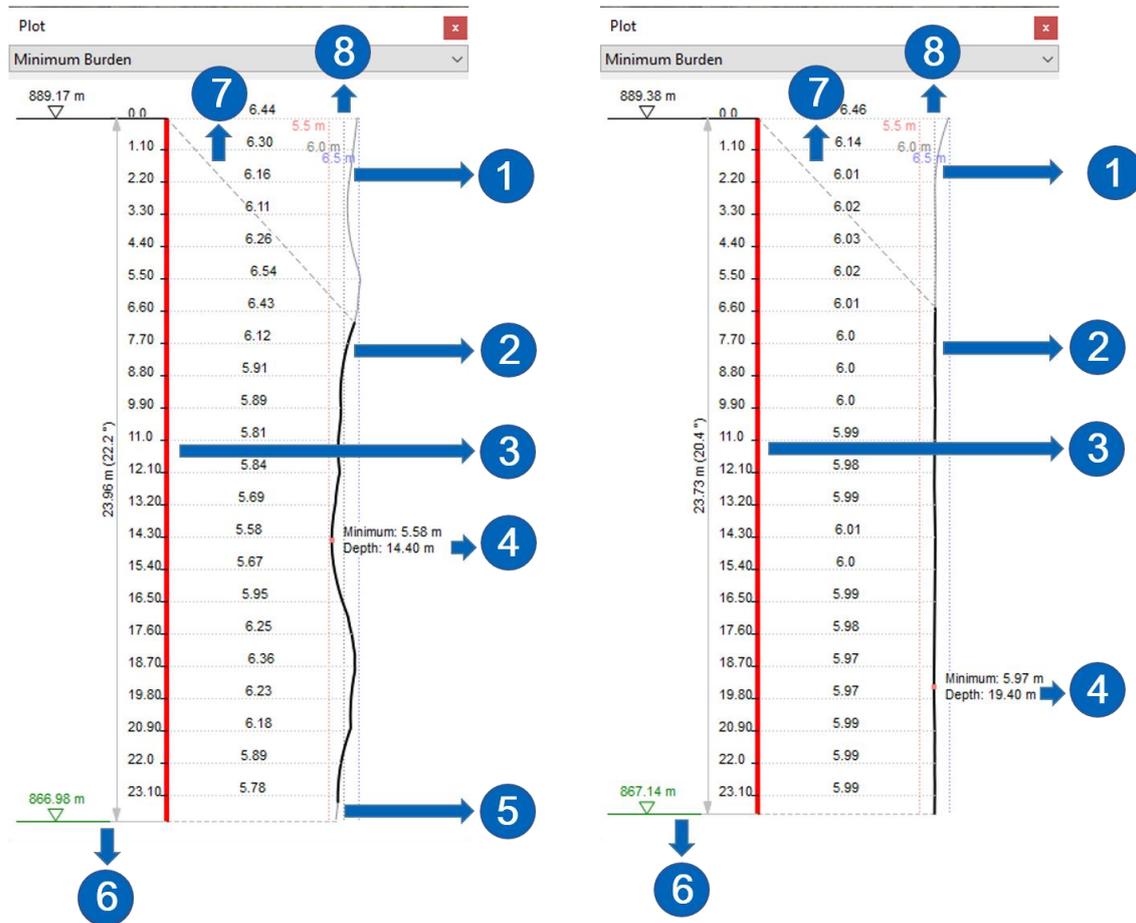


Figure 55: Location of the profiles which runs discontinuously on the surface. Top: Front row profile. Bottom: Internal row profile.

8.2 Minimum Burden diagram

The *Minimum Burden* diagrams (Figure 56 and Figure 57) shows the minimum distance between a borehole and the free surface independent of any direction. It measures towards the 3D model or the row surface. The *Minimum Burden* diagram includes the straightened borehole axis as vertical line, the *Minimum Burden* line towards 3D model or row surface, the *Floor Level Plane*, the *Minimum Burden* line towards the projected surface, the *Minimum Burden* line towards the *Top Level Surface*, the corridor of the design burden and dimensions. The inclination of the borehole is given next to its length in the *Minimum Burden* diagram (value in brackets).



- 1 *Minimum Burden* at crest region
- 2 Measured *Minimum Burden* line
- 3 Straightened borehole axis
- 4 Location of the *Minimum Burden*
- 5 *Minimum Burden* to projected surface
- 6 *Floor Level Plane*
- 7 *Minimum Burden* to *Top Level Surface*
- 8 Designed burden corridor

Figure 56: Elements of the *Minimum Burden* plot. Left: front row profile. Right: Internal row profile.

Note:

The altitude at the borehole collar and at the floor level is displayed in the *Minimum Burden* diagram by enabling “Show elevations in plot” in the *Options* dialog (see Chapter 6.1).

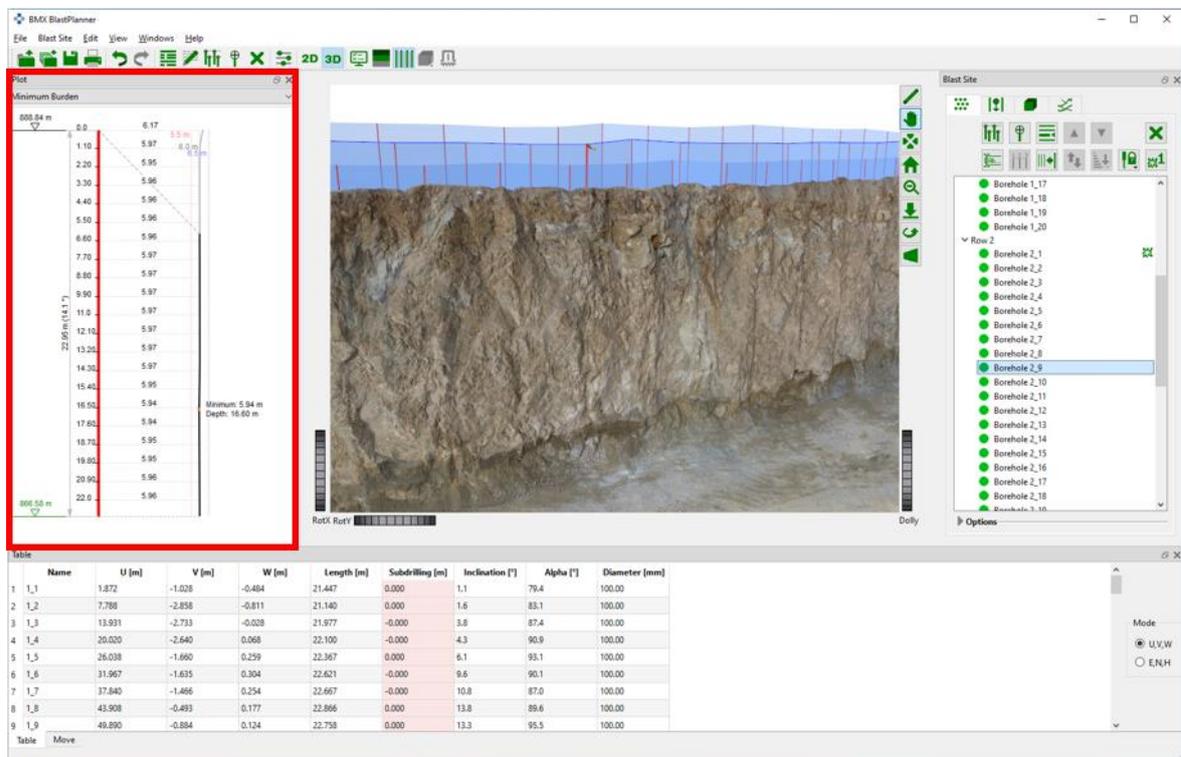
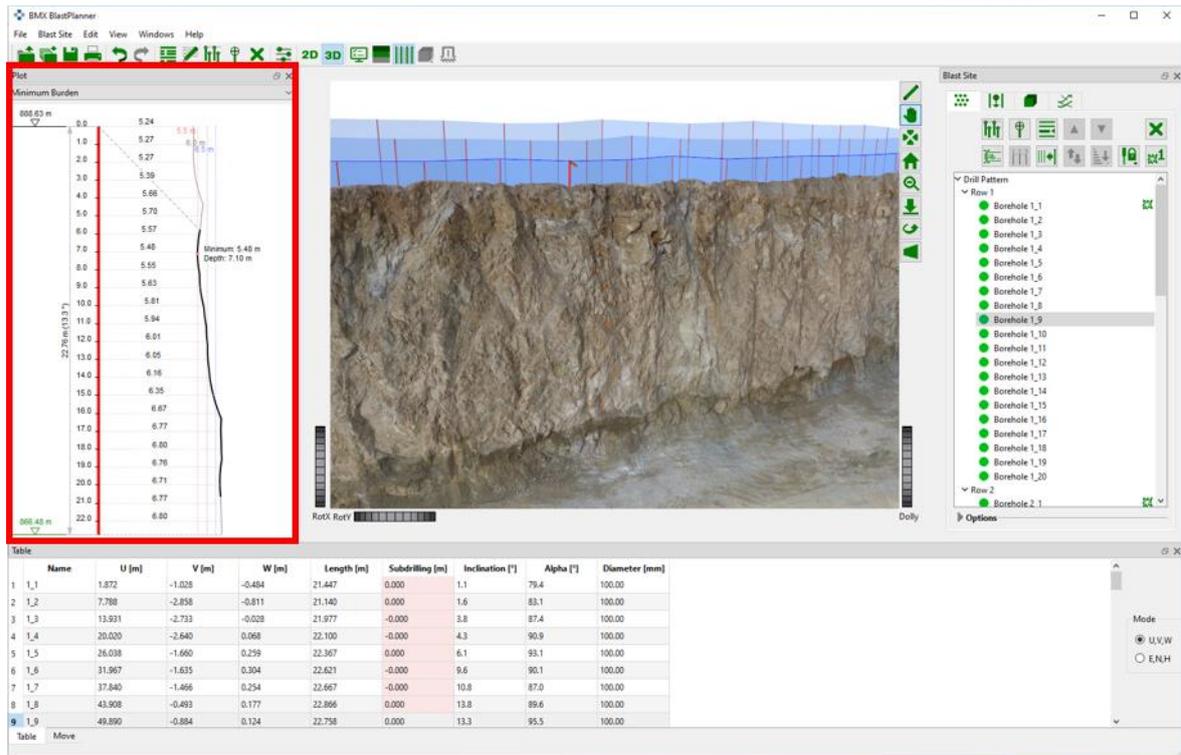


Figure 57: Location of the Minimum Burden points, which do not show a continuous run on the surface. Top: Front row profile. Red arrows marks the altitude at the borehole collar (grey line) and at the floor level (green line). Bottom: Internal row profile.

8.3 Comparison between Profile and Minimum Burden diagram

Although profiles in conjunction with a 3D model are a good information basis for the loading, this output can be sub-optimal especially when having a geometrically irregular bench face or when working at corners. At irregularities (niches, caves, corners etc.) there might be areas on the surface that have a significant smaller distance to the borehole than those parts touched by the profile. Therefore the concept of a *Minimum Burden* diagram has been realised. It shows the minimum distance between a borehole and the surface independent from any direction. Figure 58 and Figure 59 show exemplarily the difference between a *Profile* and a *Minimum Burden* diagram. Depending on the actual geometry of the bench face reported burden differs in the range of several decimetres (several feet).

As the loading is preferably based on the minimum distance between borehole and free surface the *Minimum Burden* diagram might directly influence the amount of used explosives. Also the danger of fly-rock is reduced when taking care on bench face irregularities. Furthermore upper stemming is evident.

Hint:
Switching between the *Profile* and *Minimum Burden* diagram is done using the pull-down-menu at the top of the *Plot* pane (see also Figure 10).

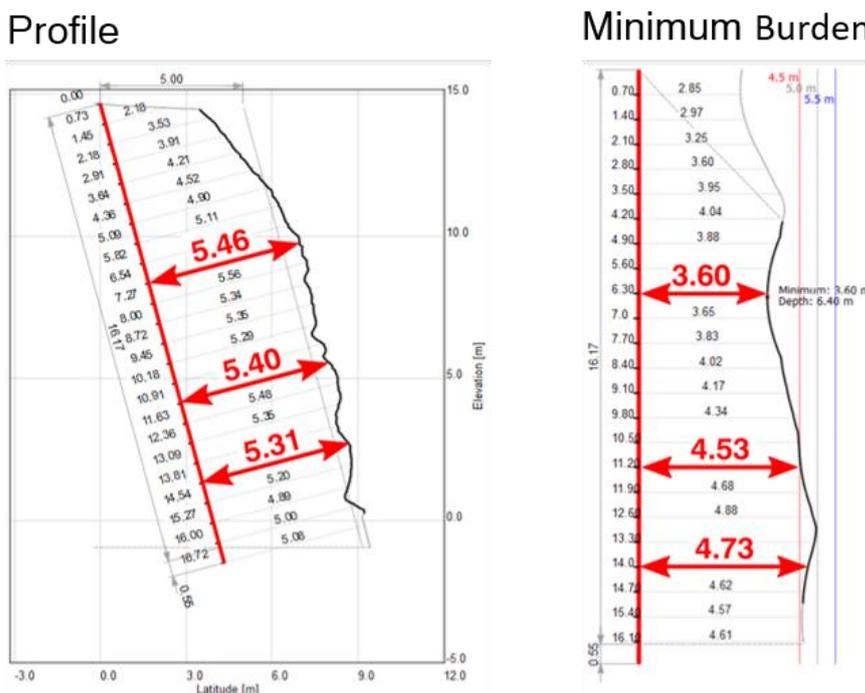


Figure 58: Comparison of a *Profile* (left) with the *Minimum Burden* diagram (right) of the same borehole. Depending on the actual geometry of the bench face the reported burden in the profile and minimum burden diagram may show significantly different values. The *Minimum Burden* always shows the smaller values.

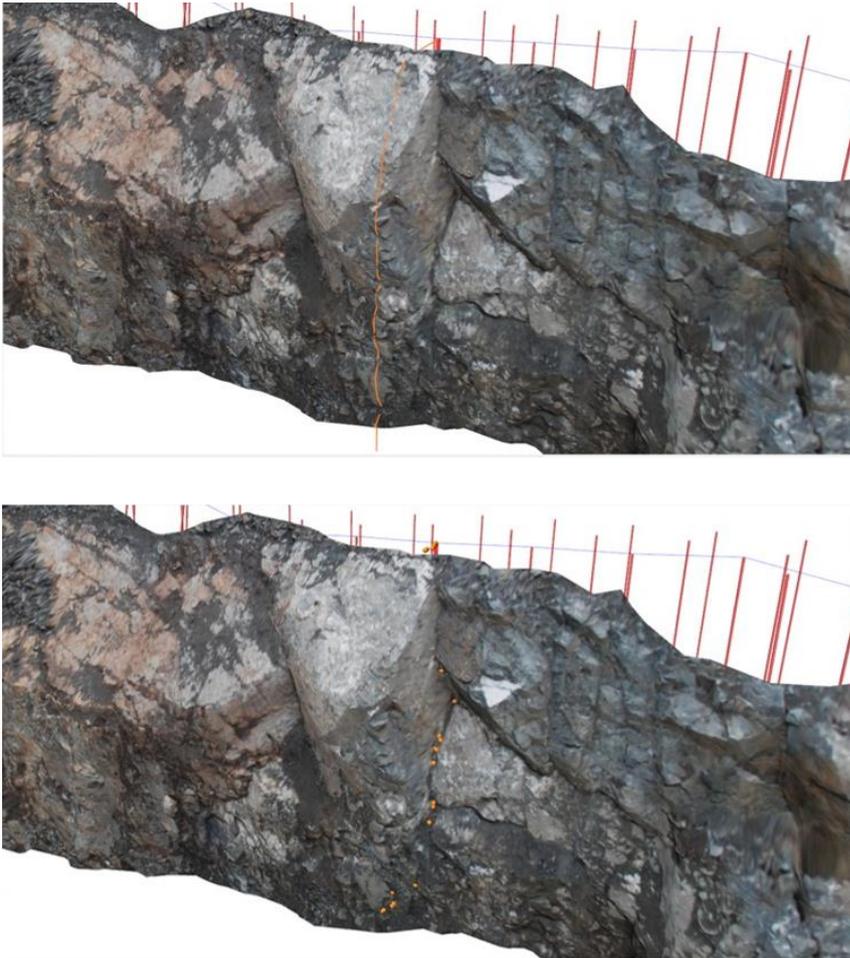


Figure 59: Location of the Profile (left) and the Minimum Burden points (right) from Figure 58 on the 3D model.

8.4 Colour-coded visualisation of burden

By clicking “View / Show Burden” in the menu bar or clicking the “Visualize Burden Over the Whole Area”  icon in the toolbar the current burden distribution over the whole bench face is plotted (Figure 60). For every point on the surface the distance to the closest borehole is determined and coloured according to the defined burden. The burden corridor can be set via the options dialog in the *General* tab (see Figure 17). The green overlay marks areas within the design burden corridor. The blue overlay marks areas in which the burden exceeds the limits of the design burden corridor. The red overlay marks areas in which the burden is below the design burden limit.

Note:

The colour code can be modified by the user in the “General Options” see Chapter 6.1.



Figure 60: Colour-coded visualisation of burden. Green marks those areas where the burden is within the defined range (entered value +/- tolerance see, Figure 17). Red areas with less and blue areas with more than the defined burden range.

9 Blast site volume

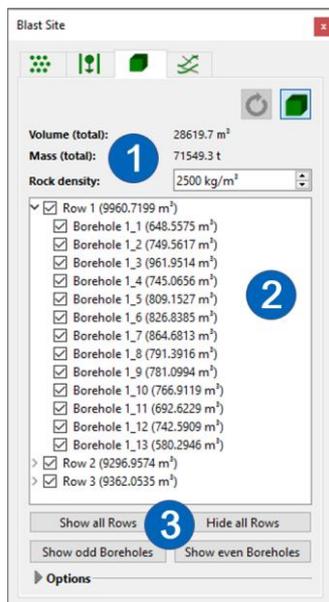
9.1 Calculation of the blast site volume

Prerequisites:

- Volume calculation must have been enabled in *BMX BlastSiteGenerator* or in the *BMX BlastSiteGenerator3D* (this is automatically attempted)
- The *Blast Site* must contain boreholes
- Boreholes must be organized in rows, unassigned boreholes are not considered
- Boreholes and rows must show feasible order
- The mesh borders must be correctly defined

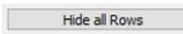
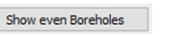
Procedure:

1. After loading or generating a *Drill Pattern*, go to the *Volume* tab in the *Blast Site* pane.
2. Click on the “*Update Volume*”  icon. The *Blast Site* volume will be calculated or updated.



- 1 Toolbar and calculated volume of the *Blast Site*
- 2 Row volume list (row and single boreholes)
- 3 Show/Hide buttons

Figure 61: *Volume* tab for calculating and displaying the volumes of the *Blast Site*

Results are displayed in the *Volume* tab for the entire blast site, the rows and single boreholes (Figure 61). The calculated volume is displayed in the 3D viewer as a blue body. It can be hidden or shown using the “*Show Volume*”  icon in the toolbar. The volume for rows or single boreholes can be shown or hidden using the checkboxes in the row volumes list or by using the buttons “*Show all Rows*” , “*Hide all Rows*” , “*Show odd Boreholes*”  or “*Show even Boreholes*”  (Figure 62 and Figure 63).

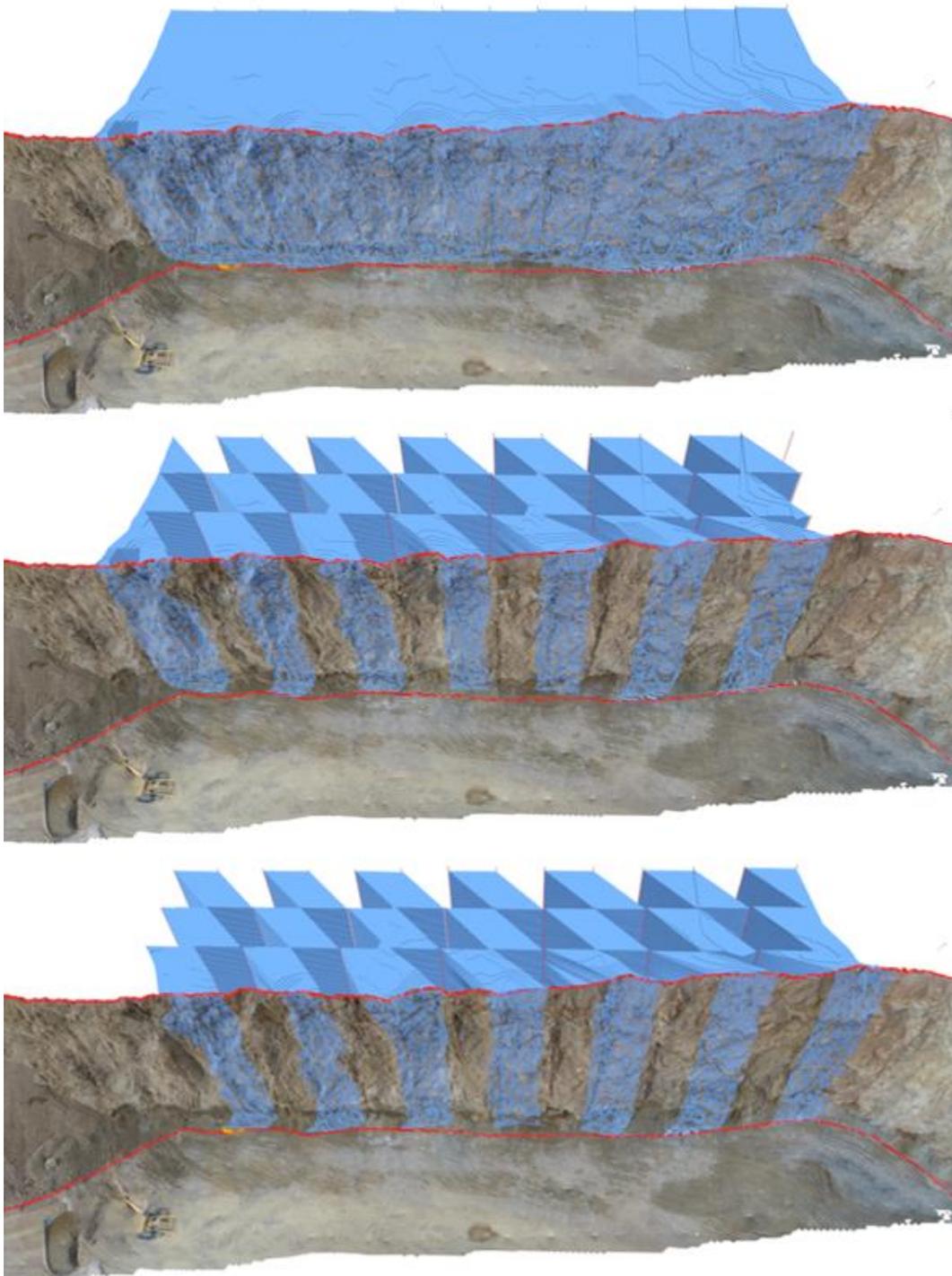


Figure 62: Borehole volumes for a three-row straight pattern. Total volume (top), odd boreholes (middle) and even boreholes (bottom).

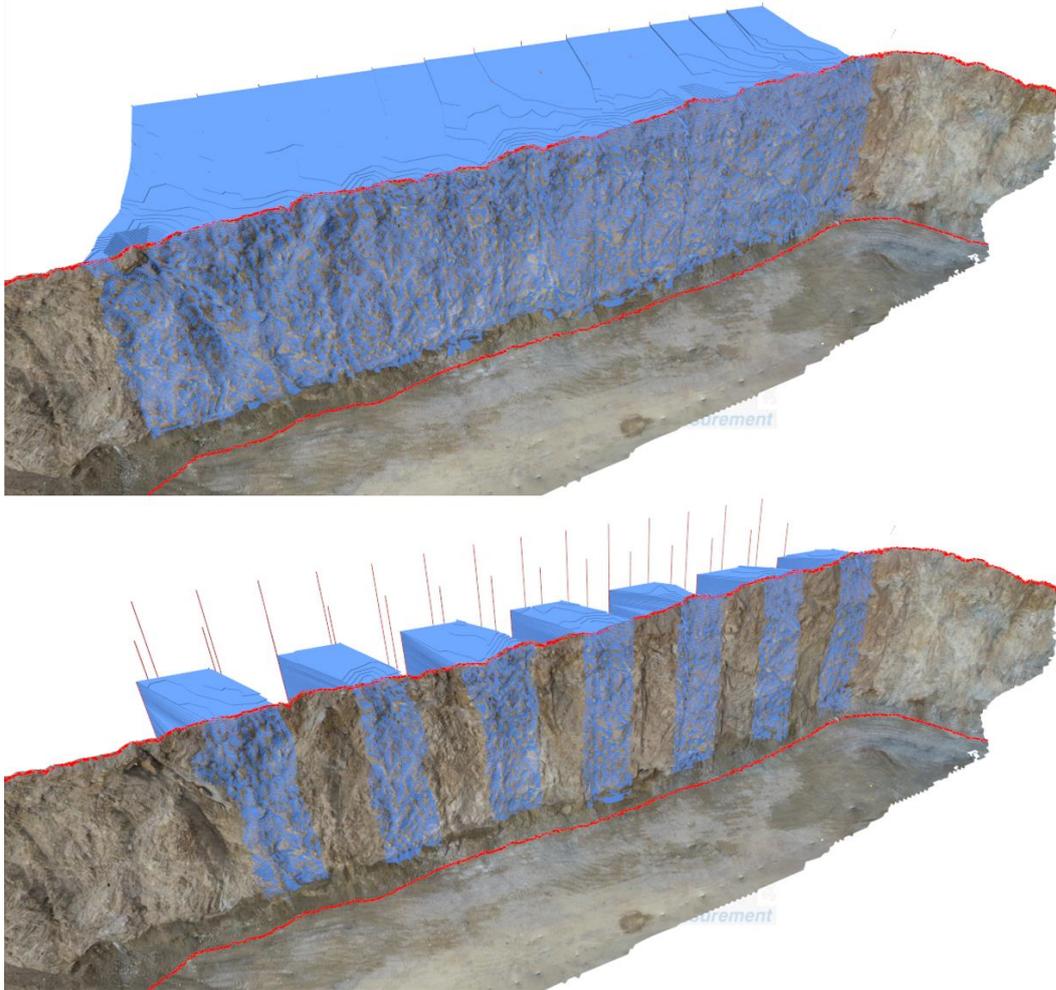


Figure 63: Perspective view of the 3D model and the entire volume of the Blast Site in the 3D viewer (top). Perspective view of the 3D model and the borehole volumes of single boreholes in the 3D viewer (bottom).

In case the *Drill Pattern* has been changed (moving boreholes, adding boreholes, etc.) or *Drill Pattern* settings have been changed, the previously calculated volume does not correspond to the current settings. In this case the volume body switches to grey (Figure 64), the “Show Volume”  icon in the toolbar switches to  and the “Update Volume”  icon in the *Volume* tab gets enabled in order to update the volume at the user’s convenience.

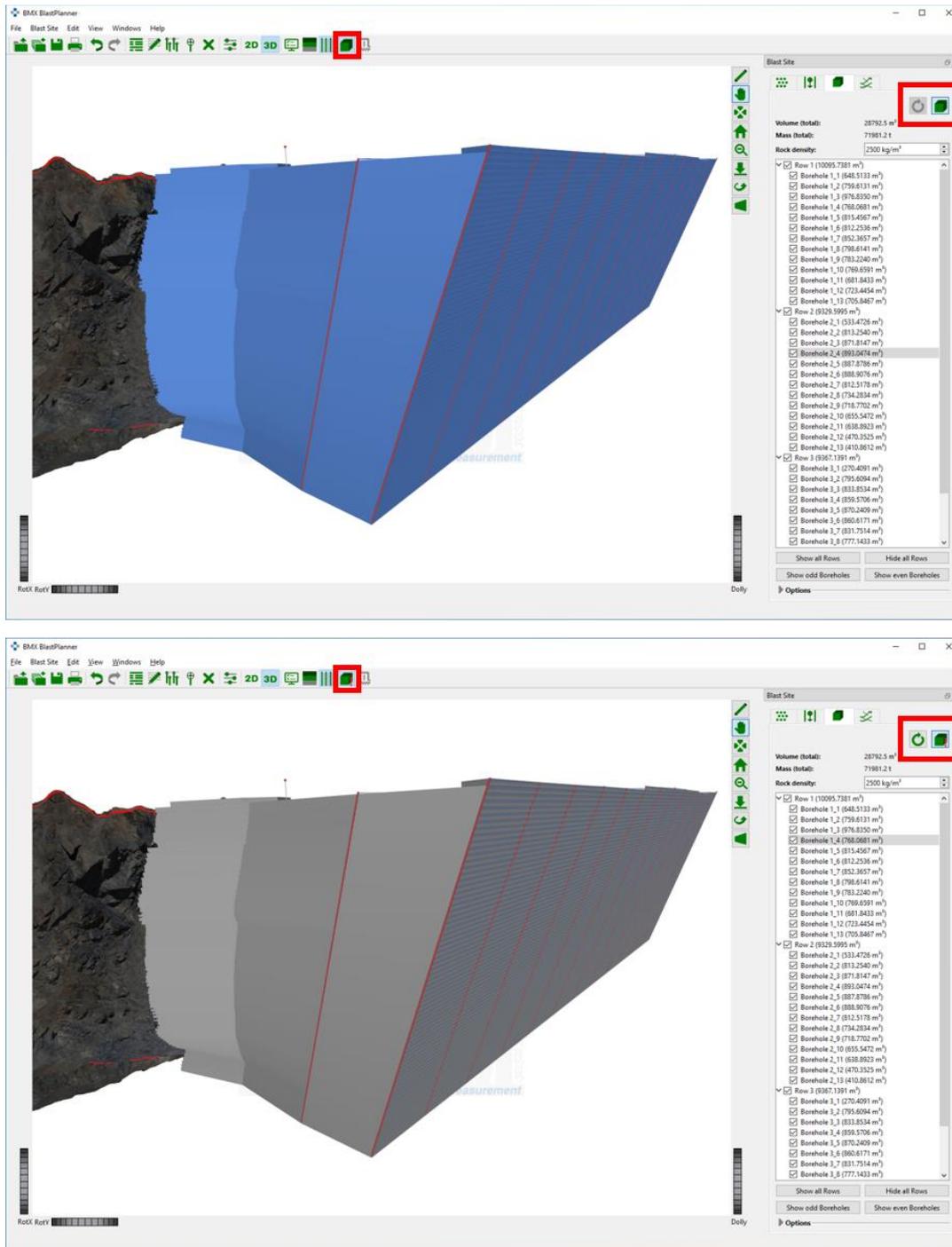


Figure 64: Top: The calculated volume is displayed in the 3D viewer as a blue body. Bottom: The grey volume body indicates a change in the Drill Pattern and/or settings. Volume has to be updated.

Note:

The volume body is defined by the *Border Planes*. Pay attention if border planes have been adjusted.

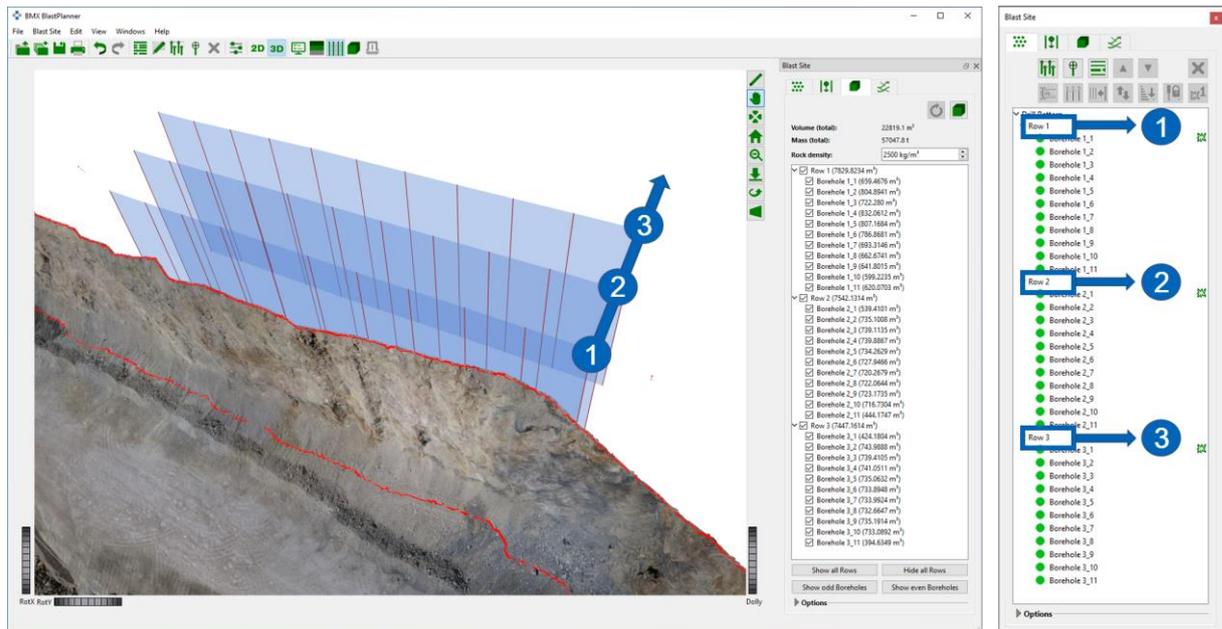
Note:

Subdrilling is counted below the *Floor Level Plane*. For desired volumes calculations including subdrilling, the *Floor Level Plane* has to be adjusted to a proper position (see Chapter 7.3).

9.2 Drill Pattern order

Row order

The consistent determination of the *Blast Site* volume requires a consistent order in the *Drill Pattern* list. It is necessary to arrange the rows from top to bottom in the order they are blasted / calculated in the *Drill Pattern* list. Figure 65 shows the corresponding spatial situation. The first row takes the bench face as the free surface (Figure 66). The subsequent rows additionally consider the already blasted volume from all previous rows as the relevant free surface (Figure 66). Please see section “Adjusting the row order” in Chapter 7.3 how to adjust the row order.



- 1 First row
- 2 Second row
- 3 Third row

Figure 65: Left: Drill Pattern list with three rows. The volume is calculated for rows in the listed order. Right: 3D model with the three rows. The rows are calculated in the indicated order.

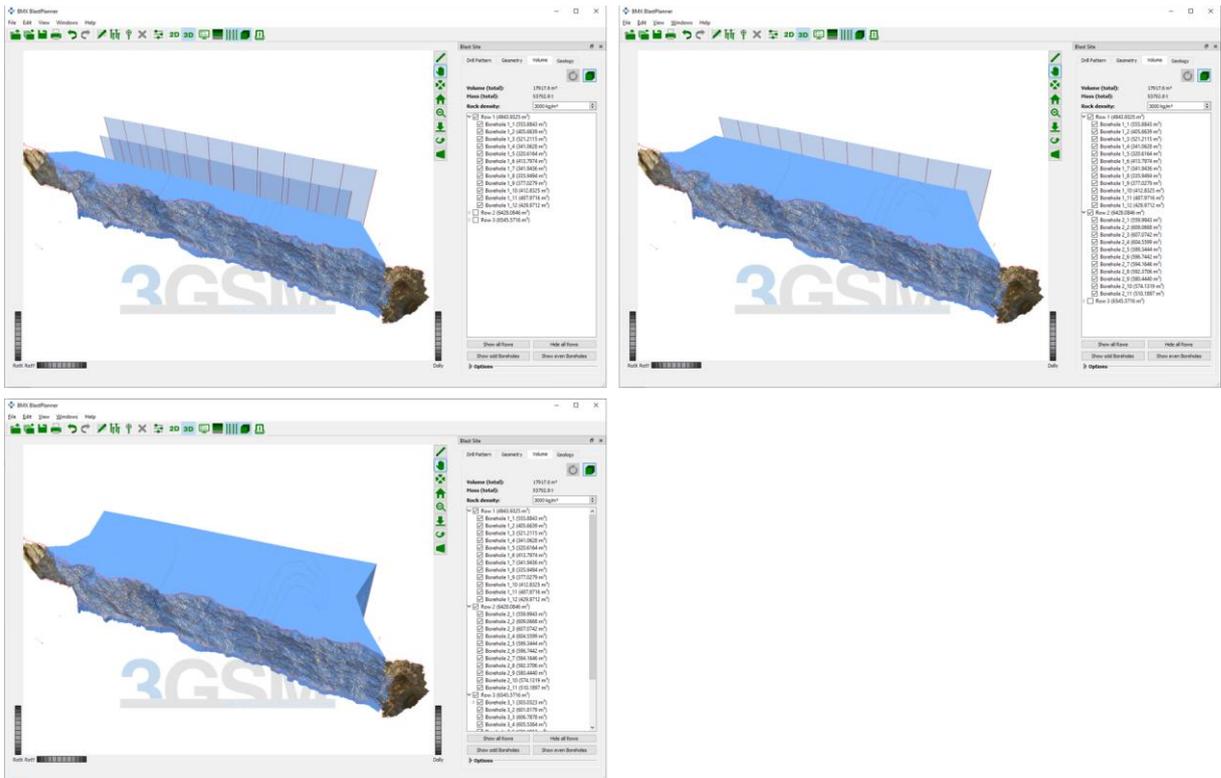


Figure 66: Calculated volume increment for each row from Figure 65. Top left: First row; Top right: Second row; Bottom left: Third row.

Borehole order within rows

The consistent determination of the *Blast Site* volume requires a consistent order in the *Drill Pattern* list. It is necessary that neighbouring holes within a row are also neighbours in the *Drill Pattern* list (Figure 67). It does not matter whether the sense of the order is left to right or vice versa. The row surface depends on the established borehole neighbours (Figure 68). Feasible orders also show feasible row surfaces. The borehole neighbourhood are also indicated in the plan view with a dashed blue line between the boreholes Figure 67). Please see section “*Adjusting the borehole order*” in Chapter 7.3 how to adjust the borehole order.

In case of wrong or unfeasible borehole order the row surface shows overlapping areas (Figure 70). The dashed blue line in the plan view also shows a zig-zag or self-intersecting pattern (Figure 71). Volume calculation requires re-ordering of the boreholes (see Chapter 7.3).

Attention:
Planar row surfaces require special attention in checking for a feasible borehole order yet intersections are difficult to identify.

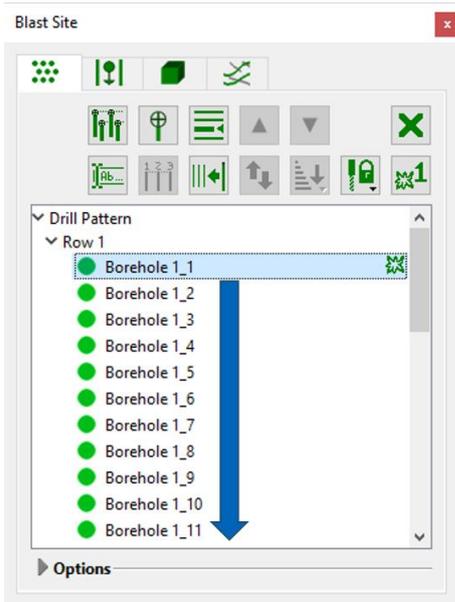


Figure 67: Boreholes must be listed in a feasible order in the Drill Pattern list. Geometrically adjacent boreholes within a row must be also adjacent in the list.

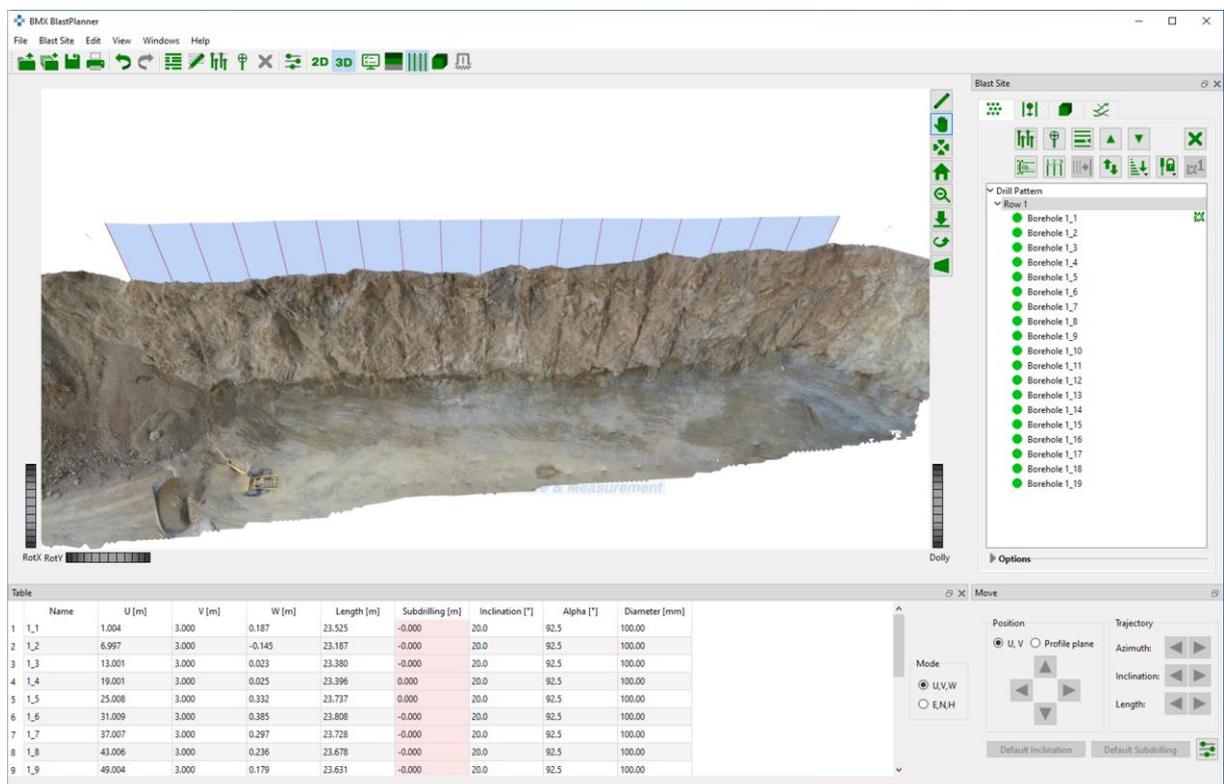


Figure 68: Feasible row surface based on the order from Figure 67

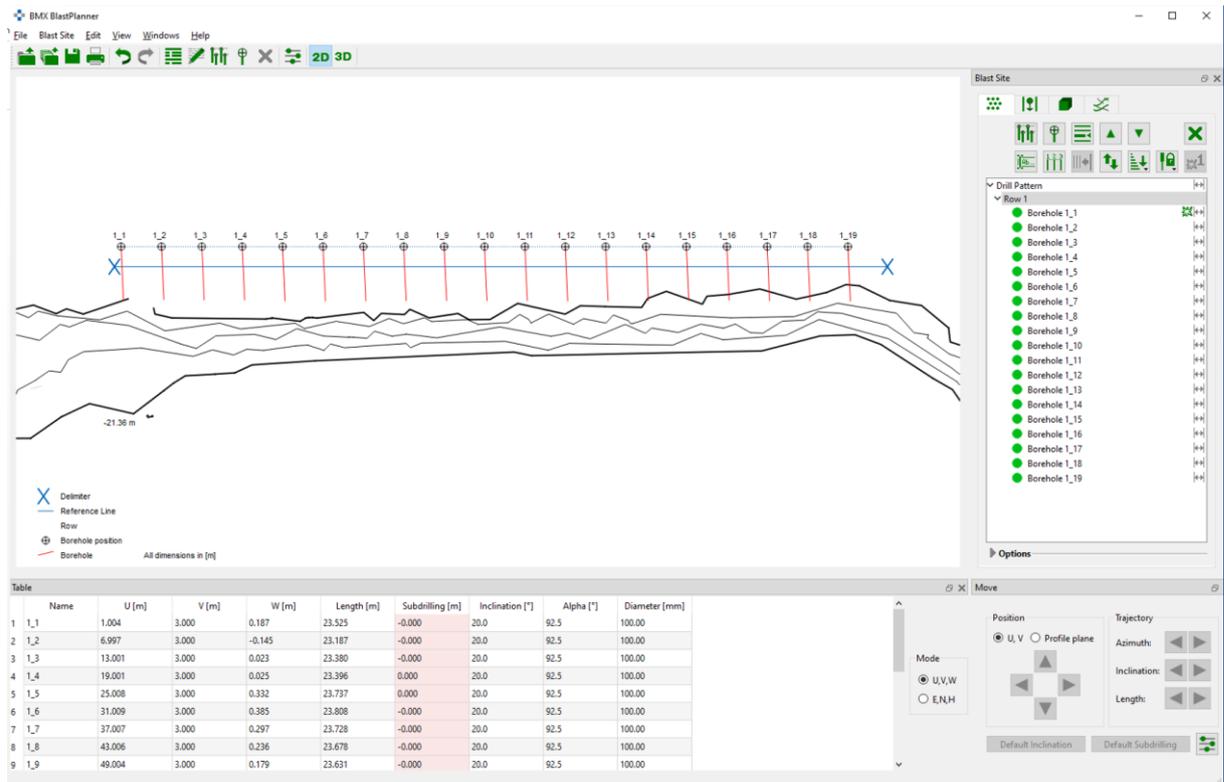
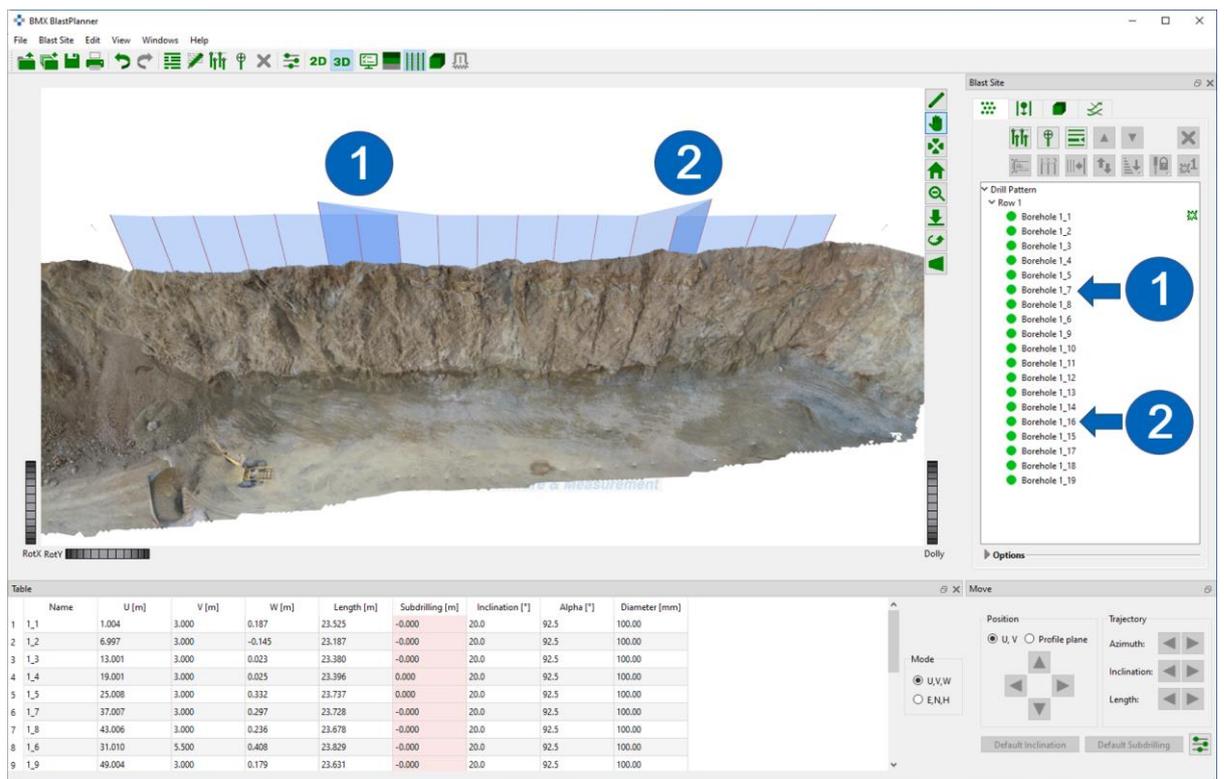
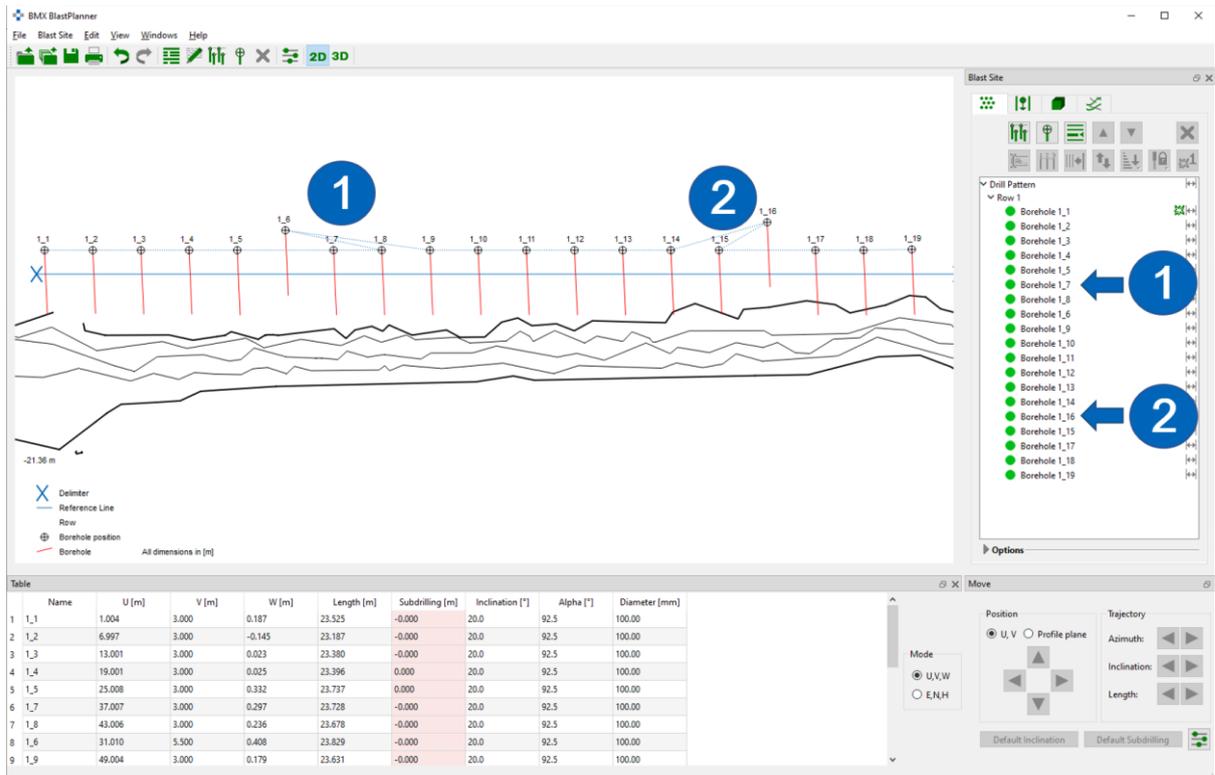


Figure 69: Feasible borehole order from Figure 67 indicated by the dashed blue line



1 Wrong borehole order leads to an unfeasible row surface in the left part
 2 Wrong borehole order leads to an unfeasible row surface in the right part
 Figure 70: Overlapping row surface due to wrong borehole order



- 1 Wrong borehole order leads to incorrect borehole neighbours in the left part
 - 2 Wrong borehole order leads to incorrect borehole neighbours in the right part
- Figure 71: Incorrect borehole neighbourhoods

9.3 Mesh Borders

Volume calculation requires the definition of the upper and lower border of the 3D surface (mesh). The mesh borders are automatically determine. *Mesh Borders* (Figure 72) are automatically displayed as red lines if the *Volume* tab is activated. *Mesh Borders* can be accessed as an annotation in the *Geometry* tab (Figure 73).

It is necessary that the *Mesh Borders* follows the physical *Upper* and *Lower Mesh Border* of the 3D model (as shown in Figure 72); otherwise the volume calculation may fail. Figure 72 shows an example with an inconsistent *Upper Mesh Border*. It extends beyond the upper border and includes also the left border and parts of the lower border.

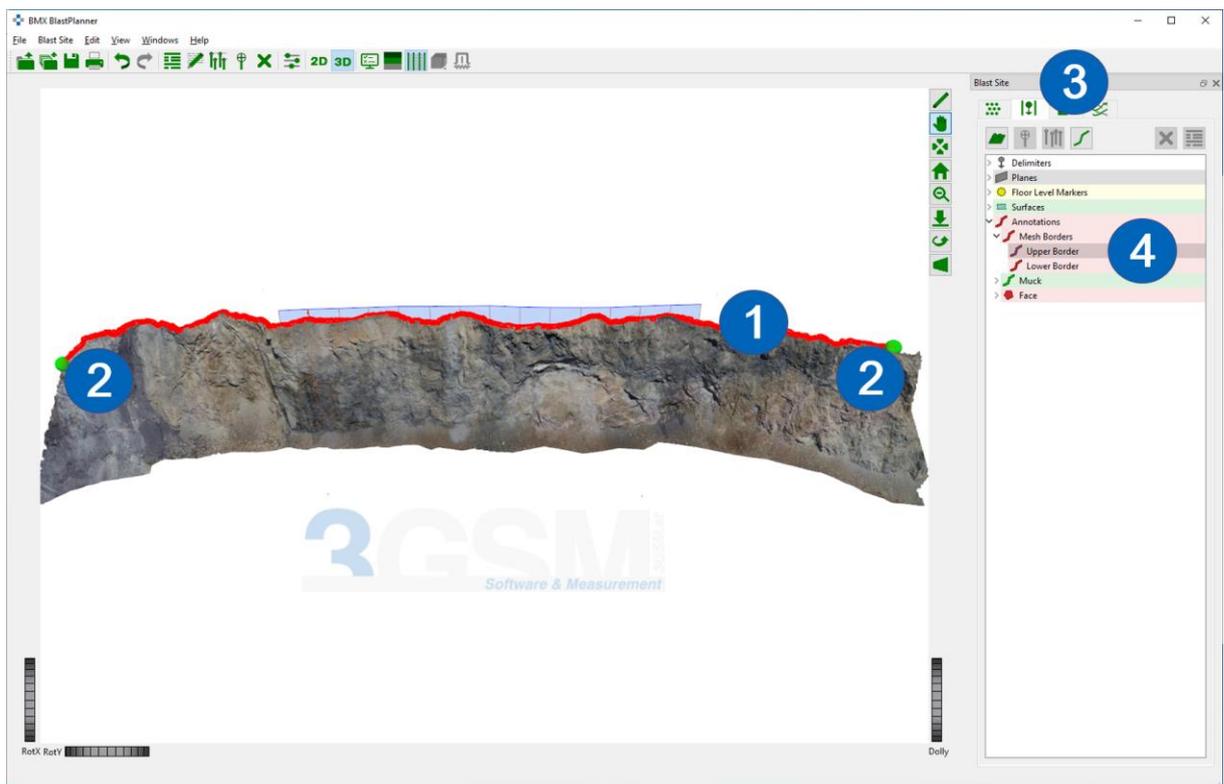
Hint:

Inconsistent *Mesh Borders* are typically a result of complex merges or merging isolated patches. Straight walls and corners are not prone to inconsistent *Mesh Borders*.

In order to correct the inconsistency the green drag point of the *Upper Mesh Border* line has to be moved to the physical limit of the *Upper Mesh Border* as shown in Figure 74.

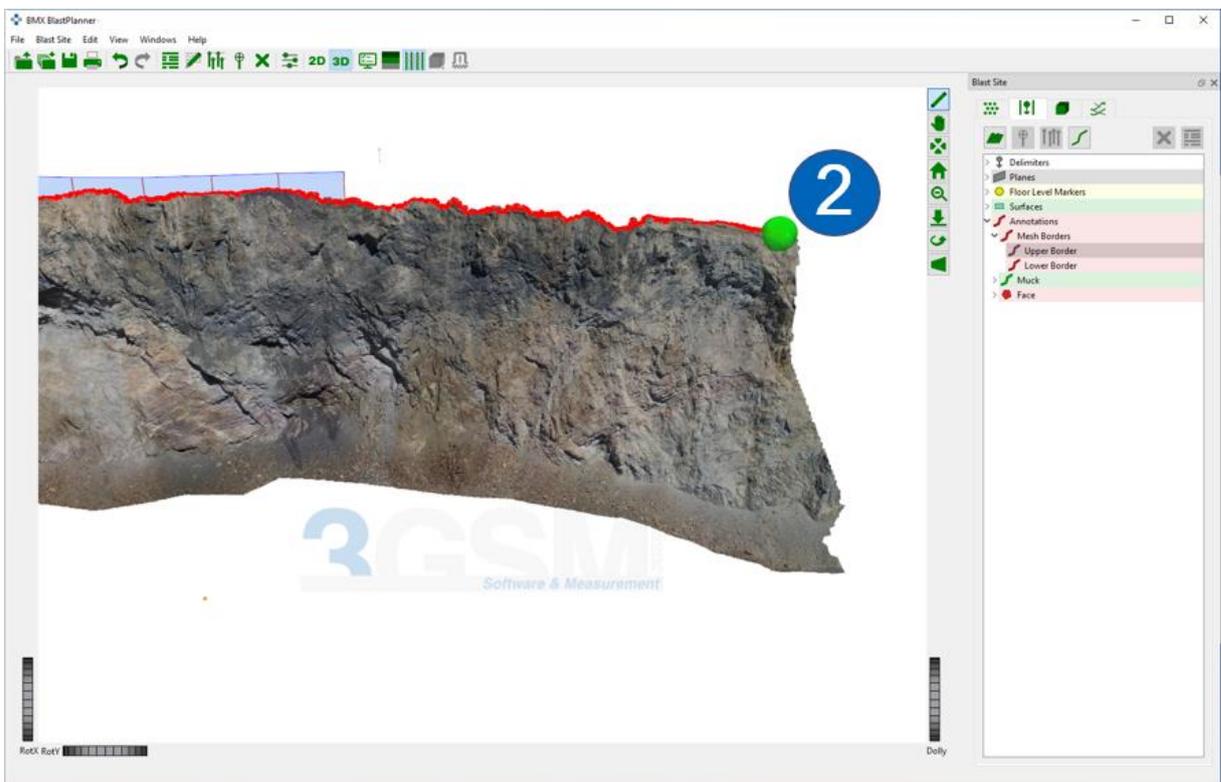
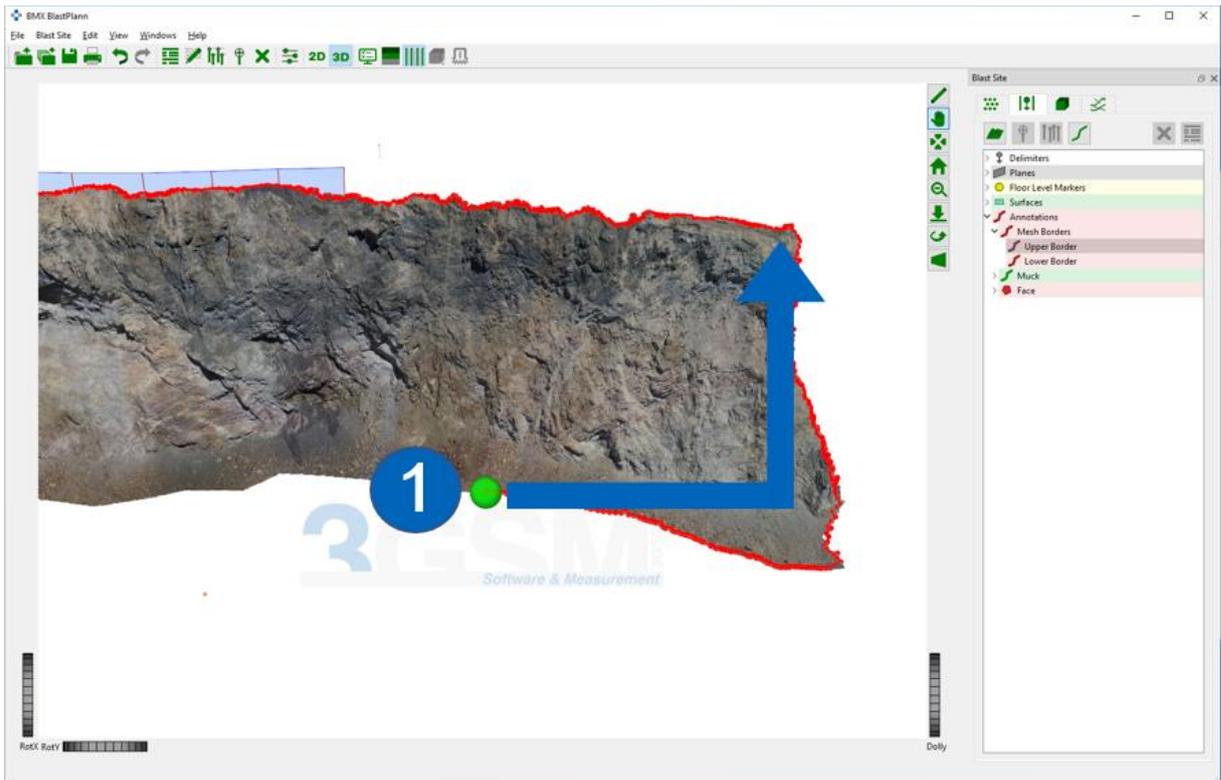


Figure 72: 3D model with Upper and Lower Mesh Border (red line)



- 1 Upper Mesh Border
- 2 Drag point (green sphere)
- 3 Geometry tab
- 4 Upper border entry as an annotation

Figure 73: 3D model with activated Mesh Border and drag point



- 1 Inconsistent drag point
- 2 Correct position of the drag point

Figure 74: 3D model with inconsistent Upper Mesh Border. Correction of the Upper Mesh Border by moving the green drag point along the border towards the physical limit. It requires an enabled Edit mode.

9.4 Face Plane and Face Area

The *Face Plane* defines the best-fit plane of the face. It is considered between the *Delimiters* in the center of the bench and cannot be modified. The *Face Plane* affects volume calculations indirectly, as the boreholes are align to the *Face Plane*. The position can be visualized in the *Geometry* tab (Figure 75). The Face Plane is defined by the Face Area (Figure 76), which is automatically defined. Nevertheless, the *Face Area* can be edited by selecting the *Edit* mode in the *Navigation* bar and drawing a polygon on the 3D model (Figure 77). After confirmation, the *Face Plane* is repositioned regarding to the drawn *Face Area*.

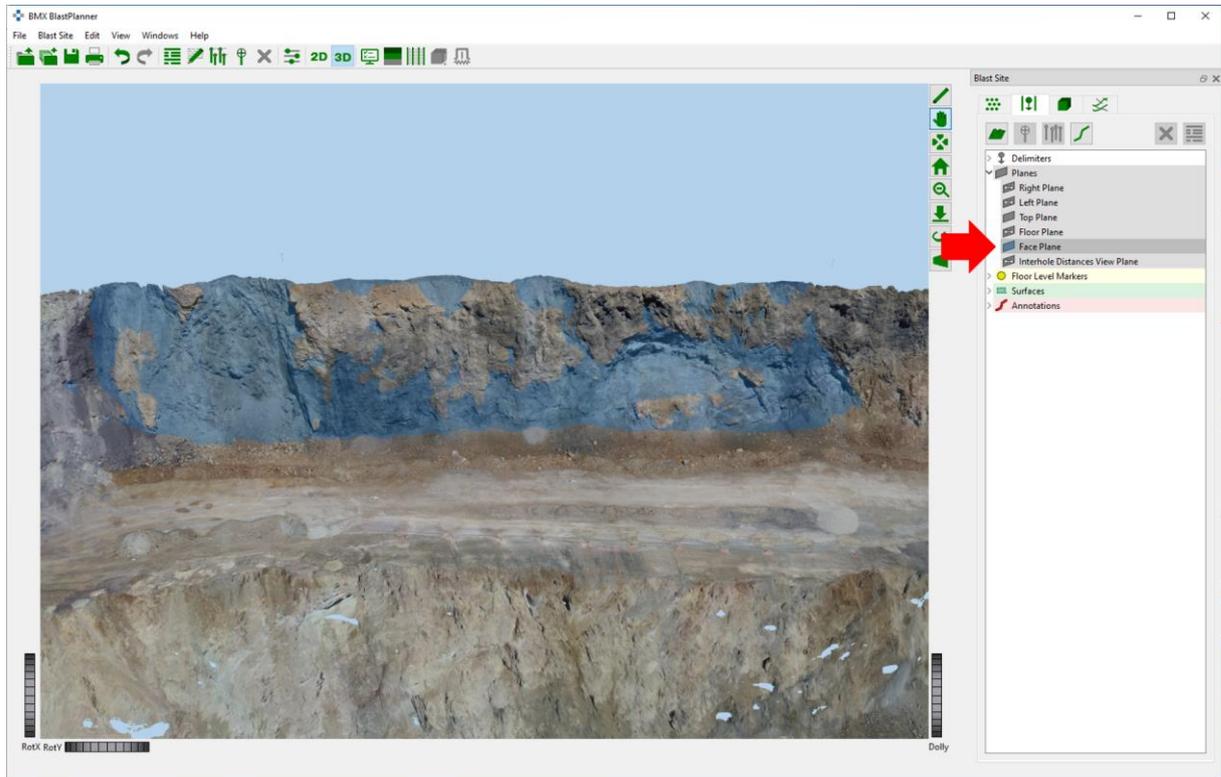


Figure 75: Face Plane of the bench

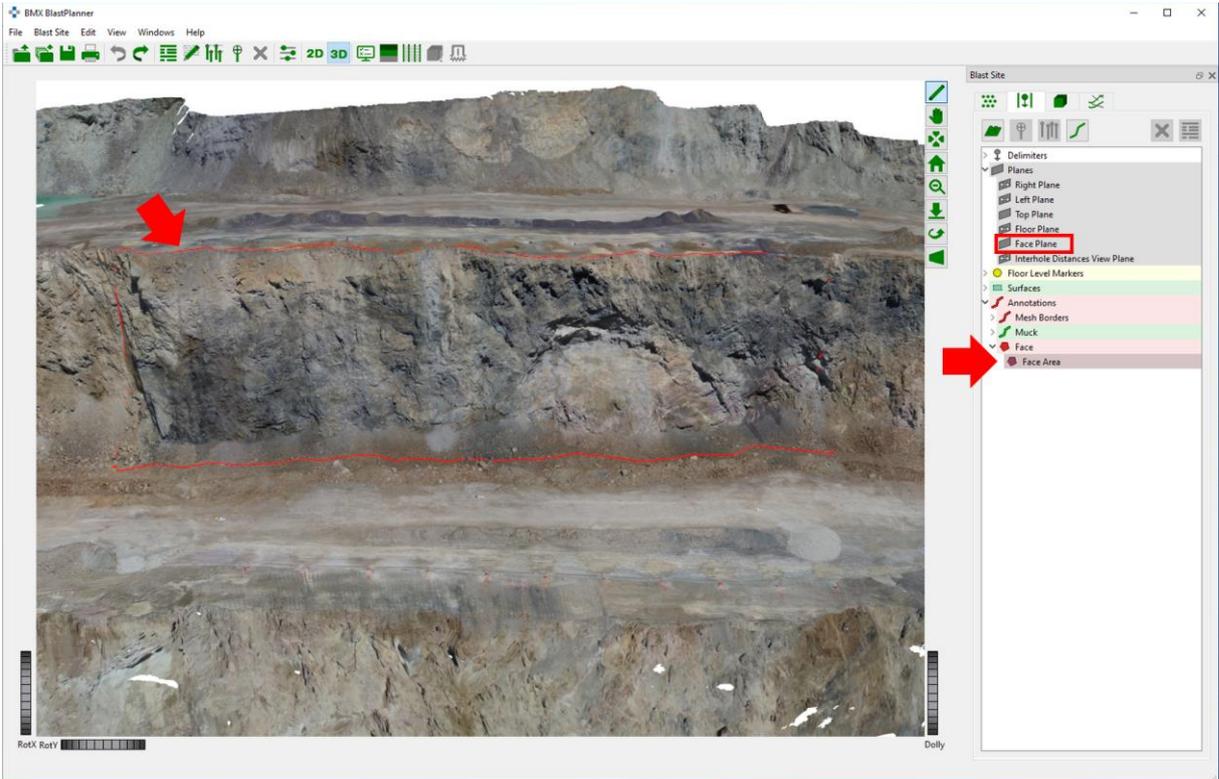


Figure 76: Face Area of the bench

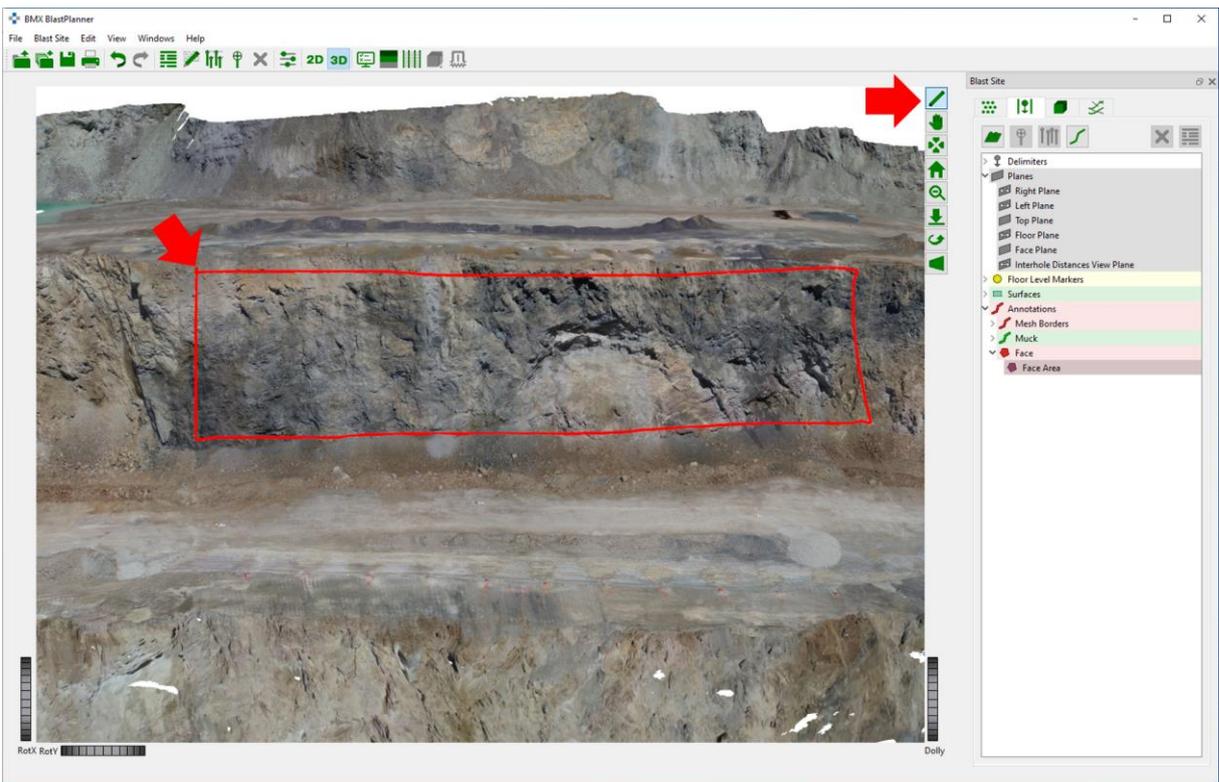


Figure 77: Editing of the Face Area by drawing a polygon

9.5 Face Surface

The *Face Surface* is generated by the software automatically and support volume calculations. Properties of the *Face Surface* are opened selecting *Surfaces/Face Surface* in the list and by clicking the corresponding icon  in the toolbar. Following options are provided:

<i>Horizontal influence</i>	Horizontal extent of the area for determining the orientations of the dynamic projections
<i>Vertical influence</i>	Vertical extent of the area for determining the orientations of the dynamic projections
<i>Max. inclination</i>	Maximum vertical inclination allowed for dynamic projections
<i>Prevent overhang</i>	If enabled, overhanging dynamic projections are inhibited and limited with 0°

Note:

The *Face Surface* is not visualized in the *BMX BlastPlanner*. The properties of the *Face Surface* should be adapted, if volume calculations (see Chapter 9) or automatic placement of boreholes (*Minimum Burden* mode; see Chapter 7.2) fail.

9.6 Muck Lines

Muck Lines are used to avoid incorrect volume estimations due to heap in front of the bench. *Muck Lines* define the outer vertical limit of volume calculations. Volume calculations are performed by a vertical projection from the *Muck Line* to the *Floor Level Plane*. Procedure:

1. Click on the “Add Muck Line”  icon in the *Geometry* tab
2. Draw the *Muck Line* by
 - a. a click on the desired start position on the 3D model
 - b. move the mouse cursor the desired end position keeping the left mouse button pressed
 - c. release the mouse button to finish the *Muck Line*

Hint:

Several *Muck Line* are drawn by clicking the “Add Muck Line”  icon again (see Figure 78) or by using the shortcut key “M”.

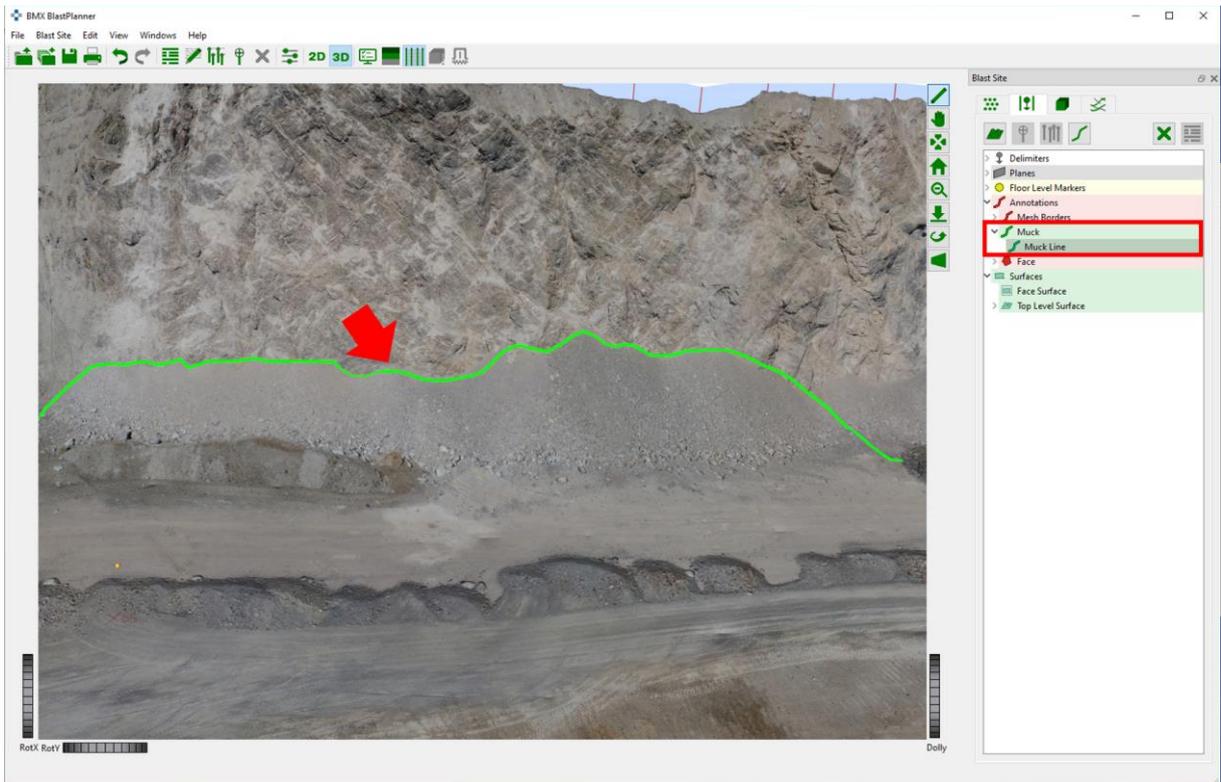


Figure 78: Definition of several Muck Lines on the 3D model

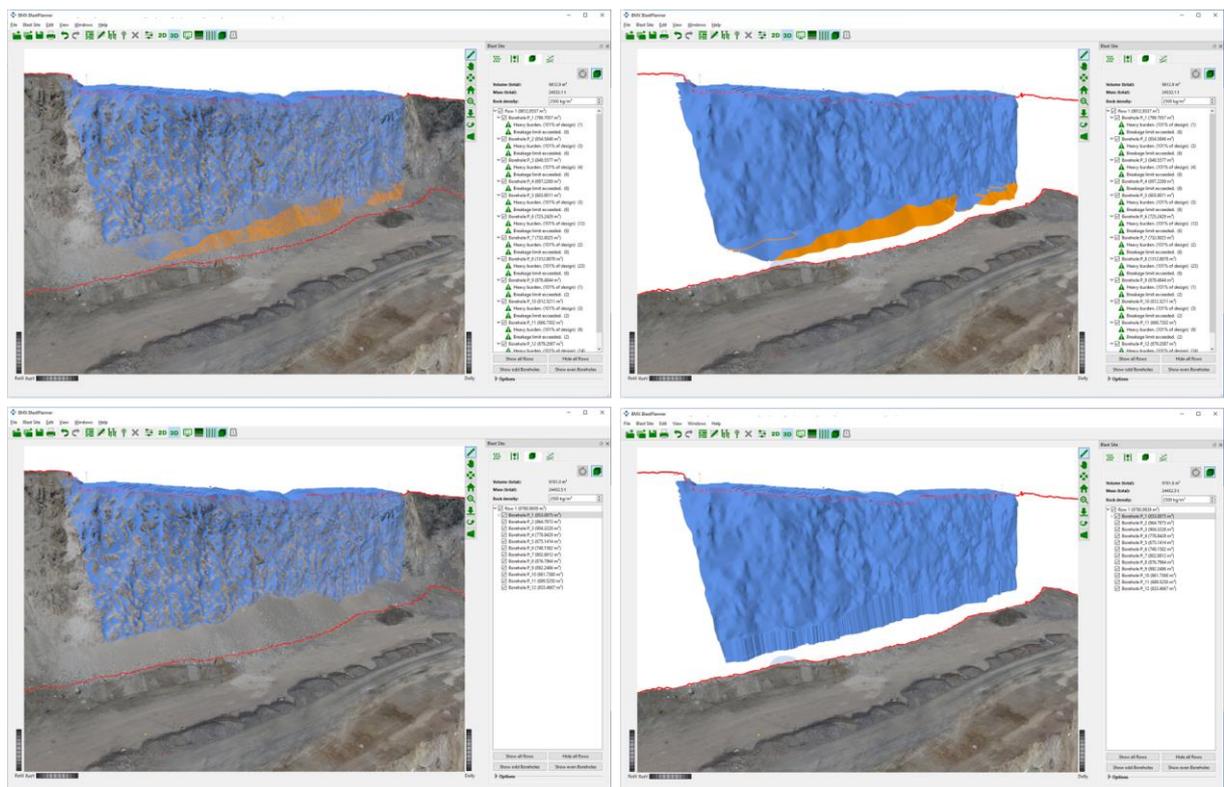


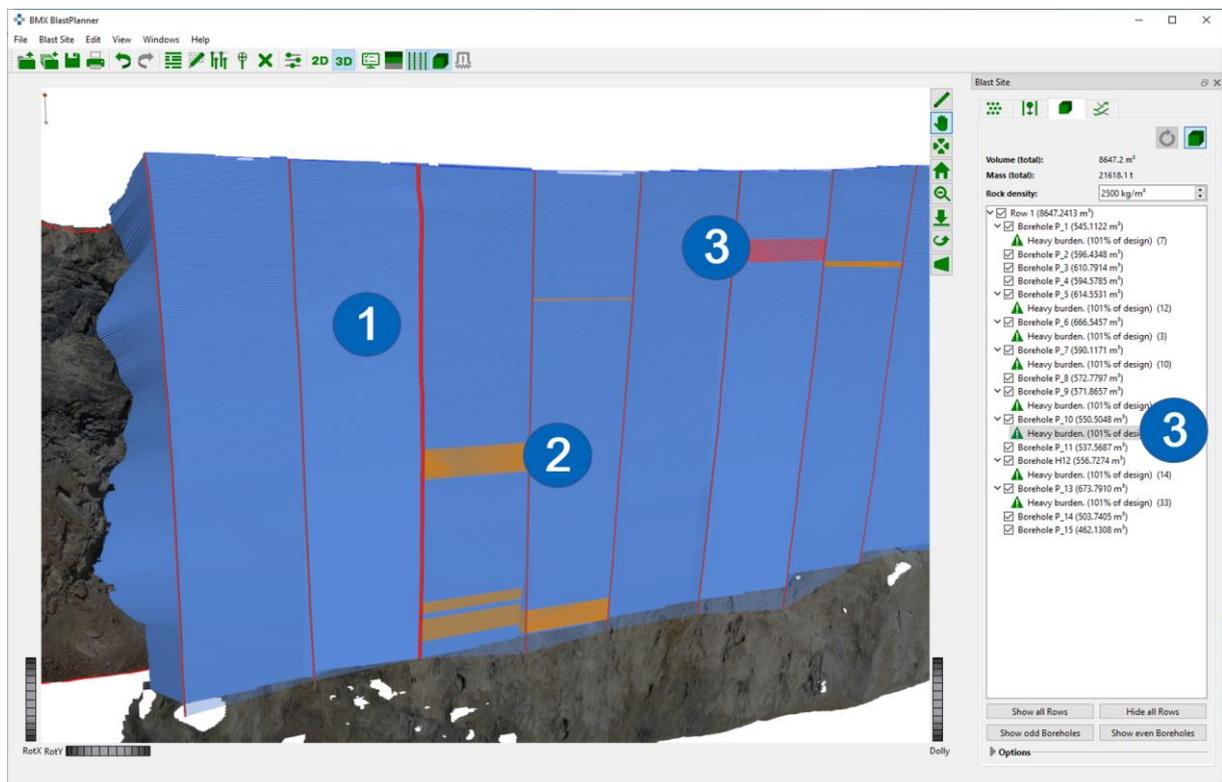
Figure 79: Top: 3D model with estimated blast site volume (blue) without Muck Lines. Yellow areas correspond to highlighted warnings (see Chapter 9.7). Bottom: 3D model with estimated blast site volume (blue) after defining the heap in front of the bench by the use of Muck Lines.

9.7 Warnings

Warnings are posted after volume calculation if limit criteria have been exceeded or inconsistencies have been encountered. Warnings still enable the volume calculation but advise potential problems in executing the blast. Warnings are listed in the list of row volumes of the *Volume* tab assigned to the corresponding boreholes. Parts of the volume which show inconsistencies are orange-coloured. If a warning is selected in the list, the volume is highlighted in red. See Figure 80.

The following warnings may be given:

- Heavy burden (Figure 81)
The distance from the borehole to the free surface at a specific depth exceeds the defined breakage limit including burden tolerance
- Borehole in a previous blasting area
The borehole is located within an already blasted volume
- Borehole intersects with face
The row surface intersects the free surface (3D model)
- Breakage limit exceeded
The distance from the borehole to the free surface exceeds the breakage limit



- 1 Volume in accordance with computational criteria (blue)
- 2 Volume with inconsistency (orange)
- 3 Volume corresponding to the selected warning (highlighted in red)

Figure 80: Volume with identified inconsistencies and corresponding warnings

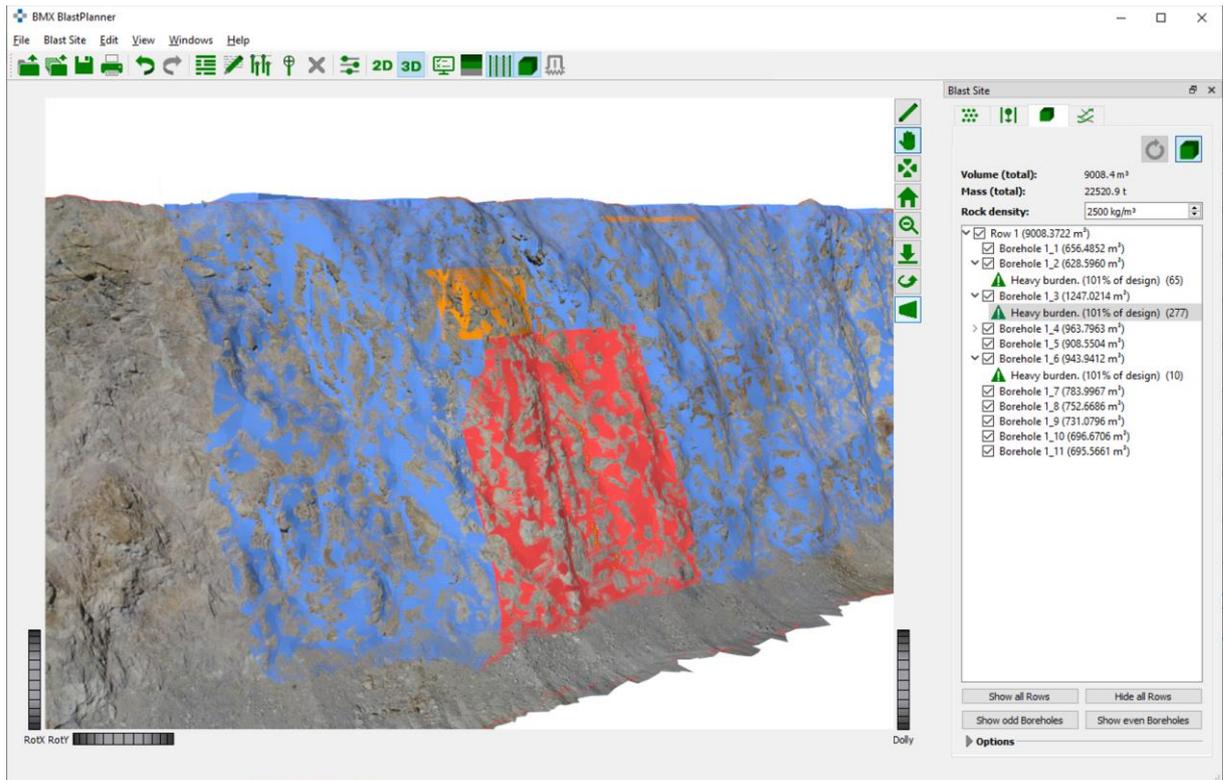
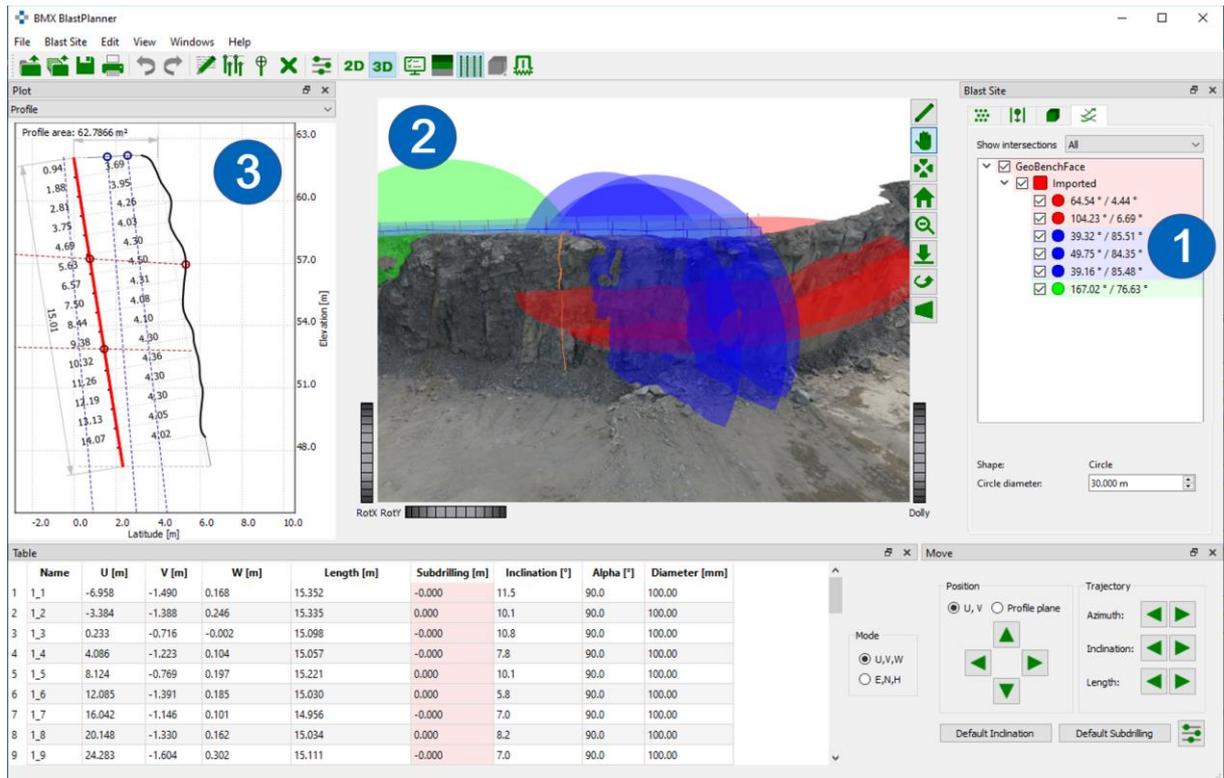


Figure 81: Warning for heavy burden

10 Import of geologic mapping

The *BMX BlastPlanner* features the import *Discontinuity Models* mapped in the *JMX Analyst* (".jms" file) in order to identify intersections with boreholes. The ".jms" file is imported by using the command "*Blast Site | Import | Import Mapping*" in the menu bar. *Discontinuity Models* are immediately shown in the 3D viewer and in the *Geology* tab. The *Profile* in the *Plot* pane is extended with the position of the discontinuity and the exact depth of intersection is highlighted. Intersections of *Discontinuity Models* with boreholes are visualized also in the *Minimum Burden* diagram in the *Plot* pane. See Figure 82 and Figure 83.



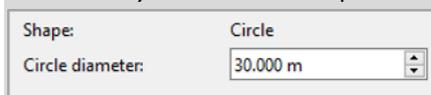
1 Imported Discontinuity Models in the Geology tab (Blast Site pane)
 2 Discontinuities in the 3D viewer
 3 Position and intersection of Discontinuities with boreholes in the Plot pane
 Figure 82: Imported Discontinuities in the BMX BlastPlanner

Discontinuity Models are shown or hidden by using the checkboxes in front of the entry in the list. Restrictions for the visibility of Discontinuities (location and intersection) in the Profile plot apply when selecting the following options in the pull down menu "Show Intersections" (Figure 84):

- All
All Discontinuity Models (position and intersections)
- Borehole
Discontinuity Models intersecting boreholes only
- Profile
Discontinuity Models intersecting the profile only
- Profile + Borehole: Discontinuity Models intersecting boreholes and the profile

Note:

Discontinuity Models are adapted in size by entering the value in the input field in the Geology tab; e.g:



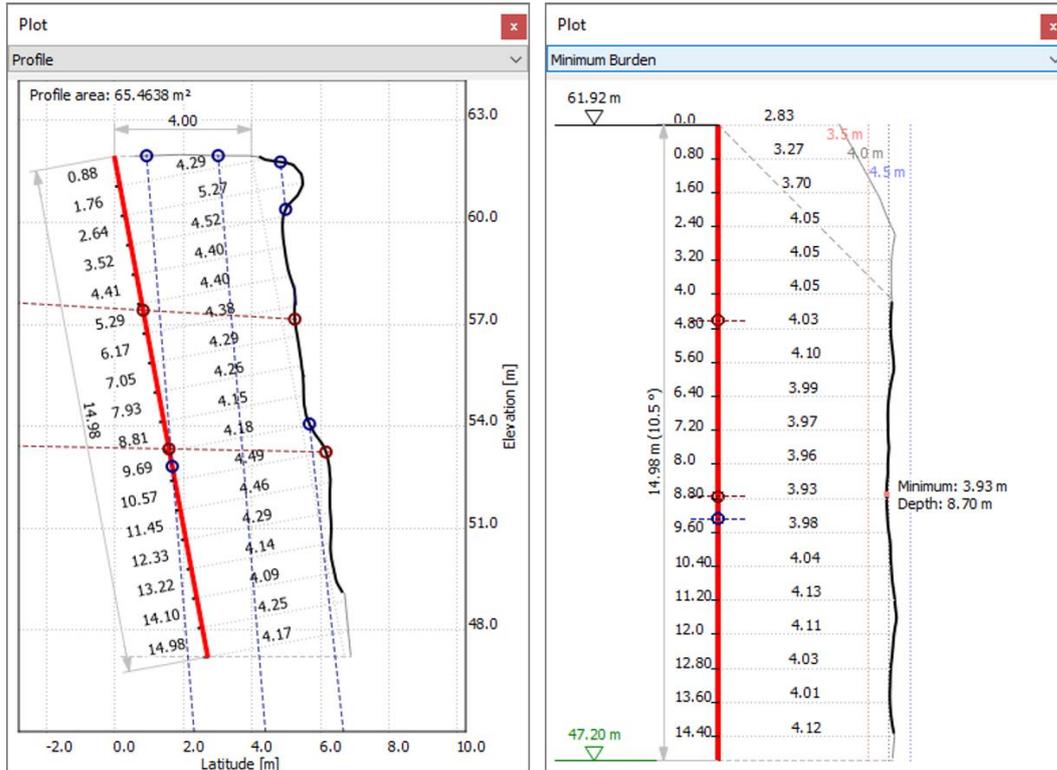


Figure 83: Position and intersection of Discontinuities in the Profile diagram (left) and in the Minimum Burden diagram (right)

Note:

Please refer to Chapter 8 for detailed information on burden analysis (*Profile* and *Minimum Burden*).

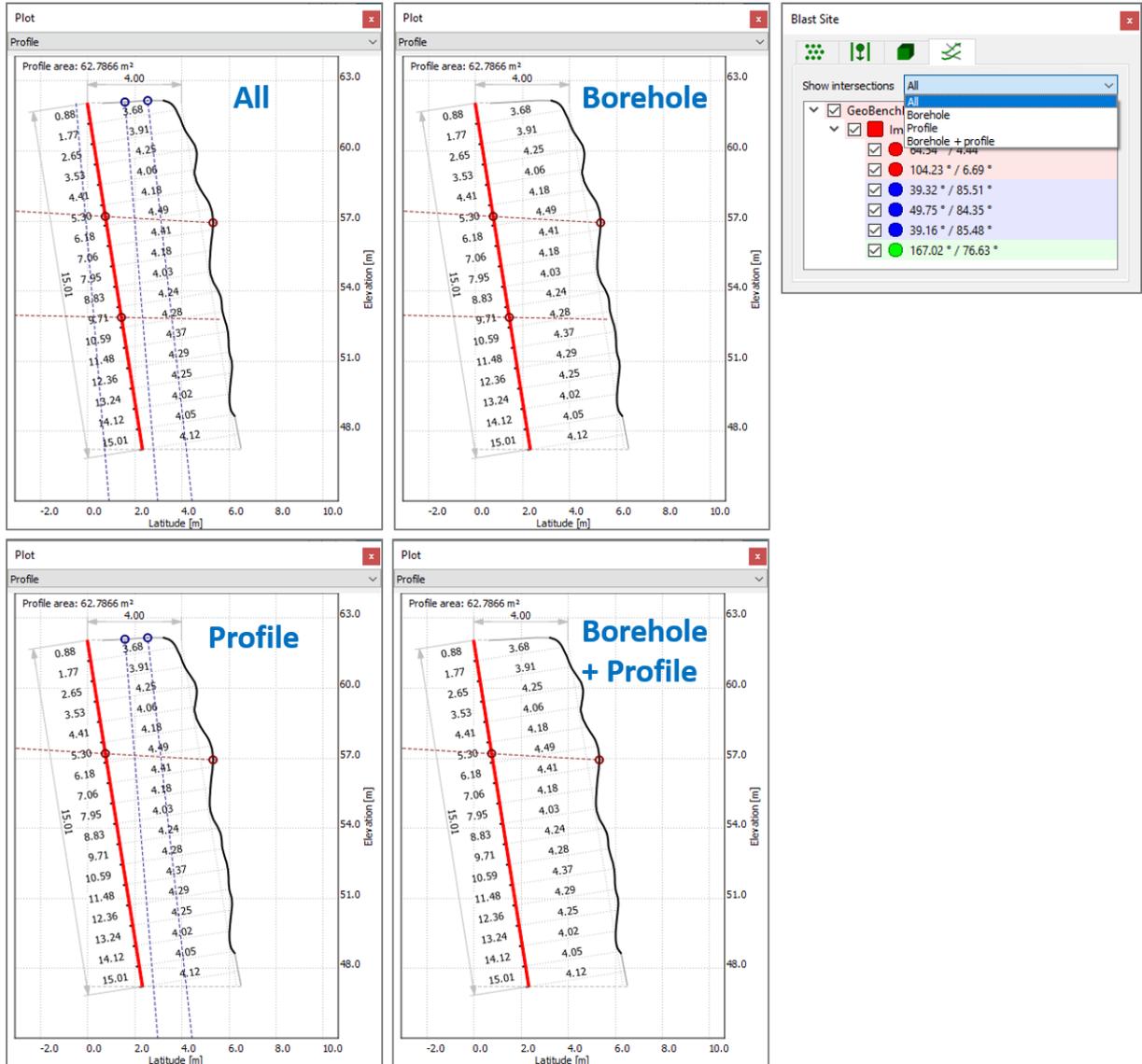
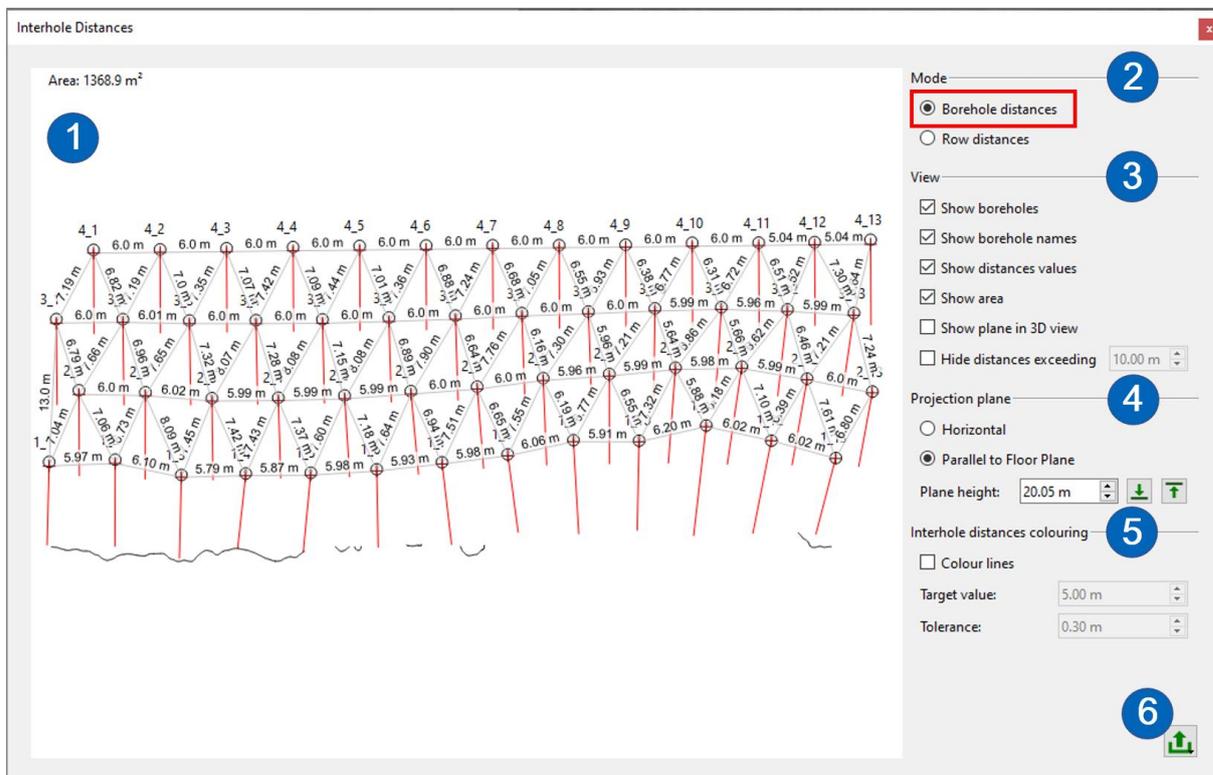


Figure 84: Profile diagram with different display constraints for Discontinuities

11 Row and Interhole Distances

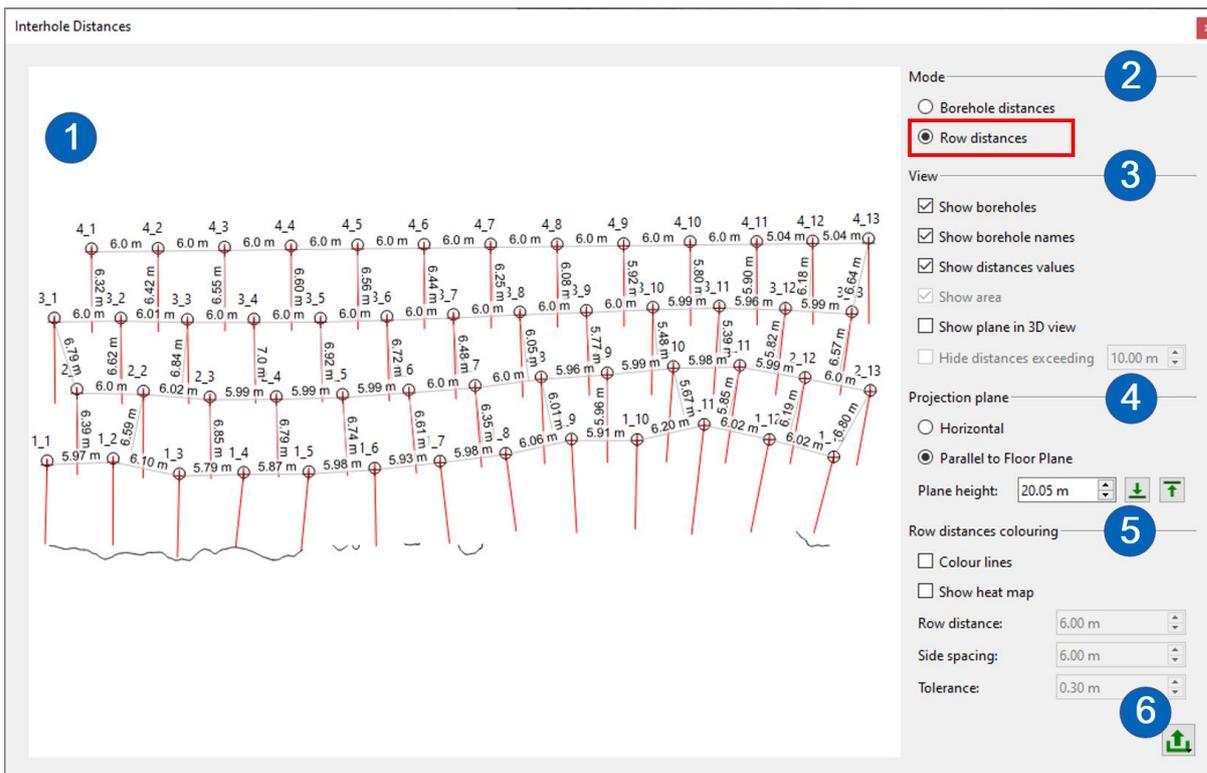
Distances between rows and individual boreholes at specific heights of the bench are calculated and visualized in the *Interhole Distances* dialog. The dialog is opened by clicking “*Window | Interhole Distances*” in the menu bar. Two modes are provided with individual user adaptable features are provided:

- *Borehole Distances* (Figure 85)
- *Row Distances* (Figure 86)



- 1 Plan view
- 2 Mode
- 3 View options
- 4 Projection plane
- 5 Colouring
- 6 Export

Figure 85: Borehole Distances



- 1 Plan view
- 2 Mode
- 3 View options
- 4 Projection plane
- 5 Colouring
- 6 Export

Figure 86: Row Distances

11.1 Projection plane

The projection plane can be switched from *Horizontal* to *Parallel to Floor Plane* by using the corresponding radio buttons. The plane is moved by entering a specific height by entering the level in the “Plane height” field. The plane is moved to the toe or the collar by using the “Move to Toe” and “Move to Collar” icons. The plane of projection is visualized in the 3D viewer by activating the checkbox “Show plane in 3D view” in the *Interhole Distances* dialog or by selecting the *Interhole Distance View Plane* in the *Geometry* tab (Figure 87). The position of the projection plane can be adjusted by using the arrows in the 3D viewer.

Procedure:

1. Activate the checkbox “Show plane in 3D view”. The plane is highlighted and an arrow appears (Figure 87).
2. Ensure that the *Edit mode* (*Navigation bar*) is active
3. Drag the plane to the new position by clicking with the left mouse button on the arrow and move the mouse

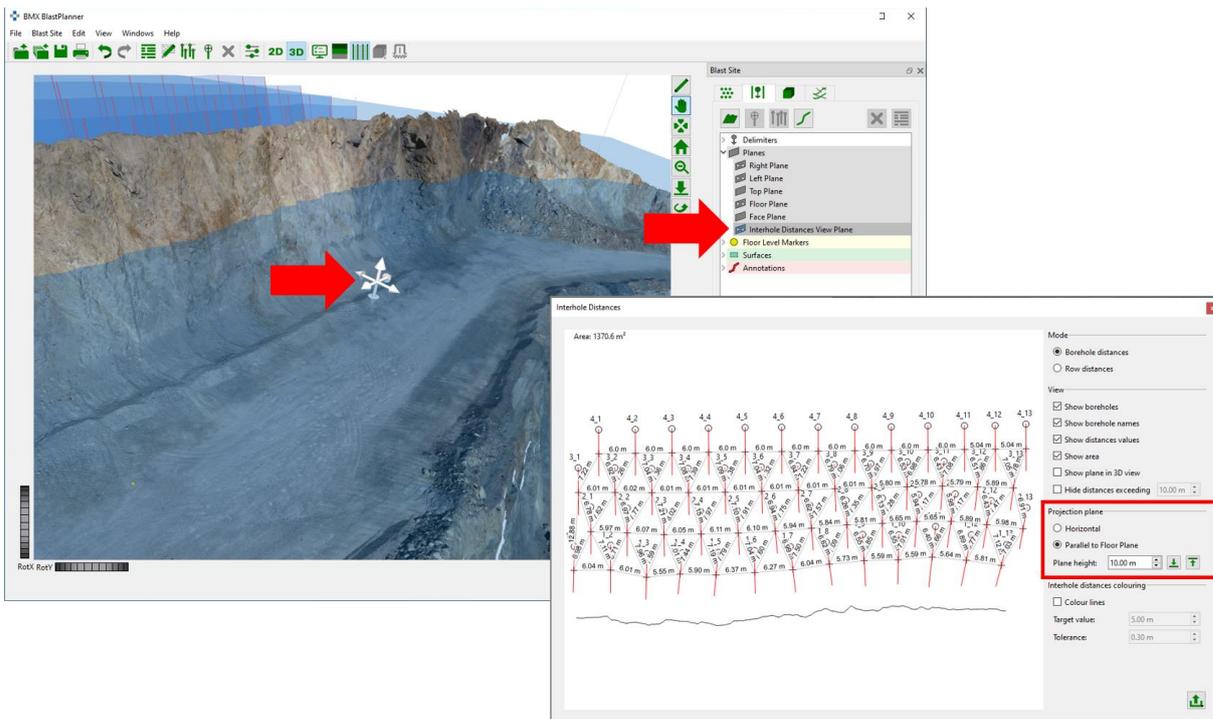


Figure 87: Projection plane visualized in the 3D viewer

11.2 Colouring

Borehole distances

Distances between individual boreholes are visualized by a colour code activated by enabling the checkbox “Colour lines”. The user can enter the target value and the accepted tolerance by entering the values in the corresponding fields (Figure 88).

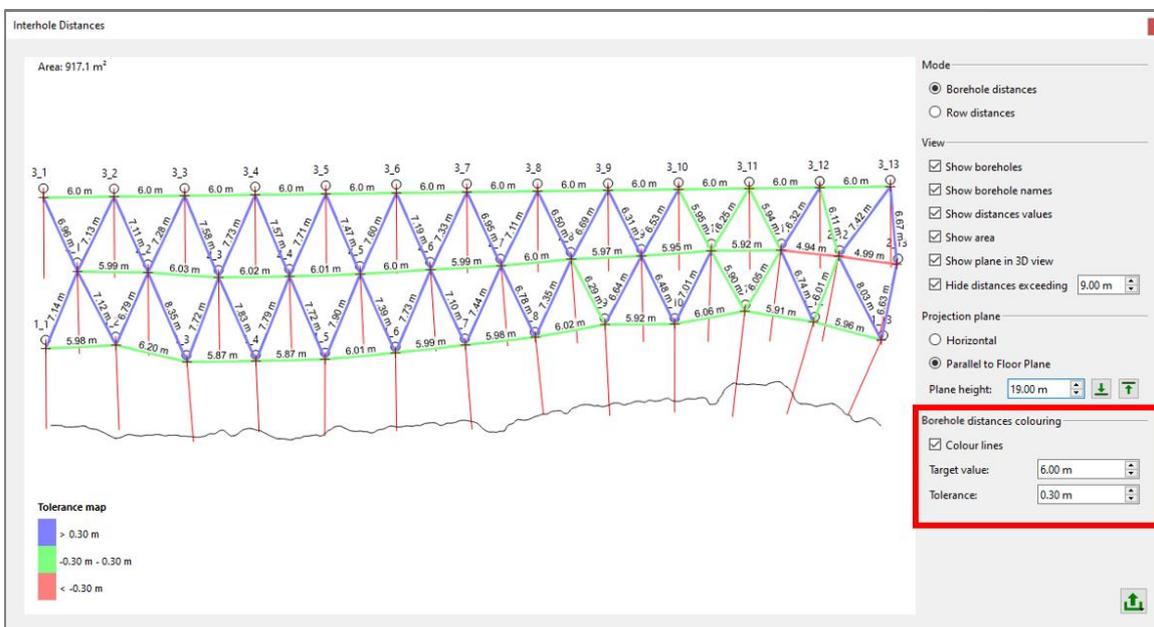


Figure 88: Line colouring of distances between individual boreholes

Row distances

Distances between rows are visualized by a colour code by enabling the checkbox “Colour lines”. The user can enter target values for the row distance, the side spacing and the accepted tolerance by entering the values in the corresponding fields (Figure 89). Deviations from a regular drill pattern are visualized in a so called *Heat Map* by enabling the corresponding checkbox. Sectors exceeding the entered values and the accepted tolerance turn from green into red (Figure 90).

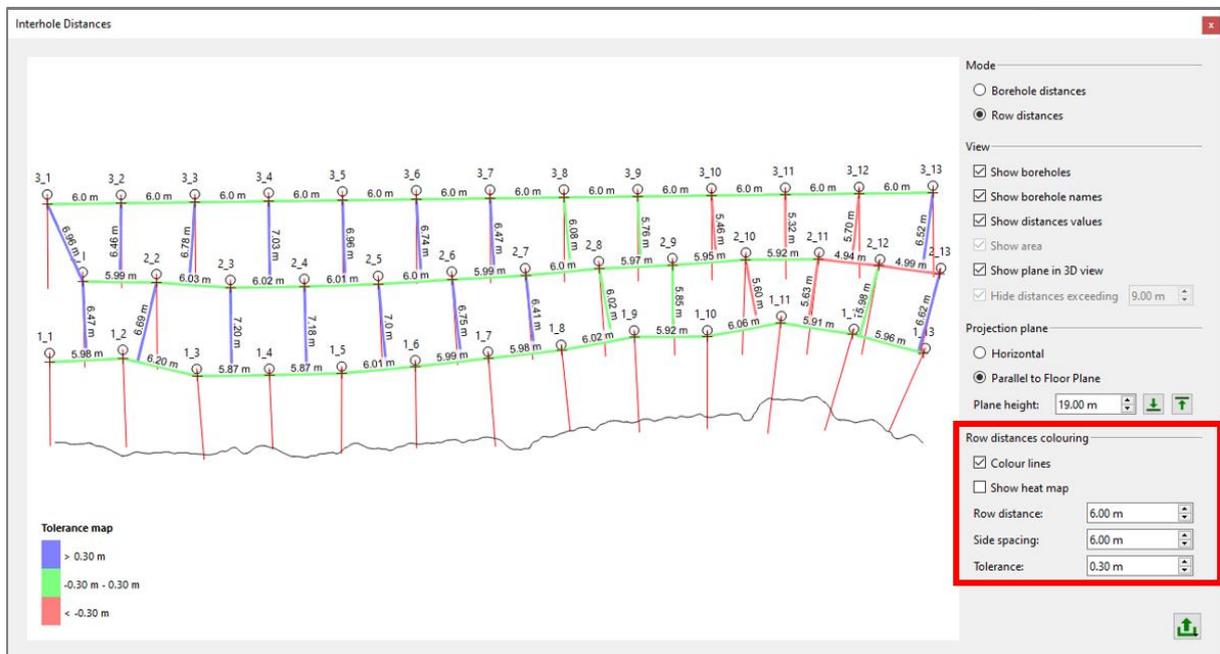


Figure 89: Line colouring of distances between rows

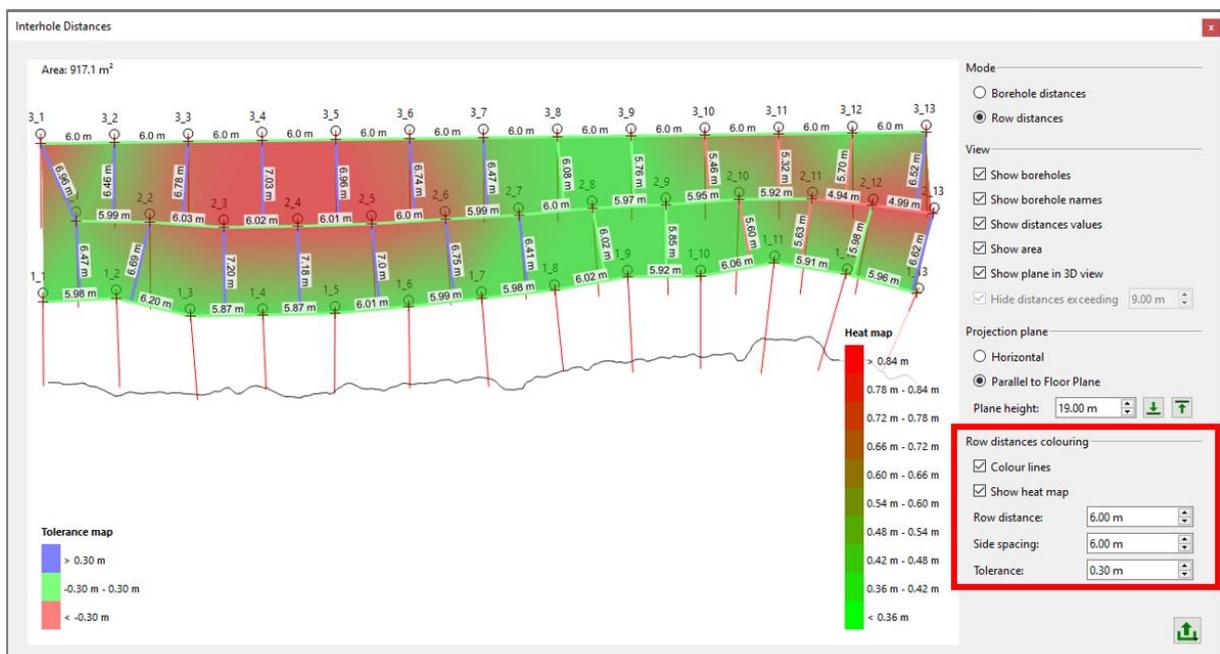


Figure 90: Row distances - heat map

11.3 View options

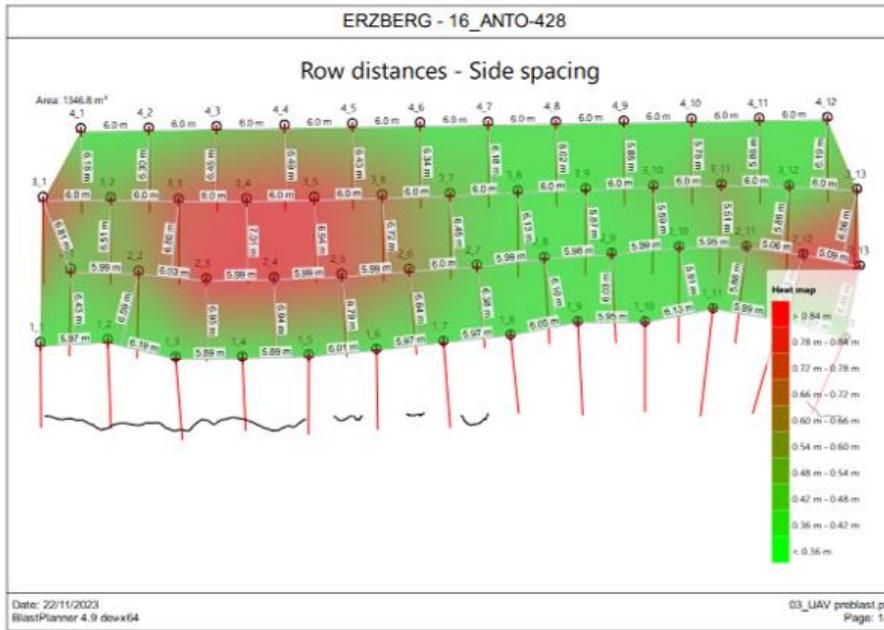
The *Interhole Distances* dialog contains following options for customizing the plan view:

- *Show boreholes*
Shows/hides boreholes
- *Show borehole names*
Shows/hides boreholes
- *Show distances values*
Shows/hides boreholes values
- *Show area*
Displays the area which the drill pattern covers
- *Show plane in 3D view*
The projection plane is visualized in the 3D viewer and can be adjusted interactively
- *Hide distances exceeding*
Distances to be displayed can be limited by activating the checkbox and entering the desired value

11.4 Export options

Export options are provided by clicking the button “Export” :

- *Export Image*: exports the plan view to a “.png” file
- *Export PDF*: generates a report including the active plan view and the corresponding drill pattern analysis (Figure 91)
- *Export CSV*: export the data of the active plan view into a “.csv” format (comma separated value) text file (Figure 92)



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Drill Pattern analysis

Mode: Row distances - Side spacing
Plane: Parallel to Floor Plane
Plane height: 20.04 m
Area: 1346.82 m²

	Row distances	Side spacing
Target value:	6.0 m	6.0 m
Tolerance:	0.30 m	0.30 m
Measurements:	38	47
Total:	240.13 m	280.06 m
Mean:	6.32 m	5.96 m
Median:	6.30 m	6.0 m
Standard deviation:	0.40 m	0.19 m
Minimum:	5.51 m	5.06 m
Maximum:	7.01 m	6.19 m

Date: 22/11/2023
BlastPlanner 4.9 devx64

03_UJAV preblast.pdf
Page: 222

Figure 91: Interhole Distances report

Export Data

Separators

Cell separator: Comma

Decimal separator: Point

Output file

_428\03_UJAV preblast_manual_interhole_distances.csv

Export Cancel

Figure 92: Export Data dialog

12 Measure while drilling

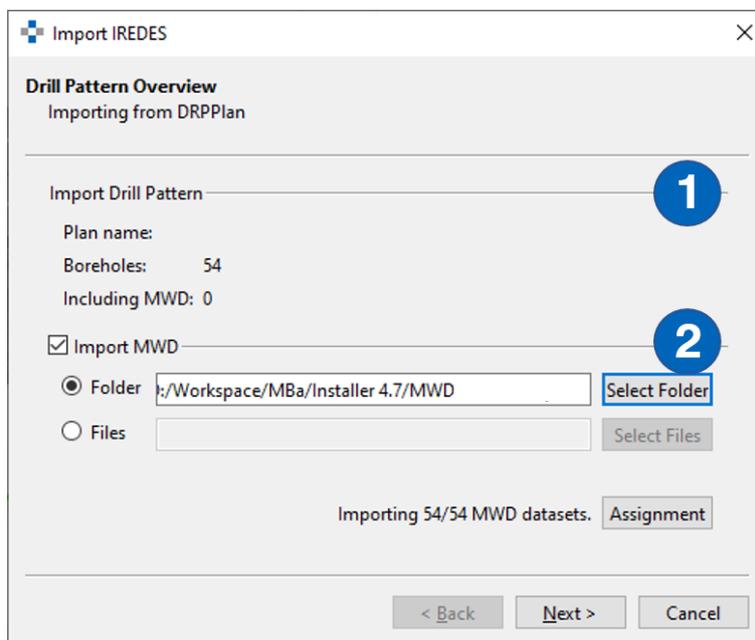
12.1 Data import

BMX BlastPlanner supports a customized import of borehole survey data (".xml" format) from down-the-hole probe and corresponding measure while drilling (MWD) data according to the IREDES standard by following procedure:

1. Select "Blast Site | Import | Custom | Import Drill Pattern from IREDES" in the menu bar. A dialog window (Figure 93) appears.
2. Enable the checkbox "Import MWD" and select the folder or files containing the MWD data by clicking the "Select Folder" or "Select Files" button.

Hint:

Manual assignment of MWD data to individual boreholes is feasible by clicking the button "Assignment". In the open dialog (Figure 94) the borehole name, ID and the corresponding MWD dataset is listed. By clicking the button "Borehole file" the desired dataset (".xml" file) can be selected from the directory on your computer.



- 1 Drill pattern import
- 2 MWD import

Figure 93: Import IREDES dialog

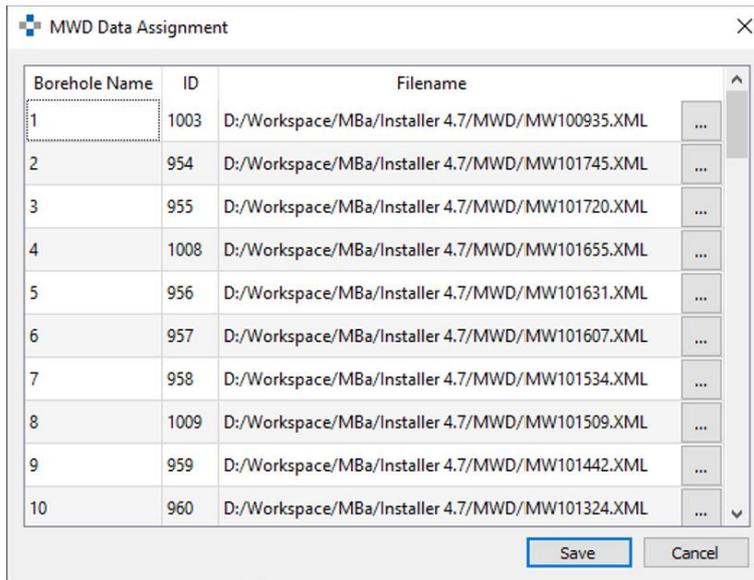
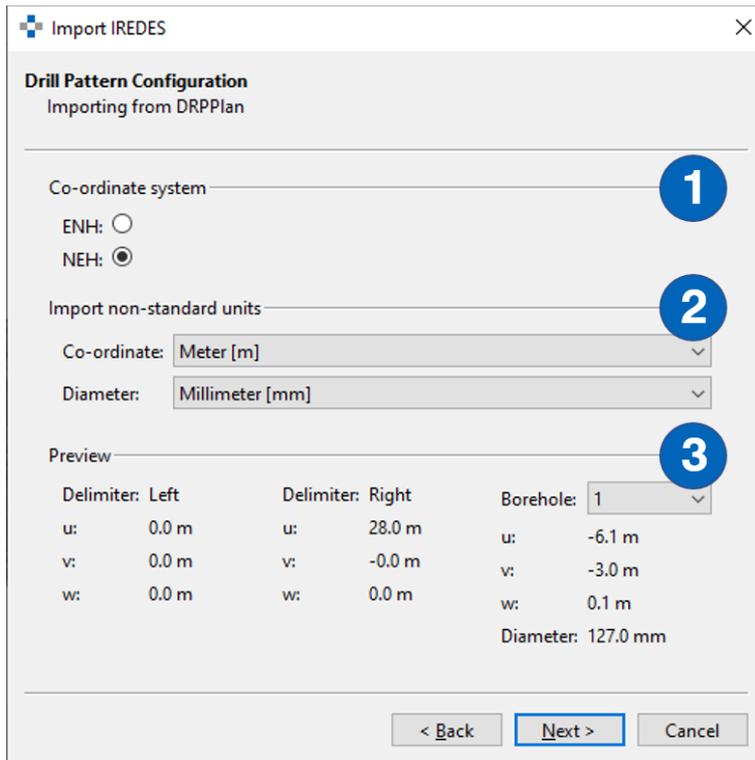


Figure 94: Manual assignment of MWD data

3. Click on the “Next” button and check the configuration of the loaded drill pattern in the open dialog (Figure 95):
 - a. select the co-ordinate order by selecting the radio button “ENH” or “NEH”
 - b. select the correct unit in the pull down menu “Co-ordinate” and “Diameter” (i.e. borehole diameter). Available units are millimetre [mm], meter [m], inch [in], international foot [ft (int)], and US survey foot [ft (us)].
 - c. check the preview data for plausibility
2. Click on the “Next” button and define the configuration of the imported MWD dataset (Figure 96). Select available data by enabling the corresponding checkbox and select the unit the data is provided in the pull down menu.
3. Finish the import by clicking the “Finish” button.



- 1 Co-ordinate system
- 2 Unit
- 3 Preview configuration

Figure 95: Configuration of drill pattern

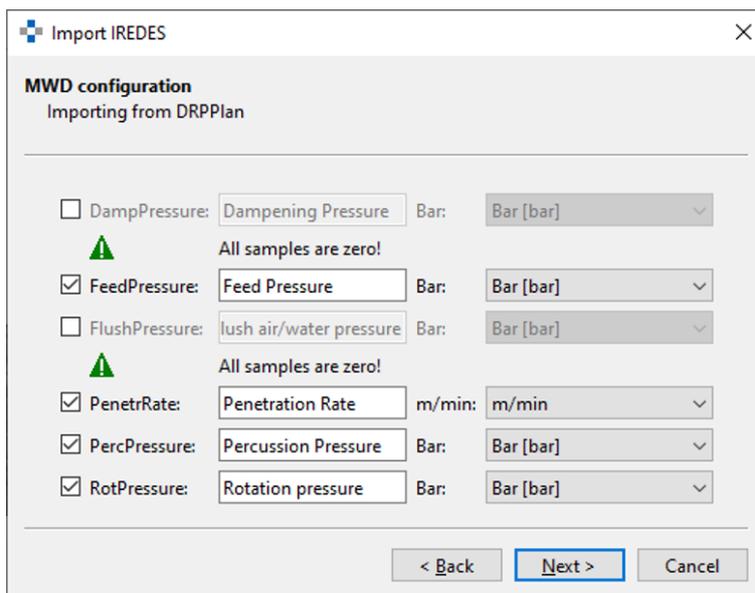


Figure 96: Configuration of the MWD dataset

4. To complete blast design and blast analysis it is necessary to assign boreholes to rows after the import by following procedure:
 - a. organise the imported boreholes in rows (see section “Adjusting borehole order” and “Assigning boreholes to row” in Chapter 7.3):

- b. add the necessary number of rows
- c. assign the boreholes to the corresponding rows
- d. if necessary rearrange the borehole order
- e. if necessary rearrange the row order

Note:
 Boreholes which have MWD data assigned are outlined in the *Drill Pattern* tab (*Blast Site* pane) with the annotation “MWD Data Available” .

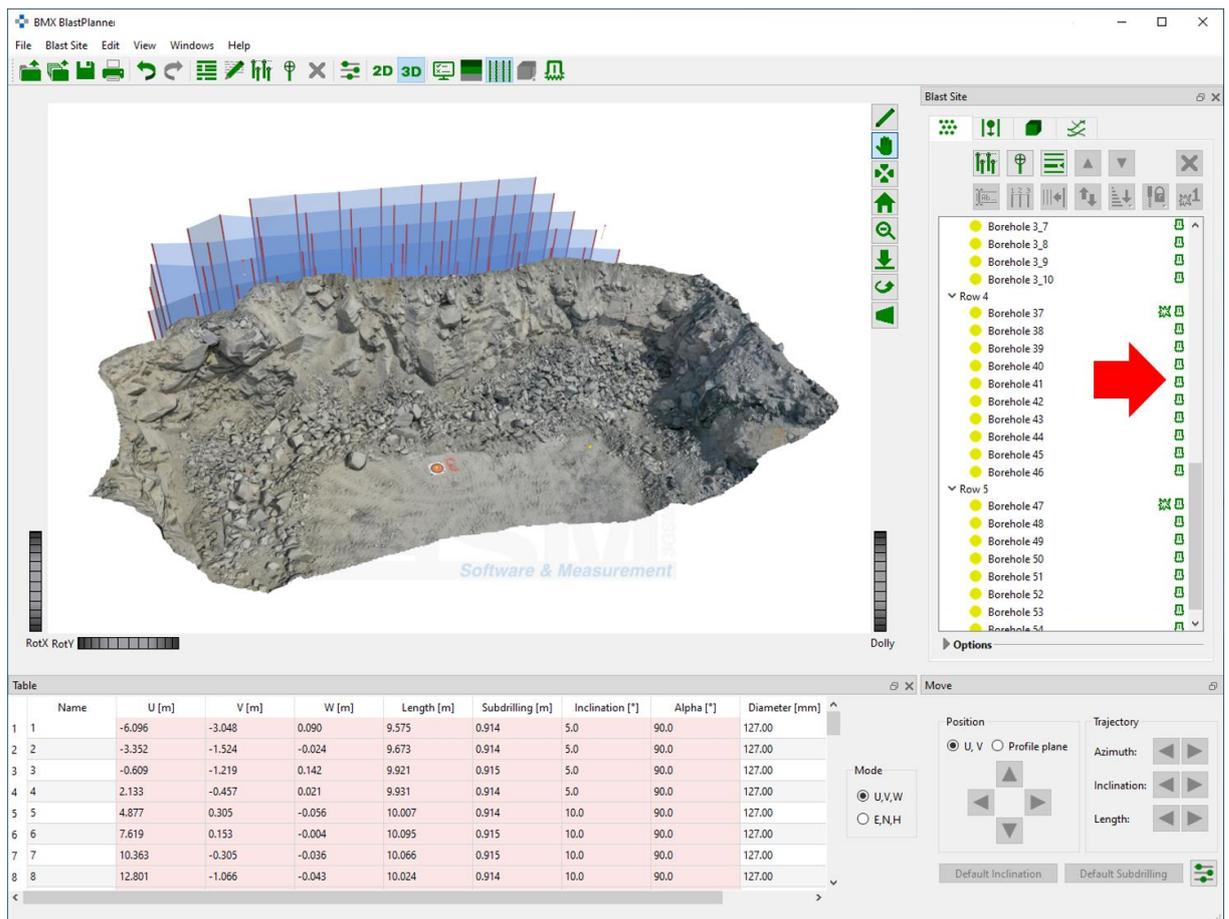


Figure 97: Boreholes with assigned MWD data in the *Drill Pattern* tab

12.2 MWD plot

Measure while drilling (MWD) data is visualized together with the burden information (*Minimum Burden*) in a plot in the *Measure While Drilling* dialog. The dialog is opened by clicking “*Window | Measure While Drilling*” in the menu bar. The plot displays the burden information (x-axis top) together with MWD data (x-axis bottom) of the active borehole. The plot displays the complete dataset, whereby the active MWD data is highlighted in bold. The active MWD data is selected in the pull-down menu (see Figure 98). The plot is edited by using the features provided in the data *Options* dialog (Figure 99) and in the plot *Configuration* dialog (Figure 100).

Note:

Please refer to Chapter 8 for detailed information on *Minimum Burden* analysis.

Hint:

Zooming is performed by using the mouse wheel.

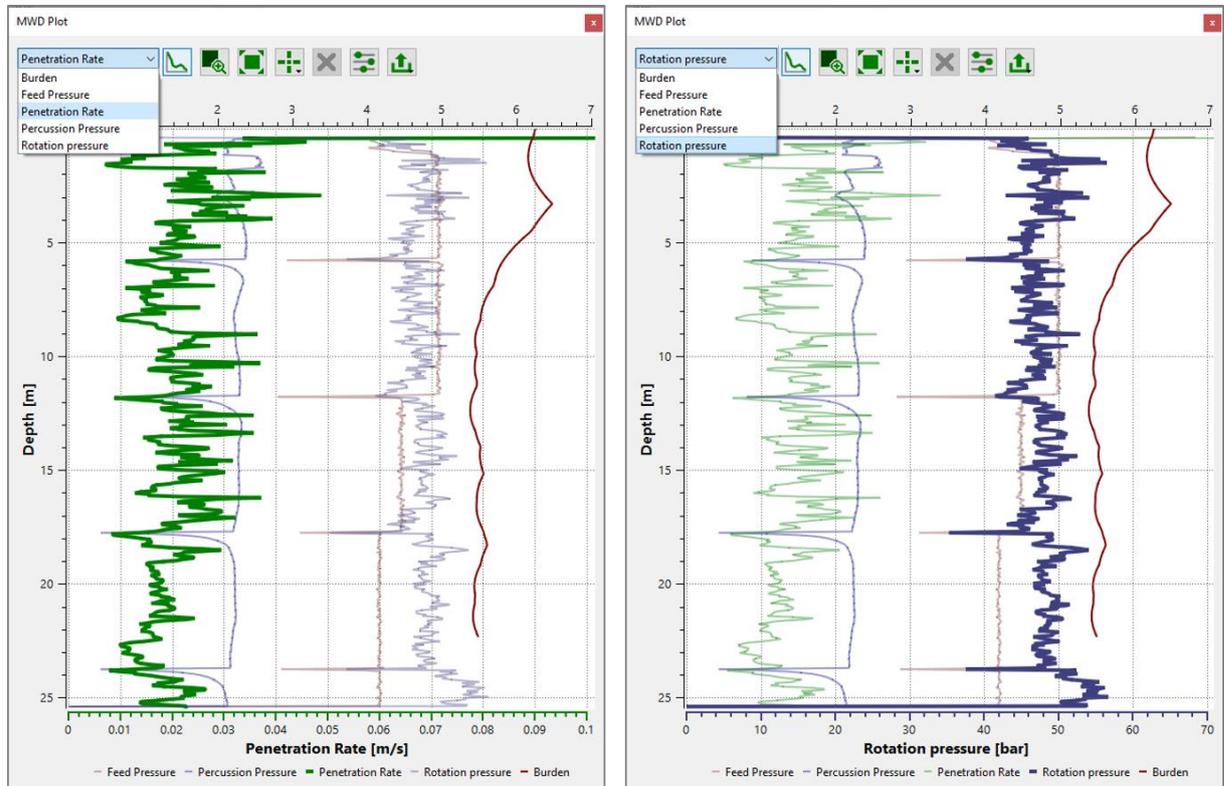
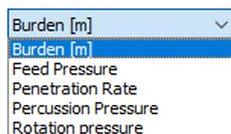


Figure 98: Measure While Drilling dialog. Switching between MWD data is performed by selecting the desired parameter in the pull down menu.

Following features are provided to adapt the plot:

Select data item



Switches between the data; the active is outlined bold in the plot

Show Data Options



Opens the *Options* dialog for the plot (Figure 99)

Zoom to Rectangle



Activates a zoom function. The plot is zoomed to the size of a rectangle drawn by holding the left mouse button pressed.

Reset View



Resets the view of the plot according to the configuration of the plot

Add Measurement



Adds a measurement to the plot (see next paragraph)

Remove Measurement



Removes measurements added to the plot (see next paragraph)

Show Plot Settings



Opens the *Configuration* dialog (Figure 100)

Exports



Saves the plot as image (".png" or ".pdf" file) or copies the image to clipboard

Data options

The *Option* (Figure 99) dialog is opened by clicking the "Show Data Options"  icon. After activating a dataset selected by a mouse click it can be edited individually:

- show or hide the data in the plot by using checkbox "Visible"
- rename the data by entering the desired name in the field "General / Name"
- select the style of the plot (points or line) in the pull down menu "Draw Style / Style"
- select the line style in the pull-down menu "Pen / Line Style", choose a colour by clicking on the colour icon and enter the desired thickness
- select the marker style in the pull-down menu "Marker / Type", choose a border and a fill colour by clicking on the colour icon and enter the desired size
- fit the data by selecting "Line" or "Quadratic" in the pull-down menu "Fit / Type"

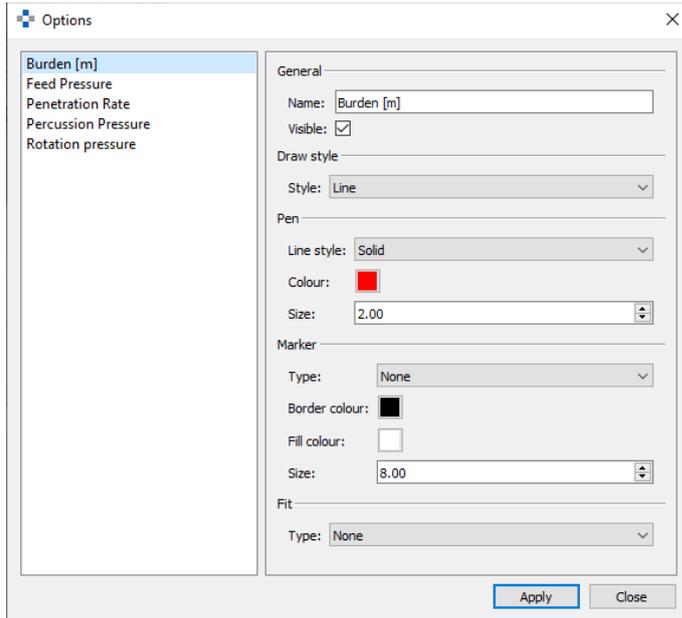


Figure 99: Data options

Plot configuration

The *Plot Configuration* (Figure 100) dialog is opened by clicking the “*Show Plot Settings*”  icon. The grid can be shown or hidden by using the checkbox “*Enable grid*”. The axes can be adapted individually by entering the desired range in the corresponding fields, *X-Bottom* (MWD data), *X-Top* (*Minimum Burden*) and *Y-Left* (depth).

Note:

Independent scaling of the MWD data (x-axis bottom) is feasible by activating the “*Independent Scaling*” checkbox. The user has to select the MWD data in the pull-down menu “*Selection*” and can enter the data range individually.

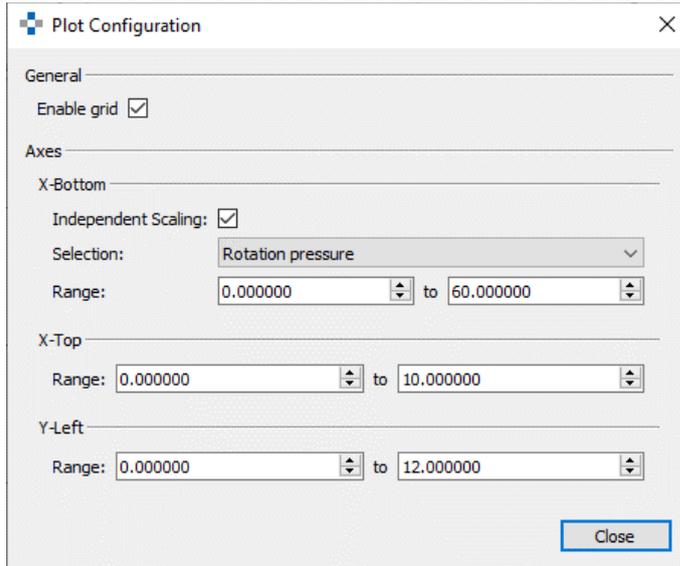


Figure 100: Plot configuration

Add measurements

The user can add multiple measurements on the plot by following procedure:

1. Click the icon "Add Measurement"  and select "Horizontal Measurement" or "Vertical Measurement" (Figure 101).
2. Move the mouse cursor over the plot and the exact x and y values are shown.
3. Leave the mode by a click on the icon "New Measurement"  icon again.
4. To delete a measurement, select the item in the pull-down menu and click on the "Remove Measurement"  icon.

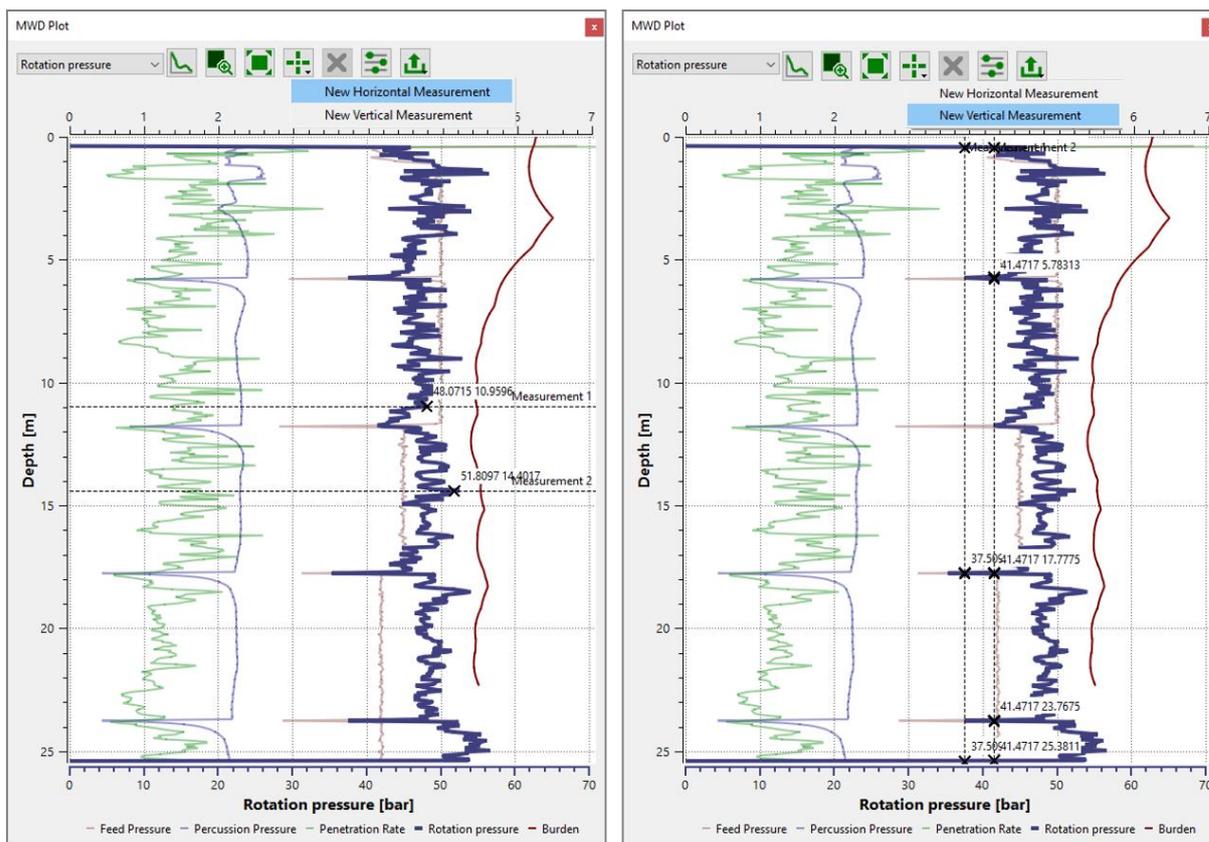


Figure 101: Adding of measurements. Left: horizontal measurement. Right: vertical measurements.

12.3 MWD Analysis ¹

MWD analysis in the *BMX BlastPlanner* evaluates the rock mass quality from drill monitoring data (penetration, rate, percussions pressure, feed pressure and rotation pressure). Two factors are introduced:

- a) *Structural Factor* that classifies the rock conditions into three classes (zones):
 - *Massive Zone*
Zone composed by massive rock, small and/or isolated discontinuities and/or fractures filled with the rock of similar properties
 - *Fractured Zone*
Blocky zone composed by a weakness area, changes in the lithology by intrusions of softer material, medium-size discontinuities and/or small size cavity
 - *Heavily Fractured Zone*
Zone of heavily broken rock mass, large discontinuities and/or medium or large cavities

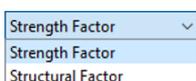
¹ J. Navarro, T. Seidl, P. Hartlieb, J. A. Sanchidrián, P. Segarra, P. Couceiro, P. Schimek, C. Godoy (2021) Blastability and ore grade assessment from drill monitoring for open pit applications; *Rock mechanics and Rock Engineering* 54/6, p.3209-3228

- b) *Strength Factor* which associates strengths properties evaluated from MWD data and associate them with the dominant lithologies. The *Strength Factor* ranks the rock into four categories:
- hard material
 - moderately hard material
 - moderately soft material
 - soft material

A *Block Model* is an approximated step function that allows to divide and simply the *Structural Factor* and the *Strength Factor* in its zones based on abrupt changes in the mean values.

The MWD Analysis is visualized for the individual boreholes in a plot opened by clicking “*Windows | MWD Analysis*” in the menu bar (Figure 102) and selecting the borehole in the *Drill Pattern* list in the *Blast Site* pane. Following options are provided to adapt the plot:

Select data item



Switches between the visualization of the *Structural Factor* and the *Strength Factor*

Show Data Options



Opens the *Options* dialog for the plot (Chapter 12.2 and Figure 99)

Zoom to Rectangle



Activates a zoom function. The plot is zoomed to the size of a rectangle drawn by holding the left mouse button pressed.

Reset View



Resets the view of the plot according to the configuration of the plot

Exports



Saves the plot as image (“*.png*” file) or copies the image to clipboard

Show Plot Settings



Opens the *Configuration* dialog (see Chapter 12.2 and Figure 100)

The limit values for the individual zones and block model options are adapted with the following options:

Rod Lengths Defines the rod lengths. By entering the rod length systematic changes which are due to the addition of a new rod are removed from the analysis.

Simplification (*Block Model*) *Simplification* is a counterbalance to the approximation and determines how sensitive the approximation function is to changes in the mean value. Lower values result in a more sensitive approximation, and therefore more steps in the function. Recommended values for the *Simplification* are between 0.05 and 0.25 for the *Structural Factor*, and between 0.40 and 1.20 for the *Strength Factor*.

Block model zones Defines the limit values between individual zones for the *Structural Factor* (massive/fractured and fractured/heavily fractured) and the *Strength Factor* (hard/moderately hard, moderately hard/moderately soft, moderately soft/soft)

The results of the MWD analysis is visualized in the 3D viewer by clicking the “Show MWD Analysis” icon in the menu bar. The results are displayed on the boreholes by a colour coded overlay. The results are highlighted (magnified) by clicking the “Augment Boreholes” in the “Render Options” in the menu bar. Sections ore boreholes were no MWD data is available are greyed-out. See Figure 103.

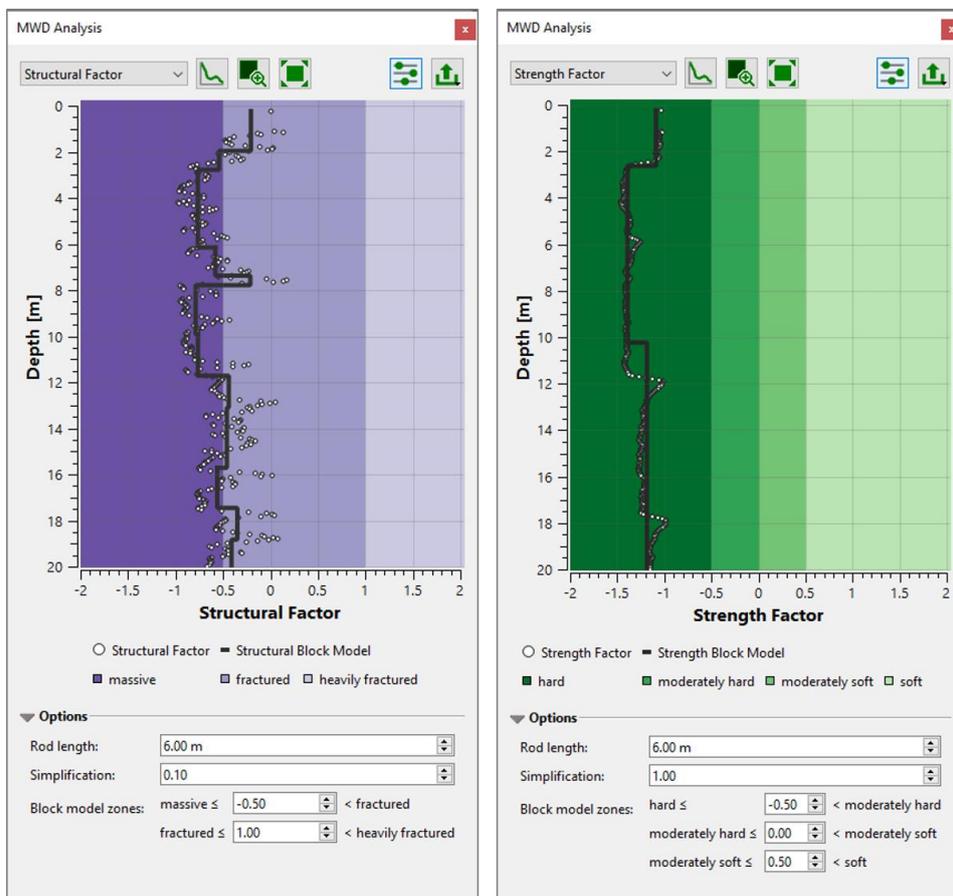


Figure 102: Structural Factor (left) and Strength Factor (right)

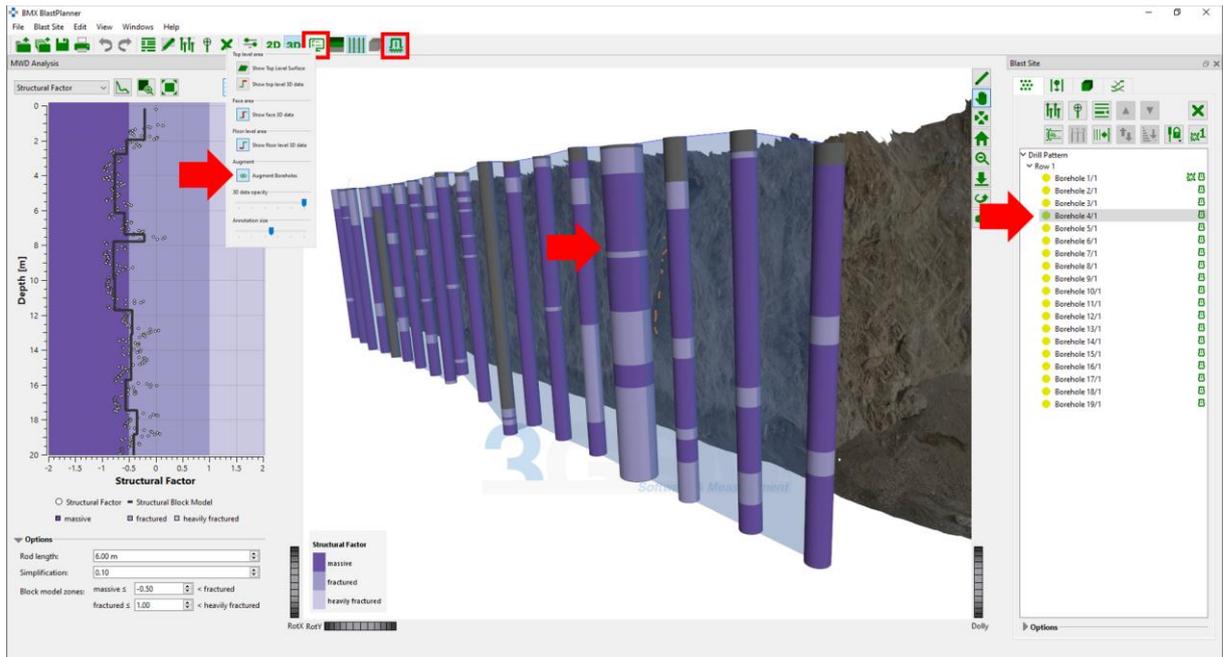


Figure 103: Results of MWD analysis visualized in the 3D viewer

13 Report

The *BMX BlastPlanner* directly sent a report to a connected printer by clicking “*File | Print Report*” in the main menu or the corresponding icon  the tool bar. However, it is recommended to use “*File | Export Report as PDF*” to generate a printer file. The *Report* dialog (Figure 104) opens and print parameters can be set:

General tab

- Blast Site
 - *Site name*
 - *Blast name*
- Pdf
 - Page size
 - Orientation
 - Portrait
 - Landscape
- Plan View:
 - Rotate: Turns Plan View about 90° counter-clockwise
 - Font scaling: Changes the font size
 - Auto scale: Scales the plan view to fit on the page
 - Scale: Enter scale 1:xxx
 - Draw active dimensions only
- Borehole Plots
 - Type:
 - *Minimum Burden*
 - *Profile*
 - *Measure While Drilling*
 - *Measure While Drilling Analysis*
 - Auto scale: Scales the profile to fit on the page
 - Scale: Enter scale 1:xxx
- Overview Page
 - Rows of boreholes on overview page: Enter the number of rows per page
 - Columns of boreholes on overview page: Enter the number of columns per page
 - Individual plot scale for diagrams

Page tab

- Mark or unmark pages (i.e. title page, plan view, row dimensions, borehole tab, individual rows, borehole diagram overview) to be included or excluded from the report by de/activating the corresponding checkboxes
- Include all pages using the “*All Pages*” button at the bottom of the tab
- Exclude all pages using the “*No Pages*” button at the bottom of the tab
- Include selected pages (“*Shift*” and left mouse button) using the “*Highlighted Pages*” button at the bottom of the tab

Logo tab

- Logos can be positioned at the top left and/ or top right of the report.

Plan View tab

- Borehole information
 - Show lengths
 - Show inclination
 - Show horizontal angles:
 - Angles to north: shows the angle values relative to north direction (only reasonable when having a north-corrected or geo-referenced model)
 - Angles to *Reference Line*: Shows the angle values relative to the *Reference Line*
- Misc: Mark or unmark the entries to show or hide the following elements
 - Draw Borehole names
 - Draw dimensions
 - Draw Borehole lines
 - Draw Row lines
 - Draw *Reference Line*
 - Draw contour line
 - Trim contour lines at border planes
 - Draw legend
 - Flip plan view
 - Dimensions behind Boreholes

Figure 105 to Figure 111 show a sample report including title page, plan view page, row dimensions page, table of borehole parameters, profile page, and overview page.

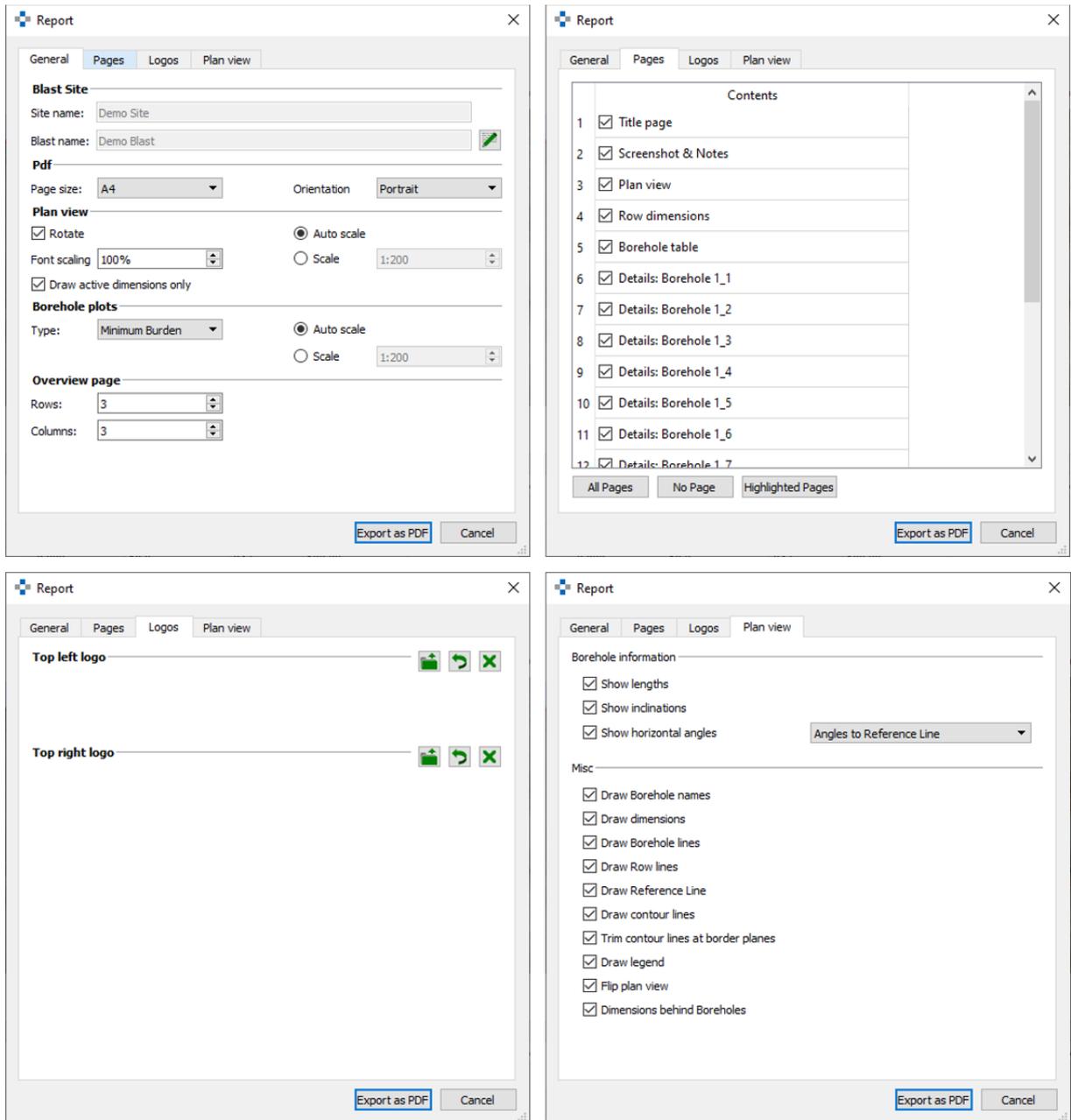


Figure 104: Dialog window for designing the report

Demo Site - Demo Blast

Overview

Site name: Demo Site
 Bench name: Demo Bench
 Blast name: Demo Blast
 Recording date: 02-Aug-19 12:12
 Rock density: 2500.0 kg/m³
 3D Model: 03_UAV preblast.jm3
 Blast Site: 03_UAV preblast.smb



Blast Site geometry

Face Plane dip direction:	231.1 °	Minimum bench height:	19.12 m
Face Plane dip angle:	66.0 °	Mean bench height:	19.98 m
Distance (Delimiters):	70.56 m	Maximum bench height:	20.97 m
Distance (delimiting planes):	70.56 m		

Design parameters

Burden:	6.0 m	Borehole inclination:	20.0 °
Number of rows:	3	Borehole subdrilling:	0.0 m
Side spacing:	6.0 m	Floor Plane elevation:	931.53 m
Row distance:	5.0 m	Floor Plane dip direction:	325.7 °
Row shift:	3.0 m	Floor Plane dip angle:	0.1 °

Drill Pattern analysis

Number of rows:	3	Minimum inclination:	17.0 °
Number of boreholes:	36	Mean inclination:	20.4 °
Total drilling length:	791.71 m	Maximum inclination:	26.2 °
Minimum side spacing:	4.7 m	Minimum subdrilling:	-0.0 m
Mean side spacing:	6.0 m	Mean subdrilling:	-0.0 m
Maximum side spacing:	6.3 m	Maximum subdrilling:	0.0 m
		Total blasting volume:	9629.8 m ³
		Total blasting mass:	24074.5 t

It is noted that the blast site planned with BlastMetriX 3D bases exclusively on the contact-free measured information of the bench face. The blast site planned with BlastMetriX 3D has to be checked in any case for completeness and correctness by a responsible blaster. It is presumed that all legally binding laws, regulations and guidelines applicable in your country are met. By using BlastMetriX 3D you agree to implement the result on your responsibility and free 3GSM from any possible claims.

Place, date	Print name	Signature

Date: 01-Oct-20 11:17 BlastPlanner 4.5 Alpha 3-x64	03_UAV preblast_blast.pdf	Page: 1/49
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Figure 105: Sample report: Title page including Blast Site overview, geometry, design parameters, disclaimer and screenshot

Demo Site - Demo Blast		
		
Notes:		
Date: 01-Oct-20 11:17 BlastPlanner 4.5 Alpha 3-x64	03_UAV preblast_blast.pdf	Page: 2/49

Figure 106: Sample report: Screenshot of the Blast Site with customer notes

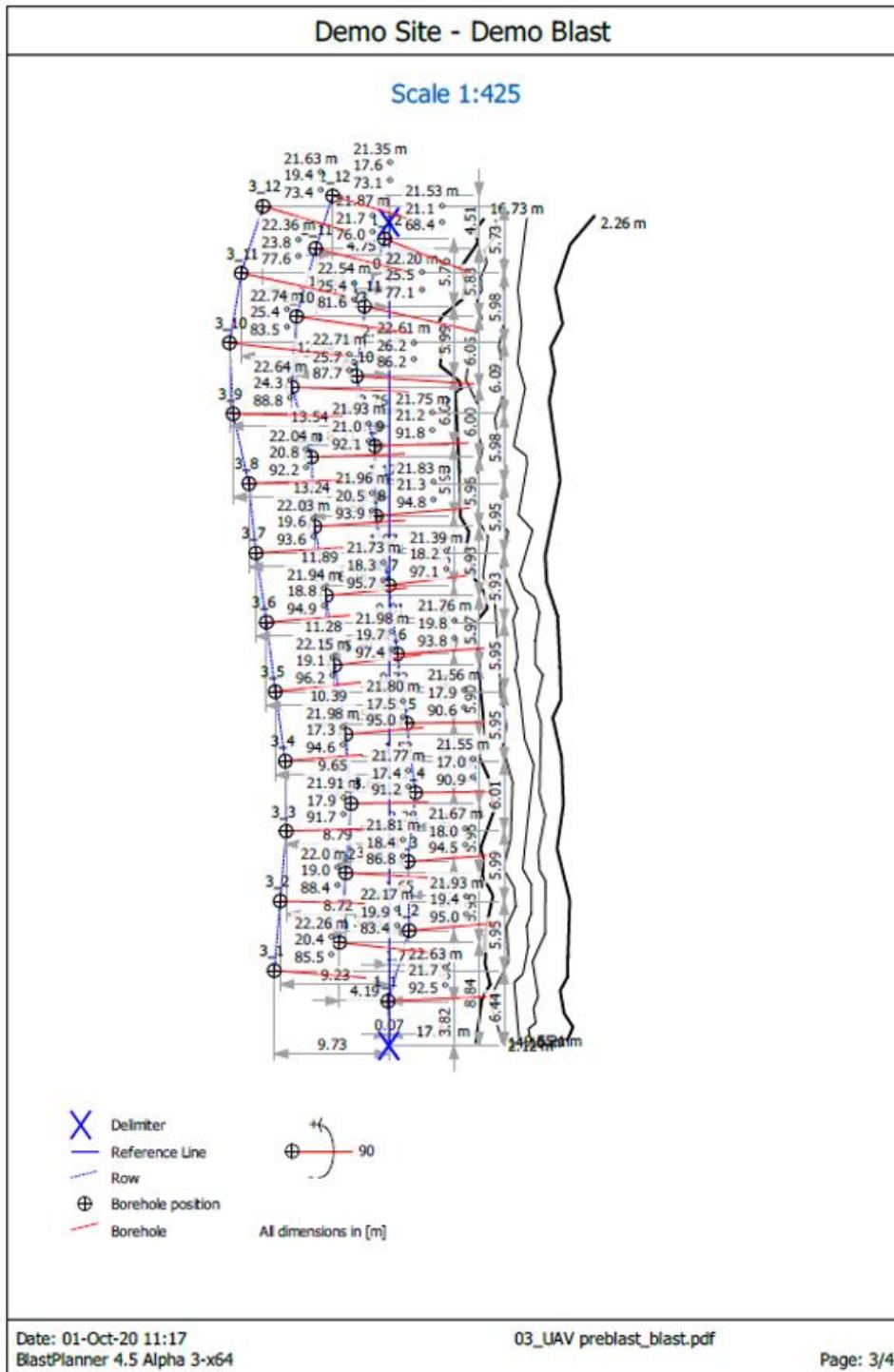


Figure 107: Sample report: Plan view including contour lines, Reference Line, collar, boreholes, row, and legend

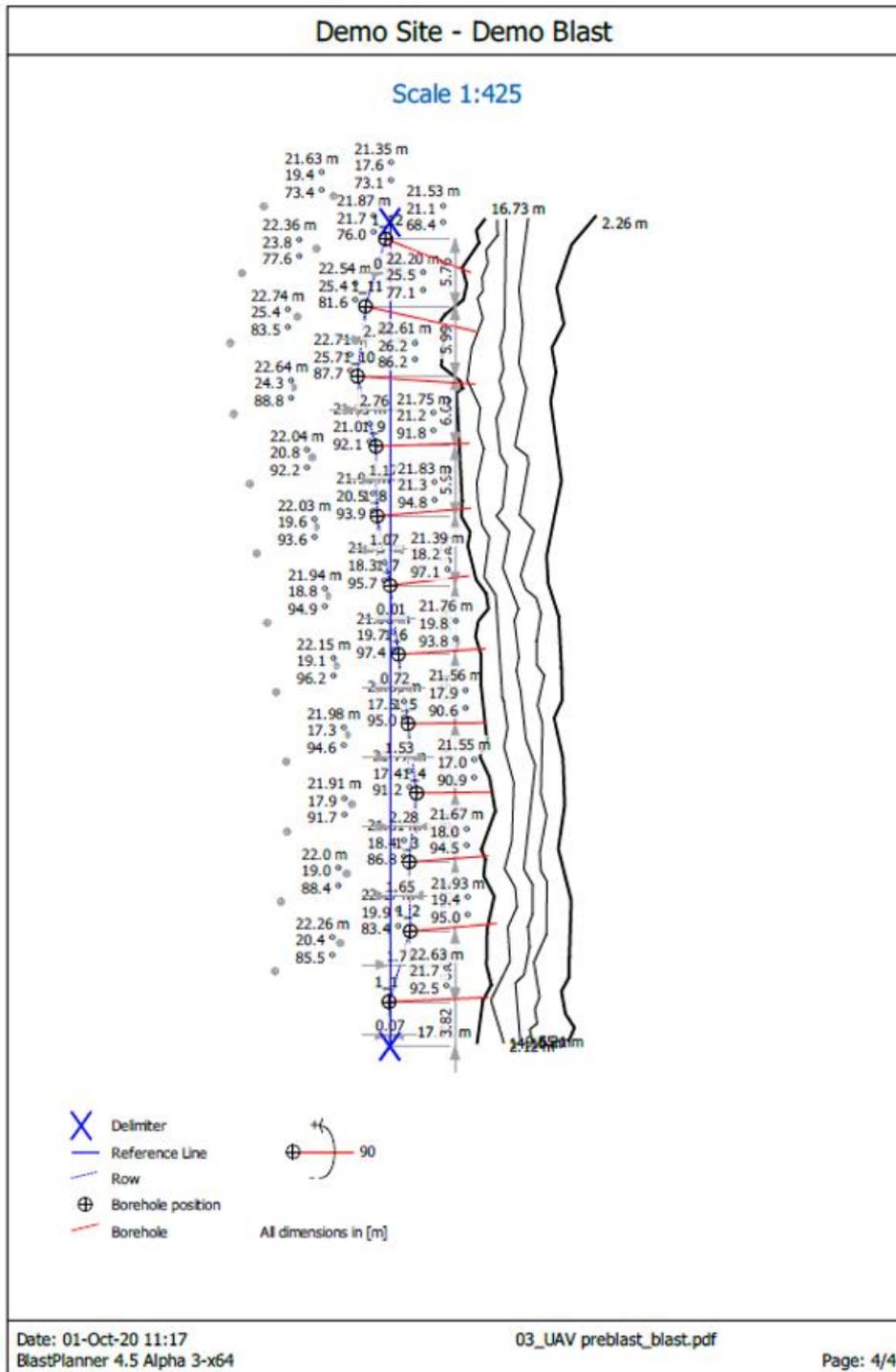


Figure 108: Sample report: Plan view for individual rows including contour lines, Reference Line, collar, boreholes, row, and legend

Demo Site - Demo Blast							
Borehole details							
Name	u [m]	v [m]	E/N/H [m]	Azimuth [deg]	Inclination [deg]	Length [m]	Diameter [mm]
1_1	3.82	0.07	-107455.05 266970.48 952.50	230.71	21.72	22.63	100.00
1_2	9.87	-1.75	-107452.88 266964.55 952.17	228.14	19.41	21.93	100.00
1_3	15.79	-1.65	-107449.25 266959.87 952.10	228.73	18.01	21.67	100.00
1_4	21.68	-2.28	-107446.23 266954.78 952.12	232.30	16.98	21.55	100.00
1_5	27.63	-1.53	-107442.06 266950.45 952.04	232.62	17.87	21.56	100.00
1_6	33.57	-0.72	-107437.85 266946.18 952.01	229.39	19.80	21.76	100.00
1_7	39.48	-0.01	-107433.75 266941.88 951.87	226.10	18.18	21.39	100.00
1_8	45.42	1.07	-107429.32 266937.77 951.90	228.38	21.27	21.83	100.00
1_9	51.40	1.17	-107425.66 266933.05 951.85	231.35	21.18	21.75	100.00
1_10	57.40	2.76	-107420.80 266929.20 951.86	237.01	26.25	22.61	100.00
1_11	63.39	2.06	-107417.76 266923.98 951.64	246.14	25.45	22.20	100.00
1_12	69.15	0.35	-107415.68 266918.35 951.69	254.81	21.05	21.53	100.00
2_1	8.84	4.19	-107448.74 266968.93 952.34	239.76	19.87	22.17	100.00
2_2	14.79	3.65	-107445.61 266963.84 952.20	236.38	18.38	21.81	100.00
2_3	20.74	3.21	-107442.40 266958.81 952.28	232.03	17.38	21.77	100.00
2_4	26.69	3.65	-107438.48 266954.31 952.31	228.14	17.48	21.80	100.00
2_5	32.59	4.58	-107434.20 266950.15 952.23	225.80	19.69	21.98	100.00

Date: 01-Oct-20 11:17
BlastPlanner 4.5 Alpha 3-x64

03_UAV preblast_blast.pdf

Page: 7/49

Figure 109: Sample report: Table of borehole parameters

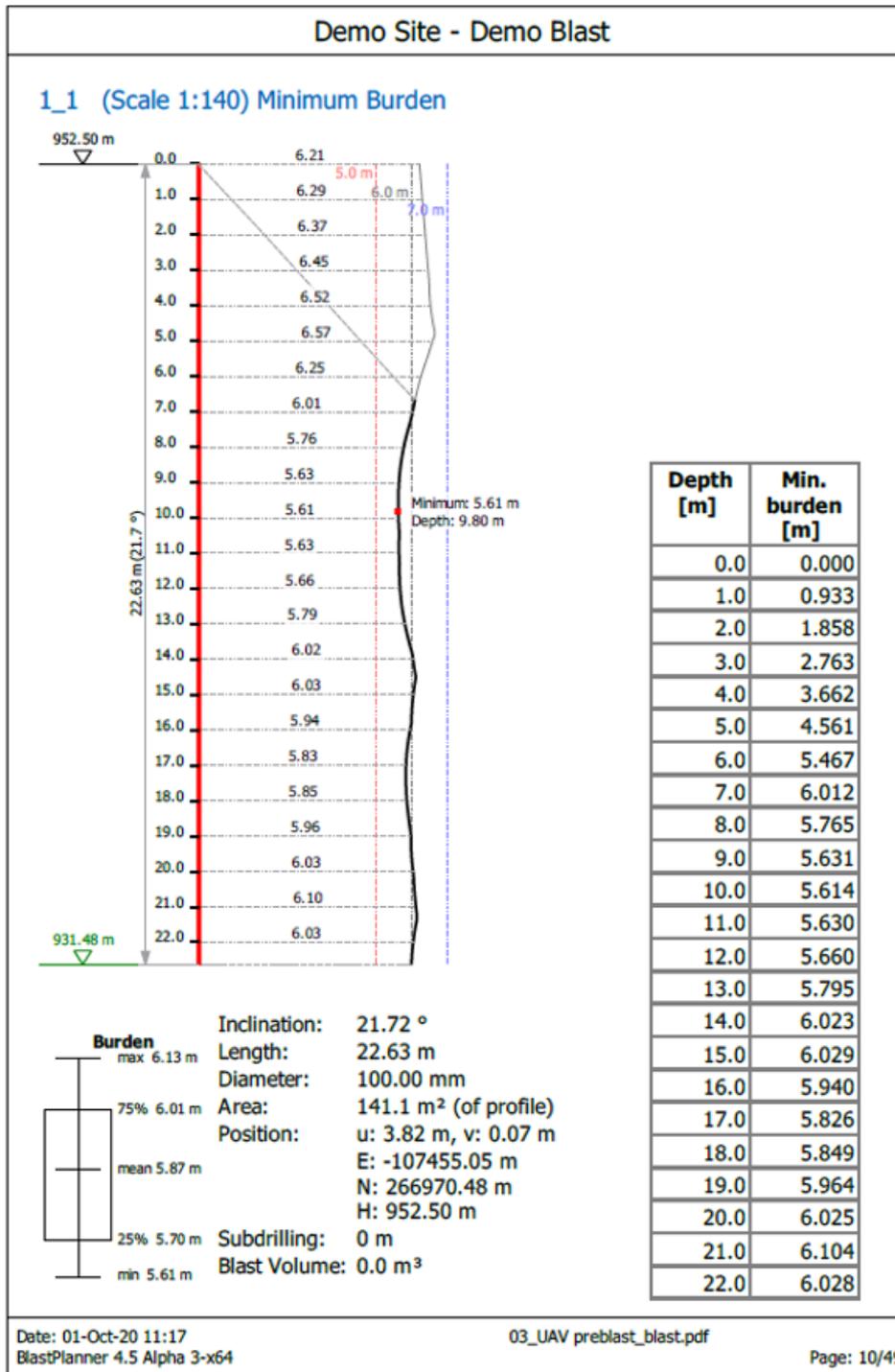


Figure 110: Sample report: Minimum Burden page including sketch and dimensions, borehole parameters, table of burden values and burden box plot

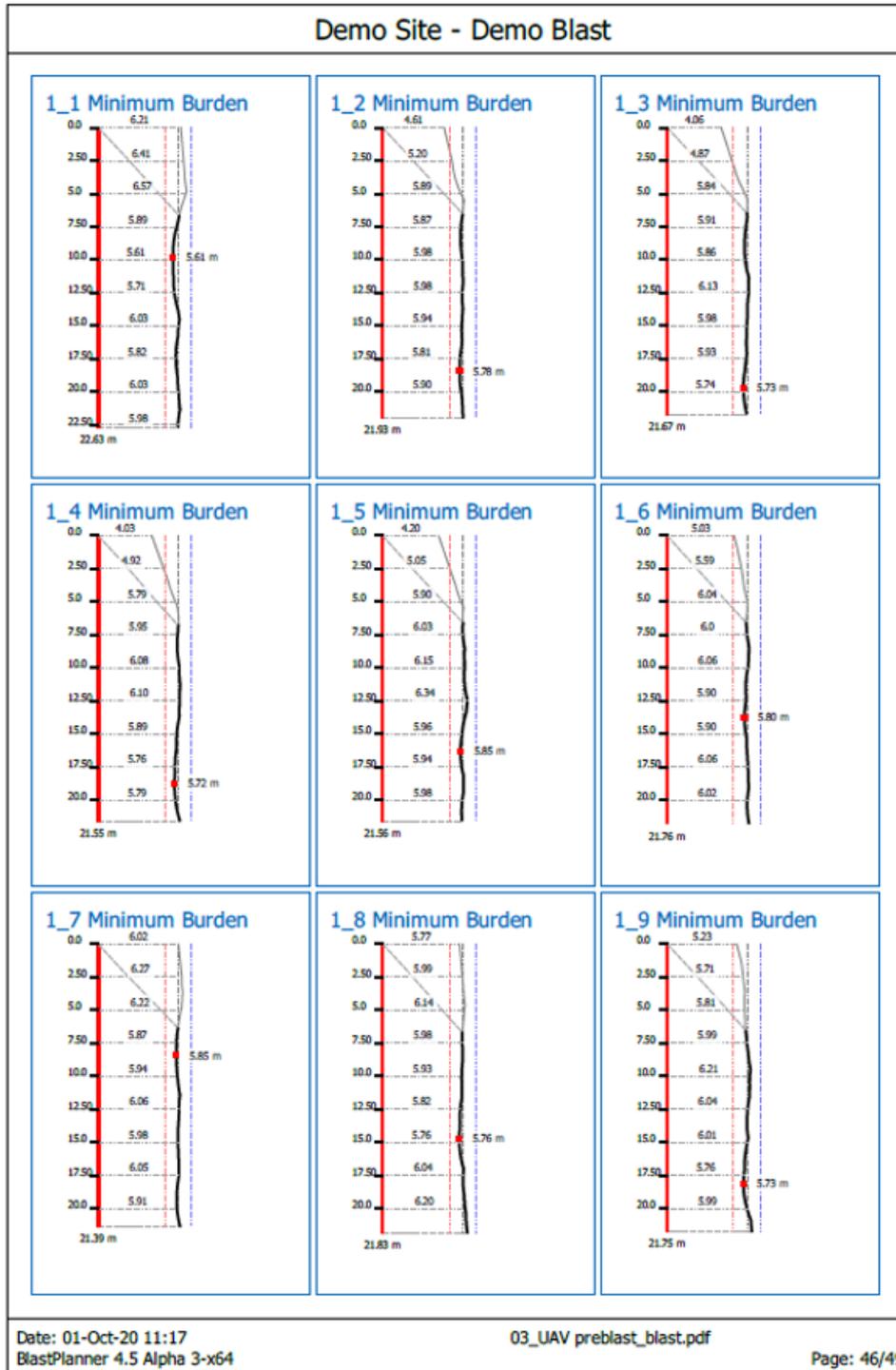


Figure 111: Sample report: Minimum Burden overview

14 Export

14.1 SHOTPlus5 Premier

The 3D model and the *Blast Site* can be exported into a format compatible with the software SHOTPlus5 Premier. The export is available from the menu “*Blast Site | Export | Export to SHOTPlus5 Premier*”. It generates a file with the extension “.spk” which contains information about the 3D model and the *Blast Site* (boreholes).

14.2 Geometry data export

The resulting geometry of the bench face is directly exportable into the “.dxf” or “.obj” data format (see Figure 112 and Figure 113). Click “*File | Export as DXF*” or “*File | Export as OBJ*” from the main menu. If there are too many 3D points from the *BlastMetriX* system, the number can be reduced (“*Number of Points to Export*”). Point reduction uses a shape-preserving algorithm.

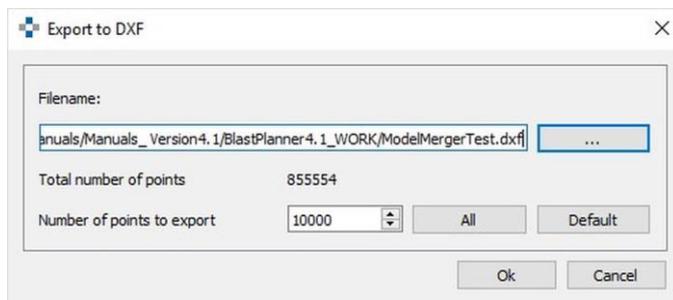


Figure 112: Dialog window for exporting the bench face geometry into the “.dxf” format

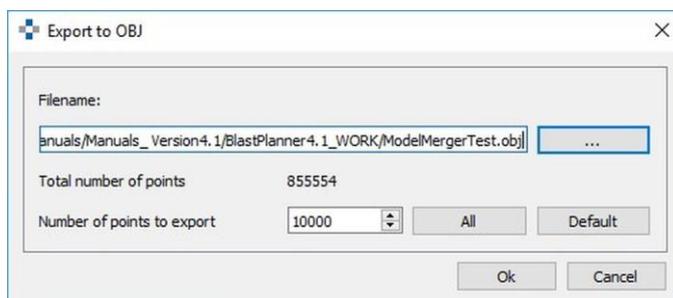


Figure 113: Dialog window for exporting the bench face geometry into the “.obj” format

14.3 CSV Export

Drill pattern

The planned drill pattern is exportable into a “.csv” format (comma separated value) text file by clicking “*Blast Site | Export Drill Pattern as CSV.*” from the main menu. Depending on the chosen option within the arising dialog window (Figure 114), the co-ordinates are provided either related to the *Reference Line* (u,v,w) or related to the local camera co-ordinate system (x,y,z).

The information is provided as with the example below. The exported “.csv” file is readable for standard spreadsheet applications. The meaning of the entries is as follows:

- First line: name of the single values
- Second line according units
- PosU / PosX: offset from the left delimiter along the *Reference Line* / x-co-ordinate [current unit]
- PosV / PosY: offset across the *Reference Line* / y-co-ordinate [current unit]
- PosW / PosZ: vertical offset of borehole collar from *Top Level Plane* / z-co-ordinate [current unit]
- DirU, DirV, DirW / DirX, DirY, DirZ: unit vector pointing into the planned direction of the borehole [1]
- Length: length of borehole [current unit, i.e. as selected in general system settings]
- Inclination: inclination of borehole (0 deg means vertical borehole) [deg]
- Angle to *Reference Line* / angle to north: horizontal angle of borehole either against the *Reference Line* or against north (azimuth) depending on the setting within the plan view (see Figure 19) [deg]
- Sectional area: sectional area between borehole and surface [current unit]

Example:

```
"Row", "Name", "PosU", "PosV", "PosW", "DirU", "DirV", "DirW", "length",
"inclination", "angle to reference line", "sectional area"
",", "m", "m", "m", "m", "m", "m", "m", "deg", "deg", "m^2"
"1", "1-1", 2.579, 1.631, -0.000, -0.002, -0.173, -0.984, 17.078, 9.999, 89.188, 47.56
"1", "1-2", 7.578, 1.561, -0.000, -0.002, -0.173, -0.984, 17.325, 9.999, 89.188, 51.83
"1", "1-3", 12.578, 1.490, -0.000, -0.002, -0.173, -0.984, 17.571, 9.999, 89.18, 43.88
"1", "1-4", 17.577, 1.419, -0.000, -0.002, -0.173, -0.984, 17.817, 9.999, 89.88, 41.48
```

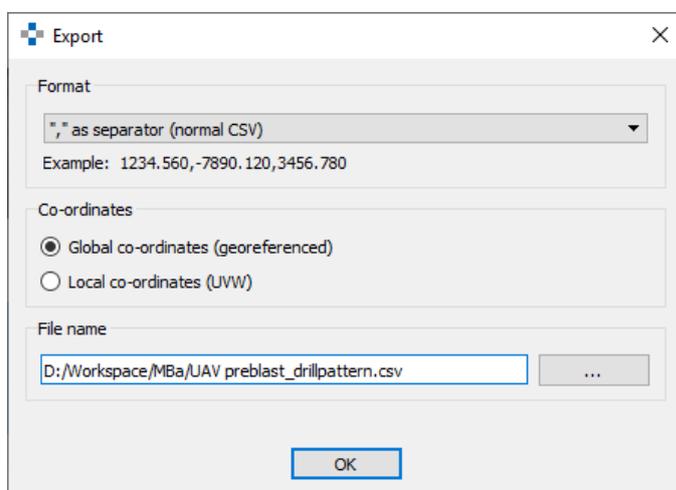


Figure 114: Dialog window for exporting the Drill Pattern as a comma separated value (“.csv” file)

Additional data export

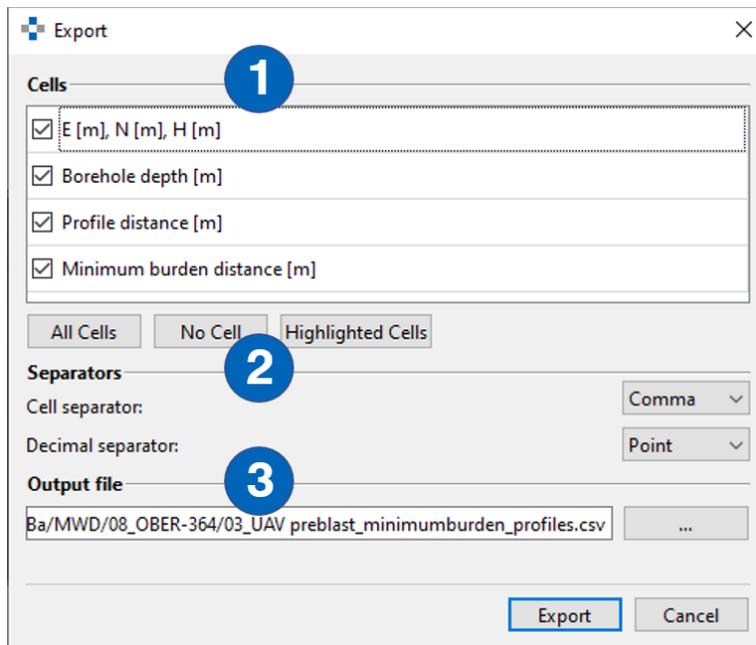
The *BMX BlastPlanner* supports the export of following data to “.csv”:

- Profiles and Minimum Burden distances by clicking “Blast Site | Export | Export Profiles and Minimum Burden as CSV” in the menu bar (Figure 115)
- Borehole volumes by clicking “Blast Site | Export | Borehole Volumes as CSV” in the menu bar
- Left and Right Delimiter positions by clicking “Blast Site | Export | Delimiter as CSV” in the menu bar

The exported “.csv” files are readable for standard spreadsheet applications.

The export of Profiles and Minimum Burden distances can be configured by the user. The following options are available:

- Coordinates – three columns (x, y, z or Easting, Northing, Height)
- Borehole depth
- Profiles distances
- Minimum Burden distances



- 1 Exported cells
- 2 Type of separator
- 3 Folder and name

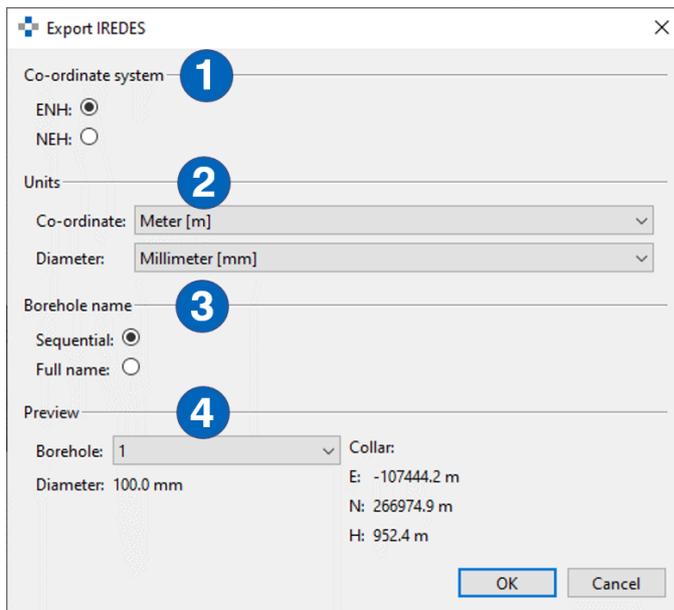
Figure 115: “.csv” export Profiles and Minimum Burden distances

14.4 Custom export

Several custom exports of the Drill Pattern are possible:

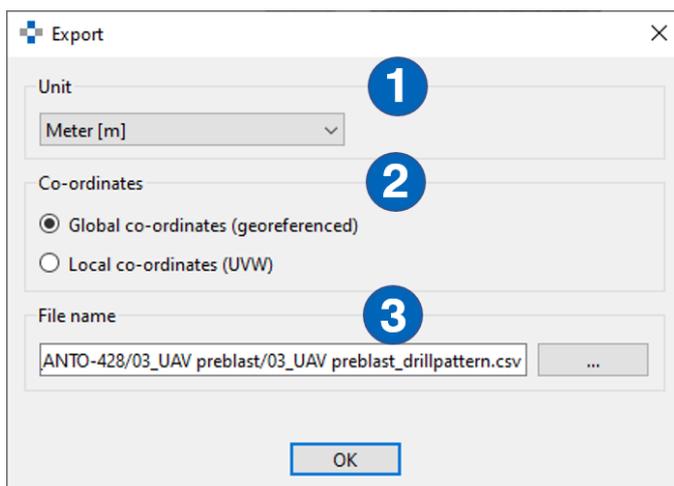
- IREDES DRPlan by clicking “Blast Site | Export | Custom | Export Drill Pattern as IREDES DRPlan” in the menu bar (see Figure 116)

- Atlas Copco CSV by clicking “Blast Site | Export | Custom | Export Drill Pattern as Atlas Copco CSV” in the menu bar (see Figure 117)



- 1 Co-ordinate system
- 2 Unit (millimeter [mm], meter [m], inch [in], international foot [ft], US survey foot [ft])
- 3 Borehole name
- 4 Preview

Figure 116: IREDES export



- 1 Unit (millimeter [mm], meter [m], inch [in], international foot [ft], US survey foot [ft])
- 2 Co-ordinate system
- 3 File name

Figure 117: Atlas Copco CSV export

14.5 Screenshot

Menu bar: “File | Generate Screenshot”: Writes a “.jpeg” file of the scene in the 3D viewer using off-screen rendering, i.e. the screen shot model is dependent form the native of the monitor display. The export of the screenshot can be modified in the screenshot dialog (Figure 118), which opens subsequently after calling the

command. Camera type, camera position and direction, and several settings options can be selected for the screenshot export.

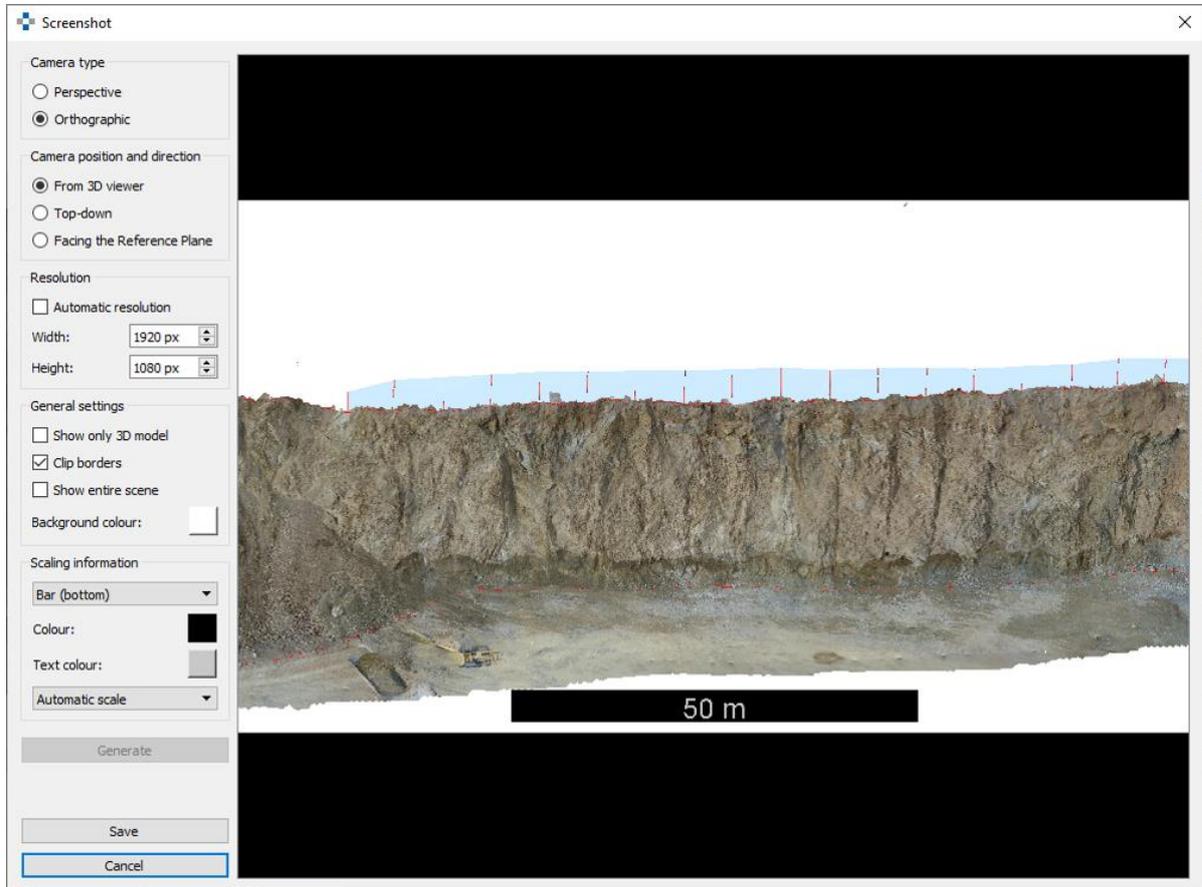


Figure 118: Export dialog for screenshot