

Rodded Boretrak

borehole deviation survey system

user manual



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1 Customer information

1.1 Dear customer

The Rodded Boretrak® system is designed to be easy to operate. However, we would ask you to take the time to read these operating instructions carefully before using the system, and to keep the manual with the instrument at all times.

For any feedback or comments, or if there are questions about the Rodded Boretrak system which are beyond the scope of this manual, contact the product support department at Carlson, or your local Carlson representative.

Alternatively, for information on your local Carlson-approved service centre, visit our website: www.carlsonsw.com.

To ensure best service, please make a note of the serial number. This can be found on the instrument (Figure 2).

1.2 User manual

It is important that you read this manual carefully before using the instrument.

This manual describes the Rodded Boretrak and all accessories supplied with a standard system. This includes a description of the **Boretrak Mobile** software which runs on an Android-based Personal Digital Assistant (PDA).

The PC software – **P3D Boretrak plug-in** – is supplied with the Rodded Boretrak system. Help for this software is available via P3D's online help menu.

This manual has been compiled with care. However, should you discover any errors, we would be grateful if you could contact Carlson directly.

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2 Rodded Boretrak system concepts

2.1 System overview

The Rodded Boretrak borehole deviation measurement system is a simple-to-use, portable system for measuring the deviation of boreholes. The Boretrak system does not use magnetic sensors and is therefore ideally suited for measuring boreholes where there may be material present which would interfere with a compass.

The Boretrak probe is deployed along a borehole using a series of hinged glass fibre rods. The Boretrak system calculates the borehole's deviation from vertical at fixed intervals using sensors located within the probe. The output from these sensors is recorded during deployment and then synchronized onto the supplied PDA.

The Boretrak system can be rapidly deployed on site, both uphole and downhole, and requires no specialised tools or equipment other than those supplied with the system.

Results from the Boretrak are available as soon as the probe has been recovered and synchronised onto **Boretrak Mobile** software which runs on a supplied PDA. The PDA acts as the survey controller and allows you to set up projects, manage holes, conduct the survey and view results.

Back in the office, data can be transferred from **Boretrak Mobile** onto a PC running **P3D Boretrak plug-in** software. **P3D Boretrak plug-in** provides more comprehensive data analysis and editing tools.

2.2 System capabilities

The Boretrak probe is designed to survey the route of drilled holes by measuring its inclination and heading at fixed intervals along the hole.

The sensor inside the Boretrak probe is a three-axis accelerometer. Data from this sensor is used to derive the angle at which the Boretrak probe is inclined with respect to gravity.

In addition to the inclination, the orientation (or heading) of the probe is also required to fully map out the path of the borehole. To establish the orientation of the system, the probe is fixed to the rods in such a way that it cannot 'twist'. The rods are held stable on the ground in a known orientation (the rod azimuth) on the local coordinate system.

As long as the rod rack remains stable, measurements from the probe can be used to establish how the orientation of the probe is changing with respect to the initial rod azimuth. Combining the orientation and the inclination generates a 3D representation of the borehole.

Beyond 45° from vertical (up or down), this method cannot be used to calculate the orientation of the Boretrak probe with sufficient accuracy. Therefore, when used for a downhole survey, the Boretrak is limited to measuring hole deviation in 3D within a range of 0° (vertically down) up to 45°. For uphole surveys, the range is 180° (vertically up) down to 135°.

Within these limits, the Boretrak measures the changing inclination of the hole, as well as changes in the direction that the hole is heading. The limits of the Boretrak are illustrated in Figure 1. The yellow cones show the area inside which the Boretrak will operate and produce data.

The angular gap between the two cones is 90°, ie: 45° to 135°. A Boretrak will not produce measurements if used in this range.

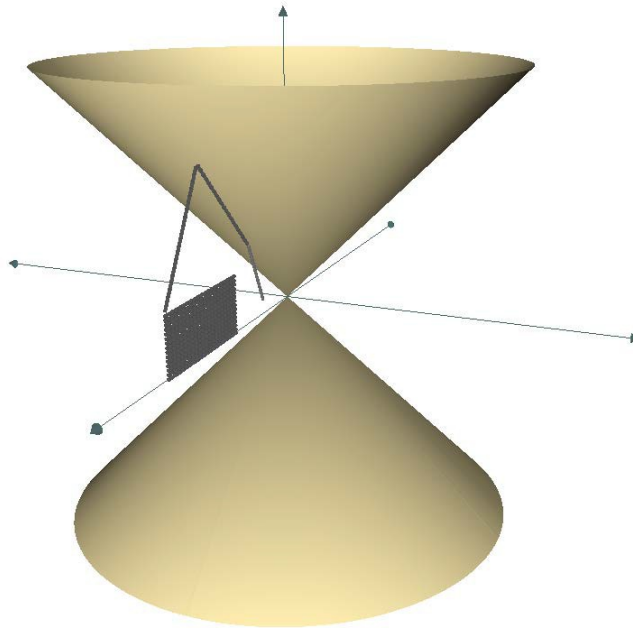


Figure 1 Boretrak measurement range: downhole 0° to 45° and uphole 135° to 180°

2.3 Data communication and storage

During a Boretrak survey, the operator configures and controls the Boretrak project via the PDA. The Boretrak probe is attached to the rods and deployed down a borehole. The system is deployed at a series of fixed intervals (the rod interval), most commonly 2 m.

During a deployment there is no physical connection or communications link between the Boretrak probe and the PDA. Instead, before deployment, the date and time in the probe are synchronised with the date and time in the PDA. From this point, the probe starts recording data from its sensors into its internal memory. A reading is taken every second and the probe LEDs flash to visually indicate that this process is ongoing. Each sensor record in the probe is accompanied by a time stamp.

At each rod interval, with the system held steady, the operator records a time stamp on the PDA.

Once a survey has been completed, or after each hole if required, all sensor data from the probe is downloaded to the PDA via a Bluetooth® connection.

Boretrak Mobile reads the time stamps recorded in the PDA and extracts the records in the probe data with matching time stamps.

With reference to a starting hole collar coordinate and a starting rod azimuth, these raw observations are converted into X, Y, Z coordinates. A model of the hole can then be created, and a comparison made to a design hole or another survey of the same hole.

2.4 Boretrak Mobile software

Boretrak Mobile provides functionality to set up projects and to manage the survey in the field.

The PDA enables **Boretrak Mobile** to communicate with the probe via a Bluetooth connection. You can see live data from the probe for troubleshooting purposes and download data from the probe.

When data has been downloaded, a visual inspection of the holes is possible. You can compare the surveyed hole with design data and export the project for use in **P3D Boretrak plug-in** or other PC software.

2.5 P3D Boretrak plug-in

Carlson's **P3D** is a point cloud package for Windows PCs which allows users to import survey data, points, polylines, surfaces and point clouds and to create usable 3D surfaces. **P3D Boretrak plug-in** is a free P3D module which can be used as a standalone package. **P3D Boretrak plug-in** provides advanced processing functionality specifically for data collected with Carlson's Boretrak equipment.

Boretrak data can be downloaded into **P3D Boretrak plug-in**, and combined with other Boretrak datasets. Hole surveys can be assigned to hole coordinates from imported ASCII files or from manually entered coordinates.

P3D Boretrak plug-in provides a range of tools to help edit, analyse and report on the data collected with your Boretrak system.

Further paid-for modules are available for **P3D**. These unlock additional functionality for general point cloud processing and surfacing.

Carlson's own DRL file format allows easy transfer of data back and forth between **P3D Boretrak plug-in**, **Boretrak Mobile** and other Carlson software packages.

3 Rodded Boretrak hardware

3.1 Probe

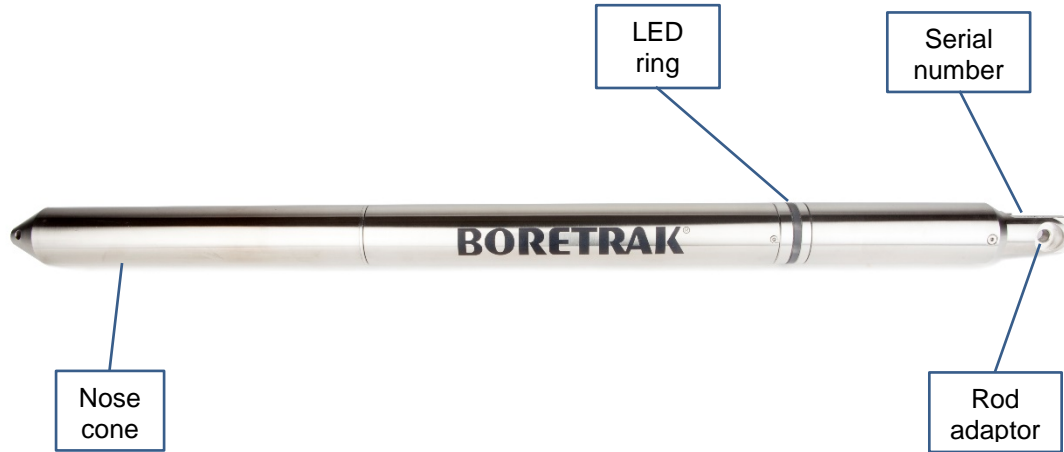


Figure 2 Boretrak probe

The Rodded Boretrak probe contains a 3-axis accelerometer which is used to measure the deviation of the probe with respect to gravity.

The sensor readings are stored in the probe's on-board memory. The probe also contains a real-time clock which is used to time-stamp all recorded data.

The Rodded Boretrak probe operates up to $\pm 45^\circ$ from vertical. The probe can be deployed either upwards or downwards within this range. The probe will automatically output the appropriate sensor values depending on whether it is held upwards or downwards. If the probe is used outside this range, i.e. between 45° and 135° , then **Boretrak Mobile** will show 'out of range' flags against the downloaded data.

A ring of LEDs provides visible information. An internal buzzer provides complementary audible information. The information conveyed is outlined below.

LED behavior	Buzzer	Message signalled
Flashes red.	Sounds twice.	Boretrak system powered ON.
Flashes red every second.	-	Probe collecting data.
Flashes for 5 seconds.	Sounds for 5 seconds.	System error: contact a Carlson-approved service centre.
Slow flash.	-	Probe memory is full. Clear or download the data in the probe.
Flashes red.	Sounds once.	Boretrak Mobile connected to probe.

The Bluetooth signal is broadcast through the LED window. Do not hold the probe by the LED window during operations as Bluetooth communications with the PDA may be affected.

The rod adaptor provides a quick-release mechanism where the Boretrak rods attach to the probe. This connection ensures that the probe is secure during deployment. It also ensures that the probe is correctly orientated in relation to the rods. This orientation is crucial for accurately surveying the route of the borehole.

The serial number of the probe is engraved on the side of the rod adaptor.

The nose cone at the bottom end of the probe houses the batteries and should be unscrewed for transportation or for changing the batteries.

3.1.1 Probe power

The Rodded Boretrak probe is powered by three size “D” (LR20) 1.5 V alkaline replaceable batteries, which can provide over 200 hours’ continuous operation. These batteries are contained in a removable nose cone that is screwed onto the bottom end of the probe.

Insert the batteries into the nose cone, ensuring that the positive terminals are facing the open end, as shown in Figure 3. Screw the nose cone onto the main probe using hand pressure only. The nose cone must be fully screwed home to ensure a watertight seal.



Figure 3 Positive battery terminals face out

Indications of discharged batteries are:

- The probe fails to beep when the nose cone is fitted.
- The LEDs do not flash when the nose cone is fitted.
- The PDA cannot establish communications with the probe as a remote Bluetooth device.

The probe is powered ON as soon as the nose cone is attached to the probe. Removing the nose cone powers OFF the probe.

As described in the table in section 3.1, when the Boretrak probe is powered ON, the LEDs will flash and the buzzer will sound. If there is an error in the system, the red LED flashes and the buzzer sounds for an additional 5 seconds. In this case, power OFF the Boretrak probe by unscrewing the nose cone. Power the probe ON again. If the LEDs flash and the buzzer sounds for another 5-second period, contact a Carlson-approved service centre for support.

When a survey is complete, and data has been downloaded from the Boretrak probe to the PDA, remove the nose cone to preserve battery life. Data is automatically deleted from the probe when it is downloaded to the PDA. If data has not been deleted, it is stored in the probe even when the probe is powered OFF.

Note that the battery compartment is sealed with an O-ring located above the retaining thread. Ensure that both the

thread and the O-ring are kept clean. The O-ring should also be kept well lubricated with silicon grease. A tube of Dow Corning Molykote III is supplied with the system for this purpose. Keep grease off the retaining thread. If this O-ring requires replacement, the required specification is size BS124 Fluorocarbon 75 (31.42 mm ID x 2.62 mm CS).



WARNING: Dispose of used batteries sensibly. Under no circumstances must the batteries (or instrument) be disposed of by burning. Explosion may occur!

WARNING: All batteries contain highly reactive, poisonous and corrosive chemicals, which are hazardous if released due to physical damage. Should the battery or battery charger stop working or become damaged, stop using it and source a replacement from a Carlson-approved source.

3.2 PDA



Figure 4 PDA

An Android PDA runs the **Boretrak Mobile** application and interacts with the Boretrak probe. **Boretrak Mobile** allows you to configure a project, control the survey operation and then view and analyse the resulting data.

The PDA can be supplied by Carlson as part of the Rodded Boretrak system. **Boretrak Mobile** is pre-loaded on any such PDA supplied by Carlson. Alternatively, the customer can source a preferred PDA of their own.

Carlson may supply a variety of PDAs. The PDA detailed in this manual is a ruggedised CT5 supplied by Cedar.

3.2.1 CT5 PDA

The CT5 PDA is highly ruggedised. It is rated to IP68 which means that it is protected against dust ingress and waterproof to at least 1 m. The rubber flaps on the top and bottom of the PDA must be closed to retain this rating. The CT5 has been tested for drops up to 91cm onto concrete.

The PDA is equipped with a 4500 mAh lithium ion battery.

At the bottom of the CT5 PDA is a micro-USB port. This is used for charging the internal battery and also for data exchange with a PC.

Hardware touch buttons are located below the screen and can assist with navigation within Android. For further details, see section 4.1.1.

A dedicated 'quickstart guide' for the CT5 PDA is loaded onto the supplied USB drive. Please read that manual before using the Rodded Boretrak system.

3.2.2 PDA accessories

The CT5 PDA is supplied with a number of accessories as standard. These are outlined below.

3.2.2.1 Carry case and neck strap



Figure 5 PDA fitted with carry case and neck strap

The carry case provides protection for the PDA and also allows use of the supplied neck strap. It is recommended that you use the neck strap for all Rodded Boretrak operations. This will ensure that, where appropriate, both hands can be free to manipulate the Boretrak rods. It also secures the PDA and reduces the risk of dropping it onto the site floor or down a borehole.

3.2.2.2 USB cable



Figure 6 USB cable

A USB cable is supplied with the CT5 PDA to facilitate charging and data exchange.

The CT5 PDA has a USB connector at the bottom of the device. Pull back the rubber plug to expose the connector. Plug the micro USB connector into the CT5's USB port. Note that some standard micro USB cables will not fit the CT5 PDA's USB port due to the ruggedised housing around the connector. Where possible, use the supplied cable.

To pass data between the CT5 PDA and your PC, plug the USB end of the cable into your PC's USB port. The PC will recognise the device and display the CT5 PDA in Windows Explorer. The PDA appears as 'Carlson Boretrak PDA'.

The battery in the CT5 PDA does charge up while plugged into a PC. However, to charge the CT5 PDA at an optimum speed, plug the USB end of the cable into the PDA charger.

3.2.2.3 CT5 PDA charger



Figure 7 PDA charger (European version shown)

The CT5 PDA is supplied with a mains charger. Different chargers are available depending on the mains plug type in your region. Only use the supplied charger to charge the PDA battery.

Plug the charger into a mains power supply.

3.2.3 Customer-supplied PDA

If you have opted to purchase a Rodded Boretrak system without a PDA, you must supply your own device to run Boretrak Mobile.

Before selecting your own device, please consider the following points:

- The PDA must run Android, version 4.1 (Jellybean) or above.
- The PDA must be rugged enough to withstand the work environment in the field. An IP rating of at least IP67 is recommended.
- Boretrak Mobile has been optimized to run on a screen sized between 4.6" – 5.2". It will run on screens of larger or smaller sizes, but the appearance of some parts of the application may seem cramped or too spaced out.
- The PDA's battery capacity should allow you to operate for a full day in the field.
- Given the nature of Boretrak deployments it is very important that you should be able to attach a neck strap to the PDA to allow you to have both hands free when appropriate. Usually the attachment will need to be to a separate case which in turn contains the PDA.
- Features improving the readability of the screen in sunlight, and the response of the touchscreen in rain are useful.
- Users running PDAs which have been supplied as part of a Rodded Boretrak system can be fully supported by Carlson. It may be more difficult to support PDAs which have not been tested and used by Carlson support staff.

3.3 Grease

The Boretrak probe incorporates a nose cone which acts as a battery compartment. This nose cone screws onto the probe and is sealed with an O-ring above the retaining thread.



Figure 8 111 Compound grease

A tube of Dow Corning Molykote III silicon grease is supplied with the Rodded Boretrak. This grease should be lightly smeared on the O-ring to ensure it is kept well lubricated and the probe retains its seal. Keep grease off the retaining thread.

3.4 USB drive



Figure 9 USB drive

A USB drive is supplied with the Rodded Boretrak system. This is loaded with:

- **P3D Boretrak plug-in** software for PC.
- This Rodded Boretrak manual.
- The CT5 PDA quickStart guide.

3.5 Transit case



Figure 10 Rodded Boretrak transit case

All components of the Rodded Boretrak system, except the Boretrak rods, are contained within a dedicated transit case. The case ensures the system is protected from shocks and vibrations. When the lid is closed and the latches are snapped in place, the case is both dust tight and watertight (IP67).

Always pack the Boretrak probe and accessories into the transit case for storage and transportation.

Clean and dry the Boretrak probe and other accessories prior to packing them in the transit case.

The case incorporates a three-dial combination lock which can be set with your own numerical code. The combination lock instructions supplied with the case are replicated in Figure 11.

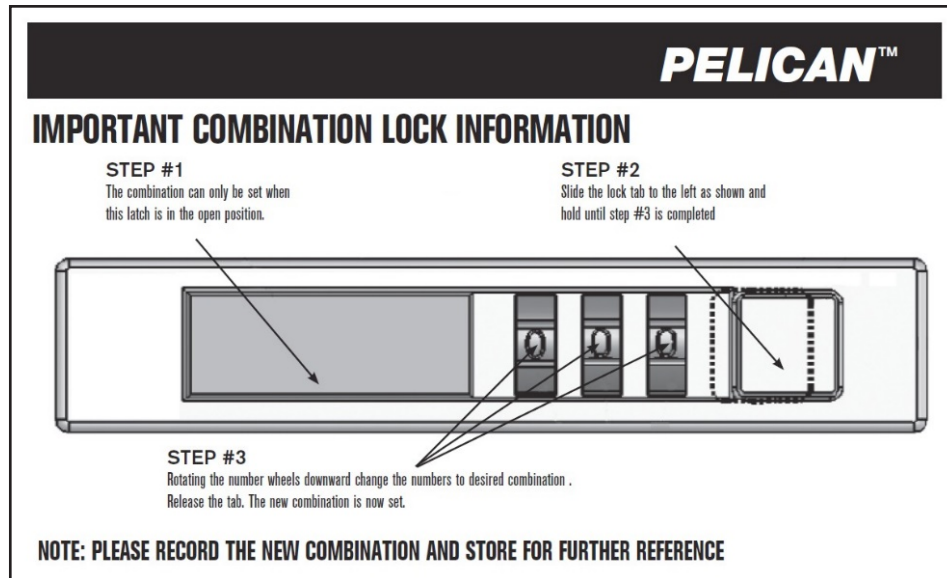


Figure 11 Combination lock instructions

3.6 Boretrak rods



Figure 12 Rod rack with rods and probe attached

A series of hinged Boretrak rods are used to lower the probe into a borehole, or to push the probe in an uphole operation.

The rods are also used to keep the probe correctly aligned. The sections of fibreglass rods are designed to be flexible, but the hinges between them ensure that they cannot 'twist'. As a result, although the Boretrak probe can 'pitch' and 'roll' while attached to the rods, it will not be able to twist along its axis. The orientation of the probe therefore remains constant during its deployment. In this way, the orientation of the entire survey is determined by the alignment of the rod rack.

An arrow on the base of the rod stack indicates the direction that the rods should be positioned in relation to the borehole.

The rods are produced in 1 m lengths. The exception to this is the 'lead' rod which is 0.3 m long. This shorter rod attaches directly to the probe. The length of the lead rod plus the probe is equal to 1 m.

The rod racks are able to fit up to 36 rods, arranged in two stacks of 18. The rod at the bottom of each stack is fitted with a female quick-release joint. This joint can connect to the rod on the top of the next stack which will have a male quick-release joint.

To connect the quick-release joints, the two rods must be held at 90° angles. The pin in the male joint can then be pushed into the hole in the female joint. Once the rods are straightened out, the joint is locked. To disconnect the rods, they must again be held at a 90° angle and pulled apart.



Figure 13 Quick release joint

For longer deployments, further racks full of rods can be used. The rods will join together in the same way as described above.

The standard bi-directional rod link is used for downhole use only. For uphole use, the rods require uni-directional uphole links. These allow the rods to be pushed.

When using the probe uphole, the length of the deployment may be restricted due to the weight of the system or the condition of the borehole. Uphole deployment is only suitable for narrow boreholes less than 100 mm diameter.



Figure 14 Uni-directional uphole link

Proper use and care of the rods is essential to ensure the accuracy of collected data and the safety and longevity of the equipment. In particular:

- Check the rods and hinges prior to every deployment. Ensure that they are in good condition, that there is no apparent 'twist' in the rods, and that all nuts and bolts and connecting pins are in place and secure.
- Should any rod approach end-of-life, or become non-functional or damaged, stop using it immediately and request a replacement from a Carlson-approved service centre.
- The rods and hinges are designed to be used predominantly in the plane of the rack. They are designed to be load-bearing along their length (tensional loads) so can withstand the weight of a long Boretrak deployment. However, take care not to force the rods in a twisting action (torsional loads) or a lever action (transversal loads).
- Side pressure, dragging the rods against the collar or excessive leverage on the rods will weaken the system and reduce rod life or even result in unexpected breakage.

3.7 P3D Boretrak plug-in

P3D Boretrak plug-in software is loaded onto the USB drive supplied with the **Boretrak** system.

P3D Boretrak plug-in runs on a Windows PC and provides advanced processing functionality for the Rodded Boretrak and Cabled Boretrak.

The DRL file format allows seamless transfer of data between **P3D Boretrak plug-in**, **Boretrak Mobile** and other related Carlson software packages.

Hole layouts can be planned in **P3D Boretrak plug-in** and then exported to **Boretrak Mobile** as a DRL file containing coordinates and design information. This layout can be used as a guide when collecting Boretrak data in the field. All surveyed data can then be exported back from **Boretrak Mobile** to **P3D Boretrak plug-in** where all data can be reviewed, analysed and exported, or incorporated into printed reports.

See **P3D's** online help menu for full details of this processing software.

4 Using the PDA with the Rodded Boretrak system

Boretrak Mobile software runs on an Android PDA. **Boretrak Mobile** allows a project to be configured, controls communications with the Boretrak probe and helps you to manage Rodded Boretrak system operations. On completion of a survey, **Boretrak Mobile** can process the collected data, visualize it and export it into **P3D Boretrak** plug-in.

4.1 CT5 PDA

Boretrak Mobile is supplied pre-loaded on PDAs which are purchased as part of a Rodded Boretrak system. Currently the PDA supplied by Carlson is a Cedar CT5. In this case, the PDA is already set up ready to be used as part of a Rodded Boretrak system. No further configuration is required.

Note that if you have chosen to not purchase a PDA from Carlson, you will need to install Boretrak Mobile onto your own PDA. Please skip to section 4.2 for details.

Boretrak Mobile is an Android application. On the Carlson-supplied CT5 PDA, **Boretrak Mobile** is set as an icon on the Android home screen. Tap the icon to start **Boretrak Mobile**.

To view other applications on the PDA swipe left or right.

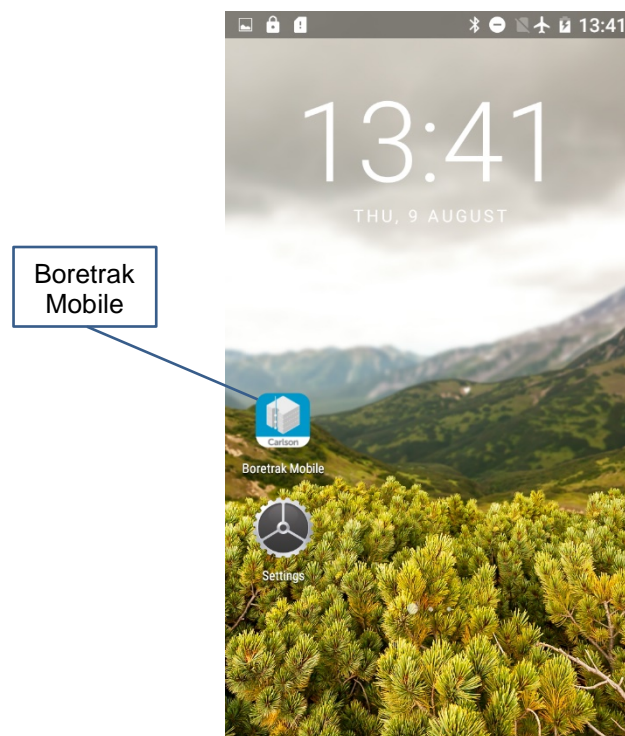


Figure 15 Android home screen

4.1.1 Hardware buttons

There are a number of hardware buttons present on the PDA (Figure 16).

The Power button is on the right-hand side of the PDA. Press and hold the Power button for a few seconds to turn the unit on.

Briefly press the Power button again to put the display to sleep. Press the Power button again to turn the unit back on from this 'sleep' state.

Hold down the Power button to turn the unit off. The "Power off/Restart/Airplane Mode" overlay appears. Tap Power off and the PDA will power down.

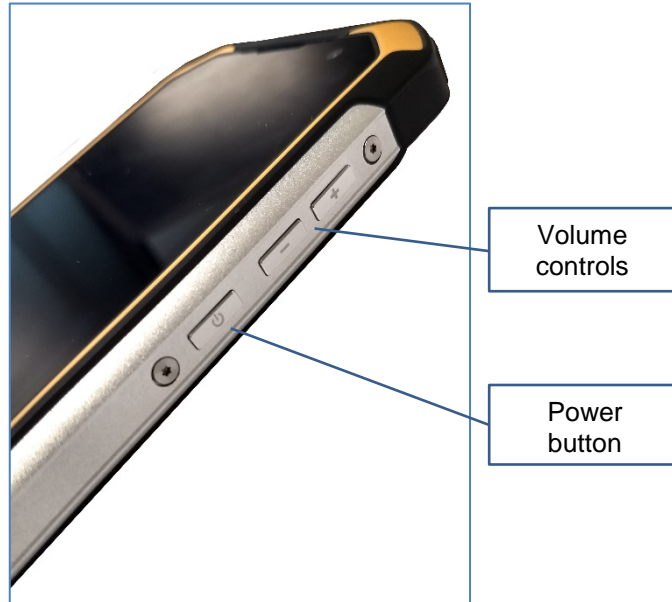


Figure 16 PDA hardware buttons

A volume controls are located on the right-hand side of the PDA above the power button. Note that it is the "Media volume" which controls the sound generated by **Boretrak Mobile**.

4.1.2 Touch buttons

Three 'touch buttons' below the screen assist with navigation around Android.

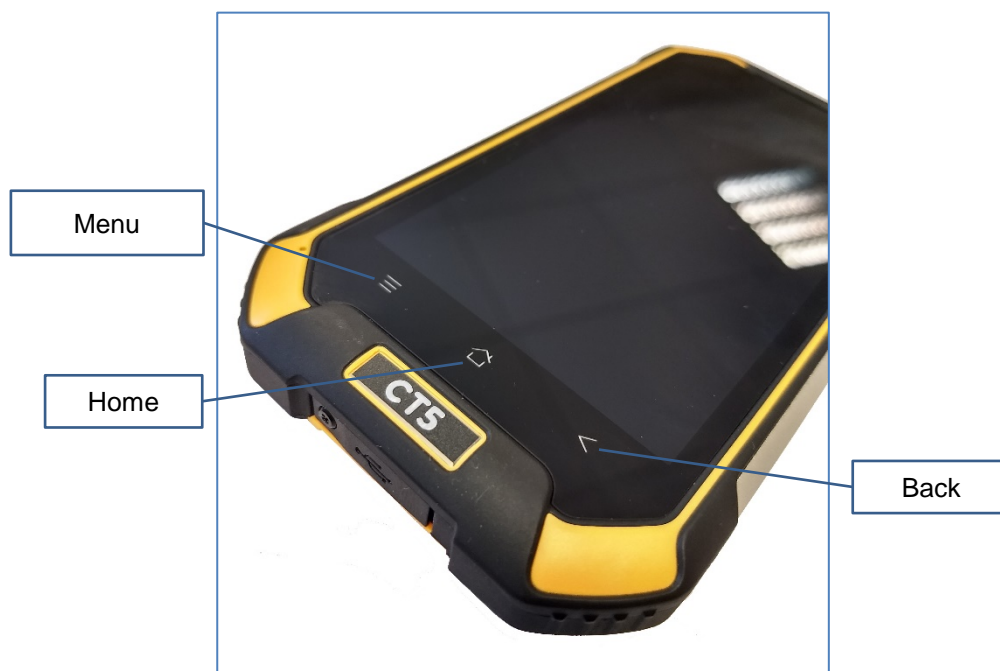


Figure 17 PDA function keys

- **Menu:** gives access to all apps on the PDA.
- **Home:** return to the Android home screen. Hold down the **Home** touch button to view all open applications.
- **Back:** executes a back/esc (to get back to the prior screen, close a window, etc). Within **Boretrak Mobile** this key performs the same function as the on-screen **Back** command.

4.2 Installing and updating Boretrak Mobile

If you have purchased a Carlson Rodded Boretrak system without a PDA then you will need to install the **Boretrak Mobile** application on your own PDA. Instructions for doing this are below.

Whether or not you are using your own PDA, future software updates may be released in which case you will also need to follow these instructions.

Please note that the details of the Android screens may change slightly depending on the model of PDA and version of Android that you are using.

The new installer is supplied as an *.APK file which is loaded onto the Carlson USB drive supplied with the Rodded Boretrak system. Attach the PDA to your PC using the USB cable. Copy the *.APK file from your PC to the root drive of the PDA (Figure 18).

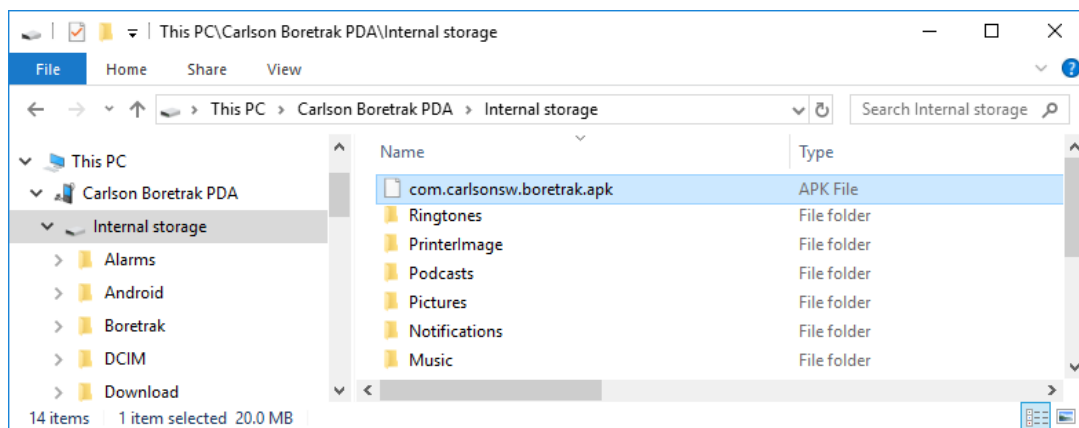
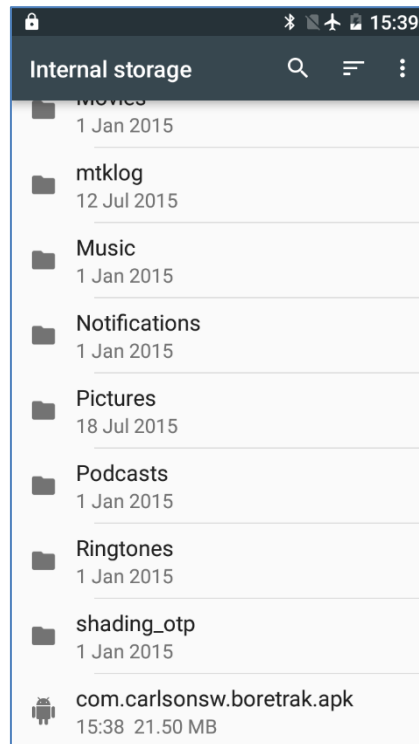


Figure 18 Locating the Boretrak Mobile installer

On the PDA, tap on the Settings icon and select **Storage and USB > Explore**. Within the Internal Storage screen, navigate to the *.APK file (Figure 19).



*Figure 19 *.APK file in Internal storage*

Tap the *.APK file. An installation screen appears (Figure 20).

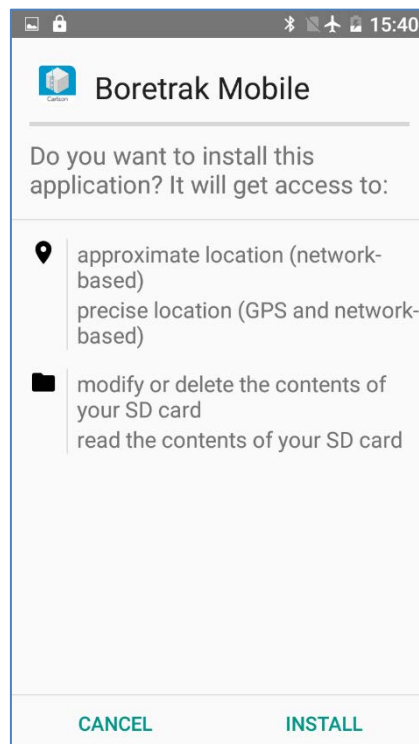


Figure 20 Installation screen

Tap **Install**.

An **Installing...** message appears followed by an **App Installed** message.

Tap **Done** to complete the installation process.

A message appears asking whether you wish to delete the installation package.

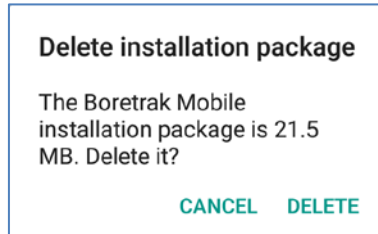


Figure 21 Delete installer?

Tap **Delete** to delete the *.APK file from your PDA.

4.3 Recommended settings in the PDA

On receipt of a new Rodded Boretrak system, no changes of any Android settings are required to run the PDA as part of the Rodded Boretrak system. However, it is recommended that you set the correct time and date for your region.

If you have purchased your own PDA you may wish to ensure that the settings below are reviewed and configured, depending on your operational requirements.

From the **Settings** icon:

- **Date and time:** either connect to a Wi-Fi network to synchronise time, or manually set the time and date to ensure all **Boretrak Mobile** projects are correctly time-stamped for your local region.
- **More > Aeroplane mode:** turn ON to disable mobile phone operation. This will help prolong battery life.
- **Wi-Fi:** turn OFF to prolong battery life.
- **Bluetooth:** must be ON to operate the PDA with the Rodded Boretrak.
- **Display > Adaptive brightness:** turn ON to ensure the screen automatically brightens when in sunlight. Turn OFF and reduce brightness to save battery power.
- **Display > Sleep:** set to Never to ensure the screen does not turn off during operations.
- **Accessibility > High contrast text:** turn ON or OFF to change text visibility if appropriate. Some screens in **Boretrak Mobile** may appear distorted in some circumstances if this setting is switched on.

Hold down the **Home** touch button to see all open applications. Close all other applications when using **Boretrak Mobile**, to prolong battery life and reduce the chance of conflict.

4.3.1 Android language settings

Boretrak Mobile is currently available in English, Spanish, German, Portuguese and Russian.

These languages are activated by setting the appropriate language in Android: **Application button > Settings > Language and Input > Language**.

Other languages can be set within Android, but since there are no other active translations of **Boretrak Mobile**, the application will appear in English.

4.4 Pairing a Boretrak probe with the PDA

The PDA and Boretrak probe communicate via a Bluetooth connection. For this connection to operate, the PDA and Boretrak probe have to be 'paired'.

When purchased as a complete system, the Rodded Boretrak system is supplied ready to use, with the Bluetooth connection already established. However, if you have purchased your own PDA or, if you are reconfiguring a PDA or swapping over a probe, you may find it necessary to establish / re-establish communications.

Tap **Settings > Bluetooth**. Ensure the Bluetooth function is turned ON.

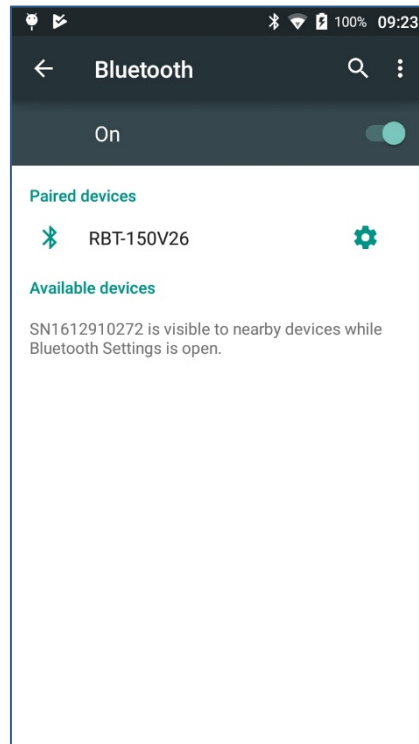


Figure 22 Ensuring the Bluetooth function is turned ON

The Boretrak probe is identified over Bluetooth by its serial number. In order to operate in conjunction with the PDA, the probe must be listed as a **Paired device** (Figure 22).

All Bluetooth devices which the PDA can see, but which are not paired, are listed as **Available devices**.

If your Boretrak probe is not listed as a paired device, but is an available device, tap the probe in the list of available devices.

A Bluetooth pairing request appears (Figure 23). A pairing code is required but this will be pre-entered by default. Tap **Pair**. The PDA pairs with the Boretrak probe. When successful, the probe is listed under **Paired devices**.

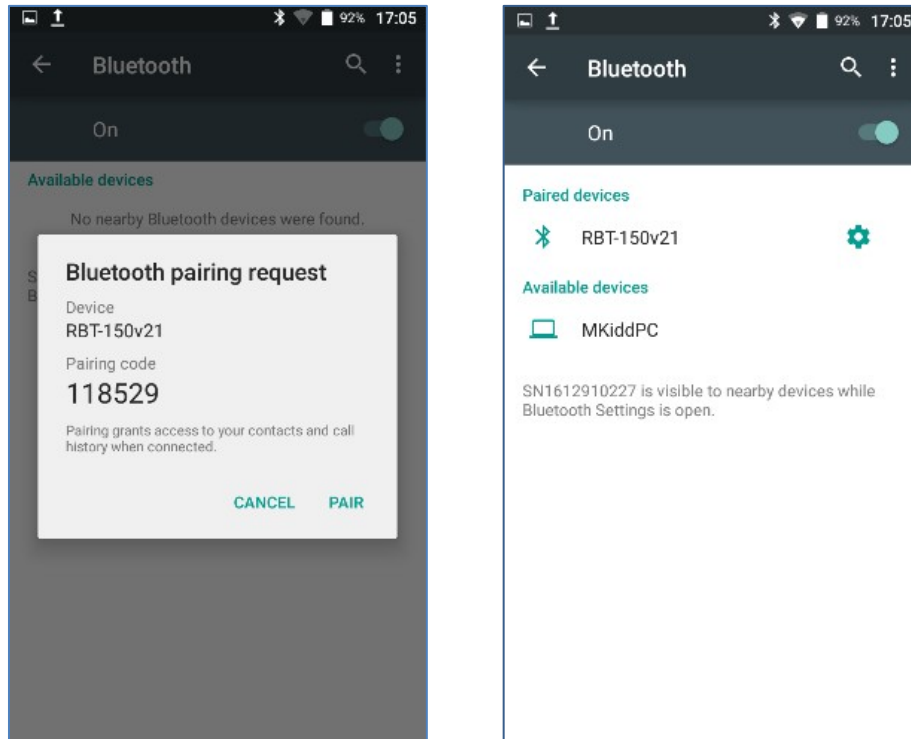


Figure 23 Pairing the PDA with the Boretrak probe

If the Boretrak probe is not listed under paired devices or under available devices, check that:

- The Bluetooth function is ON.
- The Boretrak probe is powered ON.
- The Boretrak probe is within 2 m of the PDA, with no obstructions between them.
- There are no obstructions over the Boretrak probe's LED window.

When you have checked each of these points, tap the menu (three dots) in the top right-hand corner of the screen and then tap **Refresh**.

4.5 Connecting to a PC and downloading data from the PDA

After a survey is complete and data has been downloaded from the Boretrak probe to the PDA, it is normally necessary to download data to a PC. This might be the whole project, or data files which have been exported.

There are a number of ways of connecting to a PC.

- **Bluetooth:** if your PC has Bluetooth capability, you can pair the PC with the PDA in the same way as the PDA is paired with the Boretrak probe. In the **Export** screen, use **Export + Share** to send data via Bluetooth.
- **Wi-Fi connection:** ensure that Wi-Fi is turned ON. Go to: **Settings > Wi-Fi > ON**. Data can be emailed over a Wi-Fi link using Android's Internet and email apps.
- **USB cable:** connect the PDA to a PC with the supplied USB cable. The PDA appears in Windows Explorer as **Carlson Boretrak PDA**.

Within the PDA, projects are located under: **Internal Storage > Boretrak > Projects > projectname**.

Within a project, exports are saved in the **Exports** folder.

5 Introduction to Boretrak Mobile

Boretrak Mobile is designed to offer control over the Rodded Boretrak system and to provide versatile functionality for collecting, managing and reviewing data collected during field operations.

Boretrak Mobile works closely with Carlson's **P3D Boretrak plug-in** package and can also to export files to third-party applications.

This section gives an overview of the operation of **Boretrak Mobile** software.

5.1 Boretrak Mobile interface

The **Boretrak Mobile** interface is consistent across each section of the software. Elements of the user interface are outlined in this section.

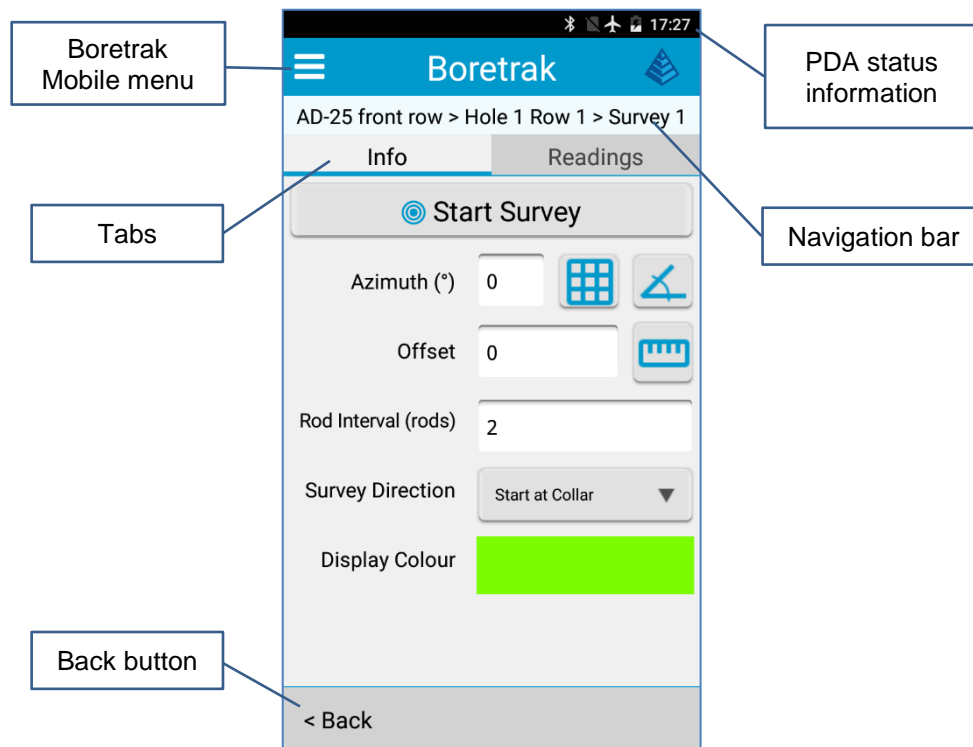


Figure 24 Boretrak Mobile user interface elements

- **Boretrak Mobile menu:** provides various, ever-present functionality. See section 6.
- **Navigation bar:** displays your current position within the software. This will consist of the project name, hole number and survey number.
- **Tabs:** use tabs to switch between multiple screens of related content.
- **Back:** back up one level. You can also use the **Back** touch button. See section 4.1.2.

5.2 Boretrak Mobile menu structure

The menus in **Boretrak Mobile** are outlined in Figure 25. The sections in this manual dealing with each menu item are shown.

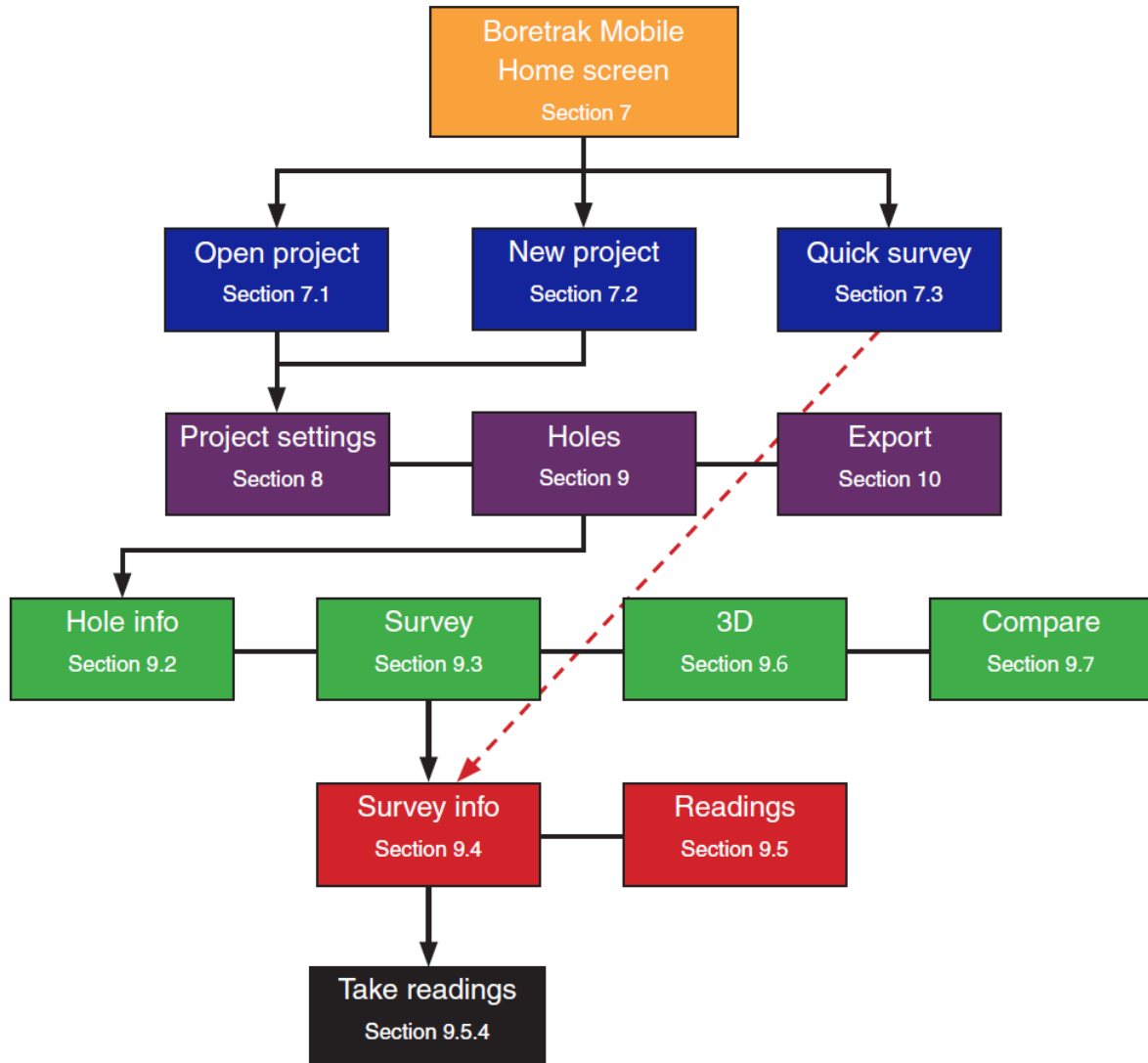


Figure 25 Boretrak Mobile menu structure

5.3 Boretrak Mobile project structure

Boretrak Mobile arranges data by Projects, Holes, Surveys and Readings.

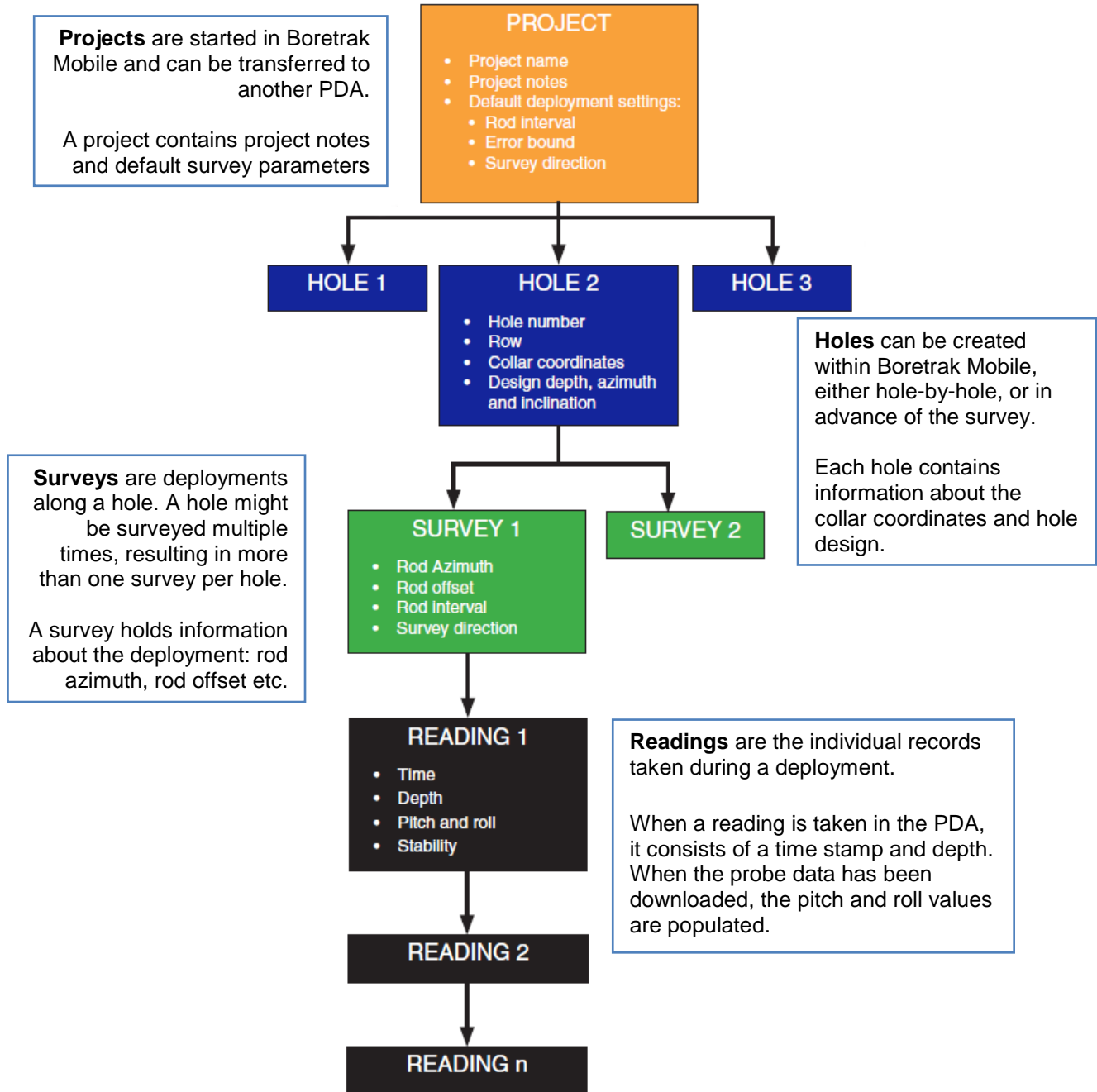


Figure 26 Boretrak Mobile project structure

6 Boretrak Mobile menu

In the top left of the **Boretrak Mobile** screen, tap the menu icon to show the **Boretrak Mobile** menu (Figure 27). This menu is accessible at all times except when a survey is in progress.

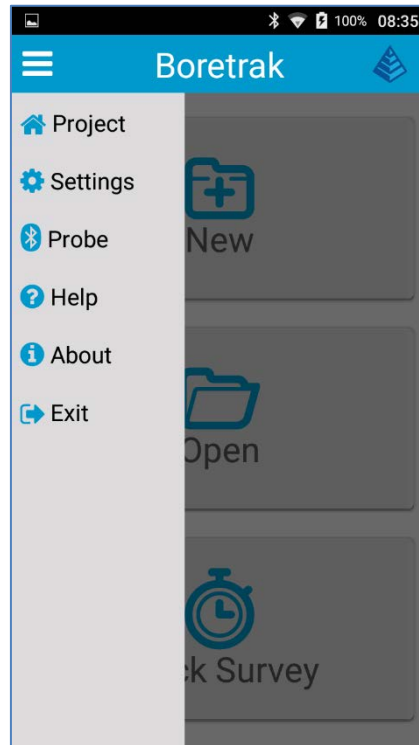


Figure 27 Boretrak Mobile menu

Available options in the **Boretrak Mobile** menu are:

- **Project:** Returns to the top level of the project structure (the **Project Settings**, **Holes** and **Export** screens).
- **Settings:** Offers a series of project settings. See section 6.1.
- **Probe:** Deals with connections to the Boretrak probe. See section 6.2.
- **Help:** Opens this user manual on the PDA.
- **About:** Shows information on the current version of **Boretrak Mobile** installed on the PDA.
- **Exit:** Exits **Boretrak Mobile**. A warning message appears: "Close the application?" Tap **Yes** to exit, or **No** to cancel.

6.1 Settings

The **Settings** menu option provides a number of options which affect how the software displays data and how a project is configured (Figure 28).

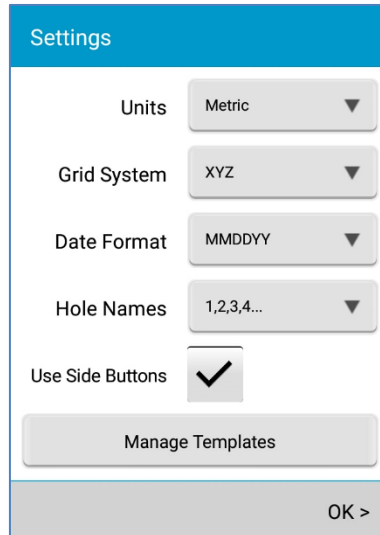
The screenshot shows a 'Settings' dialog box with a blue header. It contains five settings, each with a label and a dropdown menu: 'Units' set to 'Metric', 'Grid System' set to 'XYZ', 'Date Format' set to 'MMDDYY', and 'Hole Names' set to '1,2,3,4...'. Below these is a checkbox for 'Use Side Buttons' which is checked. At the bottom of the settings list is a 'Manage Templates' button. At the very bottom of the dialog is an 'OK >' button.

Figure 28 Settings menu

6.1.1 Units

Select units of measurement from:

- **Metric:** metres.
- **Imperial:** feet.

6.1.2 Grid system

Currently only the XYZ grid system is active.

- **XYZ:** Eastings, Northings, Height.

6.1.3 Date format

Select a date format from:

- **DDMMYY.**
- **MMDDYY.**

6.1.4 Hole names

Select a hole naming format from:

- **1, 2, 3, 4, 5...:** running hole numbers.
- **1, 2, 3, 1, 2...:** running hole numbers within each row.
- **1, 2, 3, 1a, 2a, 3a...:** hole number in row + row identifier, shown as a letter.

- 1/1, 2/1, 3/1, 1/2, 2/2...: hole number in row / row number.
- 1/1, 2/1, 3/2, 4/2, 5/3...: running hole number / row number.

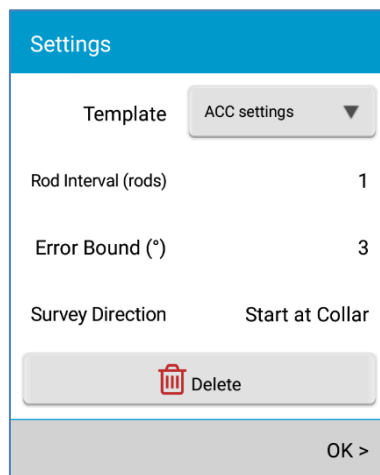
6.1.5 Use Side Buttons

Some PDAs have hardware buttons which can be activated to take Boretrak readings during a survey. Tick the **Use Side Buttons** check box to activate these side buttons. During a survey, in the **Take Readings** screen, the buttons can be used as an alternative to the green on-screen **Read** button.

Note that the CT5 PDA does not have side buttons which can be used for this purpose.

6.1.6 Manage templates

If you have set up and saved job templates, tap the **Manage Templates** button to review or delete a selected template. The **Template Settings** window opens (Figure 29)



The screenshot shows a 'Settings' window with a blue header. Below the header, there is a 'Template' label and a dropdown menu currently showing 'ACC settings'. Underneath, there are three settings: 'Rod Interval (rods)' with a value of '1', 'Error Bound (°)' with a value of '3', and 'Survey Direction' with a value of 'Start at Collar'. At the bottom of the settings list is a grey button with a red trash icon and the text 'Delete'. At the very bottom of the window is a grey button with the text 'OK >'.

Figure 29 Template settings

From the **Template** drop-down list, select a template.

The elements in the template are displayed.

Tap **Delete** to delete the template.

Tap **OK** to return to the **Settings** screen.

6.2 Probe

The **Probe** menu option provides tools to interact with the probe. If the PDA is not already connected to the probe when you tap the **Probe** menu option, a **Select Probe** window appears (Figure 30).

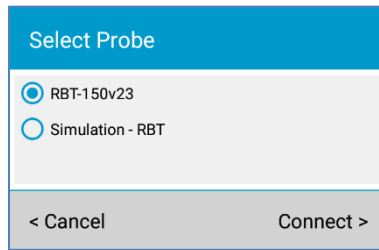


Figure 30 Select probe window

Select the correct probe and tap **Connect**. **Boretrak Mobile** is now connected to the selected Boretrak probe. Tap the Probe menu option again to open the **Probe Options** window (Figure 31).

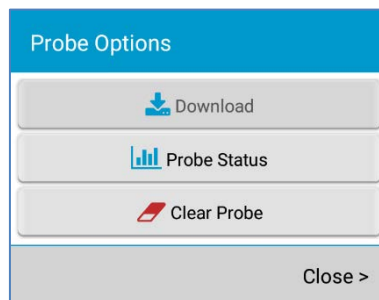


Figure 31 Probe options

The **Probe Options** window contains functions related to the Boretrak probe itself.

Note that a **Simulation – RBT** option is also available to connect to in the **Select Probe** window. This option allows you to use Boretrak Mobile for practice or training when you do not have a probe available. When simulating data collection, the inclinometers in your PDA are used to simulate those in the Boretrak.

6.2.1 Download

This option is only active if there is data in the probe which has not been downloaded. Tap **Download** to transfer data from the probe into the current **Boretrak Mobile** project. A check is carried out to ensure all data has transferred to the PDA without error. If this check is passed, the data on the probe is deleted. If the check fails, a message appears: "Download failed. Do you want to try again?".

Downloaded data is automatically assigned to the appropriate holes and readings recorded on the PDA during a deployment.

For normal operations, the **Download** option should not be required, as downloading occurs as part of the general operational workflow. If you have not downloaded data during the operation, ensure that you use this option before exiting the project so that all surveyed data is saved on the PDA.

6.2.2 Probe Status

Displays live information from the Boretrak probe (Figure 32).

Probe Status	
Firmware	F-5911-3010-01
Serial Number	150V26
Memory	(2107 mins) 96% ●
Battery	89% ●
Usage	1.10:57:12
Pitch	-27.4
Roll	5.1
Azimuth	79.1
Inclination	27.9
Position	-0.46 0.08 -0.88
PDA Space	2.06 GB ●
Close >	

Figure 32 Probe status

The displayed fields are:

- **Firmware:** probe firmware version.
- **Serial number:** probe serial number. This will match the number stamped on the Boretrak probe rod adaptor.
- **Memory:** available memory in the probe. The display shows this as a percentage and also calculates the number of minutes logging that it will take to fill the remaining memory. If there is 100% of the memory available, the probe can log for 2184 minutes (over 36 hours) before the memory is full.

The green icon turns orange when there is less than 60 minutes memory available. The icon turns red when there is less than 30 minutes memory available.

When the probe memory is full, the LEDs on the probe flash slowly. No more data is saved until the data stored in the probe is downloaded or cleared.

- **Battery:** the charge left in the Boretrak probe batteries. The green icon turns orange when there is less than 25% charge remaining. The icon turns red when there is less than 10% charge remaining.
- **Usage:** the total time that the probe has been powered ON during its lifetime, shown in days, hours, minutes and seconds.
- **Pitch:** the inclination perpendicular to the rod rack, assuming the probe is connected to the rods.
- **Roll:** the inclination along the line of the rod rack, assuming the probe is connected to the rods.
- **Azimuth:** the heading of the probe relative to the rod rack, assuming the probe is connected to the rods.
- **Inclination:** the angle of the probe relative to gravity. 0° is vertically down, 90° is horizontal and 180° is vertically up.
- **Position:** calculated X, Y, Z position of the end of the probe, assuming a one metre deployment.
- **PDA Space:** available storage space in the PDA. The green icon turns red when there is less than 10 MB available.

6.2.3 Clear Probe

Clears all data from the probe.

For normal operational use, this option should not be used, as all data should be cleared automatically when it has been downloaded in the correct sequence. Any data left in the probe because it has not been downloaded will not have been applied to a project. Use with caution.

7 Home screen

The **Home** screen appears when the software is started (Figure 33).

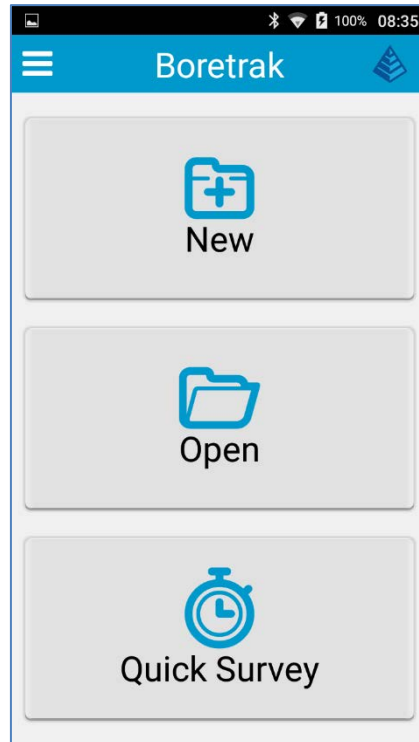


Figure 33 Home screen

Three buttons offer choices to start working with **Boretrak Mobile**:

- **New:** Create a new **Boretrak Mobile** project. See section 7.2.
- **Open:** Open a list of existing **Boretrak Mobile** projects to resume working on one, or to review or delete a project. See section 7.1.
- **Quick Survey:** Start a **Boretrak Mobile** project with default settings and minimum set-up. See section 7.3.

7.1 Open project

Tap **Open** to open a list of all **Boretrak Mobile** projects on the PDA (Figure 34).



Figure 34 List of Boretrak Mobile projects

Each project is listed in order of the date it was last modified.

To open an existing project, tap on the appropriate project on the list. The **Project Settings** screen appears: see section 8.

To delete a project, tap and hold the appropriate project. A **Project Delete** window appears (Figure 35).

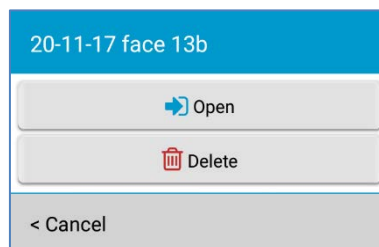


Figure 35 Project Delete window

Tap the **Open** button to open the selected project.

Tap the **Delete** button to delete the selected project. You are asked "Are you sure you wish to delete this project?". Tap **Yes** to delete the project.

7.2 New project

Tap **New** to start a new **Boretrak Mobile** project (Figure 36).

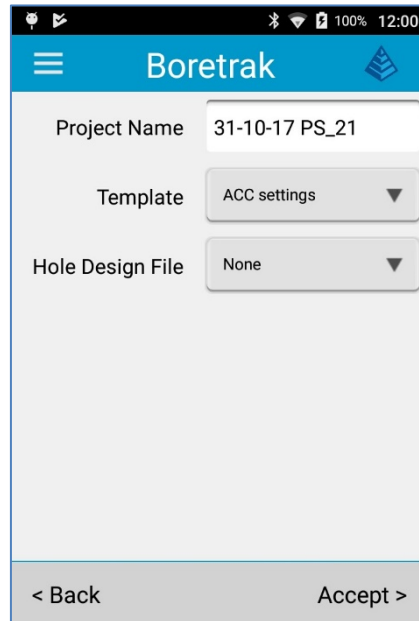


Figure 36 Creating a new project

Enter a **Project Name**. By default, this is the current date.

If required, select an existing template from the **Template** drop-down list. If required, select an existing hole design file (HDF) from the **Hole Design File** drop-down list.

To create the new project, tap **Accept**. The **Project Settings** screen appears: see section 8.

7.2.1 Hole Design Files

An HDF file can be created in **P3D Boretrak plug-in**, or other PC software package, and then used in **Boretrak Mobile** as a guide to the field survey operation. In the PDA, copy the HDF file to **Internal Storage > Boretrak > External HDF**. The **Hole Design File** drop-down list shows all files within that folder.

An HDF file can be created and imported into **Boretrak Mobile** either as a *.DRL file or a *.CSV file.

A *.DRL file can be exported from P3D Boretrak plug-in. This format is transferrable across a number of Carlson software packages. The *.DRL file can contain hole names, coordinates and design information as well as Boretrak survey data.

Once data has been collected with the Rodded Boretrak, an updated *.DRL file, now containing survey data, can be re-exported back into P3D Boretrak plug-in for further analysis and combination with other data.

A *.CSV file just contains coordinate and design information about a hole. This should be formatted as below:

```
2,1,25008.973,5008.194,994.650,0,5,20
```

Where the fields refer to:

```
hole, row, X, Y, Z, design_azimuth, design_inclination, design_depth
```

7.3 Quick Survey

The **Quick Survey** option is intended to provide the quickest method of surveying a series of sequential holes. Default deployment settings are used, and minimum configuration is required.

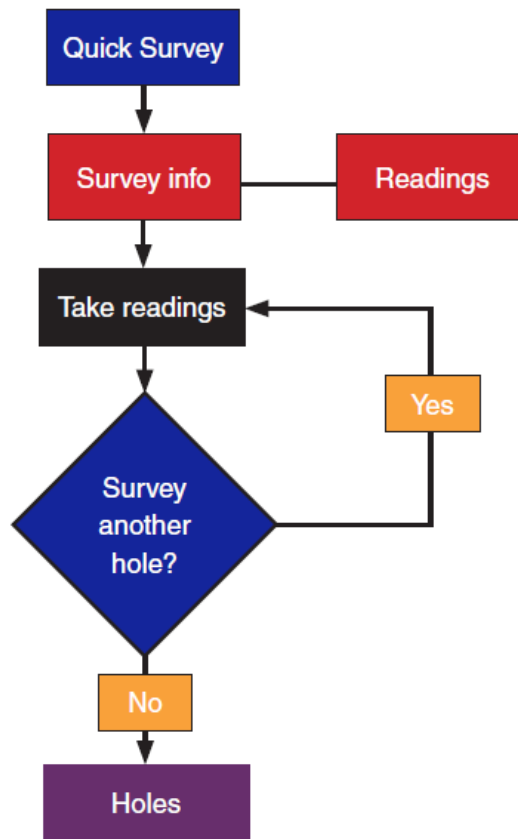


Figure 37 Quick survey flowchart

The **Quick Survey** option skips directly to a survey. The **Survey info** screen appears: see section 9.4.

The project is given a default name of the day's date.

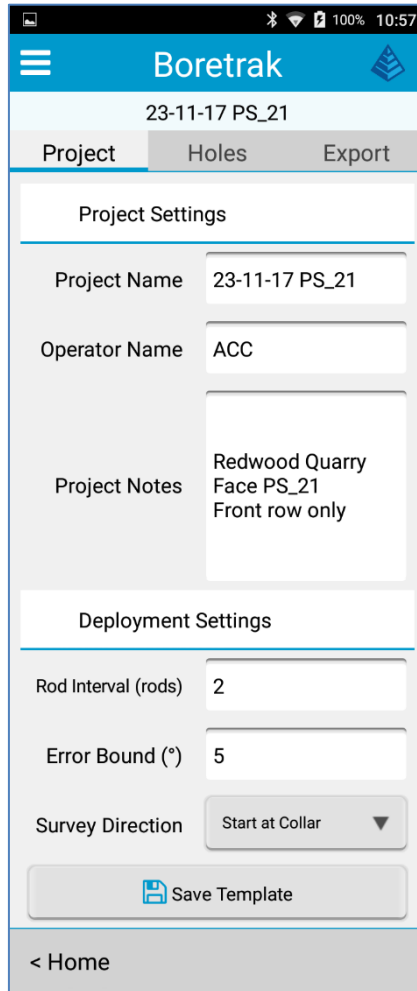
Default deployment settings are used, although these can be changed for each survey. Holes are numbered sequentially from Hole 1.

When the sequence of holes is completed, you will revert to the main **Boretrak Mobile** structure. You can resume the survey or review the data and configuration and edit as required.

A full survey carried out using the **Quick Survey** option is described in section 11.6.

8 Project Settings screen

The **Project Settings** screen (Figure 38) offers text entry boxes to create notes on the project and to set up default parameters for all Boretrak deployments within the project.



The screenshot shows the Boretrak application interface. At the top, there's a blue header with the Boretrak logo and a menu icon. Below the header, the current project name "23-11-17 PS_21" is displayed. There are three tabs: "Project" (selected), "Holes", and "Export". The "Project Settings" section contains fields for "Project Name" (23-11-17 PS_21), "Operator Name" (ACC), and "Project Notes" (Redwood Quarry Face PS_21 Front row only). The "Deployment Settings" section includes "Rod Interval (rods)" (2), "Error Bound (°)" (5), and "Survey Direction" (Start at Collar). A "Save Template" button is located below the deployment settings. At the bottom, there is a "< Home" button.

Figure 38 Project Settings

Other screens directly accessible from the **Project Settings** screen via the upper tabs are:

- **Holes:** see section 9.
- **Export:** see section 10.

The settings are arranged into two groups.

- **Project Settings.**
- **Deployment Settings.**

8.1 Project Settings

Project Settings offers the following categories:

- **Project Name:** edit the existing text to change the name of the project.
- **Operator Name:** enter a value as required for reports and project records.
- **Project Notes:** enter a value as required for reports and project records.

8.2 Deployment Settings

Deployment Settings offers the categories listed below. These become the default deployment settings for each survey in the project. However, if required, these values can be altered on a hole-by-hole basis in the **Survey Info** screen. See section 9.4.

- **Rod Interval:** the distance between each deployment during a survey. This is measured in rods, each of which is one metre long. The default rod interval is 2.
- **Error Bound:** enter a value in degrees. If the inclination measured in successive Boretrak readings is greater than the error bound, the values will be displayed in yellow in the **Readings** screen. If the error bound is exceeded, you may wish to consider whether the collected Boretrak data is reliable. Readings exceeding the error bound could indicate that the probe was moving when the reading was taken or that the probe was misaligned in the hole.
- **Survey Direction:** Select **Start at collar** or **Finish at collar**. By default, Rodded Boretrak operations are carried out starting at the collar and deploying the probe until it hits the end of the hole. This is the **Start at collar** option. Where the **Finish at collar** option is selected, deploy the probe to the end of the hole then survey the hole as the probe is recovered to the collar. See section 11.6.4, for further details.

If you regularly use the same default values, tap the **Save Template** button. The **Save Template** window opens (Figure 39).

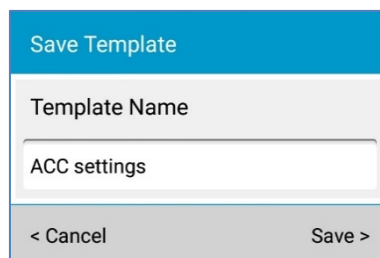
The image shows a mobile application window titled "Save Template". It has a light blue header bar with the title. Below the header is a white box with a label "Template Name" and a text input field containing the text "ACC settings". At the bottom of the window are two buttons: "< Cancel" on the left and "Save >" on the right.

Figure 39 Save Template window

Enter a template name. Tap **Save** to save the template.

When creating new projects in the future, the template is available from the **Template** drop-down list. See section 7.2.

9 Holes

9.1 Holes screen

The **Holes** screen displays a list of holes within the project (Figure 40). Use the **Holes** screen to add holes, delete holes, review holes that have been surveyed, or select holes to survey or resurvey.

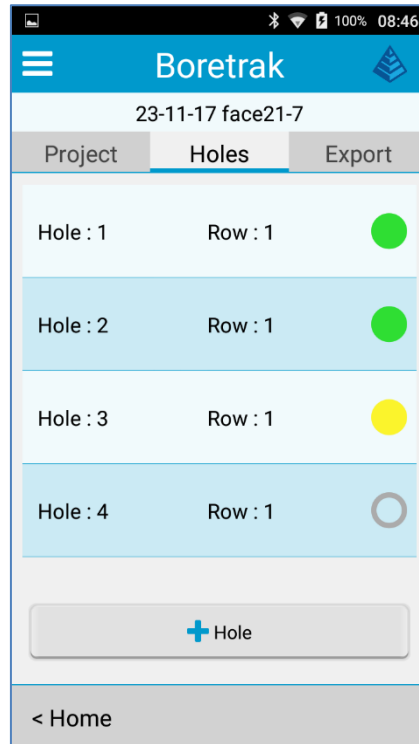






Figure 40 Holes screen

Other screens directly accessible from the **Holes** screen via the upper tabs are:

- **Project:** see section 8.
- **Export:** see section 10.

Each hole in the hole list is displayed, showing:

- **Hole.**
- **Row.**
- A **status icon**: this shows the status of surveys in the hole.

	No survey carried out in hole.
	Survey carried out: awaiting data download.
	Survey carried out: data has been downloaded.
	Survey carried out and data downloaded - some readings display 'out of range'.*

* This indicates that the Boretrak has been used between 45° and 135° inclination which is outside of the standard range of the system.

9.1.1 Add Hole

Tap the **Add Hole** button to add a single hole to the project. The **Add Hole** window appears (Figure 41).

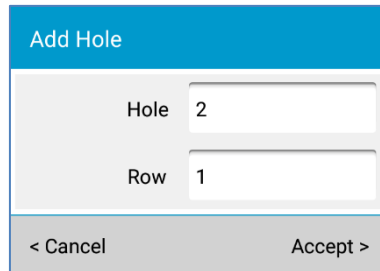
The 'Add Hole' window has a blue header with the title 'Add Hole'. Below the header, there are two input fields: 'Hole' with the value '2' and 'Row' with the value '1'. At the bottom, there are two buttons: '< Cancel' on the left and 'Accept >' on the right.

Figure 41 Add hole window

Review the **Row** and **Hole Number** values and edit as required. Tap **Accept** to add the hole to the project.

Note that the Hole / Row combination must be unique for the new hole to be accepted.

Note that holes can be added to the project in three ways:

- As above, use the **Add Hole** button to manually add holes prior to carrying out Boretrak deployments.
- Import an HDF file containing designed hole layouts. Select an *.DRL or *.CSV file when creating a new project: see section 7.2.
- Automatically add subsequent holes to the list during a deployment: see section 9.5.4.

9.1.2 Select Hole

Tap a hole to select it for review or to carry out a survey from that hole. The **Hole Info** screen appears: see section 9.2.

9.1.3 Delete Hole

To delete a hole, tap and hold the appropriate hole. The **Hole Delete** window appears (Figure 42).

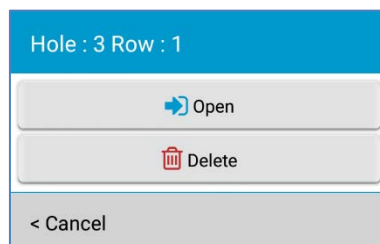
The 'Hole Delete' window has a blue header with the text 'Hole : 3 Row : 1'. Below the header, there are two buttons: 'Open' with a blue arrow icon and 'Delete' with a red trash can icon. At the bottom, there is a button: '< Cancel'.

Figure 42 Hole Delete window

Tap the **Delete** button to delete the selected hole. A message appears: "Are you sure you want to delete this hole?". Tap **OK** to delete the hole.

Tap the **Open** button to open the selected hole for review or to carry out a survey from that hole. The **Hole Info** screen appears: see section 9.2.

9.2 Hole Info

The **Hole Info** screen contains editable information about the selected hole (Figure 43).

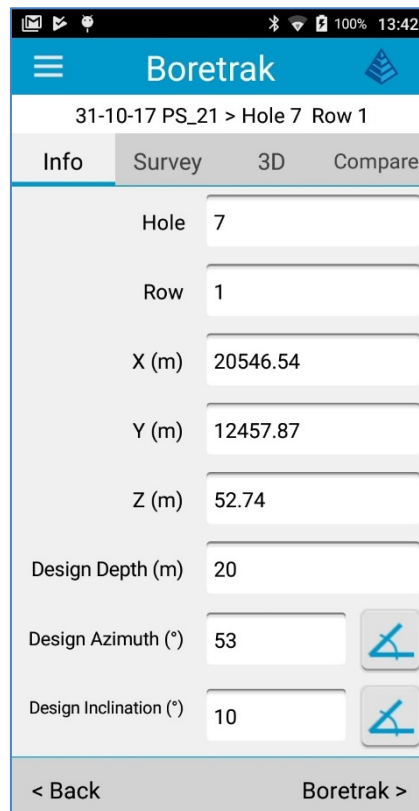


Figure 43 Hole Info screen

Other screens directly accessible from the **Hole Info** screen via the upper tabs are:

- **Survey:** see section 9.3.
- **3D:** see section 9.6.
- **Compare:** see section 9.7.

The values in the **Hole Info** screen may have been imported in an HDF file. Alternatively, they may be generated by default when holes are added in **Boretrak Mobile**. In either case, all fields are editable. The following values are displayed:

- **Hole:** all holes are assigned an identifying name or number. By default this is a numeric value, sequentially incrementing from hole '1'. However, user-defined names can be entered using alpha-numeric characters. Bear in mind when naming or renaming holes:
 - The Hole / Row combination must be unique for the new hole to be accepted.
 - If you are exporting data to a third party package, can that package only accept holes which use numeric values?
 - If you want to match surveys exported from Boretrak Mobile with holes already existing in P3D Boretrak plug-in, the names of the two sets of holes must be identical if the automatic matching process is to work.
 - If you have imported your holes in an *.DRL file, the Hole and Row values are not editable.

If using a hole name format other than **1,2,3,4...** (see section 6.1.4) this is reflected in the **Hole** field.

- **Row:** all holes are assigned a row. By default this is row 1.
- **X,Y,Z:** the 3D coordinates of the hole collar.
- **Design Depth:** the length of the design hole.
- **Design Azimuth:** the heading of the design hole.
- **Design Inclination:** the inclination of the design hole. 0° is vertically down, 90° is horizontal and 180° is vertically up.

9.3 Survey

If no surveys have yet taken place in a hole, the **Survey** tab forwards you directly onto the **Survey Info** screen (see section 9.4), with the assumption that you are about to begin the first survey in the selected hole. When one or more surveys are completed within a specific hole, the **Survey** screen shows the list of surveys which have been carried out (Figure 44).

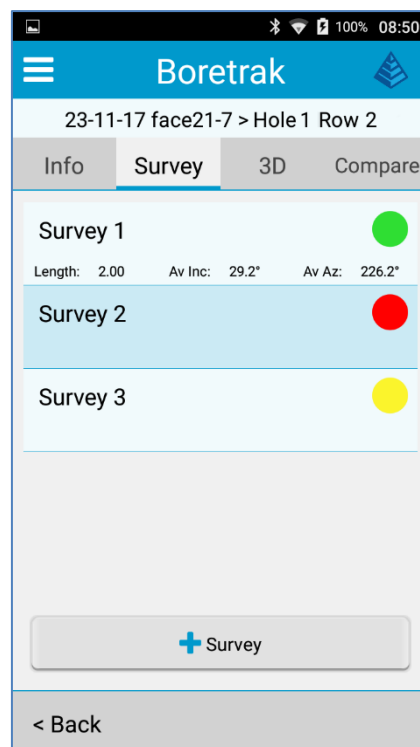





Figure 44 Survey screen

Other screens directly accessible from the **Survey** screen via the upper tabs are:

- **Hole Info:** see section 9.2.
- **3D:** see section 9.6.
- **Compare:** see section 9.7.

Each survey in the list is displayed showing:

- **Survey number.**
- **A survey summary:** if a survey is complete and the relevant data has been downloaded, a summary of the survey is displayed. This shows:
 - **Length:** the total length which was surveyed.
 - **Av Inc:** the average inclination of the hole survey.
 - **Av Az:** the average azimuth of the hole survey.
- **A status icon:** this shows the status of each survey:

	Survey carried out: awaiting data download.
	Survey carried out: data has been downloaded.
	Survey carried out and data downloaded - some readings display 'out of range'.*

* This indicates that the Boretrak has been used between 45° and 135° inclination which is outside of the standard range of the system.

9.3.1 Add Survey

To add an additional survey of the current hole, tap the **Add Survey** button. The **Survey Info** screen appears, ready to start a new survey in the current hole.

9.3.2 Select Survey

Tap a survey to select it for review or to resume the deployment. The **Survey Info** screen appears: see section 9.4.

9.3.3 Delete Survey

To delete a survey, tap and hold the appropriate survey. The **Survey Delete** window appears (Figure 45).

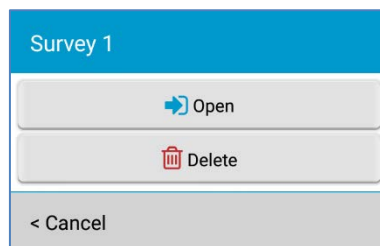


Figure 45 Survey Delete window

Tap the **Delete** button to delete the selected hole. A message appears: "Are you sure you want to delete this survey?". Tap **OK** to delete the survey.

Tap the **Open** button to open the selected hole for review or to resume the survey. The **Survey Info** screen appears: see section 9.4.

9.4 Survey Info

The **Survey Info** screen contains information about the selected survey (Figure 46). From here you can begin, or resume, a survey of the current hole.

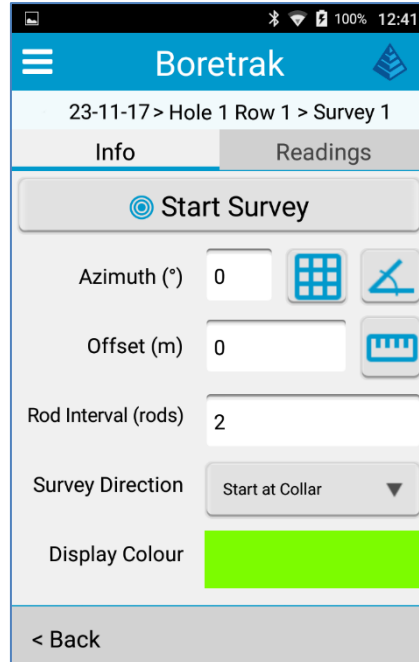


Figure 46 Survey Info screen

The other screen directly accessible from the **Survey Info** screen via an upper tab is:

- **Readings:** see section 9.5.

Tap the **Start Survey** button to begin a survey using the settings displayed. The deployment process begins: see section 9.5.4.

Note that if you are returning to view an existing survey, the **Start Survey** button is replaced by a **Resume Survey** button. This option allows you to continue surveying a hole if you were interrupted in the middle of a deployment. Tap the **Resume Survey** button to continue surveying a hole. The deployment process continues from where you left off: see section 9.5.4.

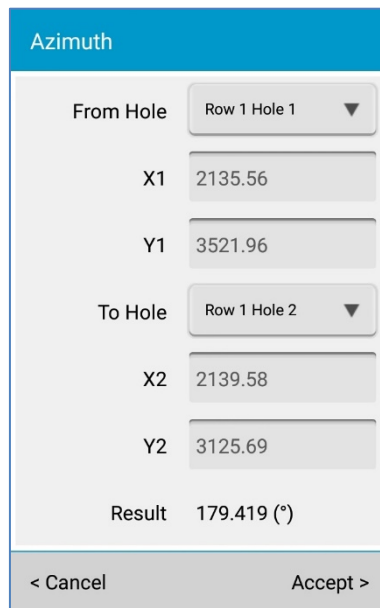
The **Survey Info** screen displays the following values:

- **Azimuth:** the rod azimuth. See section 11.3, for an explanation of the rod azimuth. By default, this is set at 0°. Enter a surveyed value if known. This can be entered before or after the deployment. Alternatively, the rod azimuth can be entered in **P3D Boretrak plug-in** software during post-processing.

Next to the **Azimuth** data entry box are two buttons which provide other options for entering the azimuth.



The **Calculate** button opens an **Azimuth** window (Figure 47). This function allows you to determine the azimuth between two points.



Azimuth

From Hole: Row 1 Hole 1 ▼

X1: 2135.56

Y1: 3521.96

To Hole: Row 1 Hole 2 ▼

X2: 2139.58

Y2: 3125.69

Result: 179.419 (°)

< Cancel Accept >

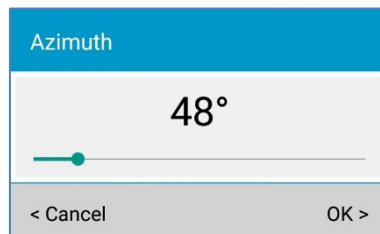
Figure 47 Azimuth window

Use the **From Hole** and **To Hole** drop-down lists to select two holes in the project. An azimuth is calculated between the X,Y coordinates of the two holes. Alternatively, select **New Coordinate** from the drop-down list and manually enter a coordinate into the X, Y text boxes.

The result is displayed at the bottom of the **Azimuth** window. Tap **Accept** to transfer this result to the **Survey Info** screen. Tap **Cancel** to reject the result.



The **Angle** button opens an **Azimuth** window (Figure 48). This function provides a slider which can be used as an alternative way of entering the rod azimuth.



Azimuth

48°

< Cancel OK >

Figure 48 Azimuth slider

Use the slider to select the appropriate azimuth. Tap **OK** to transfer this result to the **Survey Info** screen. Tap **Cancel** to reject the result.

- **Offset:** the rod offset. This value should be entered at the end of a deployment when the Boretrak probe is at the end of the hole. The exception to this is a survey using the **Finish at Collar** survey direction, where the offset should be entered at the start: see section 11.6.4. The value can be edited later, either in **Boretrak Mobile** or in **P3D Boretrak plug-in** software.



The **Offset** button offers an alternative way of entering a value. This function provides a drop-down list of pre-defined offsets (Figure 49). The offset is expressed as a fraction of the rod interval. For example, if you are using a 2 m rod interval, $\frac{1}{4}$ will equate to half a rod.



Figure 49 Offset drop down

Select the required rod interval. Tap **OK** to accept the result. Tap **Cancel** to reject the result.

- **Rod interval:** the distance between each successive Boretrak reading along the hole. This is a distance measured in rods (or in metres, as each rod is one metre long). Most commonly, use a rod interval of 2 and deploy two rods between each reading.
- **Survey direction:** by default, the Rodded Boretrak is deployed using the **Start at Collar** option. Choose **Finish at Collar** from the drop-down list to carry out a survey from the end of the hole back to the collar: see section 11.6.4.
- **Display colour:** sets the colour that the survey is displayed in when viewing the **3D** screen: see section 9.6. If multiple surveys are carried out in one hole, it is useful to differentiate the surveys by colour. Tap the colour box to set the colour of the survey.

9.5 Readings

The **Readings** screen displays all the readings taken during the selected survey (Figure 50).

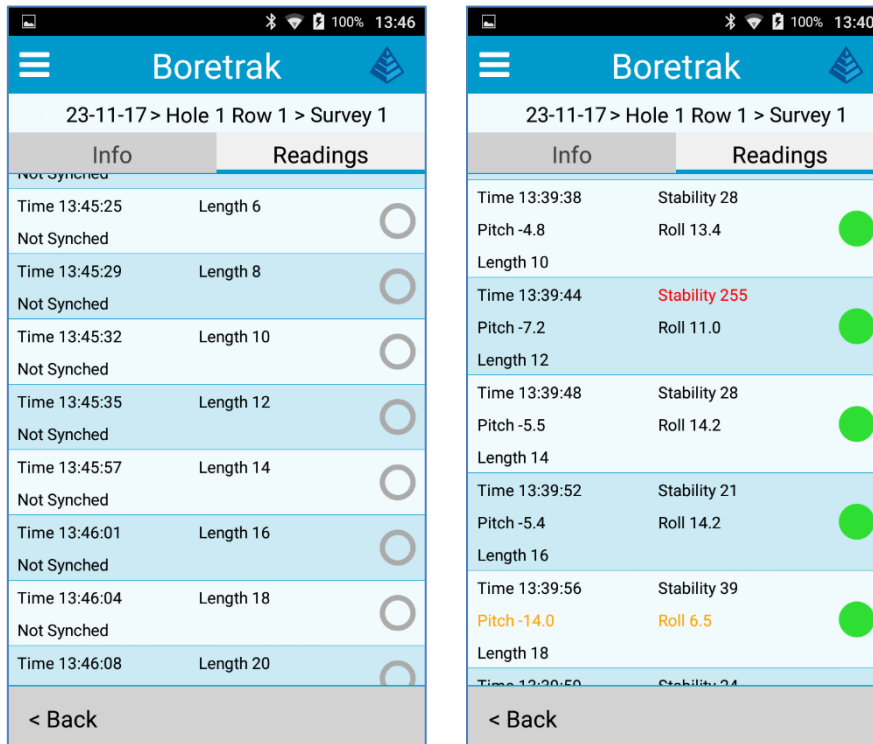


Figure 50 Readings screen before (left) and after (right) data download

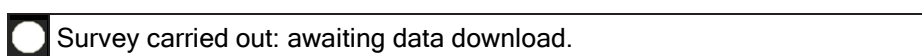
The other screen directly accessible from the **Readings** screen via an upper tab is:

- **Survey Info:** see section 9.4.

9.5.1 Readings before data download

Before any data is downloaded from the Boretrak probe, each reading is listed without sensor data (Figure 50 – left). Each reading is displayed along with:

- **Time:** the PDA time at which the reading was recorded.
- **Length:** the distance along the hole at which the reading was recorded. This is calculated by multiplying the number of readings by the rod interval. Note that this is the assumed length. This value may be incorrect if multiple readings were taken at one location, if readings were missed or if the wrong rod interval was used at any point in the deployment.
- **Not synched:** this label flags all readings until corresponding data is downloaded from the Boretrak probe.
- **A status icon:** this shows the status of each reading in the survey. Prior to data being downloaded, all readings show the same icon:



9.5.2 Readings after data download

After data has been downloaded from the Boretrak probe, each reading is populated with the matching data from the probe (Figure 50 – right). In addition to the values detailed above, each listed reading now displays:

- **Stability:** a measure of the stability of the probe when the reading was taken. '0' is most stable; '255' is the least stable. Three samples of the Boretrak probe's sensors are recorded when a reading is taken. The most stable sample is used.

If you encounter issues with Boretrak data – for example, a kink in the track of the hole - you may refer to the stability reading to give you a clue about the source of the problem. The greater the value (ie the closer it is to 255) the more movement was experienced by the probe while the reading was in progress.



If the stability value is 255, then it is displayed in red.

- **Pitch and Roll:** these values indicate the angle of the probe relative to gravity. **Pitch** is the inclination perpendicular to the rod stack; **Roll** is the inclination along the line of the rod stack.

These values are for display and troubleshooting purposes only. The final inclination and azimuth of the Boretrak probe are calculated directly from raw accelerometer values.

When the **Error Bound** value is exceeded, the **Pitch** and **Roll** are displayed in yellow.

- **Depth:** the distance along the hole at which the reading was recorded.
- **A Status icon:** this shows the status of each reading in the survey.

	Reading synched.
	Reading synched - 'out of range'.*

* This indicates that the Boretrak has been used between 45° and 135° inclination which is outside of the standard range of the system.

9.5.3 Delete a reading

To delete a reading, tap and hold the appropriate reading. The **Reading Delete** window appears (Figure 51).

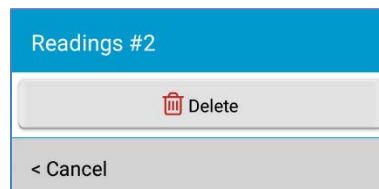


Figure 51 Reading Delete window

Tap the **Delete** button to delete the selected reading. Note that you should only consider deleting a reading if you know that multiple readings were taken at one location in the deployment, or if you know that the probe was moving while the reading was being taken.

9.5.4 Take Readings

The **Take Readings** screen is active during a deployment and allows you to take readings when the Boretrak probe is in the hole.

After tapping the **Start Survey** (or **Resume Survey**) button, if the PDA is not connected to the probe, the **Select Probe** window appears. Select the correct probe and tap **Connect**. At this point, the Boretrak probe begins logging data. The LED flashes red every second to indicate logging is in progress. Logging continues until the probe is downloaded or cleared.

A message appears: "Deploy the probe into the start of the hole".

Deploy the Boretrak probe and first rods into the collar. Tap **OK** to continue to the **Take Readings** screen (Figure 52).

If you are resuming a survey, initially a message appears: "Do you wish to resume this survey from the last reading?".

Tap **Yes** to continue. A message appears: "Deploy the probe for the next reading". Deploy the probe to the next deployment position beyond where the last reading was taken. Tap **OK** to continue to the **Take Readings** window (Figure 52). You must be able to correctly relocate the probe in the correct position. If you are in any doubt about where the next deployment should be, start a new survey.

In the **Take Readings** window, tap the green **Read** button to take a reading at the appropriate points along the hole. After each reading, **Boretrak Mobile** beeps for 3 seconds and a progress bar appears.

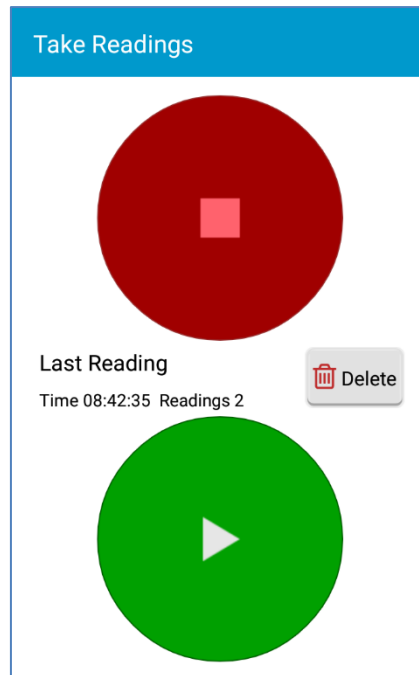


Figure 52 Take Readings screen

When the reading is complete, the **Last Reading** information is updated:

- **Time:** shows the PDA time of the last reading.
- **Readings:** shows the number of readings that have been taken during the survey. The length of the hole is calculated by multiplying the number of readings by the **Rod Interval**.

If a reading was taken erroneously, tap the **Delete** button.

A message appears: "Are you sure you wish to delete the last reading?". Tap **Yes** to delete the last reading. Tap **No** to retain the last reading.

On completion of the survey (in a **Start at Collar** deployment this will be when the probe reaches the end of the hole) tap the red **End Survey** button.

A message appears: "Are you sure you wish to stop?". Tap **Yes** to end the survey. Tap **No** to continue the survey from the last reading.

At the end of a survey you must enter the rod offset value. The **Rod Offset** window appears (Figure 53).

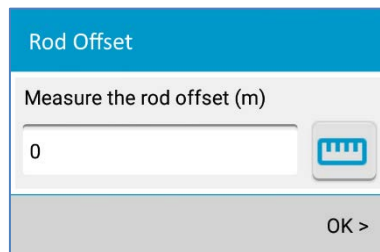
The image shows a software window titled "Rod Offset" with a blue header. Below the header, the text "Measure the rod offset (m)" is displayed. There is a text input field containing the number "0" and a button with a grid icon. At the bottom right, there is an "OK >" button.

Figure 53 Rod Offset window

Enter the rod offset distance in the text entry box, or click the **Offset** button to enter the value from a drop-down list.

Tap **OK** to continue.

A message appears: "Continue to survey the next hole?".

Tap **Yes** to continue to the next hole. **Boretrak Mobile** progresses to the next hole listed in the **Holes** screen. If there are no further holes in the list, a new hole, numbered sequentially, is automatically generated. The relevant **Survey Info** screen appears.

Tap **No** to end the survey operation.

A message appears: "Download Data?".

Tap **No** if you wish to continue without downloading. The **Holes** screen appears. You can continue to manually add holes or to review the project. The probe continues to log data.

Tap **Yes** to end the survey and download data from the probe to the PDA. A downloading bar appears that tracks the download progress. When the download is complete, a summary of the download appears (Figure 54).

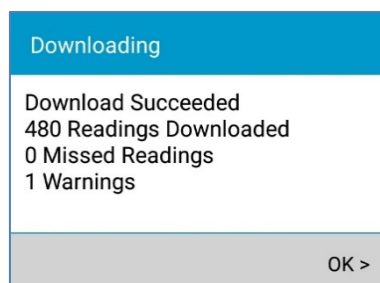
The image shows a software window titled "Downloading" with a blue header. Below the header, the text "Download Succeeded" is displayed, followed by "480 Readings Downloaded", "0 Missed Readings", and "1 Warnings". At the bottom right, there is an "OK >" button.

Figure 54 Downloading window

Tap **OK**. With the data successfully downloaded, the probe's memory is cleared. The survey is complete and the probe stops logging data. The **Holes** screen appears. All surveys are now populated with the downloaded data and you can review the surveyed holes in the project.

A full description of a standard survey along with recommendations for deployment procedures are outlined in section 11.

9.6 3D

The **3D** screen displays a 3D graphic of all active surveys carried out in the current hole (Figure 55).

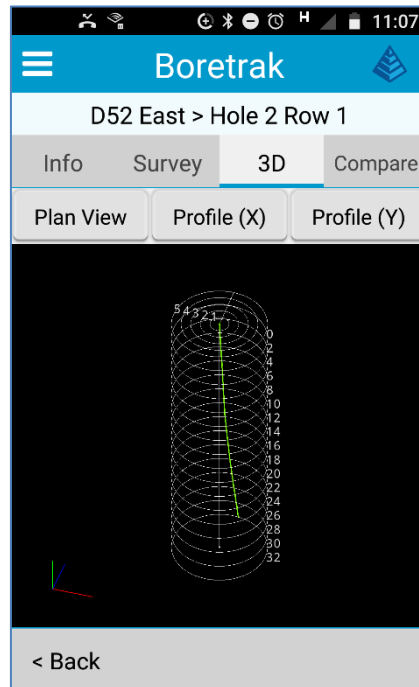


Figure 55 3D screen

Other screens directly accessible from the **3D** screen via the upper tabs are:

- **Hole info:** see section 9.2.
- **Survey:** see section 9.3.
- **Compare:** see section 9.7.

Each survey is displayed in the colour assigned to it in the **Survey Info** screen: see section 9.4.

The design hole is displayed in white, alongside the surveys.

Rotate the **3D** display by dragging across the touchscreen.

Tap the **Plan View** button to view a bullseye view of the hole.

Tap the **Profile (X)** button or the **Profile (Y)** button to view side views of the hole.

9.7 Compare

The **Compare** screen allows a comparison of the design hole and a survey, or of two surveys carried out in the current hole (Figure 56).

100% 14:15

Boretrak

23-11-17 PSa > Hole 9 Row 1

Info

Survey

3D

Compare

Design

Survey 1

X = 0.04

0.03

X = 0.08

Y = 0.48

-0.01

Y = 0.47

Z = -1.94

0.00

Z = -1.94

X = 0.08

0.07

X = 0.15

Y = 0.96

-0.02

Y = 0.95

Z = -3.88

0.00

Z = -3.88

X = 0.13

0.12

X = 0.25

Y = 1.45

-0.03

Y = 1.42

Z = -5.82

0.00

Z = -5.83

X = 0.17

0.14

X = 0.31

Y = 1.93

-0.04

Y = 1.89

< Back

Figure 56 Compare screen

Other screens directly accessible from the **Compare** screen via the upper tabs are:

- **Hole info:** see section 9.2.
- **Survey:** see section 9.3.
- **3D:** see section 9.6.

From the left-hand drop-down list, select either the design hole or one of the surveys in the current hole.

From the right-hand drop-down list, select one of the surveys in the current hole.

A comparison between the two selected holes is displayed in tabular form.

Each row displays the following values at each deployment interval:

- **X, Y, Z:** coordinates of the first selected hole, relative to the collar.
- **Delta X, Y, Z:** showing the distance along each axis between the two holes.
- **X, Y, Z:** coordinates of the second selected hole, relative to the collar.

10 Export

The **Export** screen enables data to be exported from a **Boretrak Mobile** project in various forms (Figure 57).

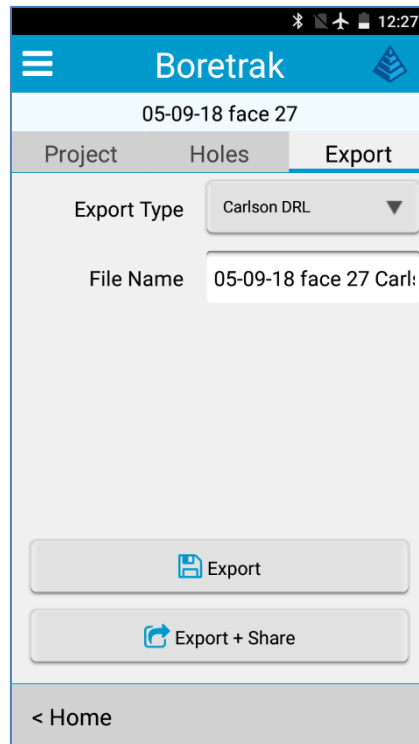


Figure 57 Export screen

Other screens directly accessible from the **Exports** screen via the upper tabs are:

- **Project**: see section 8.
- **Holes**: see section 9.

Select the required **Export Type** from the drop-down list. Available options are listed in the sections below.

Enter a name for the exported data in the **File Name** text box. By default, the name is taken from the name of the project and the selected format.

Tap **Export** to export the defined file to the **Export** folder in the **Boretrak Mobile** project.

Tap **Export + Share** to export the defined file using Android's options for sharing data.

Note that some third-party packages do not support imports of holes which are identified with alpha characters. If this is the case for the desktop software you are using, you should aim to keep the hole names in Boretrak Mobile as sequential numbers. If you have named holes using alpha characters and if you intend to export in a format which does not support this, Boretrak Mobile will convert the exported the hole names to numbers. In addition to the exported file, a text file (NameConversions.csv) is created in the export directory. This file is for your reference and lists the user-defined name against the newly converted name. The export files which do not support alpha characters are noted below.

10.1 Carlson DRL

Export the project in *.DRL format for use in **P3D Boretrak plug-in** and other Carlson software packages.

The *.DRL file will contain all hole information for those holes which have surveys attached to them. Any edits or configuration of the survey that has been entered in **Boretrak Mobile** is incorporated into the file. Holes which have not been surveyed are not added to the *.DRL export.

Note that, by default, a *.DRL file is also created on creation of the **Boretrak Mobile** project. This *.DRL file can be found in the root project directory, alongside the *.PRJ file. The *.DRL file is updated every time the main **Boretrak Mobile** project is saved. This is intended to make data transfer to **P3D Boretrak plug-in** easier as no explicit request to export a DRL file is required.

10.2 DAT

Export the Boretrak data in *.DAT format for use in **P3D Boretrak plug-in** software. Two files are exported, both of which must be imported into **P3D Boretrak plug-in**:

- **Rodded CDU.dat** which contains raw data from the PDA.
- **Rodded Probe.dat** which contains raw data from the Boretrak probe.

Note that if any surveys have been deployed uphole or using the **Finish at collar** option, then these options must be manually confirmed during the data validation stage in **P3D Boretrak plug-in**.

The *.DAT file format does not support hole names which have used alpha characters (see section 10).

10.3 Project

Export the entire project with its complete folder structure. The project can be opened on another PDA running **Boretrak Mobile**.

The project is exported as a *.ZIP file. To reuse the project, unzip the project and copy the project folder onto the second PDA in: **Internal Storage > Boretrak > Projects**.

10.4 BV hole collars

Export the hole collars in a *.CSV file that can be imported into the **Hole Design** module of **P3D Boretrak plug-in**.

If holes in the project are arranged into more than one hole, the rows are exported in separate files.

10.5 DXF holes

Export hole surveys in a *.DXF file.

10.6 DXF hole design

Export the design holes in a *.DXF file.

10.7 QPH

Export the hole surveys in a *.QPH file that can be imported into QuarryX.

The *.QPH file format does not support hole names which have used alpha characters (see section 10).

10.8 QX hole collars

Export the hole collar coordinates in a tab-separated *.TXT file that can be imported into QuarryX.

If holes in the project are arranged into more than one hole, the rows are exported in separate files.

10.9 PHD

Export the hole surveys in a *.PHD file that can be imported into Quarry6.

The *.PHD file format does not support hole names which have used alpha characters (see section 10).

10.10 Q6 hole collars

Export the hole collar coordinates in a tab separated *.TXT file that can be imported into Quarry6.

Quarry6 does not support hole names which have used alpha characters (see section 10).

10.11 Q6 HXY

Export the hole collar coordinates and design holes in an *.HXY file that can be opened in HoleDev6.

The *.HXY file format does not support hole names which have used alpha characters (see section 10).

10.12 RHD holes

Export a file in *.RHD format. This file contains raw pitch and roll data and is used by various third-party packages.

The *.RHD file format does not support hole names which have used alpha characters (see section 10).

10.13 CSV holes

Export holes in a *.CSV file in the format:

```
1,1,1000.000,1000.000,1000.000
```

Where the fields refer to:

```
Hole, row, X, Y, Z
```

Each row represents the coordinates at a deployment interval along the specified hole.

10.14 CSV hole design

Export the collar coordinates and design information in a *.CSV file in the format:

```
1,2,1,1005,1000,1000,0,5,32
```

Where the fields refer to:

```
Hole, row, survey, X, Y, Z, design_azimuth, design_inclination, design_depth
```

10.15 Shotplus

Export the Boretrak data in a format for use in Shotplus software. Two files are exported, both of which must be imported into Shotplus:

- **<projectname>Shotplus CDU.cdl** which contains raw data from the PDA.
- **<projectname>Shotplus PROBE.cdp** which contains raw data from the Boretrak probe.

Note that if any surveys have been deployed uphole or using the **Finish at collar** option, then these options must be manually confirmed within Shotplus.

The Shotplus file format does not support hole names which have used alpha characters (see section 10).

11 Rodded Boretrak system operation



Figure 58 Rodded Boretrak system on-site

11.1 Georeferencing a survey

When using the Rodded Boretrak system, it is often the case that the absolute position and orientation of the surveyed hole will be required. For example, if deviation is detected in the borehole, in which direction is it inclined and how does this relate to other features above or below the ground?

In order to establish the position and orientation of the surveyed data, two values are required (Figure 59):

1. The position of the borehole collar.
2. The orientation of the rod stack.

With these two values established, when the Boretrak probe is deployed down the borehole, all subsequent readings can be related back to the starting position and orientation. The surveyed hole can also be referenced to any other features surveyed on the same coordinate system: for example, a quarry face or an underground tunnel.

11.2 Position of the borehole

The position of the borehole can be established by:

- GPS.
- Traditional survey methods.
- A Carlson Quarryman Pro. The Quarryman Pro is used in quarrying operations to scan a quarry face as well as to position the borehole collars.

11.3 Orientation of the rod stack

The rod stack should be positioned so that the arrow on the base of the rack is pointing directly towards the hole. Also check that the pin on the end of the lead rod is pointing to the right as you look along the rods towards the borehole.

The orientation of the stack can be derived by establishing the position of the back of the stack and calculating an azimuth between this point and the collar coordinates. Again, this position can be surveyed by GPS or traditional survey techniques.

Alternatively, the rod stack can be set up along, or perpendicular to, a line of known heading.

In a quarrying application, the row of holes is commonly used as a reference. If the collars have been surveyed, then the heading of the row can be extracted from the software. The rod stack can therefore be located along this line, or perpendicular to it. This avoids the need to resurvey the rod stack for every hole.

Where no orientation is known, a good quality hand-held compass can be used to obtain a reference bearing. To observe the orientation, stand behind the rods and take a bearing looking along the rod rack towards the borehole. Ensure that the area is free from external magnetic influences, such as drill rigs or mobile phones. Note that if a compass is used, the bearing will be relative to magnetic north. The relationship between the magnetic bearing from the compass and any local grid north that is used for other survey data will need to be established if data from the Rodded Boretrak is to be used in conjunction with data from other systems such as GPS or the Quarryman Pro.



Figure 59 Orientation of the rod stack

11.4 Example of orientation for rock face profiling

A Quarryman Pro system can be used to scan the quarry face to create an accurate 3D model. The Quarryman Pro will also be used to shoot in the position of the collars. This information can then be combined with Boretrak data in a blast design package. The aim is to understand the relationship between the face and the boreholes and thus to determine the burden across the blast area. This information can then be used to determine how each hole is loaded with explosives.

A typical rod stack set-up is shown in the Figure 60. In this case, the rod stack is aligned along the front row. The bearing of this row can be determined within the appropriate software, given relevant data from the Quarryman Pro.

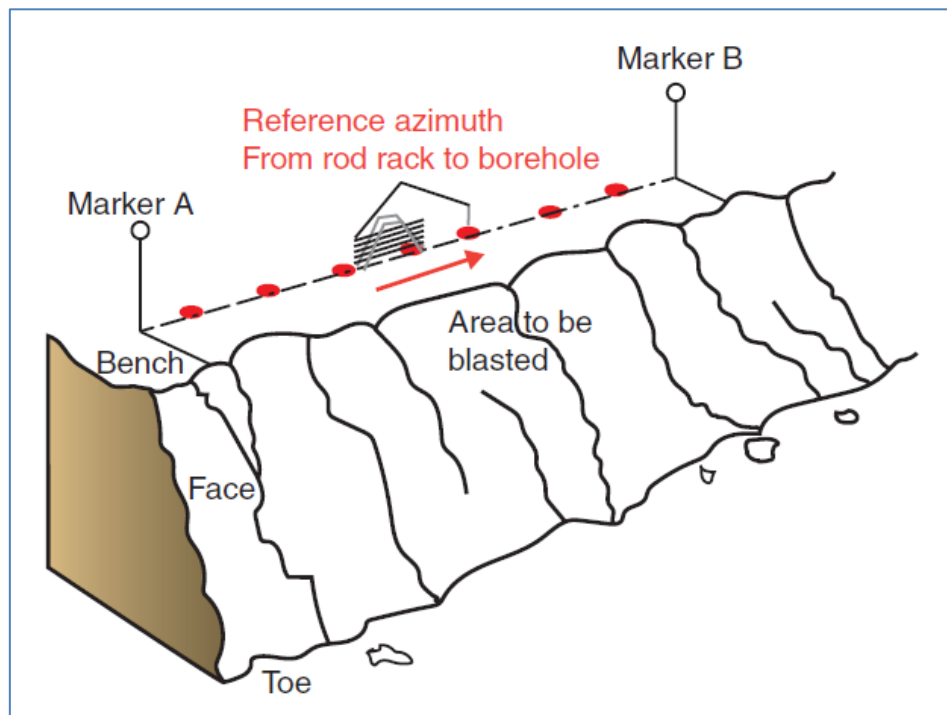


Figure 60 Rod stack alignment on a quarry

11.5 Setting up the rod stack

With reference to section 11.3, an appropriate area should be chosen on-site for setting up the rods. Try to pick as flat an area as possible beside the collar and clear the area of rocks or other obstacles. Ensure there is enough space between the rod stack and the collar to allow a comfortable workspace.

Stand behind the rod stack and sight along it towards the collar to ensure that the rack is correctly aligned. Once set up, the rod stack must not be moved during the survey. Note that, when using multiple rod stacks for long holes, you must ensure that each stack is correctly and consistently aligned to the starting reference position while it is being used. It is often worth marking the alignment of the rod stack with pegs or paint on the ground in case the rod rack is accidentally knocked or dragged out of position.

Each rod stack must also be kept vertically upright to ensure the rods are not twisted with respect to the reference azimuth.

11.6 Data collection

Once the rod stack is arranged as described above, a borehole survey should proceed as follows. In this example, the **Quick Survey** option is used in **Boretrak Mobile**.

11.6.1 Getting ready to deploy

Insert three size “D” batteries into the Boretrak nose cone, ensuring that the positive terminals face the open end. Screw the nose cone fully onto the main probe using hand pressure only. Once connected, the Boretrak probe is powered on and its LEDs flash red. A buzzer also sounds to confirm that the power is on.

Connect the Boretrak probe to the lead rod using the quick-release joint. On the PDA, start **Boretrak Mobile**. Select **Quick Survey**.

A new project is started using the date as the project name. The **Select Probe** window appears (Figure 61).

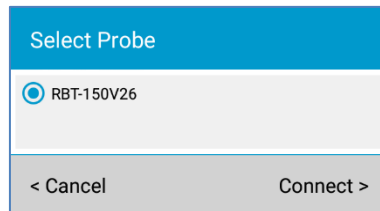


Figure 61 Select Probe window

Select your probe and tap **Connect**. **Boretrak Mobile** connects to the probe. The buzzer in the probe sounds and the red LED flashes.

Hole 1 is generated automatically. The **Survey Info** screen appears (Figure 62), displaying the current default survey values.

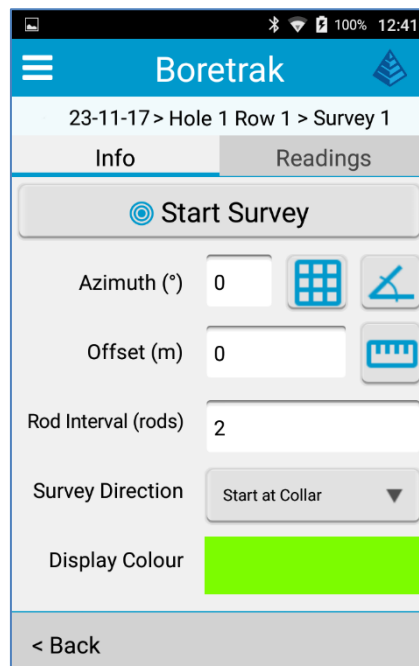


Figure 62 Survey Info screen

Amend the on-screen values if required. All entries can be edited after the survey.

Tap **Start Survey** to begin a survey of the hole. At this point, the Boretrak probe begins logging data. The LED flashes red every second to indicate logging is in progress. Logging continues until the probe is downloaded or cleared.

11.6.2 Deployment

A message appears: "Deploy the probe into the start of the hole" (Figure 63).

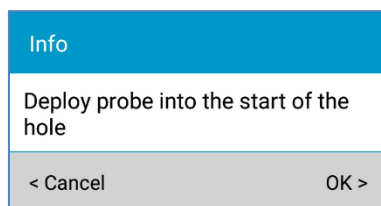


Figure 63 Deploy probe window

The tip of the Boretrak probe is the starting point for measurements. Use the rods to deploy the Boretrak probe by the defined rod interval. For a 2 m rod interval, deploy the probe, the short 0.3 m lead rod and the first 1 m rod into the hole.

Tap **OK**.

The **Take Readings** window appears (Figure 64).

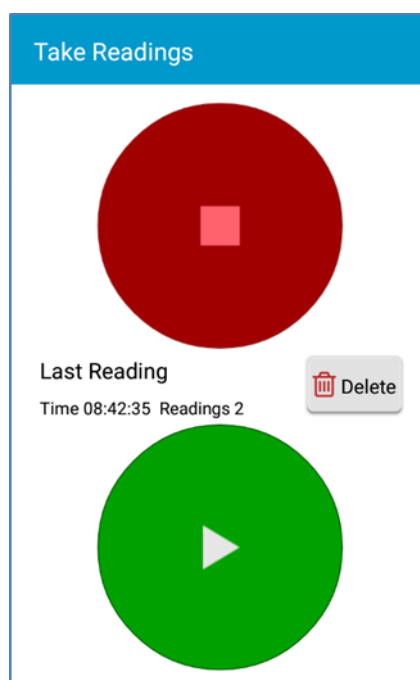


Figure 64 Take Readings window

Allow the probe and rods to stabilise, then tap the green **Read** button. The PDA beeps for 3 seconds. The time and the sequential number of the last reading are displayed.

Deploy two more Boretrak rods and take another reading. Repeat this process until you feel the Boretrak probe touch the end of the hole. Keep tension on the rods and take a final reading.

When deploying the Boretrak probe, be aware of the following points:

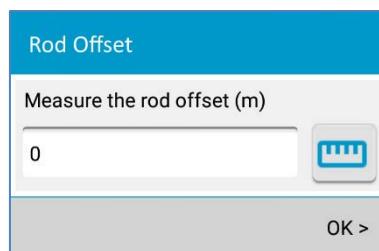
- The hinge between rods should be at the level of the hole collar when a reading is taken.
- Take just one reading at each rod interval along the hole. If you accidentally take additional readings at one location along the hole, delete the additional reading before progressing.
- If you forget to take a reading at one deployment interval and you have not taken any subsequent readings further along the hole, return to the appropriate location in the hole and resume the survey by taking the

missed reading.

- If there is any confusion as to whether a reading has been missed, or taken multiple times, consider starting the survey again. Alternatively, when you reach the end of the hole, repeat the survey from the end back to the collar (change the Survey direction to **Finish at Collar**). This will give you two surveys of the same hole to compare.
- When you take a reading, the probe should be held stable. If the probe is moving or wobbling, the recorded data may be incorrect. The stability value gives an indication of how stable the probe was. A value of 255 indicates that the probe was not stable. Also use the error bound to highlight readings which differ from the previous reading by an unacceptable amount.
- Keep the rod rack stable and static throughout the deployment. Mark the position of the rod rack on the ground so that you have a reference if the rod rack is knocked or dragged out of position.
- When you reach the end of the first stack of 18 rods on one side of the rack, do not change the position of the rod rack as you switch to the stack of rods on the other side of the rack. If you deploy beyond 36 m, you will need to change to a second rack of rods. In this case, ensure the second rod rack is located in exactly the same position as the first rod rack.
- When the Boretrak probe touches the end of the hole, maintain tension on the rods to ensure that the probe is stood upright, parallel to the sides of the hole, rather than flopping against the side.
- Ensure due attention is given to safe manual handling during all deployments.
- When carrying out a typical **Finish at Collar** deployment, the last reading should be taken with the probe still within the hole, with the selected rod increment between the hole collar and the tip of the probe. Do not take a final reading with the probe held at the hole collar or outside the hole.

After taking the final reading in the **Take Readings** screen, tap the red **End Survey** button. A message appears: "Are you sure you wish to stop?". Tap **Yes** to end the survey.

The **Rod Offset** window appears (Figure 65).



The screenshot shows a mobile application window titled "Rod Offset". Below the title bar, there is a text prompt "Measure the rod offset (m)". Underneath this prompt is a numeric input field containing the value "0". To the right of the input field is a small icon of a rod rack. At the bottom right of the window is a button labeled "OK >".

Figure 65 Rod Offset window

Enter the distance from the hole collar back along the rods to the next measurement point, i.e. the next rod joint to which you would deploy if the hole were longer. See illustration in Figure 66.



Figure 66 Measuring the rod offset

Tap **OK** and retrieve the probe back to the surface.

A message appears: "Continue to survey the next hole?" (Figure 67).

Info	
Continue to survey next hole?	
< No	Yes >

Figure 67 Continue survey window

Tap **Yes** to continue to the next hole. Hole 2 is automatically generated, and the relevant **Survey Info** screen appears.

Tap **No** to end the **Quick Survey**. A message appears: "Download Data?" (Figure 68).

Info	
Download Data?	
< No	Yes >

Figure 68 Download data window

Tap **No** if you wish to continue surveying. The **Holes** screen appears. You can continue to manually add holes or review the project. The probe continues to log data.

Tap **Yes** to end the survey and download data from the probe to the PDA. A downloading bar appears, which tracks the download progress. When the download is complete, a summary of the download appears (Figure 69).

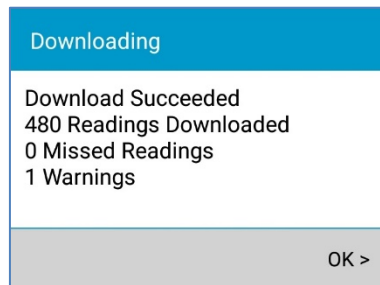


Figure 69 Downloading window

Tap **OK**.

With the data successfully downloaded, the probe's memory is cleared automatically. The survey is complete and the probe stops logging data. The **Holes** screen appears.

All surveys are now populated with the downloaded data and you can review the surveyed holes in the project.

11.6.3 Uphole deployments

The procedure for deploying a Boretrak probe uphole is similar to that for downhole deployments. Note the following points:

- Due attention should be given to safe manual handling during all Boretrak deployments, but especially when pushing the system uphole.
 - Ensure there are enough personnel at the deployment zone to manage the weight of the equipment. If necessary, use a separate operator to control the PDA/CDU so that those physically deploying the system do not need to take a hand away from supporting the rods.
 - Do not be over-ambitious about the length of hole you can deploy the system along: for steeper holes approaching vertical, the distance that the system can be deployed using standard manual techniques may be very limited.
 - Ensure the hole collar is low enough that the Boretrak probe and rods can be directly fed into the hole from a height that is convenient and ergonomic for the operator (ie from waist height or chest height). A pipe extended down from the collar can bring the hole closer to the rod rack and operators if necessary. Alternatively, a cherry picker or other platform may be required to bring the rod rack and operators closer to the hole. The probe should not be deployed into a collar where the operators are having to push the system from above their heads. It is very difficult to safely control the system from this position.
 - It may be necessary to employ a customized device to hold the unit in place or to brace the probe and lead rod or adjacent rods, or to assist with the deployment. Given the wide variety of operations that the equipment is used for, Carlson has not developed a 'one-size-fits-all' device but can offer advice on specific applications and sites.
- The distance that the Boretrak probe can be deployed uphole will depend on the inclination of the hole. As the hole approaches vertical, the weight of the system will become the main limiting factor. As the rods 'concertina' in the hole, increased friction can also restrict the deployment length.
- As the probe is retrieved from the collar, ensure it is fully supported to prevent it folding back towards the operator.
- Check the area around the collar for loose rocks or debris which may loosen or fall if aggravated during the deployment.

- Use Boretrak rods fitted with uphole links.
- The narrower the hole diameter, the better the Boretrak probe can track the hole. In wide holes, the probe may have a tendency to flop away from a position parallel to the sides of the hole. This problem is more noticeable, the closer the hole is to vertical.
- A narrower hole will also make pushing the system easier as the rods will have less chance to ‘concertina’ inside the hole.
- Establish the rod azimuth in exactly the same way as with a downhole survey: align the rod stack pointing at the hole collar and survey the heading from the back of the rod stack towards the collar.
- If you are using the Carlson Rodded Boretrak (with Boretrak Mobile Android app), the system will detect automatically that it is in an uphole borehole. It may be physically easier to conduct the operation as a ‘Finish at Collar’ deployment. In this case, push the system all the way to the end of the hole. The readings are then taken as the boretrak probe is being recovered from the hole.

11.6.4 Finish at Collar deployments

By default, the Rodded Boretrak is deployed from the collar to the end of the hole. In **Boretrak Mobile** this is identified in the **Survey Info** screen as the **Survey Direction** option: **Start at Collar**.

Boretrak Mobile offers the option of surveying in the opposite direction: from the end of the hole back to the collar. To survey in this way, select **Finish at Collar**.

At the start of the survey the message reads “Deploy probe to end of hole”. Deploy the Boretrak probe until you feel the probe touch the end of the hole. Keep count of the rods that are deployed. Tap **OK**.

Keep tension on the rods. You are prompted for the rod offset. Measure the distance from the hole collar back along the rods to the next measurement point. For this reason, it is important to keep count of the rods when they are deployed, so you know which joint would be the next measurement point. Enter this value and tap OK.

The **Take Readings** screen appears. With the probe still at the end of the hole and with tension still keeping the probe upright, tap the green **Read** button.

When the reading is complete, pull the probe back towards the collar until the next measurement point (depending on the selected rod interval) is at the collar. Take another reading.

Now continue recovering the probe. Stop at every rod interval to take another reading. The last reading is taken when the tip of the probe is a rod interval away from the collar. Once the probe is retrieved, tap the red **End Survey** button.

12 Regular checks and preventative maintenance

Carlson recommends that you carry out regular functional testing of the Rodded Boretrak system. Any damage, malfunctions or poor performance detected should be reported to a Carlson-approved service centre.

A yearly calibration should be arranged by contacting a Carlson-approved service centre.

Where necessary, replacement accessories such as rods and cables can be purchased from Carlson or from your local Carlson representative.

Before and after each session in the field, carry out routine checks of the system as outlined below.

12.1 Probe

Clean the probe thoroughly with warm soapy water.

Ensure that the screw threads in the nose cone and body of the probe are free of dirt, grease and grit.

Check the O-ring around the nose-cone thread. If there is any visible damage or breaks, it should be replaced with a new O-ring: size BS124 Fluorocarbon 75 (31.42 mm ID x 2.62 mm CS).

Clean any dirt from the nose cone and O-ring seal. Lubricate the O-ring with the supplied silicone grease (Dow Corning Molykote III).

Store within the specified environmental temperature limits.

12.2 PDA

Recharge the internal lithium polymer battery.

Check the USB connector on the bottom of the PDA to ensure that it is free from mud and water.

Ensure that the battery cover is fully closed. The PDA is not environmentally protected if the cover is partially open.

Store within the specified environmental temperature limits.

Wherever possible, use the PDA carry case and neck strap to keep the PDA protected and secure.

12.3 Rod stack maintenance

Clean the rods by soaking thoroughly with warm soapy water.

Ensure the rod joints are clear of mud and grit to maintain the condition of the rod stack.

Check the rods and hinges prior to every deployment. Ensure that they are in good condition, that there is no apparent "twist" in the rods, and that all nuts and bolts and connecting pins are in place and secure.

The rods are made from abrasion-resistant fibreglass with stainless steel quick-release joints. However, the rods will need replacing at intervals depending on usage. Rods should be replaced before they compromise the safety and operation of the system.

The nuts and bolts used to hold the hinges in place should be periodically checked and tightened to a torque of 1.5-1.8 Nm. If necessary, a small amount of thread-locking compound (Loctite 270) can be used, but it must not be used on the hinge itself.

12.4 Transportation

In addition to the points above, care should be taken when transporting the Rodded Boretrak system.

Always pack the Rodded Boretrak system into the transit case supplied for storage and transportation.

Clean and dry the Boretrak probe and other accessories prior to packing them in the transit case.

When transporting the rods, ensure they are packed into a dedicated rod case or other suitable container.

Do not allow the equipment to slide around inside transport vehicles or containers.

13 Rodded Boretrak system troubleshooting guide

13.1 Diagnosis of some common issues

Some of the most common support questions are outlined below. If you experience a problem with your Rodded Boretrak system or the resulting data, check the list to find the cause and action, and also a reference to the relevant section in this manual.

PDA does not power up		
Cause	Remedy	Reference in manual
PDA not turned on.	Hold Power button until 'power up' is complete.	Section 4.1.1 Hardware buttons.
Battery not charged.	Charge battery.	Section 3.2.2.3 CT5 PDA charger.

Probe LEDs do not illuminate / probe does not sound when nose cone is fitted		
Cause	Remedy	Reference in manual
Batteries discharged.	Replace batteries.	Section 3.1.1 Probe power.
Batteries inserted incorrectly.	Ensure positive battery terminals face outwards from nose cone.	Section 3.1.1 Probe power.
Nose cone is not screwed onto probe sufficiently.	Check that the thread is clean and ensure the nose cone is fully tightened onto the probe by hand.	Section 3.1.1 Probe power.

Probe LEDs flash red and buzzer sounds for 5 seconds when probe is powered ON		
Cause	Remedy	Reference in manual
System error.	Contact a Carlson-approved service centre.	Section 3.1 Probe.

PDA cannot connect to the probe		
Cause	Remedy	Reference in manual
Bluetooth pairing has not been established between the probe and the PDA.	Use the Settings > Bluetooth controls to pair the probe and the PDA.	Section 4.4 Pairing a Boretrak probe with the PDA.
Probe and PDA too far apart or not within 'line-of-sight'.	Bring probe and PDA within 2 m of each other, with no obstructions between them.	Section 4.4 Pairing a Boretrak probe with the PDA.
Hands are blocking the Bluetooth signal from the probe.	Do not hold the probe by the LED window.	Section 3.1 Probe.

Data or complete holes missing at processing stage		
Cause	Remedy	Reference in manual
Not all data downloaded.	Connect to the probe and download data.	Section 6.2 Probe.
Holes or readings made inactive.	Check all required holes and surveys are active in Boretrak Mobile.	Section 9.2 Hole Info, and section 9.4 Survey Info.

Erroneous readings or unexpected results		
Cause	Remedy	Reference in manual
Probe moving while readings are taken.	Keep probe steady while a reading is being taken.	Section 11.6.2 Deployment.
Probe not aligned with hole during deployment.	Narrow holes are preferable, especially for uphole. Probe is more likely to 'flop' inside wider holes.	Section 11.6.2 Deployment, and section 11.6.3 Uphole deployments.
Probe resting on bottom of hole for last reading.	Keep tension on the rods when probe is at the bottom of the hole to avoid it 'flopping' against the side of the hole.	Section 11.6.2 Deployment.
Wrong rod azimuth entered.	Measure from the back of the rod rack to the hole collar.	Section 11.5 Setting up the rod stack.
Rods not pointing directly to hole collar.	Stand behind the rod rack and ensure they are pointed towards to the hole collar.	Section 11.5 Setting up the rod stack.
Rod stack moved during deployment.	The rod rack must be kept in a fixed location during a deployment.	Section 11.5 Setting up the rod stack.
Probe out of calibration.	Return to a Carlson-approved service centre.	Section 1.3 Product warranty, and section 13.2 Other faults.

Processed holes appear back-to-front (heading is incorrect by 180°)		
Cause	Remedy	Reference in manual
Rod stack is the wrong way around.	Looking along the rod stack towards the hole, the pin in the lead rod should point to the right.	Section 11.5 Setting up the rod stack.

Pitch or roll shown as 'Out of range' in live display or downloaded readings		
Cause	Remedy	Reference in manual
Probe was out of range when reading was taken.	Do not use the Boretrak to survey between 45° and 135° inclination.	Section 2.2 System capabilities.

Processed holes are longer or shorter than expected		
Cause	Remedy	Reference in manual
Rod increment incorrect.	Enter the number of rods deployed between readings.	Section 9.4 Survey Info, and section 11.6.2 Deployment.
Reading missed.	Ensure that during a deployment a reading is taken at every rod increment.	Section 11.6.2 Deployment.
Extra readings taken.	Ensure that during a deployment only one reading is taken per rod increment.	Section 11.6.2 Deployment.
Incorrect rod offset entered.	Enter the correct rod offset at the end of a hole.	Section 9.5.4 Take Readings, and section 11.6.2 Deployment.

13.2 Other faults

If you are not able to repair or pinpoint a fault from the table above, you should contact the product support department at Carlson, or your local Carlson representative for further assistance.

Rodded Boretrak Specifications

Construction		
Probe	Stainless steel	
Rods	Fibreglass rods; acetal joints; aluminium hinges; stainless steel quick-release joints, nuts and bolts	
Rack	Tubular aluminium	
Physical	Weight	Dimensions
Probe (including batteries)	3.2 kg	710 mm × 40 mm (L × Dia)
Rods (individual)	400 g	1000 mm × 30 mm (L × Dia)
PDA (including batteries)	225 g	152 mm × 81 mm × 17 mm (L × W × D)
Sensors		
Angular range	0° to 45° and 135° to 180°	
Angular resolution	0.01°	
Angular accuracy	0.1°	
Power		
Probe	3 × 1.5 V “D” cells (LR20)	
PDA	4500 mAh rechargeable Li-ion battery	
PDA charger	100 V to 240 V input / 5 V 2 A output	
Environmental		
IP degree of protection (probe)*	IP68 (pressure rated to 30 bar, equivalent to 300 m water depth)	
Operating temperature (probe)	−10 °C to +60 °C**	
Storage temperature (probe)	−20 °C to +70 °C**	
PDA (Option supplied with system)		
Model	Cedar CT5	
Display	4.7” high-definition (720 mm × 1280 mm) with Corning® Gorilla® Glass 3	
Interface	Capacitive touch-screen and buttons	
Communications	Bluetooth (probe to PDA), Wi-Fi and USB (PDA to PC)	

* Environmental compatibility requirements of EN 60529:1992+A1:2002

** The probe operating and storage temperature may be limited by the choice of battery. The supplied Duracell® ID1300 battery has an operating temperature of −20 °C to +54 °C and a storage temperature of +5 °C to +30 °C.

14 Product information

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Warranty

Equipment requiring attention under warranty must be returned to your equipment supplier.

Unless otherwise specifically agreed in writing between you and Carlson, if you purchased the equipment from a Carlson company, the warranty provisions contained in Carlson's CONDITIONS OF SALE apply. You should consult these conditions to find out the details of your warranty but, in summary, the main exclusions from the warranty are if the equipment has been:

- neglected, mishandled or inappropriately used, or
- modified or altered in any way except with the prior written agreement of Carlson.

If you purchased the equipment from any other supplier, you should contact them to find out what repairs are covered by their warranty.

Safety

The Rodded Boretrak is designed as a means of auditing the results of drilling activity quickly and accurately, for downhole and uphole use. The system is non-magnetic and therefore may be used in all types of rock, flooded holes and areas of ferrous materials and hole castings. It is essential that the unit and all accessories are operated in accordance with the instructions in this user manual and it is the responsibility of the user to ensure that, in the event of a failure of any part of the Carlson system, the equipment remains safe.

In the case of equipment with powers or speeds capable of causing injury, it is essential that appropriate safety protection measures are included in the machine usage. Further guidance can be found in *BS EN ISO 12100:2010*

Safety of machinery – General principles for design – Risk assessment and risk reduction.

Information to the equipment supplier/ installer

It is the equipment supplier's responsibility to ensure that the user is made aware of any hazards involved in any operations involving the Rodded Boretrak system, including those mentioned in Carlson product literature.

EC declaration of conformity



Carlson declares that the Rodded Boretrak complies with the applicable standards and regulations.

Contact Carlson or visit www.carlsonsw.com for the full EC declaration of conformity.

Radio-frequency disturbance characteristics

As defined by *BS EN 55011:2016 Industrial, scientific and medical equipment – Radio-frequency disturbance characteristics – Limits and methods of measurement*, the Carlson Rodded Boretrak probe is defined as Group 1, Class A equipment.

The Carlson Rodded Boretrak probe is suitable for use in all locations other than those allocated in residential environments and those directly connected to a low-voltage power supply network which supplies buildings used for domestic purposes. The Carlson Rodded Boretrak probe does not use radio- frequency energy for the treatment of material, for inspection/analysis purposes, or for transfer of electromagnetic energy.



CAUTION: This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

FCC (USA only)

Information to the user (47CFR section 15.19)

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

Information to the user (47CFR section 15.21)

The user is cautioned that any changes or modifications not expressly approved by Carlson or authorised representative could void the user's authority to operate the equipment.

Information to the user (47CFR section 15.105)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WEEE directive



The use of this symbol on Carlson products and/or accompanying documentation indicates that the product should not be mixed with general household waste upon disposal. It is the responsibility of the end user to dispose of this product at a designated collection point for waste electrical and electronic equipment (WEEE) to enable reuse or recycling. Correct disposal of this product will help to save valuable resources and prevent potential negative effects on the environment. For more information, please contact your local waste disposal service or Carlson representative.

Battery safety

The Rodded Boretrak is supplied with non-rechargeable alkaline batteries (3 × Duracell LR20 1.5 V). The probe also contains a CR 2032 3 V 220 mAh lithium coin cell. The PDA contains a lithium polymer battery (4500 mAh).

- Do not attempt to recharge the probe batteries.
- Please dispose of waste batteries in accordance with your local environmental and safety laws.
- Replace the batteries only with the specified type.
- Ensure that all batteries are inserted with the correct polarity.
- Do not store batteries in direct sunlight.
- Do not heat or dispose of batteries in a fire.
- Do not short-circuit or force discharge the batteries.
- Do not introduce a metal connection between the batteries in the nose cone and the external metal housing.
- Do not disassemble, pierce, deform or apply excessive pressure to the batteries.
- Do not swallow the batteries.
- Keep the batteries out of the reach of children.
- Do not get batteries wet.
- If a battery is damaged, exercise caution when handling it.

Battery disposal



The use of this symbol on the batteries, packaging or accompanying documents indicates that used batteries should not be mixed with general household waste. Please dispose of the used batteries at a designated collection point. This will prevent potential negative effects on the environment and human health which could otherwise arise from inappropriate waste handling. Please contact your local authority or waste disposal service concerning the separate collection and disposal of batteries. All lithium and rechargeable batteries must be fully discharged or protected from short circuiting prior to disposal.

Bluetooth module: U.S. compliance

Contains Transmitter Module FCC ID: T9J-RN42

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/ TV technician for help.

Bluetooth module: Canada compliance

Contains Transmitter Module IC: 6514A-RN42

This device complies with Industry Canada's licence-exempt RSSs. Operation is subject to the following two conditions:

1. This device may not cause interference; and
2. This device must accept any interference, including interference that may cause undesired operation of the device.

15 Boretrak Mobile End Use License Agreement

License Agreement

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It is understood and agreed that, notwithstanding any other provision of this Agreement, LICENSOR has the unequivocal right to obtain timely injunctive relief to protect the proprietary rights of LICENSOR.

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