



MRRD GeoVista Geophysical Borehole Logging Manual

Version 1



by
Andreas de Jong

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Acronyms and abbreviations

DD/MM/YYYY	Day/month/year format
EC	Electrical Conductivity
GPS	Global Positioning System
MEW	Ministry of Energy and Water
MoM	Ministry of Mines
MRRD	Ministry of Rural Rehabilitation and Development
MS	Microsoft
PDF	Portable Document Format
Ru-WatSIP	National Rural Water Supply, Sanitation Irrigation Programme
UK	United Kingdom



1 Introduction

1.1 Background

This manual was developed by Andreas de Jong during the NORPLAN capacity building project in MRRD, Afghanistan. The project purchased geophysical logging equipment from GeoVista, UK. This comprised:

- GeoVista Slim Camera & Camera Control Unit (CCU)
- GeoVista sondes (Temperature, Electrical Conductivity, 3-Arm Calliper & Dual Induction)

A logging vehicle was designed and built in Kabul using a Toyota Landcruiser. The design was carried out as a group exercise involving geophysicists from Ru-WatSIP (MRRD), MEW & DACAAR. It was built by the Toyota garage in Kabul during late 2014/early 2015.

On-the-job training of the Afghan geophysicists was carried out during March & May/June 2015 using a number of wells provided by MRRD, MEW and the Medical University of Kabul. This was followed by a theoretical course in the interpretation of geophysical logging data for water wells in October 2015.

1.2 Scope of this manual

This manual summarises the main tasks required to perform a borehole geophysical logging survey of a water well in Afghanistan, using the GeoVista logging vehicle designed and built by NORPLAN/MRRD. Although this manual is aimed primarily for use by MRRD, it can be used with small modifications by the other institutions who have GeoVista logging equipment (DACAAR & AGS/MoM). The sonde manuals and procedures developed by GeoVista are not repeated here, and should be studied separately.

1.3 Important Notice

Downhole geophysical logging is a complex procedure that should only be carried out by trained professionals. The equipment is very sensitive, and can easily be damaged or even lost in boreholes unless a high degree of professionalism and caution is employed.

The GeoVista camera and sondes produce currents of approximately 100 Volts DC. This can be fatal to humans and animals, and the tools should NEVER be touched when they are powered up.

1.4 Disclaimer




The recommendations and procedures proposed in this manual are based on the experiences accumulated during the use of the GeoVista borehole geophysical logging equipment in Afghanistan during 2015. The information and views set out in this report are those of the author and do not necessarily reflect the official opinion of NORPLAN, GeoVista, or the Government of Afghanistan. Neither the author nor NORPLAN, GeoVista or any person acting on their behalf may be held responsible for the use which may be made of the information contained therein.



2 Pre-Mobilization

Before you go to the field you need to carefully pack the logging truck, and carry out a pre-mobilization check of all the equipment & accessories. Do not arrive in the field without a critical part of your equipment!

2.1 Packing the Logging Truck

<p>1 When the logging truck is parked at the office it should only contain the winch (permanently bolted to the chassis & covered with the grey protective cover), the generator and perhaps the standard tools that are part of the vehicle. You should keep all the tools and accessories in your office. The reason for this is to avoid theft of the geophysical equipment.</p>	
<p>2 First load the work table/box with all the items which are small and need to be stowed away. These include:</p> <ul style="list-style-type: none"> a) Laptop b) Black camera box c) Camera control unit (CCU) d) GV Logger Winch Control Unit e) Voltage regulator f) Tripod sheave wheel g) Sports bag of spare parts. 	
<p>3 Close the work table/box, and lock it.</p>	



- 4 Place the green tool box carefully along the right hand side. Attach it using the supplied belts.
- 5 Lay the tripod legs on the floor of the vehicle. You may need to attach them if you are planning to drive off road, and protect them by wrapping in a cloth.



2.2 Office Check list

Use the Office checklist to make sure you do not forget something. Once you are in the field it is too late! Check that you have the following in good working order:

Table 1: Office Check List

Check	Item to be checked
<input type="checkbox"/>	The vehicle has been serviced, and is fully fuelled.
<input type="checkbox"/>	Vehicle spare parts are complete: e.g. tool box, snow chains, fire extinguished, first aid kit.
<input type="checkbox"/>	The driver is in good health and has all he needs for the field.
<input type="checkbox"/>	All geophysical sondes, the generator, laptop, tripod & sheave wheel, voltage regulator and sports bag with spares has been packed.
<input type="checkbox"/>	The generator is fully fuelled & serviced.
<input type="checkbox"/>	Your personal field kits are packed. e.g. satellite phone, mobile phone, GPS with spare batteries, field notebook, pencils/pens, first aid, gloves, safety glasses, hard hat.
<input type="checkbox"/>	You have made a travel plan, and communicated it to your office & where you are going. This should include strict reporting schedules at checkpoints along the road if you are travelling through dangerous areas.
<input type="checkbox"/>	You have confirmed that the roads you are planning to travel on have security clearance, or you have made the necessary security arrangements (armed escorts etc).
<input type="checkbox"/>	You have checked the weather forecast, including risk assessment of snowstorms in winter and floods/landslides in spring/summer.



3 Set-up in the field




On arrival at site, the first thing is to check that the well is accessible & does not contain any obstacles such as a pump inside it.

Unpack the equipment carefully and systematically, and arrange everything in a neat and tidy manner.


3.1 Set-up Logging Vehicle and Unpack the Equipment

<p>1 Reverse the logging vehicle towards the well/borehole. If the helper stands behind the well/borehole he can direct the driver so that the vehicle lines up with the well/borehole.</p>	
<p>2 Prevent people from walking near the well using some red & white tape. You can tie the tape to the logging vehicle & any other fixed objects. Remember that you are responsible for Health & Safety issues on site, and have the responsibility to prevent accidents from happening.</p>	
<p>3 Remove all the equipment from the work table box inside the logging vehicle. This includes:</p> <ol style="list-style-type: none"> Laptop Black camera box Camera control unit (CCU) GV Logger Winch Control Unit Voltage regulator Tripod sheave wheel Sports bag of spare parts. Green box with geophysical logging sondes. 	



<p>6 Put everything outside the vehicle, except for the laptop and CCU which should be on the work table.</p>	
<p>7 Remove the tripod legs from the floor of the vehicle, and place them near the well along with the sheave wheel.</p>	
<p>8 Untie the generator & move it to a safe location away from the logging vehicle. Check the wind direction – you do not want it upwind of the vehicle. The best location is downwind, or across the wind direction.</p>	

3.2 Set up the Tripod

<p>9 Set up the tripod over the well. The two long legs should be pointing towards the vehicle, and the sheave wheel aligned correctly with the winch. Check that the alignment is correct by sighting down the sheave wheel – it should point directly at the centre of the winch.</p>	
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10 If the wellhead is too tall, you need to have longer tripod legs, or hang the sheave wheel from something strong like a drilling rig. Alternatively, you can fasten the sheave wheel to the casing as shown here. It is important to do this properly. If the tripod falls over while you are logging it can kink the logging cable!



11 The cable should be able to pass easily over the sheave wheel into the well. Ideally the cable it should be exactly in the centre, but as long as it does not touch the side of the well it is OK. Remember that no wells are exactly vertical.



3.3 Set up the Power Supply

- 12 Make sure that the generator is switched off, and that all power switches are in the off position.
- 13 Plug stabilizer into generator.
- 14 Plug power extension lead into stabilizer & far end into multiple sockets inside the vehicle.

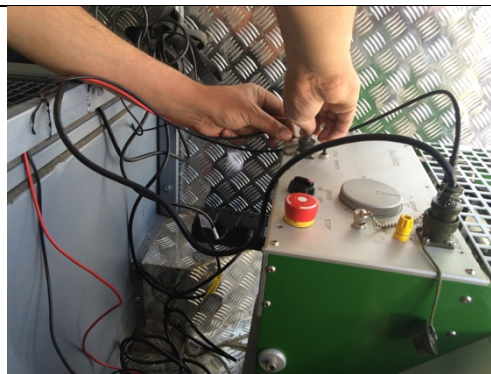


- 15 Unpack the voltage transformer (110/220V – 12V) & plug into power socket inside the vehicle.





- 16 Connect the red and black electrical cables with the red and black plugs on the winch. Hand tighten, but not too tight.
- 17 Make sure that the winch is in the 'off' position.
- 18 Connect laptop power cable to the power socket.



3.4 Start the Generator & Let Out Some Cable

- 19 Start the generator.
- 20 Once it sounds stable, switch on the power switch on the generator. Check that the voltage needle has moved to 220V.
- 21 Switch on the voltage stabilizer. Check that there is current passing through it – the voltage needle should show 220V.



- 22 Switch on the mail power switch inside the logging vehicle. The red light should go on.
- 23 Switch on the winch voltage transformer. The red light should be on.
- 24 Power up the winch. Switch power from off to on. Arm red the emergency stop button.
- 25 Open the manual brake.



- 26 Ask the helper to hold the end of the cable and walk slowly towards the well.





- 27 Start the winch in the DOWN HOLE direction. The cable will start to unwind and the helper can pull it to a location just past the well.
- 28 Stop the winch.
- 29 Apply the manual break.
- 30 Switch off the power in the truck.








4 Camera Logging

The camera log is the first one that should be carried out on all wells, especially those that are old, or have not been used for some time.

It is not advisable to put any geophysical logging sonde in a well that has not first been inspected by a camera log.

It is assumed here that you have arrived on site and set up the logging vehicle and that the generator is running. All cables have been connected, but (and this is very important):
THE POWER SUPPLY INSIDE THE VEHICLE HAS BEEN SWITCHED OFF

4.1 Set up the Camera Control Unit (CCU)

<p>31 Open the CCU on the work table. We will plug everything in a clockwise direction, starting from the power plug, located at the top right.</p>	
<p>32 Make sure that the power is switched off. Connect the power cable between the CCU and the power socket inside the vehicle.</p> <p>33 Untie the keyboard and place it on the table to the right of the CCU.</p> <p>34 Plug in the USB cable into the CCU, and the laptop which should be on the right side of the CCU. The USB cable should be placed behind the CCU so it is out of the way.</p>	
<p>35 Plug the winch cable into the CCU and the winch. It should also be placed behind the CCU, so it is out of the way.</p> <p>36 Plug the camera cable into the CCU and the winch.</p>	

37 You may need to use some acrobatics to plug this one in!



4.2 Connect downhole camera with the winch cable

38 Remove the camera from it's box.
39 If the well diameter is small (e.g. <6") remove the centralizers from the camera. You will need to use the hexagonal keys from the green tool box.






40 Remove the metal protector from the end of the cablehead. Put it in a safe place.
41 Put a little amount of silicon grease on the o-rings. This will stop any water getting past them when we log under water.




42 Remove the black plastic protection from the end of the camera. Put it in a safe place.
43 Check the cable head. There is a small protrusion on one side that fits into a groove in the camera.



<p>44 Slide the cable head into the camera. It should fit easily.</p>	
<p>45 Screw on the cable head connector by hand.</p>	
<p>46 Apply some electrical tape over the cable head connector. This is a safety feature that should stop it from unwinding itself for whatever reason when it is in the well.</p>	

4.3 Get ready for downhole camera logging

<p>47 Place the camera into the well. 48 Power up the winch, arm the emergency stop button & undo the manual brake.</p>	
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49 Adjust the position of the camera very carefully so that the end of the camera lines up with the top of the casing. If the sheave wheel is very close to the well head, you can use the top of the cable protector as your reference. The helper should be at the wellhead to give you the correct instructions.



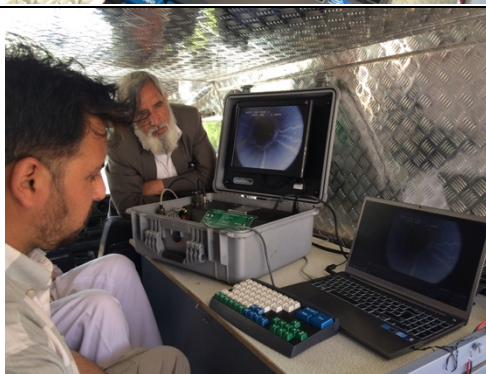
50 Put some electrical tape on the cable to mark the exact position. This will warn us later when to stop we pull the camera up.



51 Switch on the laptop.
52 Activate the Arcsoft ShowBiz software.
53 Switch on capture & select the USB port.







54 Switch on the CCU.
55 Switch on the camera lights – from position 1 to 2. The camera has an auto-aperture, so it should not make a big difference if you use higher power settings.
56 The camera picture should now show on the screen of the CCU & the laptop.



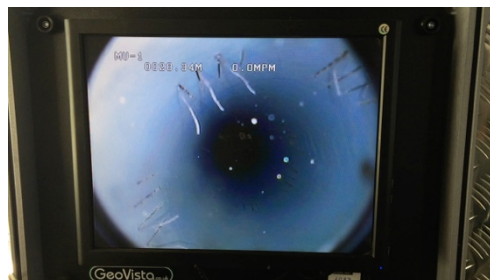


4.4 Set up the Video Log

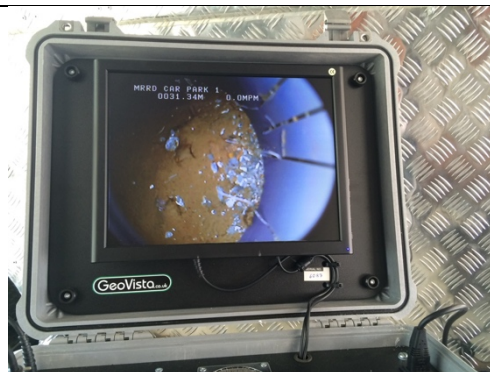
<p>57 Press the “SETUP” key on the CCU keyboard.</p> <p>58 Press “T”</p> <p>59 Add the name and location of the well e.g. MRRD CAR PARK-1</p> <p>60 Press “SET DEPTH”</p> <p>61 Insert 0.98 and press ENTER. This is the distance from the top of the camera to the camera lens. Note that the distance we record is the depth below the datum, which is normally the top of casing.</p>	
<p>62 Press “CAPTURE” on the laptop. After a few seconds it will show a green colour which indicates that you are now recording the video. Remember that everything you say will be recorded by the microphone, so please be professional!</p>	
<p>63 Give a brief statement about the well:</p> <ol style="list-style-type: none"> Date Time Location Client/owner of the well <p>It is advisable to make a few notes in advance so that your verbal information is correct, and delivered in a professional way.</p>	
<p>64 Start logging slowly downwards. Keep your eyes on the CCU screen at all times. The well could be obstructed at depth, so you will need to stop the camera from colliding with any obstructions and damaging itself.</p> <p>65 When you enter the water, go down some 20cm and then move the camera up and down to remove any air bubbles which may be trapped in front of the lens.</p>	



- 66 Carry out the camera log slowly – 3m/min is a good speed. Stop whenever you see something interesting, and if necessary go up a bit to get a better view. This includes:
- All casing/screen joints.
 - Any changes e.g. from casing to screen.
 - Any incrustation / corrosion or other damage to the well.
 - Any foreign objects in the well.



- 67 Stop recording when you reach the bottom of the well.



4.5 Pull camera out of the well

- 68 Pull up the camera, starting very slowly.
69 Slow down when you are at 10m from surface. Alert the helper to watch for the camera at the well head.
70 Slow down further when you are 5m from the surface. You should see the black electrical tape marker on the cable.







- 71 Stop looking at the CCU. Concentrate on the black marker and signals from the helper.
72 Stop the winch when the camera has reached the surface.
73 Apply the hand break.





4.6 Pack up the camera

<p>74 Switch off the power to the winch.</p> <p>75 Switch off the power to the camera & the CCU. Never touch the camera when it is powered up. The high DC voltages are very dangerous if they should ever short out & can be fatal. i.e. they could kill you, the helper or anyone else who touches the camera.</p>	
<p>76 Remove the camera from the well.</p>	
<p>77 Unplug the cable from the camera.</p>	
<p>78 Clean the camera and store it in its box.</p>	



5 Geophysical Borehole Logging

It is assumed that you have already carried out a camera log if this is an old well, and that the well is safe for downhole geophysical logging. If this is a newly drilled borehole, there should normally be no camera log, unless this is a stable borehole in hard rocks and you want to look for fractures.

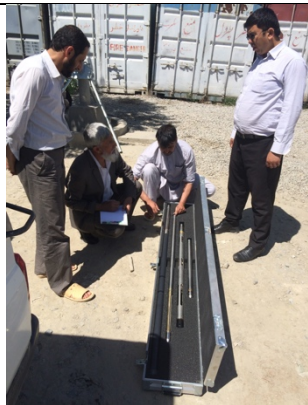

It is assumed that the generator is running. All cables have been connected, but (and this is very important):

THE POWER SUPPLY INSIDE THE VEHICLE HAS BEEN SWITCHED OFF

5.1 Select the sondes to be run


79	It is advisable to run the temperature-conductivity sonde first, before the water in the well is disturbed. Note that this may already have happened to some extent if the camera log has been run first.
80	The second log should be the calliper sonde. This sonde gives us important information about the well/borehole diameter, and is especially important to see if a newly drilled borehole is stable, before you introduce any other sondes.
81	Note that you can stack the GeoVista sondes – recommended is Temp-Cond & Calliper and Natural Gamma & Induction.

5.2 Connect Sonde (Stack) with the winch cable




82 Remove the sonde(s) from the green box.	
83 If you are going to use stacked sondes, connect them together, after applying silicon grease to the O-rings of the connectors. Make sure you place the sondes on a flat surface to prevent them from rolling off/falling down.	

<p>84 Remove the metal protector from the end of the cable head. Put it in a safe place.</p> <p>85 Put a little amount of silicon grease on the O-rings. This will stop any water getting past them when we log under water.</p>	
<p>86 Remove the black plastic protection from the end of the sonde. Put it in a safe place.</p> <p>87 Check the cable head. There is a small protrusion on one side that fits into a groove in the sonde connector.</p> <p>88 Slide the cable head into the sonde connector. It should fit easily.</p> <p>89 Screw the cable head close by hand.</p>	
<p>90 Apply some electrical tape over the connection. This is a safety feature that should stop the cable head connector from unwinding itself for whatever reason when it is in the well.</p>	

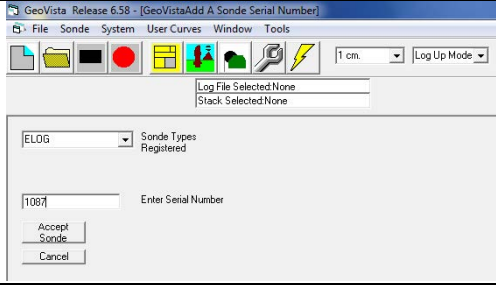
5.3 Get ready for downhole geophysical logging

<p>91 Place the sonde into the well.</p> <p>92 Power up the winch, arm the emergency stop button & undo the manual brake.</p>	
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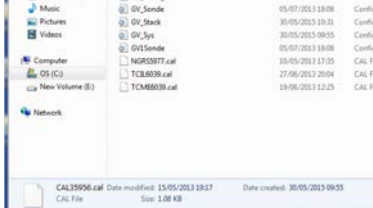
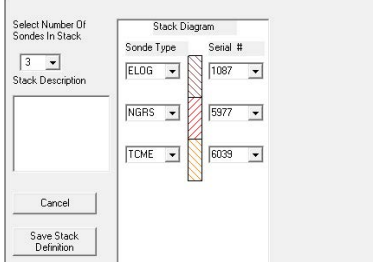
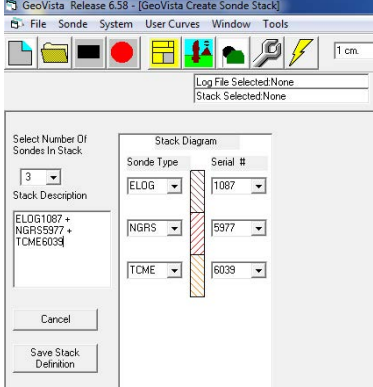
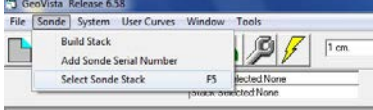
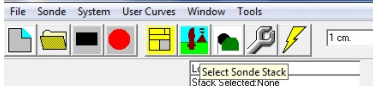


<p>93 Adjust the position of the sonde (stack) very carefully so that the end of the sonde lines up with the top of the casing. The helper should be at the well-head to give you the correct instructions.</p>	
<p>94 You have now set up everything, and are ready to start logging.</p>	
<p>95 Switch on the GV Logger. 96 Switch on the laptop. 97 Activate the GeoVista Software.</p>	

5.4 Carry out downhole geophysical logging

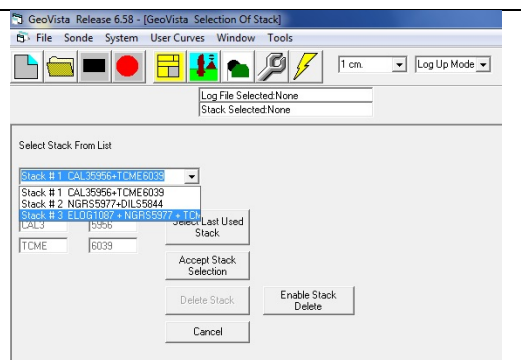
<p>Logging Down</p>	
<p>***** This section only needs to be done once (preferably in the office) *****</p>	
<p>98 Add the Sonde serial number, if it has not already been registered on the laptop. Note that each GeoVista sonde has a unique ID, which is also linked with its calibration file.</p>	



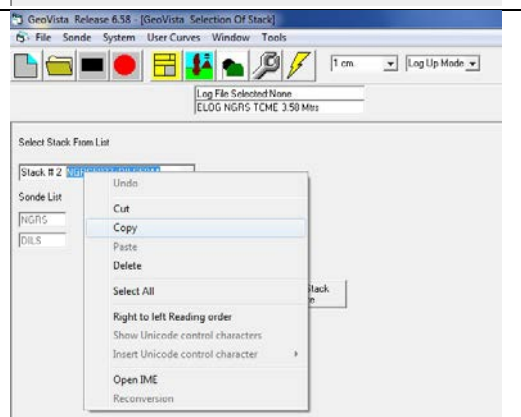
<p>99 Check to see that you have a calibration (CAL) File for each sonde. It should be in C:\gvsystem and have the same name as the sonde number with a *.cal extension. If you do not have a CAL file, you need to copy it from the CD provided by GeoVista & check if the sonde needs to be re-calibrated.</p>	
<p>100 Select Stack. Select the number of sondes in the stack on the right. Then add them in the stack diagram. If the sondes are not shown, you will need to add them.</p>	
<p>101 Name the stack. It is advisable to use the sondes and their numbers as shown here.</p>	
<p>***** Start here if you already have a stack *****</p>	
<p>102 Select the stack. You can click on Sonde-Select Sonde Stack, or press F5.</p>	
<p>103 Another option is to click on the Select Sonde Stack Icon.</p>	



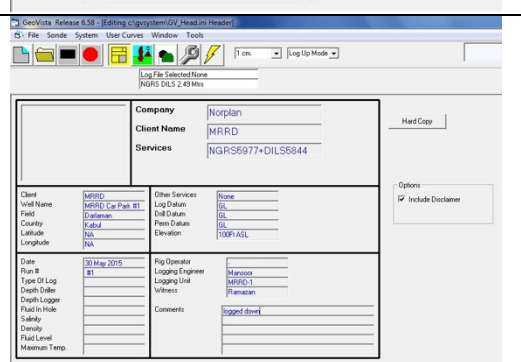
104 Select the stack from the drop down list. It will be numbered in the sequence in which you have add the stacks, so the most recent will be at the bottom.



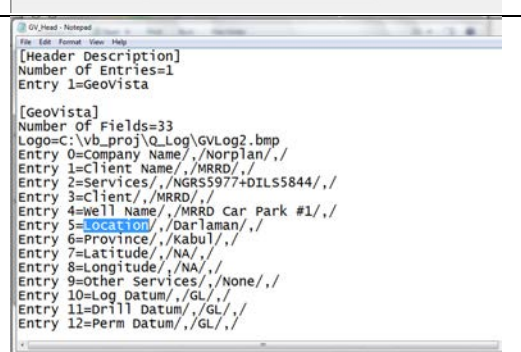
105 Select the stack name and copy it. This puts it on the clipboard. We will use it later, so you don't need to retype it.



106 Make a new logging header & fill in all the parameters shown.



107 Change the header parameters if needed. Open the GV_Head file in notepad to edit/adjust the parameters.





108 Example of a new header

109 When you have finished editing, click on Yes to save your entries.

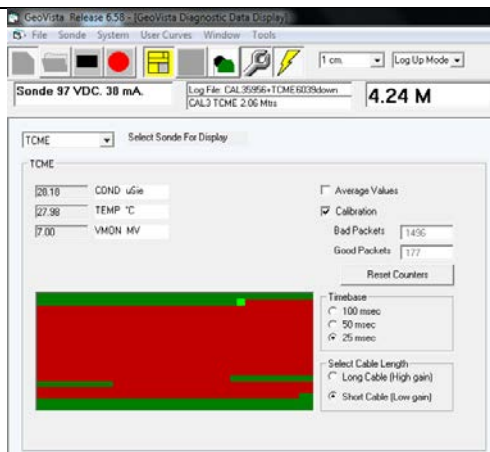
110 Select the RDF file name. Press Control-V to paste the stack name from the clipboard which you saved earlier. Add 'down' or 'up' at the end of the filename, depending on which way you are logging.
111 Save the RDF file inside a directory named:
LOCATION_YYYY-MM-DD

112 You should see the correct log file name on the screen now.

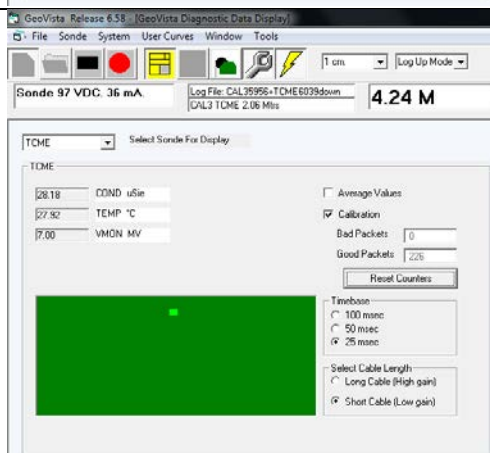
113 Run diagnostics. If it is producing red pixels, the sonde is not working. In this case because the sonde has not been powered up.



114 Power up the tool by clicking on the yellow lightning icon. It should now be producing green pixels. The tool is functioning correctly. Note that you can see the power going to the sonde on the top left. In this case 97 VDC & 38mA.



115 Reset the counters. The Bad Packets counter should read zero, and the Good Packets will be increasing. Select a Timebase of 25 msec & Short Cable. *If you get intermittent red bad data packets, you may have a problem with the cable head. Increase to Long Cable, and replace the cable head when you get back to the office.*

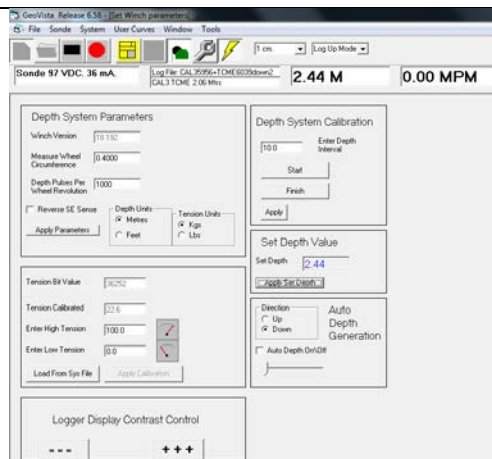


116 Click on Set Winch Parameters. Set the depth by clicking on Set Depth. The depth you enter should be the entire length of the sonde (stack), from the bottom end to the reference point. In this case it is 2.44m.

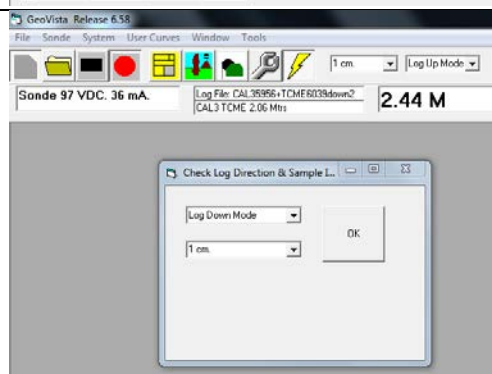




117 Check that the system has accepted the new depth. Note the 2.44m shown at the top right.



118 Click on the red logging button. Select the down mode, and a sample interval of 1 cm and click OK.



119 Start logging slowly downwards. Keep your eyes on the laptop screen at all times, and monitor the tension on the cable.

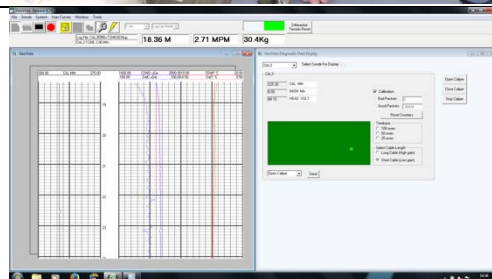


120 Carry out the geophysical log slowly – 3m/min is a good speed. Remember that every sonde is specific and is either downward only, upward only or can be both downwards and upwards.

- Downhole log only: Temperature-Conductivity
- Upward Log only: Calliper
- Downward & Upward Logs: Natural Gamma & Induction



121 Logging is ongoing. Note the logs on the left & the good data packets (green) on the right.

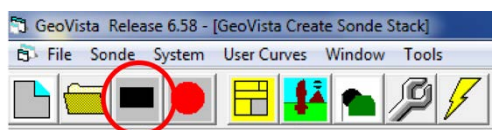




- 122 When you reach the bottom of the well, you should see a big reduction in tension on the cable, and also a change in the noise coming from the winch.
- 123 Stop the winch and put on the hand brake.



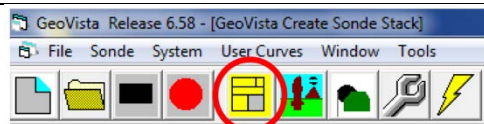
- 124 Press the black square icon to stop recording the log.



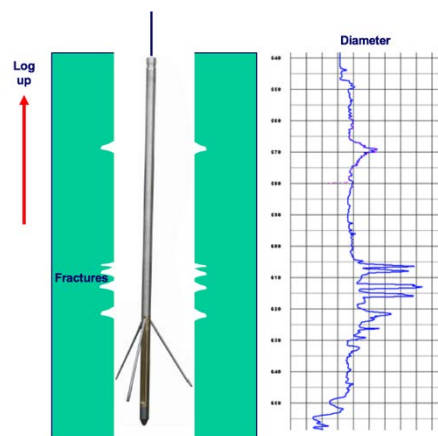
Logging Up

Note that it is a good idea to always log up-hole even if you have already carried out a downhole log. This helps us to check if the sondes are functioning correctly.

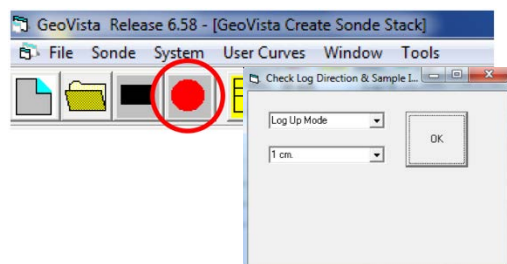
- 125 Edit the header file, for the up log.
- 126 Save it with the same name as before, but ending as 'up', not 'down'.



- 127 If you are doing a **calliper log**, open the calliper arms at the bottom of the well/borehole. This takes a few seconds, so make sure it is fully open before you start to log upwards.



- 128 Click on the red icon to start logging, and select the 'Log Up Mode'.



<p>129 Slow down when you are at 10m from surface. Alert the helper to watch for the sonde (stack) at the well head.</p> <p>130 Slow down further when you are 5m from the surface. You should see the black electrical tape marker on the cable.</p>	
<p>131 Stop looking at the laptop screen. Concentrate on the black marker and signals from the helper.</p> <p>132 Stop the winch when the sonde (stack) has reached the surface.</p>	
<p>133 Stop logging, by pressing on the black square icon.</p>	
<p>134 Switch off the power to the sonde. Never touch the sonde (stack) when it is powered up. The high DC voltages are very dangerous if they should ever short out & can be fatal. i.e. they could kill you, the helper or anyone else who touches the sonde (stack).</p>	
<p>135 You may need to lower the sonde (stack) 1 – 2 metres down the well/borehole before you can pull it out of the well.</p> <p>136 Apply the hand break of the winch.</p> <p>137 Switch off the power to the winch.</p>	

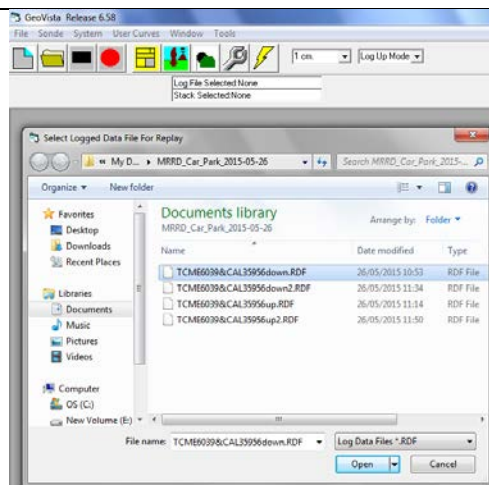


Back up your Logging Data

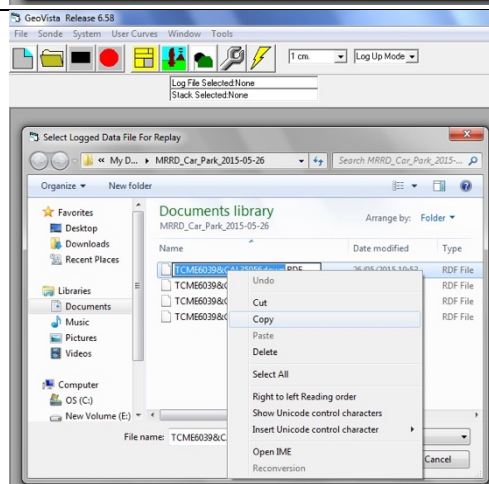
It's important to back up all your data before you leave the site.

You can make a LAS file at the same time. The LAS file is in a data standard that can be read by all borehole geophysical processing software.

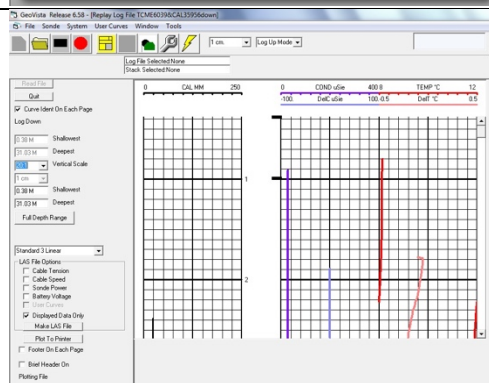
138 Select the log replay file (second icon from left)



139 Select and copy the file name.

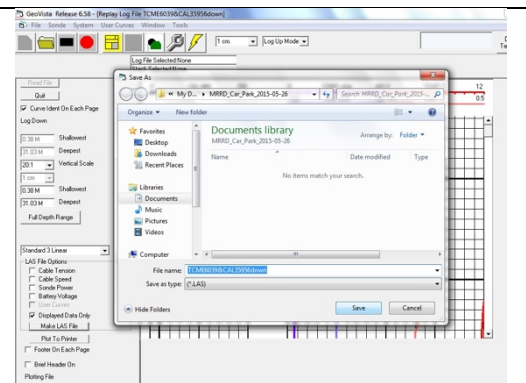


140 Read the file





- 141 Under LAS File Options, select Displayed Data Only and click on Make LAS File.
- 142 Make LAS files for all of the logs you have produced.
- 143 Make a copy of the data directory onto at least one Flash Drive. Logging is expensive in terms of time and resources, so you do not want to have to come back to the well/borehole because of lost data.



5.5 Pack up the Sonde (Stack)

- 144 Pull the sonde (stack) out of the well/borehole.
- 145 Carry the sonde (stack) to the logging vehicle.



- 146 Clean the sonde (stack) if necessary.



- 147 Remove the insulation tape.
- 148 Unscrew the cable connector.
- 149 Unscrew the tools if they are in a stack.
- 150 Screw the black plastic protectors onto the end of the tools.
- 151 Place the tools back into the green tool box.



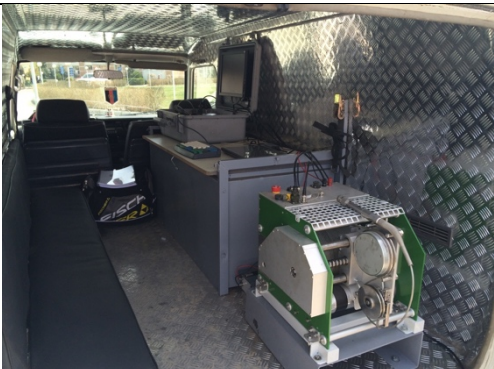








6 Pack up all Equipment & Demobilize

When you have finished logging (and backed up your field data!), its time to pack up and leave the site in the same condition in which you found it.

6.1 Pack up the Equipment

<p>152 Switch on the power to the winch & pull in the remaining spare cable.</p>	
<p>153 The helper should maintain some tension on the cable. Holding a rag over the cable can help to clean it as it is pulled in.</p>	
<p>154 Switch off all power switches starting from inside the truck and working your way towards the voltage regulator and the generator. 155 Switch off the generator. 156 Bring the voltage regulator and cables back to the logging vehicle.</p>	



<p>157 Unplug the laptop power cable & USB cable & pack it away.</p> <p>158 Unplug the CCU camera cable, winch cable, USB cable & power cable.</p> <p>159 Put all the cables underneath the CCU keyboard & tie it down with the black belt.</p> <p>160 Close the CCU.</p>	
<p>161 Put the CCU, Laptop, camera box, tripod sheave wheel & sports bag in the box.</p>	
<p>162 Close the box & engage the latch so it will not open during the journey.</p>	
<p>163 Fold up the bench & attach it securely at both ends.</p>	



<p>164 Load the generator inside the vehicle & tie it down. Take care with the parts which can still be hot on the generator.</p>	
<p>165 Load the green sonde box & attach it securely to the top of the box.</p>	
<p>166 Load the tripod legs inside the vehicle. 167 Put the cover over the winch. 168 Close the vehicle doors. 169 Check outside that you have not left anything behind.</p>	
<p>170 Pick up any rubbish from the site & take it to the nearest disposal facility. Keep Afghanistan clean!</p>	