



MSF Environmental Health Toolkit

Technical Manual on Operating Borehole Diagnostics Tool Kit

Toolkit component 1.1



Foreword

A borehole is a structure that is susceptible to physical, chemical and biological processes that may influence its life span, yield and water quality. The above factors depend on quality of borehole construction, the way it is operated and geological conditions or aquifer characteristics. Deterioration of a borehole may lead to some serious contaminations of water harmful for human use and eventually it being abandoned, leading to costly measures to develop alternative water sources for communities. Borehole diagnosis and rehabilitation is often a cheaper alternative to new borehole drilling.

Borehole diagnosis entails using visual enhancement tools like down-the-hole camera, depth water sampling probe and data logging probe tools to infer the physical, chemical, geological and aquifer characteristics that may be influencing the poor performance of a borehole. This inference combined with water quality analysis and borehole capacity pumping tests help to understand the cause of borehole deterioration and determine the relevance of a corrective measure.

Borehole diagnosis within MSF WASH Projects reveals that borehole deterioration is often linked to physical problems related to poor construction of the borehole, leading to contaminated borehole water, sand intrusions and silting up, electrochemical and bacterial corrosion and clogging of the borehole screen, etc. Another cause of poor water quality observed is high levels of certain minerals (e.g. fluoride). Such problems could be addressed by carrying out complete diagnosis of the borehole to determine the underlying cause and give recommendations.

This manual presents a technical description and the utilization of the Borehole Diagnostic Tool Kit used for the diagnosis of the existing boreholes. The diagnosis can be used for the targeted rehabilitation of the problematic boreholes as well as for gathering information on the existing boreholes. Such information could also serve as a guide for the drilling and construction methods for new boreholes as well as for research purposes.

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Introduction

The MSF borehole diagnostic technics include;

- Video inspection
- Data logging
- Water sampling
- Pump tests

Diagnostic tools used for these technics include an underwater high resolution camera, a depth water sampling probe, a GFTC data logging probe and winch operated cable that serves the dual purpose of sending the tools down the borehole and for the data collection. A submersible pump is used to do the step and long term pump tests to check the productivity of the borehole and the maximum productivity of the surrounding aquifers providing water to the borehole.

The down-the-hole camera allows one to observe the general condition inside the borehole in terms of water turbidity, condition of the installed casings, potential deposit that could develop in the slots decreasing yield, sand and root intrusion zones and sediments and trash accumulation at the bottom of the borehole.

The depth water sampler allows for collection of water samples at the desired aquifer depth to check the water quality of the aquifers providing water to the boreholes.

The data logging probe is equipped with sensors to measure temperature, electrical conductivity, natural gamma and a propeller to measure flow up or down the borehole. Water temperature is important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the rocks. Therefore, it will have a higher electrical conductivity. Temperature exerts a major influence on biological activity and growth.

Electrical conductivity (EC) is an important water quality parameter because it gives quick idea of the chemical quality of water including ions, dissolved salts and other inorganic chemicals. EC increases with increasing salinity.

The flow measurements in the borehole allows for the location and quantification of water in-rushes into the borehole while the natural gamma ray logging characterize the rock or sediments (geology) in the borehole.

The borehole diagnostic tool kit has helped facilitated the successful rehabilitation of boreholes affected by biological contamination, chemical and physical water quality problems, structural and pump defects within MSF projects.

Objective of the manual

The principle objective of the manual is to serve as a training and operation guideline for the users to use the borehole tool kit at the field. It comprises all the steps to follow, to perform the different operations linked to diagnosis of the borehole.

Who is this manual for?

The training manual is the guideline for MSF Environment Health staff members, experts and technicians, engineers from the universities and staff from the borehole drilling and rehabilitation companies.

Borehole diagnostics field intervention

Preliminary

The Borehole needs to be decommissioned in order to be able to send the borehole diagnostics tool equipment inside the borehole. The equipment taken out from the borehole should be placed on plastic sheeting or on a clean zone to avoid contamination. This is followed by the unloading of the material from the diagnostic tool car, this includes generator, submersible pump, poly pipe, tool boxes, pulley etc. which will be used later during the course of the investigation.

The borehole diagnostic tool car is then aligned in front of the borehole so the borehole diagnostics tools can be lowered down into the borehole through a fixed winch installed inside the vehicle.

Measure the static water level, the inner diameter of the borehole and height of the casing above the ground.



Install the pulley/tripod at the head of the borehole, in front of borehole diagnostic tool car.



Power supply and connections

- 1- Connect the generator with the electrical board inside the DT car



- 2- Connect the regulator to the electrical board



3- Connect the winch to the extension cable



4- Ground the electrical board by connecting it to the metal bar inserted in the ground



5- Connect the control unit VSR20 MKII to the power supply



6- Connect the video recorder to the power supply.



7- Connect the back umbilical cable of the winch to the control unit VSR20 MKII.



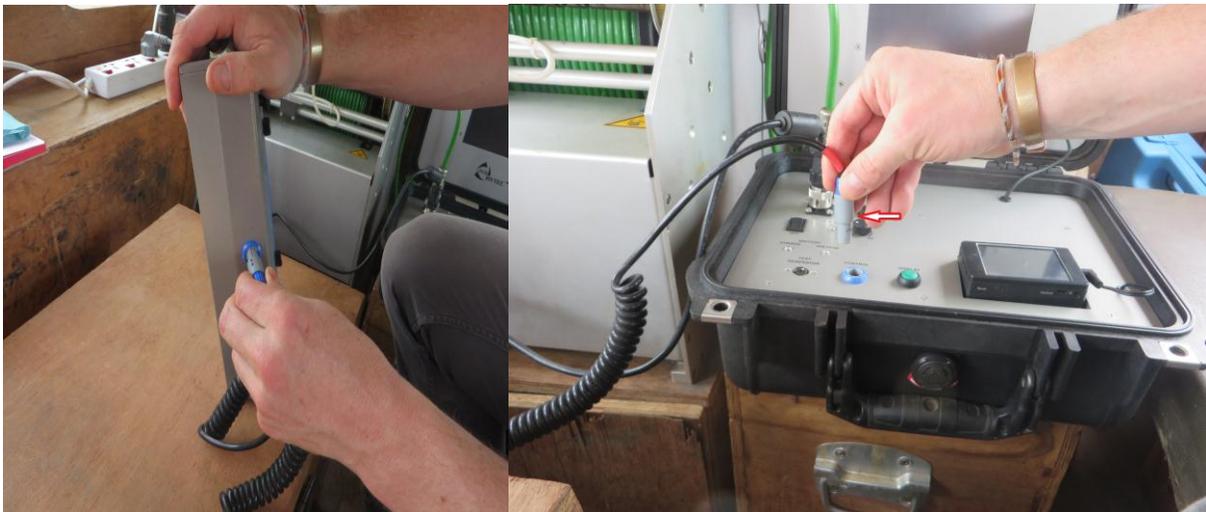
8- Connect the TV monitor to the control unit VSR20 MKII and to the power supply



9- Control unit VSR20 MKII.



10- Connect the control unit VSR20 MKII to the controller unit VSR65.



11-Switch on the generator to supply power to the system as all the connections are already done.



12- Switch on the electrical board once the generator is on.

13- Wait for the output voltage to be 230 on the regulator

Switch on the winch and press the “Remote” button on the winch so the red light disappears. The winch cannot move up and down if the red light is still on.

14- Extend the front umbilical cable to make a space to connect the tools to the cable.



Down-the-hole camera investigation

1- Mounting of the down-the-hole camera

Connect the front umbilical cable of the winch to the camera following the steps below and wipe the camera before the video inspection.







2- Sending the camera down the borehole

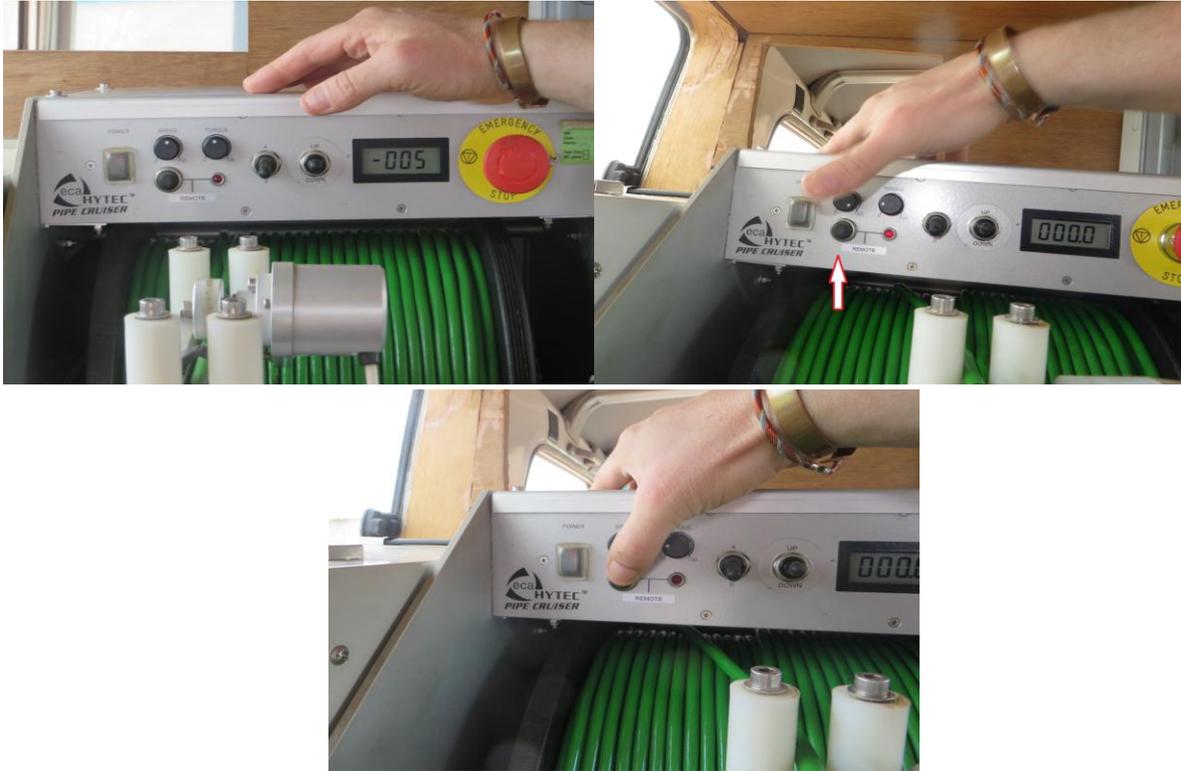
Send the camera down the borehole so that its bottom is at the same level than the ground level.



1- Switch on the control unit so the camera will be on.



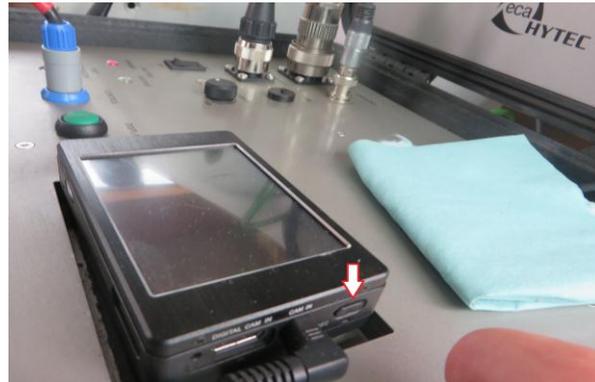
- 2- Adjust the winch at depth zero by pressing the button “remote” on the winch. This needs to be done to make sure that all the readings will be taken at the ground level (level zero). Make sure that the red light on the winch is removed by pressing the remote button. This is needed to make sure the winch can move freely up and down.



- 3- Insert the SD card in the video recorder



4- Switch on the video recorder



5- Launch the video recording.



6- Put on the TV to see the video on a bigger screen.



- 7- If the above procedure is followed properly the length at the screen will be showing Lf: +0.00. In case the cable length is not showing zero at the screen then follow as under:
- Make sure that the controller for VSR65 unit is on
 - Press on Escp-> F1-> F4->F1
 - After pressing F1 it shows you the message to use the right joy stick to adjust the cable length (LF).
 - Use the right joy stick up or down till achieving the length zero at the control unit/TV screen.



- 8- Centralize camera in the borehole by using the left joy stick. The brightness of the camera could be adjusted by using nab and zoom in and out by using + or – button.
- 9- 360 degrees view inside the borehole could be achieved by pressing the 360 degrees button on the controller for VSR65 unit.
- 10- Start sending camera down by pressing the down button on the winch with a reasonable speed (3m to 5m/minute). This speed can be achieved by adjusting the speed button on the winch.



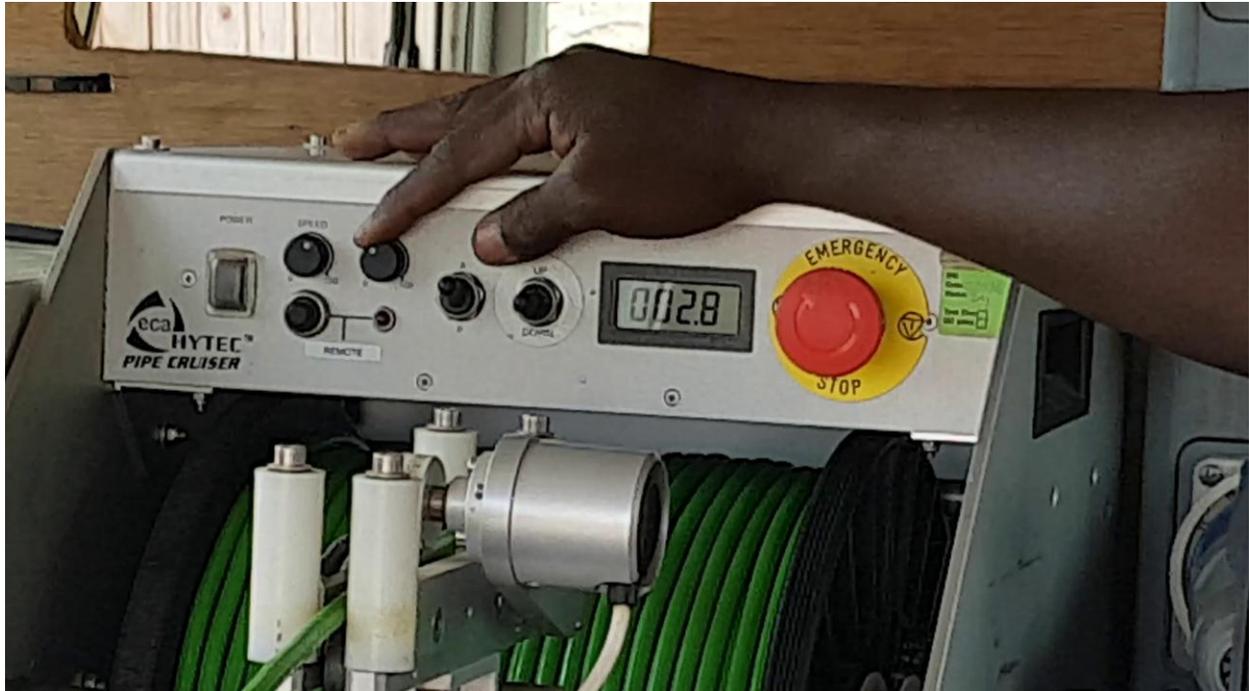
11- Write down all findings, distortion in the borehole by using the diagnostic sheet.

Video inspection sheet	
General informations	
Country :	Dominique
Project :	Work in preparation around Harare
Area :	St. John's Hill
Site name :	St. John's Hill
Borehole ID :	15
GPS Coordinate :	Latitude : Longitude :
State of intervention :	Height :
Technical detail	
Static water level (m) :	
Borehole depth (m) :	
Borehole equipments :	Manual pump <input checked="" type="checkbox"/> Number of tank : 1 Electrical pump <input checked="" type="checkbox"/> Tank Capacity (m ³) : 20 Solar pump <input checked="" type="checkbox"/> Diameter (mm) : 150 Date of drilling : 11/04/2017 Datum above ground level (m) : 600m Type of casing : PVC
Video inspection	
Starting & ending time :	Remarks (different level of crepine and full pipe) trashes existing !

12- You can use the remote of the video recorder to launch/stop recording or to take a snapshot by pressing on the button on the top of the remote (snapshot in red will appear on the screen). When recording is on-going, 2 lights red and white will appear on the top of the remote.



13- The “Torque” button on the winch should not be at zero if you want to come back up to get some images above. In case if it’s at zero it should be moved towards away from the point zero, as at point zero the winch cannot be moved backward.



14- Save recording by bringing the rec button back to stop.



15- Switch off the video recorder by pressing the side on/off button.

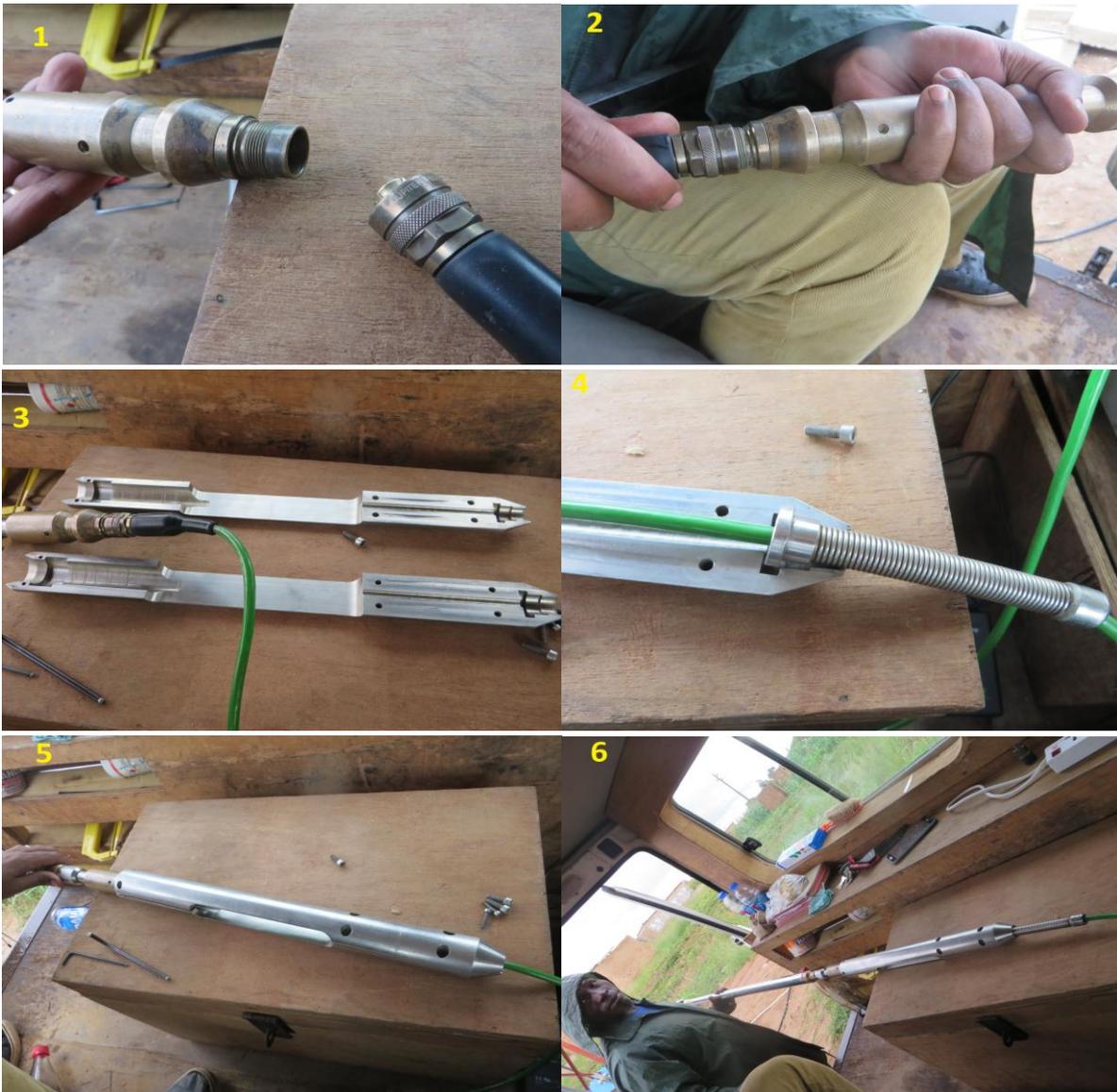


- 16- As we have already done the video inspection now it's the time to bring back the camera. The two buttons "Speed and Torque" can be placed at maximum i.e. 100 to increase the speed to bring back the camera. Just be careful when the camera reaches closer to the surface reduce the speed for safety reasons and to hold the camera easily when it gets out.
- 17- Once the camera is out, switch off the control unit VSR 20 MKII and remove all the connections.
- 18- Disconnect the camera, swipe it with clean tissue and pack it in its box.
- 19- Remove the SD card from the video recorder, save the video in the laptop and put back the SD card into the video recorder.

Data logging

1- Mounting of GFTC probe

Follow the steps below to connect winch front umbilical cable to probe



2- Connections

1. Connect winch back umbilical cable to logger,



2. Connect the logger to the lap top,



3- Diagram in static mode

- 1- Send the probe in the borehole so that its bottom (the part next to the cable) be at the same level than the ground level,

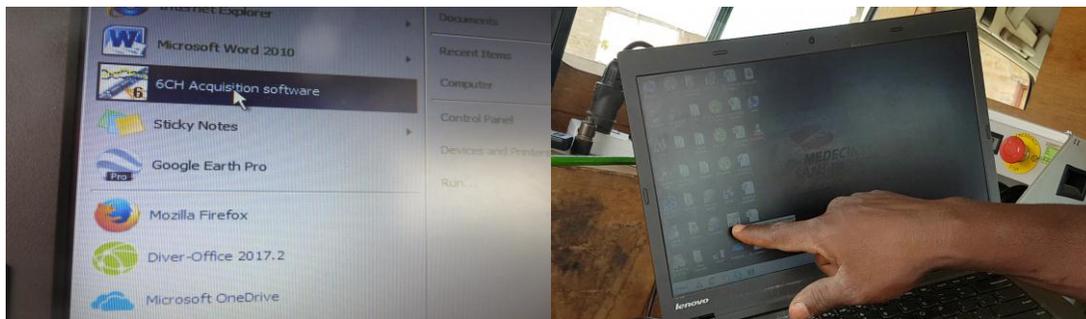


- 2- Calibrated the depth at 0.00 on the winch dash board by pressing on the remote button, press on it once again to disappear the red light nearby





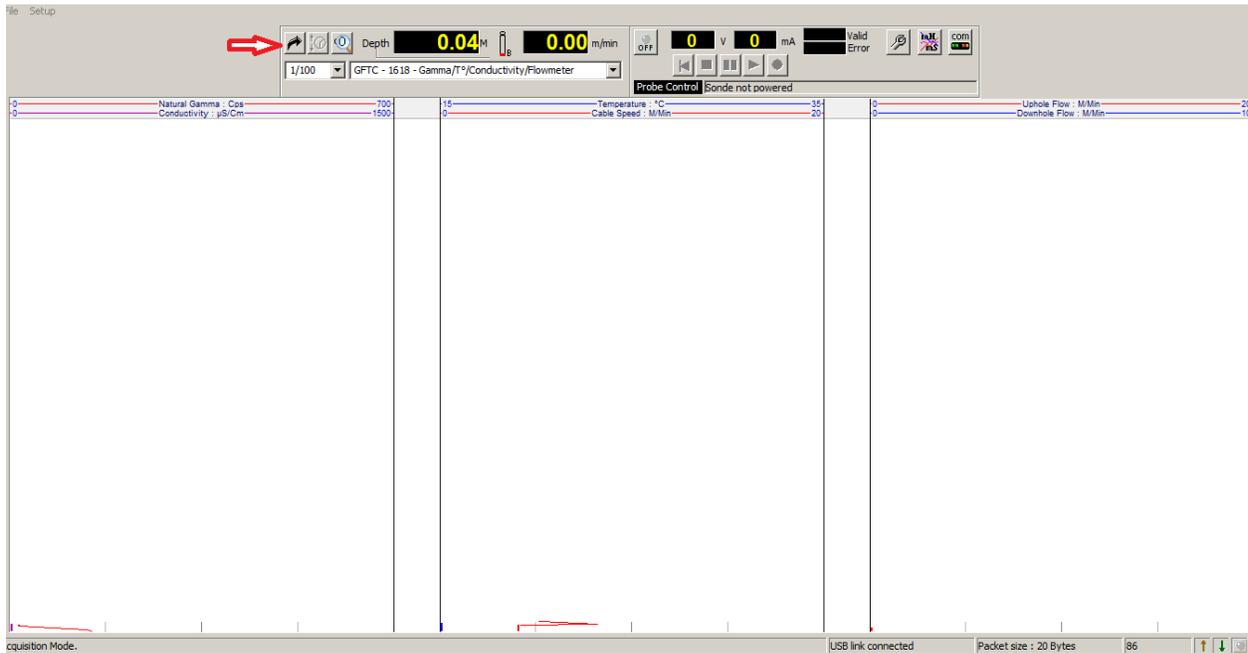
- 3- Click on the 6CH Acquisition software after clicking on Start or click on the 6CH Acquisition software short cut at the lap top's screen,



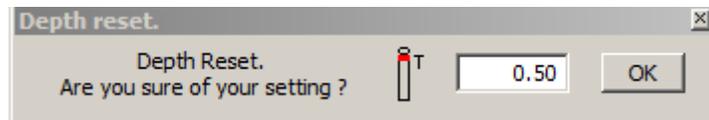
- 4- Switch on logger by pressing on the power button, the three green light on the logger will display



5- Press on the black arrow on the top left of the screen, a depth reset box will appear



6- Calibrate the length of the probe by adding 0.5 in the depth reset box, press OK/Enter



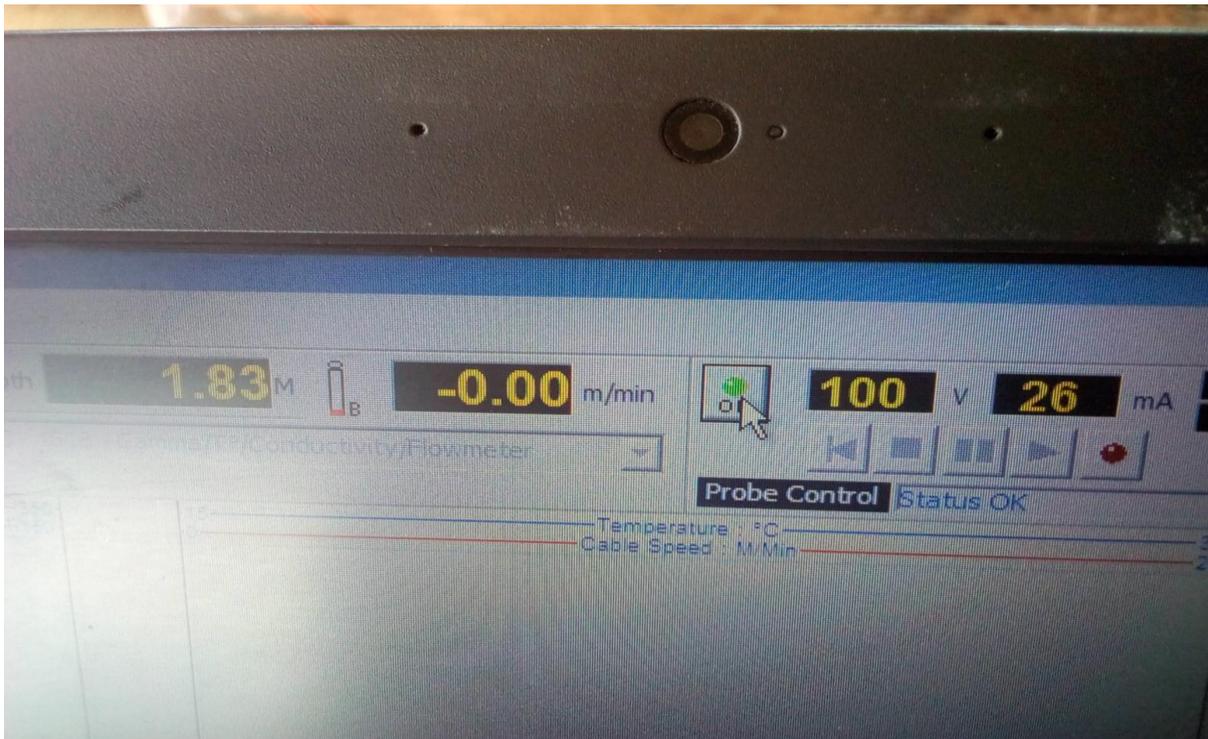
7- Depth will automatically change to **1.83** m which is the total length of the probe including the protection



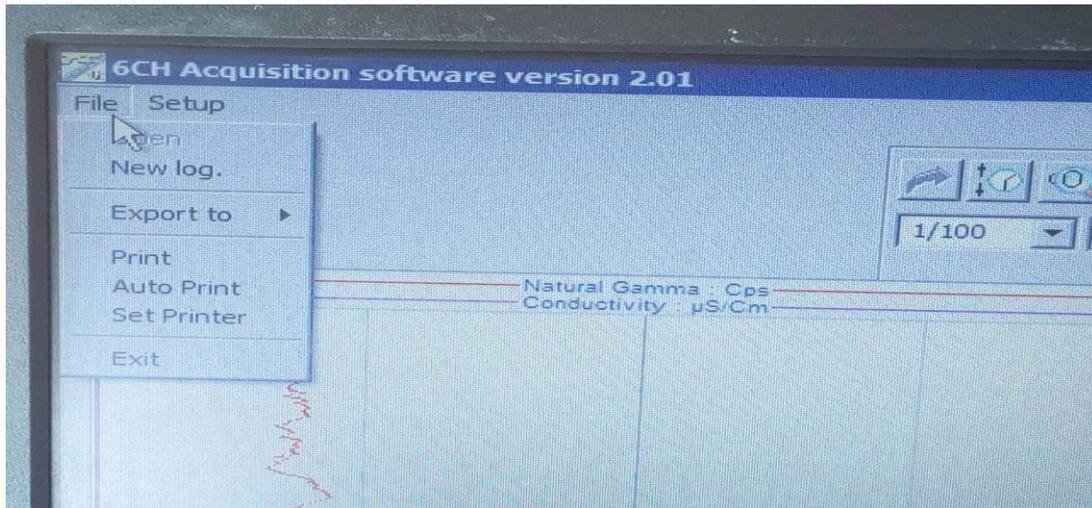
- 8- Double click on the bottom of the cylinder to bring the red bottom from top position to bottom i.e. T to B.



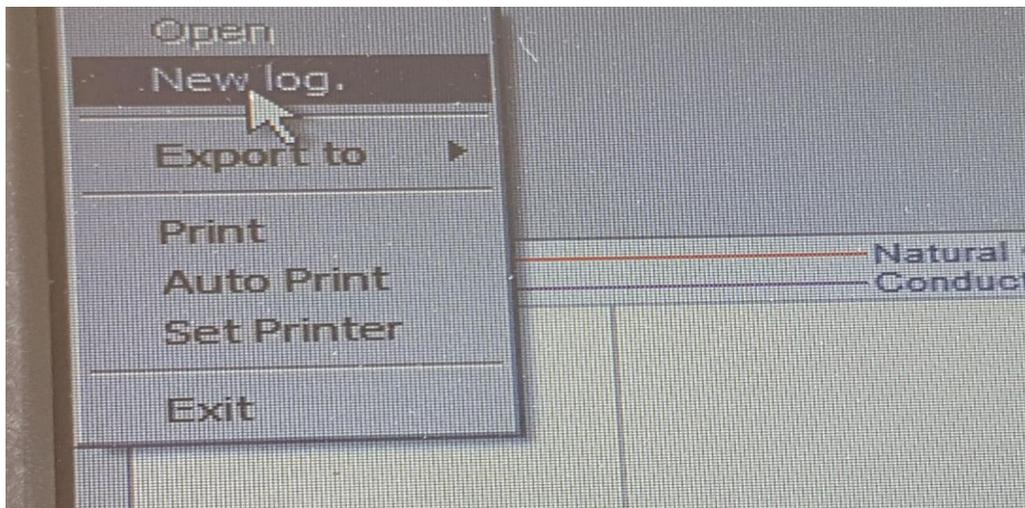
- 9- Click on the button ON on the lap top screen to switch on the probe. It will show Probe Control: status OK written in blue



10- Click on File on lap top's screen (on left side)



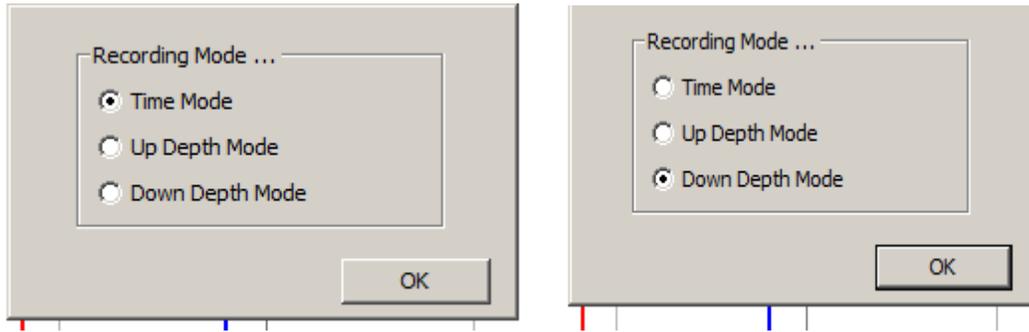
11- Click on new log



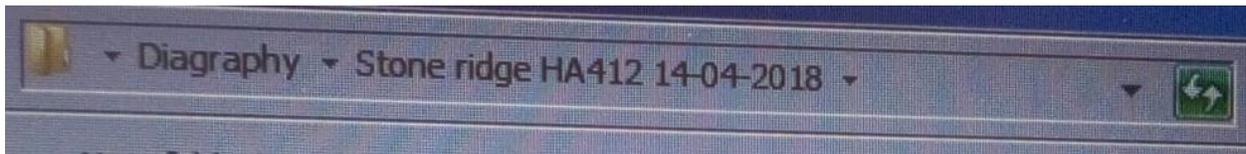
12- Recording mode dialogue box will appear

Click on the Down Depth Mode button

Click OK



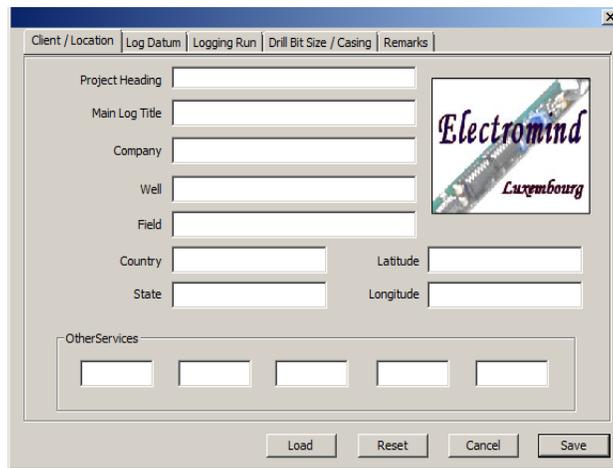
13- A "Save As" dialogue box will appear. Please make sure that you make a new folder with the Site name, Site ID and date, in the diagraph folder to save your data



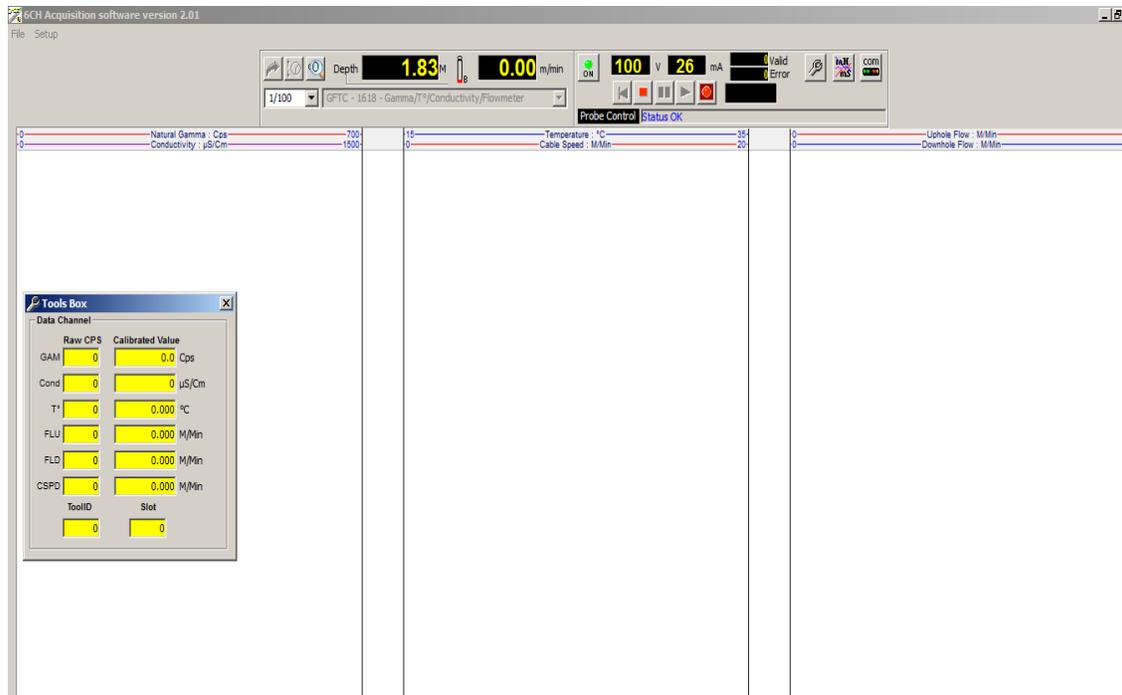
14- Name the file with site name; site ID, date and recording mode i.e. static

Static: Stone ridge HA412 14-04-2018 stat.log

15- Click on save and a new dialogue box (Electromind Luxembourg) will appear.



Save again on this dialogue box and the recording will start which will be seen by the blinking of the red button on the computer screen.



16- Start sending the probe down the borehole by pushing the up/down button on the winch downwards

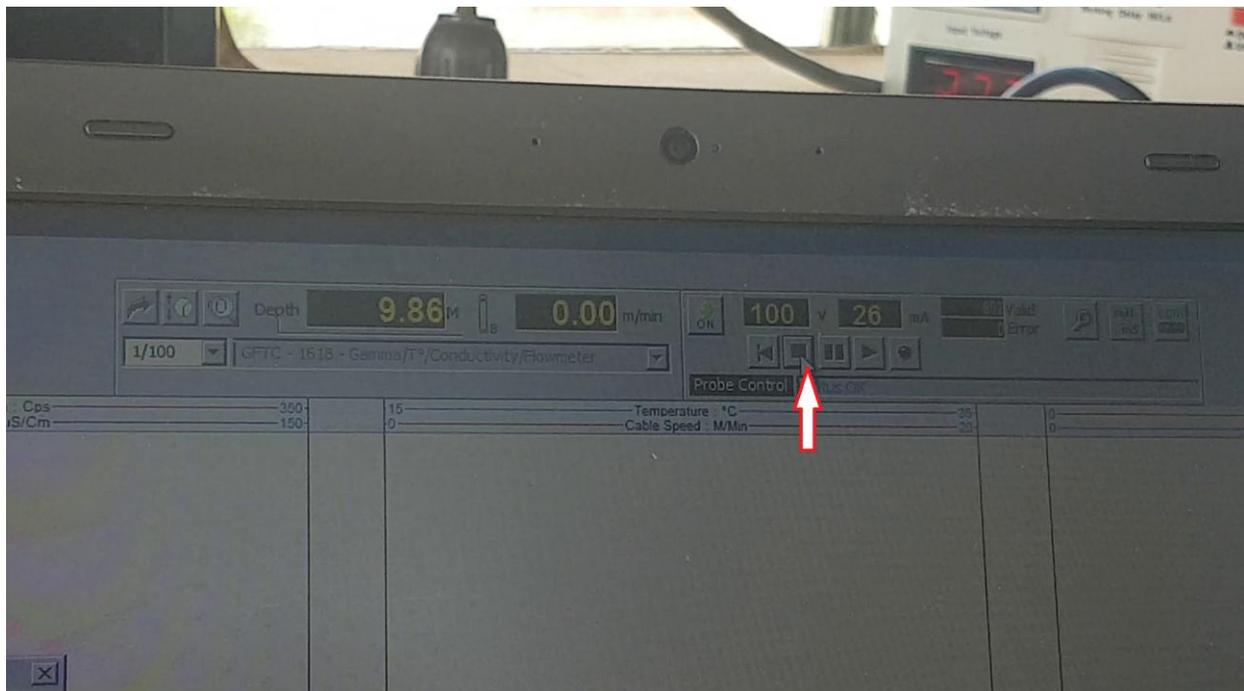


17- Calibrate the speed of the cable using the speed button on the winch to achieve 4m/min cable speed. This speed is used both for static as well as for dynamic mode. However in dynamic mode we also take readings at 6m/min that why it's important to write the speed of the cable while saving your file as explained in point number 14.

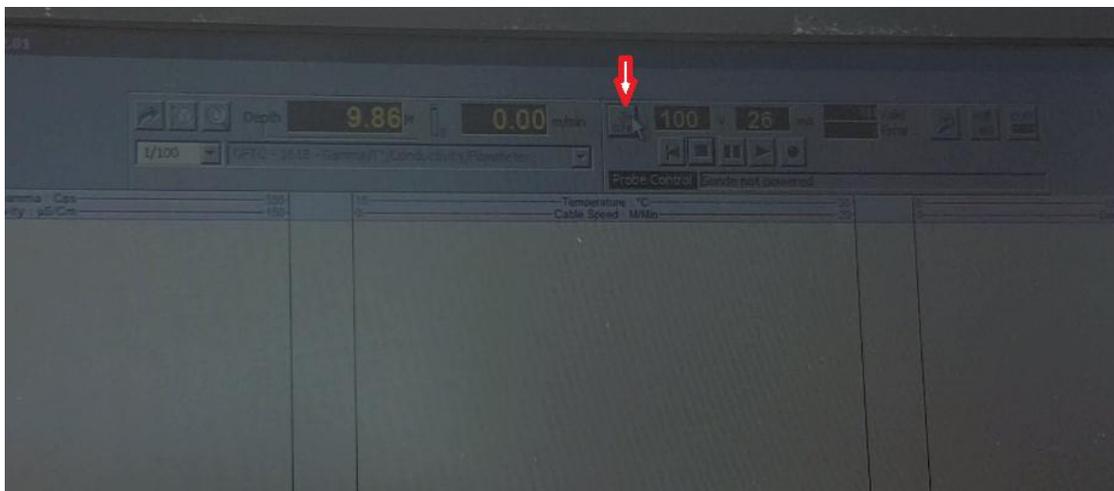


18- Keep on pressing on the down button till reaching the bottom of the borehole
No pic

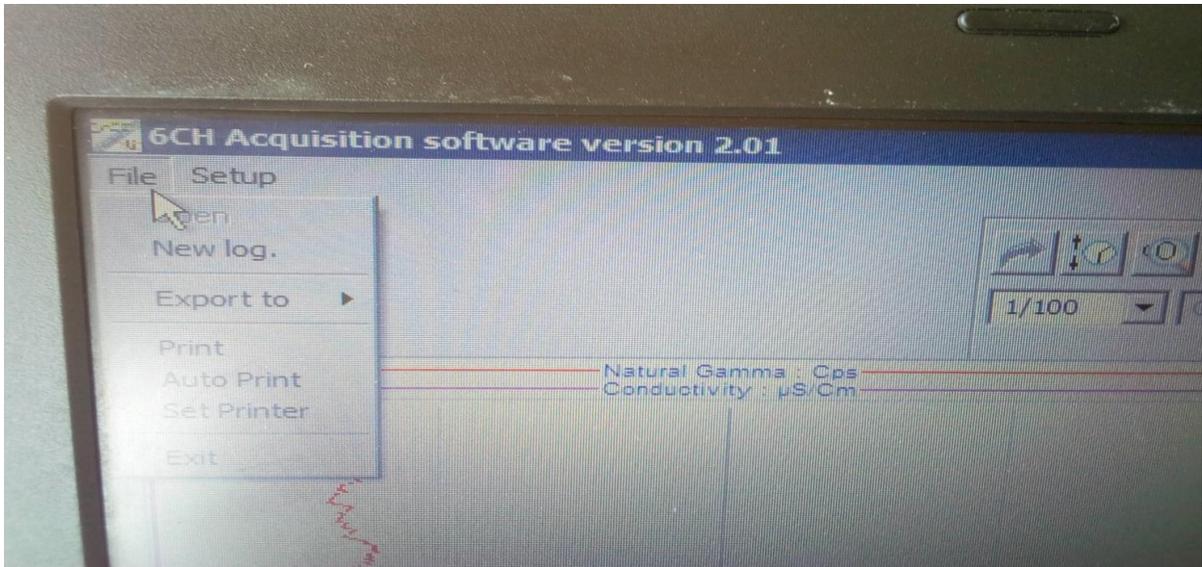
19- If the data logging is finish, stop recording by pressing on the square red button



20- Switch off the probe by clicking on ON/OFF button



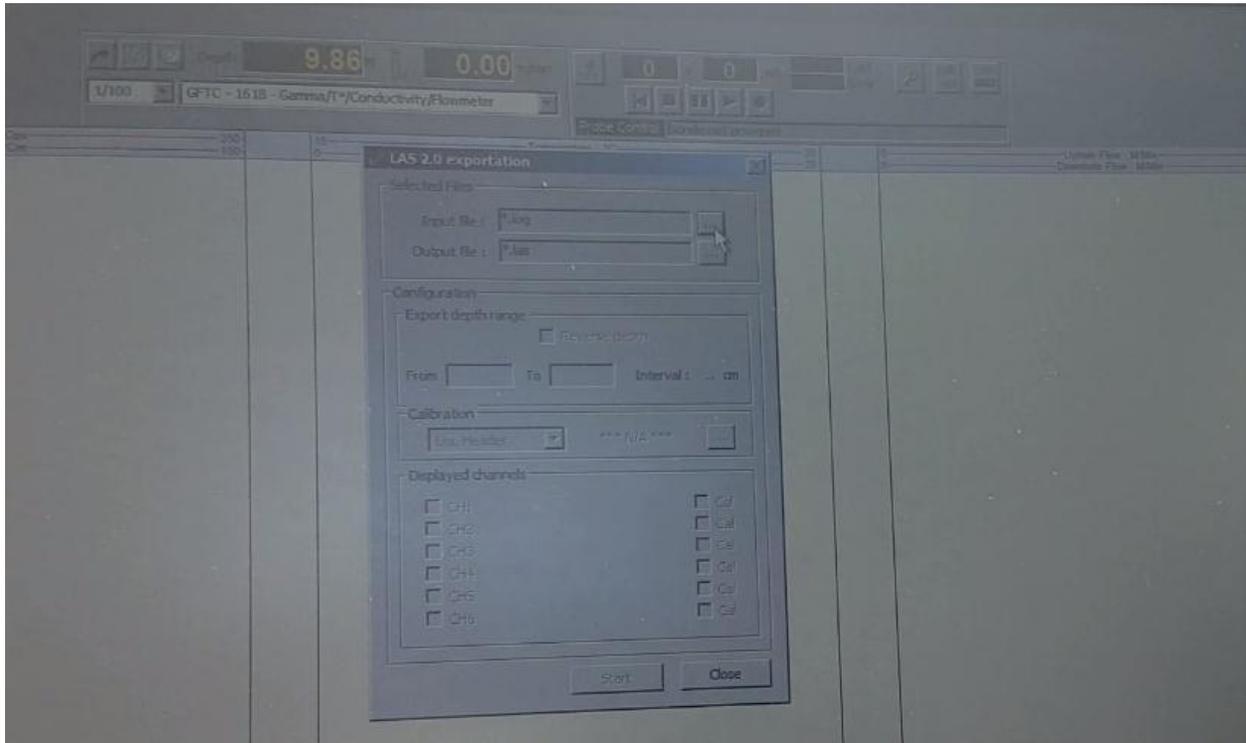
21- To save the recorded data, go to File



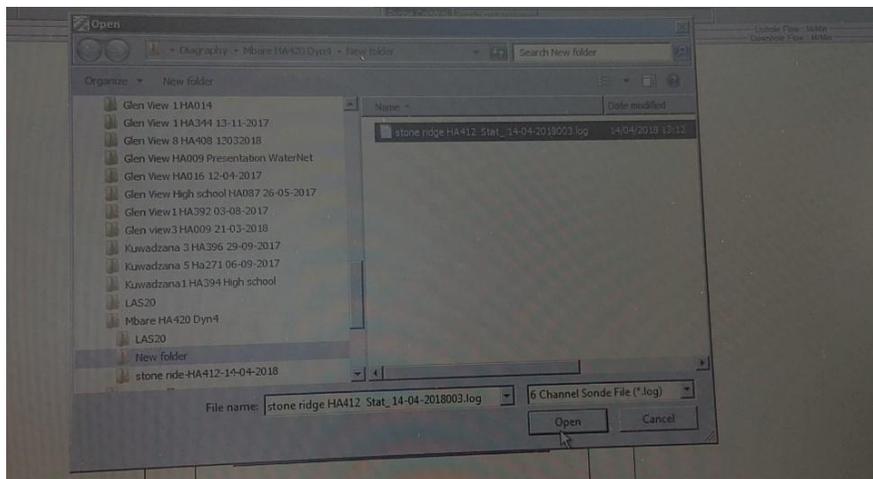
22- Export to LAS20

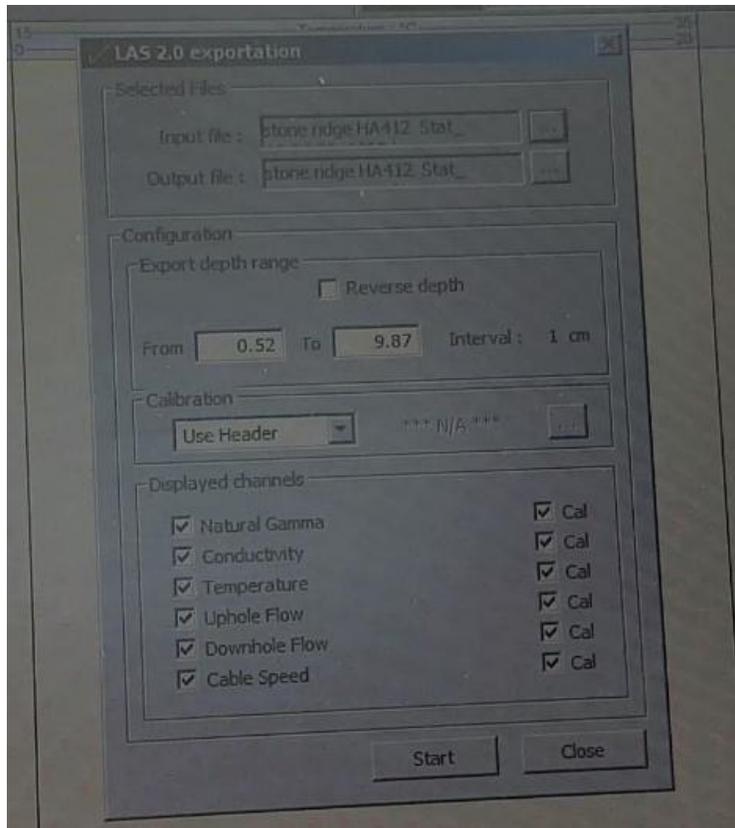


23- A LAS 2.0 exportation folder will open, click on input file link on the folder, a new dialogue box will appear with the existing “.log” file which you created previously.

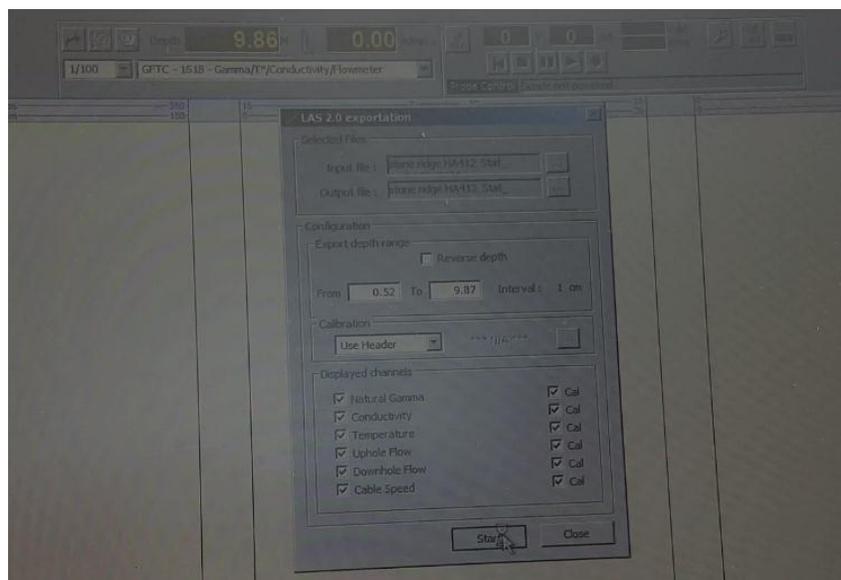


24- Select the “.log” file and click “open” another dialogue box will appear showing the logging depth.





25- Press start on the LAS 2.0 dialogue box, a new dialogue box will appear showing you the “Migration to LAS is completed” click OK (the box will disappear). Close the LAS 2.0 box.



26- All your logged data is saved.

27- During the diagraph, record the information mentioned on the diagraph sheet. This will help making the report of the intervention

Diagraphy Sheet



General informations			
Country :	Zimbabwe		
Project :	Wash as prevention around Harare		
Area :	Olwezi View 3		
Site name :	Maitika Academy school		
Borehole ID :	Latitude :	Longitude :	Height :
GPS Coordinate :	17-03-17		
Date of intervention :			
Technical detail		Tank Capacity (m3):	
Static water level (m) :	0.54	Diameter (mm) :	
Borehole depth (m) :		Datum above ground level (m) :	
Borehole equipments :	Manual pump <input checked="" type="checkbox"/>	Type of casing :	
	Electrical pump <input checked="" type="checkbox"/>	Turbidity :	
	Solar pump <input checked="" type="checkbox"/>		
Date of drilling :		AVERAGE	
Type of diagraphy	Pump inlet depth (m) : 8	Gamma (CPS) :	
Cable speed :	On static :	Flow up (m/mn) :	
	On dynamic : 4-6	Temp (°C) : 22.0	
	Flowrate (m3/h) : 3	Conductivity (µS/cm) : 22.0	
Starting & ending time	Remarks		
Static			
Dyn4 13h43-13h47			
Dyn5 13h50-13h59	5-		

Operator name : *Saradze*

4- Diagraph in Dynamic mode:

The main difference between the diagraph in static and in dynamic mode is, in dynamic mode we insert the pump at least 1 meter above the probe to create the flow so we can accurately identify the inflow areas inside the boreholes (location of the aquifers). The pumping rate depends on the yield of the borehole. It is advised to monitor the depth of the dynamic water level in order not to run the pump dry.

While saving the file in dynamic mode along with the location and date, cable speed is also mentioned in the file name i.e. 4 meters/min or 6 meters/min as the diagraph is done with different cable speed. The registration path of the files is same as of the static mode. An example of the file name during dynamic mode is as under:

Dynamic: Stone ridge HA412 14-04-2018 dynamic 4.log

Dynamic: Stone ridge HA412 14-04-2018 dynamic 6.log