Two (2) X Borehole Sitting, Two (2) X 100m Borehole Drilling and Two (2) X 48 Hour Borehole Yield Tests at IphuphaLobawo Farmers Trust, Eastern Cape

TECHNICAL SPECIFICATIONS

Phase 1: Water Survey

Specifications	Specifications Details
Borehole sitting and geophysical surveys by Geohydrologists ((Use Advanced Electronics Survey Machines)	The survey report must be a detailed analysis of the groundwater potential, and the following must be reflected in the survey report: • **Location** of the site to be drilled through the use of Geohydrologist expertise, geological and hydrogeological maps, and advanced geophysical instrumentation • **The correct drilling method/rig** • **Drilling depth/target** For each borehole, a surveyor must select a suitable line of survey for identification of suitable drill targets. For each borehole siting/survey, a 200 meters long geophysical traverse must be surveyed at 5m spacing, with the use of both Pulse Quick Wavelet Transform (PQWT), and Magnetic method (Proton Magnetometer).

	These survey techniques must be used interchangeably. The hydro-geological report must be signed off by a professional Certified Natural Scientist that is registered with **SACNASP** Note: **Survey report** to be handed to ARC Personnel. The survey report must include the instruments and methods used No drilling work will be conducted without a professional survey report **If the geohydrologists reports no ground water availability in the farm, then no borehole water drilling work will continue. The service provider will be paid for only survey work.**

Phase 2: Borehole Drilling, Casing and Capping

Site establishment	Initial preparation of a construction site for borehole drilling
Borehole drilling	100m borehole (165mm diameter) Drilling work to be conducted according to SANS 10299-: 2003 – Development, Maintenance and Management of Groundwater Resources
Casing	**12m steel casing: Casing 177mm x 3mm,** Steel casings must be welded together one by one while lowering them down the borehole
Sanitary Seal	Gravel pack
Concrete collar around a borehole	The Drilling Contractor will construct a **shallow circular concrete collar** around a

	successfully completed borehole. This collar shall have the dimensions set out in the attached Drawing as seen in **APPENDIX A.1**, yielding a volume approaching 0.08 m^3. **The concrete mixture shall consist of water, Portland cement, stone aggregate (10 mm),** and river sand. Quantities of these materials sufficient to make 0.1 m^3 of concrete with the required strength of 30 MPa after 28 days are: (1) 20 litre of water, (2) 42 kg (0.8 bag) of Portland cement, (3) 0.07 m^3 of stone aggregate and (4) 0.07 m^3 of river sand
Cap	The drilling contractor must put a **borehole cap** (Welded borehole lid**)** to prevent any foreign material from entering the borehole
Drilling Machine Requirements	The equipment must be of a suitable size and capacity to deal, on occasion, with: • Deep boreholes (up to 200 m) • Larger than average borehole diameters (up to 254 mm) • Large quantities of groundwater and • Potentially onerous drilling conditions
Borehole drilling report	A driller's log gives details of the construction of the borehole. As a minimum the report must include **Borehole depths and diameters, Casing depths and diameters, Water level, and so on.** A full borehole drilling report must be handed to ARC personnel.
Unsuccessful Borehole	A borehole will be declared unsuccessful at the discretion of the Hydrogeological Consultant who is supervising the borehole

	drilling. At any time during the course of the work, The Hydrogeological Consultant can order the abandonment of a borehole in progress. When such an unfortunate incidence occurs, ARC will cover only the costs of work done as determined in the bill of quantities (Total costs will be recalculated according to costs per item, e.g. costs per meter of casing/drilling).

If soil formation needs less Steel casing, costs must be adjusted accordingly. If soil formation requires more Steel casing, costs can be adjusted to use the contingency amount.

Similarly, cost adjustments must apply if sufficient water is found at less than 100 m or at more than 100 m.

Screening (Steel type can be put under contingency amount should a need arise).

Phase 3: Borehole Yield and Water Tests

48-Hour Borehole Yield Tests-Sustainable yield	Step draw-down and constant discharge tests, and water level recovery tests Determine correct **sustainable yield** according to the South African National Standard for Water Borehole Test Pumping (SANS 10299-4:2003) The borehole yield test serves as a certificate of compliance and as proof that the borehole installation meets the SANS 10299-4:2003 specifications, **thus a <u>Borehole Yield Tests Certificate must be issued</u>**

	This certificate must include key parameters, such as the: • Yield rate (Litres per Second/Litres per Hour), • Static water level, • Dynamic water level, • Installation depths at which the sustainable rate must be maintained and so on. Please see **APPENDIX A.2** for further details
Water tests-Chemical and microbial analysis	Tests must be according to the SANS 241-1: 2015 standards. Test report must be supplied with the conclusion **1. Drinking Water Tests** SANS241 Chemistry + Microbiology Testing (Tests to be conducted at SANAS Accredited Laboratory). EC, pH, SAR, Langelier, Ryznar, Turbidity, Colour, Odour, TDS, TSS, Free Cl, F, Cl, SO_4, NH4-N, NO3-N, NO2-N, Acidity, Alkalinity, Ca, Mg, Na, K, Mn, Fe, Al, HPC Heterotrophic Plate Count, Total coliforms, Faecal Coliforms
Permitting Process	**Permitting Process before any drilling work** A service provider must obtain an approval to conduct drilling work from local municipal or regulatory authorities. Thus, an approval letter for drilling must be submitted to ARC

	before any drilling work can commence. Additionally, all by-laws must be followed before drilling work commences.

Contingency Provision

A **contingency amount equal to 10%** of the quoted price must be included. This reserve will be held by the Agricultural Research Council (ARC) to address any unforeseen circumstances. The use of this amount will be subject to prior written agreement between ARC and the appointed Contractor/Service Provider.

APPENDIX A

A.1 Diagram of a Concrete collar around a borehole

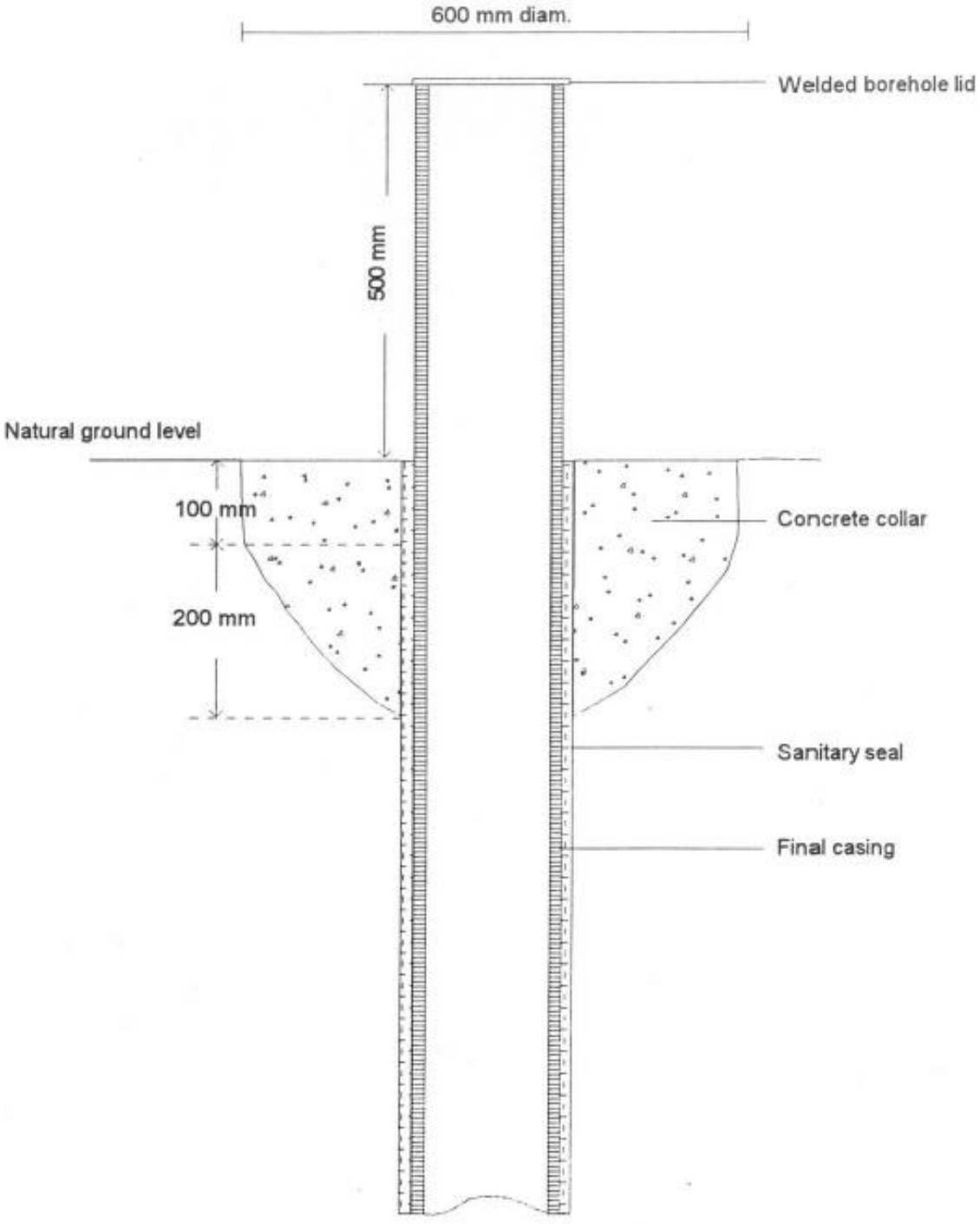

Figure 1 Concrete Collar Dimensions

A.2 Summary of the specifications for test-pumping of boreholes

Step-drawdown Test:

4 to 6 x 1 hour steps, each at a different rate – incrementally increasing.

During the last step try to draw the water level down to the pump depth.

The yields to use for the steps are:

- Step1 – One third of the expected yield
- Step2 – two-thirds of the expected yield
- Step3 – equal to the expected yield
- Step4 – one and a half times the expected yield

The planned steps can be adjusted during the test, although the yield during the individual steps must be constant. Yield must be measured at least 3 times during the test to ensure it is constant.

Recovery of the water level after the step test should be monitored till the water level recovers to ~ 1 m hours of the Static water level or for ~ 12 hours.

Constant Discharge Test:

- 24 – 72 hours at a constant rate
- If the water level is drawn down to pump inlet during the test, the pump must be stopped immediately and recovery of the water level monitored.
- The constancy of the yield is very important, otherwise the data cannot be analyzed.
- The water level measurements should be taken and recorded according to the the South African National Standard for the test pumping of water boreholes (SANS 10299-4:2003).

Recovery Test:

Immediately after the pump is turned off after the pumping test, start measuring water levels.

You need to measure recovery until:

- Water levels recover to less than 5 % of the total drawdown during the constant discharge test
- At least three readings taken in succession are identical
- A time equal to the total time taken for the Constant Discharge Test has elapsed

The data that needs to be collected includes:

- Data and time at commencement of test
- The Static Water level at the start of the test
- The depth of the borehole

- The distance from the borehole to observation boreholes (if applicable)
- Pump installation depth
- Water strike depths (if known from drilling/landowner)
- Borehole diameter
- Rainfall (if it rains during the test)
- Drawdown of the water level
- Rate of discharge (for Steps and constant Tests)

Pump:

- Pump must have suitable power drive and have the correct pumping capacity. This needs to be managed properly!
- It is VERY IMPORTANT that the pumping rate is CONSTANT during the individual steps and the constant discharge test. The mathematical equations used for analysing the data are only valid if the flow is constant! If the variation in the pump yield exceeds 5 % the test must be stopped, water levels allowed to recover, and the test restarted using suitable equipment! Valves and flow gauges are needed to monitor and control the flow rates as during pumping the change in head results in the pump yield changing.
- Pump inlet must be at the main water strike. If this is not known, install the pump 3 – 5 m from the bottom of the hole.
- Pump must have a non-return valve to ensure water doesn't flow back into the borehole
- Flow can be measured using:
    - Bucket of known volume and stop watch (most reliable, and should be used to check other methods)
    - Flow meter (note that if using a flow meter it will only work when the discharge pipe is full and the flow is not turbulent)
    - Orifice weir
    - V-notch weir

Observation Boreholes:

Boreholes close by should have their water levels monitored during the Test. Boreholes in the area should be rested for at least a day before pumping.