



**Date: 12<sup>th</sup> February 2026**

## **TENDER ADVERTISEMENT**

**Habitat for Humanity Kenya (HFHK)** invites bids from interested eligible, reputable, and competent contractors:

<b>TENDER REF NO</b>	<b>ITEM DESCRIPTION</b>	<b>LOCATION</b>	<b>PRE-TENDER SITE VISIT</b>
HFHK/BMZ/MAC/001/02/2026	Drilling Development and Test Pumping of 1No. Borehole at Mukusu Secondary School, Masinga Sub-County, Machakos County	MACHAKOS COUNTY	MANDATORY 17 <sup>th</sup> February 2026
HFHK/BMZ/MAC/002/02/2026	Drilling Development and Test Pumping of 1No. Borehole at Kyuasini Primary School, Masinga Sub-County, Machakos County	MACHAKOS COUNTY	MANDATORY 17 <sup>th</sup> February 2026
HFHK/BMZ/MAC/003/02/2026	Drilling Development and Test Pumping of 1No. Borehole at Mukameni Primary School, Masinga Sub-County, Machakos County	MACHAKOS COUNTY	MANDATORY 17 <sup>th</sup> February 2026

Detailed invitation to bid may be obtained **(Free of charge)** from the Habitat for Humanity Kenya website: <https://hfhkenya.org/tender-advertisements/> or requested through: [procurement@hfhkenya.org](mailto:procurement@hfhkenya.org)

Duly completed and sealed tender documents in plain envelope with the **TENDER REF NO.** and **TENDER DESCRIPTION** title clearly indicated on the envelope should be deposited in the tender box placed at the Habitat for Humanity Kenya on or before on or before **5:00 PM on 26<sup>th</sup> February 2026** addressed to:

**The National Director**  
Habitat for Humanity Kenya  
CVS Plaza, 3<sup>rd</sup> Floor, Lenana Road  
Nairobi, Kenya

**Tender Box Location:** CVS Plaza, 3<sup>rd</sup> Floor Reception

**Habitat for Humanity Kenya** reserves the right to accept or reject any tender in part or in whole and does not bind itself to accept the lowest bidder. Only successful bidders will receive communication from HFHK office. **Any form of canvassing either directly or indirectly shall lead to disqualification of the tender.**



## INVITATION TO BID

### TENDERING DOCUMENTS FOR THE COMPETITIVE TENDERING OF CONSTRUCTION WORKS

DRILLING DEVELOPMENT AND TESTPUMPING OF 1NO. BOREHOLE AT KYASINI PRIMARY SCHOOL, MUKUSU SECONDARY SCHOOL AND MUKAMENI PRIMARY SCHOOL IN MASINGA SUB-COUNTY, MACHAKOS COUNTY

Tender Reference Number	Tender Description	Quantity
HFHK/BMZ/MAC/001/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT KYASINI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 1
HFHK/BMZ/MAC/002/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKUSU SECONDARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 2
HFHK/BMZ/MAC/003/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKAMENI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 3
<b>The tenders are proposed to be issued in three (3) separate lots, as outlined above, with only one (1) lot to be awarded to a single contractor. All Lots cannot be awarded to the same contractor.</b>		

Line	Item	Time, date, address as appropriate
1	Tender published	12/02/2026
2	Closing date for clarifications	19/02/2026 1700hrs EAT
3	Site visit	Tenderers to make private arrangements at own convenience for the Mandatory site visit Date: 17 <sup>th</sup> February 2026 Time: 10 a.m Location: Machakos County Meeting Time 10 a.m Venue: Ndallas Hotel Matuu Contact Person: Stellamaris Mumbua Tel: 0727905688 GPS Coordinates: Kyuasini Primary school GPS -01.1.0258°S and 37.7676°E Mukusu Secondary School GPS -0.9145°S and 37.64098°E Mukameni Primary school (GPS -01.001722°S and 37.58447°E)

4	Closing date and time for receipt of tenders	26/02/2026 1700hrs EAT
5	All clarifications arising from this process will be posted on the link provided below.	<a href="#"><u>BMZ Masinga Tender Clarification</u></a>
6	Tender Opening Date and time	Organization: Habitat for Humanity Kenya Date: 27th February 2026 Time: 02 p.m Venue: CVS Plaza Third Floor Kasuku Lane off Lenana Road, Kilimani, Nairobi

## Table of Contents

Section 1	Instructions to Bidders (ITB) .....	6
	<b>Table of Clauses</b> .....	6
Section 3	CONDITIONS OF CONTRACT .....	20
	<b>Table of Clauses</b> .....	20
Section 4	CONTRACT DATA .....	32
Section 5	STANDARD FORMS .....	35
	<b>Table of Standard Forms</b> .....	35
	<b>Standard Form A:</b> <b>Contractor's Bid</b> .....	36
	<b>Standard Form B:</b> <b>Qualification Information</b> .....	37
	<b>Standard Form C:</b> <b>Letter of Acceptance</b> .....	40
	<b>Standard Form D:</b> <b>Agreement</b> .....	41
	<b>Standard Form E:</b> <b>Bid Security Form</b> .....	43
	<b>Standard Form F:</b> <b>Performance Security Form</b> .....	44
Section 7	DRAWINGS .....	47
Section 8	BILL OF QUANTITIES .....	48

## Table of Clauses

1. Scope of Bid.....	2	17. Modification and Withdrawal of Bids.....	5
2. Qualification of Bidder.....	2	18. Bid Opening.....	5
3. One Bid per Bidder.....	2	19. Process to Be Confidential.....	5
4. Cost of Bidding.....	2	20. Clarification of Bids .....	6
5. Site Visit .....	2	21. Examination of Bids and Determination of Responsiveness .....	6
6. Content of Bidding Documents .....	2	22. Correction of Errors.....	6
7. Clarification of Bidding Document.....	3	23. Evaluation and Comparison of Bids.....	6
8. Language of Bid.....	3	24. Award Criteria.....	7
9. Documents Comprising Bid.....	3	25. HFHK's Right to Accept any Bid to Reject any or all Bids.....	7
10. Bid Prices .....	3	26. Notification of Award and Signing of the Agreement.....	7
11. Currency of Bid & Payment.....	4	27. Performance Security.....	7
12. Bid Validity.....	4	28. Interim payment Payment.....	8
13. Format and Signing of Bid.....	4		
14. Sealing and Marking of Bid.....	5		
15. Deadline for Submission of Bids.....	5		
16. Late Bids.....	5		

**1. Scope of Bid**

**1.1** Habitat for Humanity Kenya (HFHK) as defined in the Contract Data invites bids for the construction of Works, as described in the Contract Data. The name and identification number of the Contract is provided in the Contract

Data.

**1.2** The successful Bidder will be expected to complete the Works by the Required Completion Date specified in the Contract Data.

**2. Qualification of the Bidder**

**2.1** All bidders shall provide in Section 3, Forms of Bid and Qualification Information, a preliminary description of the proposed work method and schedule, including drawings and charts, as necessary.

**2.2** To qualify for award of the Contract, bidders shall meet the following minimum qualifying criteria:

- (a) annual volume of construction work during past two years of at least the amount specified in the Bidding Data;
- (b) experience as prime contractor in the construction of at least one works of a nature and complexity equivalent to the Works over the last 2 years (to comply with this requirement, works cited should be at least 80 percent complete);
- (c) proposals for the timely acquisition or (own, lease, hire, etc.) of the essential equipment listed in the Bidding Data; and
- (d) Engineer's with minimum 5 years' experience in works of an equivalent nature and volume.

**3. One Bid per Bidder per facility**

**3.1** Each Bidder shall submit only one Bid, either individually or as a partner in a joint venture. A Bidder who submits or participates in more than one Bid will be disqualified. Partners in a joint venture shall be jointly and severally liable for the execution of the Contract.

**4. Cost of Bidding**

**4.1** The Bidder shall bear all costs associated with the preparation and submission of his Bid, and HFHK will in no case be responsible or liable for those costs.

**5. Site Visit**

**5.1** The Bidder, at the Bidder's own responsibility and risk, is encouraged to visit and examine the project Sites for the excavated water pans and the existing tank to be replaced and its surroundings and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense.

**6. Content of Bidding Documents**

**6.1** The set of bidding documents comprises the documents listed in the table below and any addenda issued.

Section	1. Instructions to Bidders 2. Bidding Data 3. Conditions of Contract 4. Contract Data 5. Forms of Bid and Qualification 6. Specifications
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7. Drawings  
8 Bill of Quantities or Activity Schedule for lump sum contracts

**7. Clarification and Amendments of Bidding Documents**

7.1 A prospective bidder may request HFHK in writing for clarifications and queries on the bidding documents via email to [procurement@hfhkenya.org](mailto:procurement@hfhkenya.org). Bids shall not be sent to the above email. HFHK shall respond to such requests if it receives those 5 days prior to the deadline for the submission of bids. All questions during the tender period, as well as the associated answers, will be accessed by all suppliers through the following link: [BMZ Masinga Tender Clarification](#)

7.2 Similarly, prior to the submission of the deadline, HFHK may modify the bidding documents by issuing addenda on the same link above.

**8. Language of Bid**

8.1 All documents relating to the Bid and contract shall be in the language specified in the Contract Data.

**9. Documents Comprising the bid**

9.1 The Bid submitted by the Bidder shall comprise the following:

- (a) The Bid (in the format indicated in Section 2);
- (b) priced Bill of Quantities or priced Activity Schedule;
- (c) Qualification Information Form and Documents;
- (d) If the Bidding Data specifies a Bid Security is required, this must be provided in the format provided and shall be for a value of not less than 2% (two percent) of the offer value and shall be valid for at least 30 days past the validity period, and any other materials required to be completed and submitted by bidders, as specified in the Bidding Data.

**10. Bid Prices**

10.1 The Contract shall be for the whole Works, as described in Sub-Clause 1.2, based on the priced Bill of Quantities or priced Activity Schedule for lump sum contracts submitted by the Bidder. The type of contract ***lump sum based on Activity Schedule*** will be specified in the Bidding Data.

10.2 The Bidder shall fill in rates and prices for all items of the Works described in the Bill of Quantities (***for lump sum contracts, described in the drawings and specifications and listed in the Activity Schedule***). Items for which no rate or price is entered by the Bidder will not be paid for by HFHK when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities or Activity Schedule.

10.3 All duties, taxes, and other levies payable by the Contractor under the Contract, or for any other cause, as of the date 15 days prior to the deadline for submission of bids, shall be included in the rates, prices, and total Bid price submitted by the Bidder (***for lump sum contracts, "the rates and prices" are not applicable***).

	<b>10.4</b> The rates and prices ( <i>or the lump sum price</i> ) quoted by the Bidder shall be fixed for the duration of the Contract and shall not be subject to any adjustment on any account.
<b>11. Currency of Bid and Payment</b>	<b>11.1</b> Prices shall be quoted in the currency specified in the Bidding Data.
<b>12. Bid Validity</b>	<b>12.1</b> Bids shall remain valid for the period specified in the Bidding Data. HFHK may request that the bidders extend the period of validity for a specified additional period. The request and the bidders' responses shall be made in writing or by cable or by fax. A Bidder may refuse the request in which case he may withdraw his bid without penalty. A Bidder agreeing to the request will not be required or permitted to otherwise modify the Bid.
<b>13. Format and Signing of Bid</b>	<p><b>13.1</b> The Bidder shall prepare one original of the documents comprising the Bid as described in Clause 6 of these Instructions to Bidders, with the Form of Bid. In addition, the Bidder shall submit the bid by email to the following dedicated, controlled, &amp; secure email address unless otherwise stated in the bid data sheet: <a href="mailto:procurement@hfhkenya.org">procurement@hfhkenya.org</a></p> <p><b>13.2</b> When the bids are being emailed, the following conditions shall apply</p> <ul style="list-style-type: none"> <li>• The ITB number and Lot number shall be inserted in the Subject Heading of the email.</li> <li>• Bid documents required, shall be included as an attachment to the email in PDF, JPEG, TIF format, or the same type of files provided as a ZIP file.</li> <li>• Email attachments shall not exceed 4MB; otherwise, the bidder shall send their bid in multiple emails</li> </ul> <p><b><i>Failure to comply with the above may disqualify the Bid.</i></b></p> <p><b>13.3</b> The Bid shall contain no alterations or additions, except those to comply with instructions issued by HFHK, or as necessary to correct errors made by the Bidder, in which case such corrections shall be initialled by the person or persons signing the Bid.</p> <p><b>13.3 a)</b> The Bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the Bidder. All pages of the Bid where entries or amendments have been made shall be initialled by the person or persons signing the Bid.</p>
<b>14. Sealing and Marking of Bids</b>	<p><b>14.1</b> The Bidder shall seal the original and all copies of the Bid in two inner envelopes and one outer envelope, duly marking the inner envelopes as "ORIGINAL" and "COPIES".</p> <p><b>14.2</b> The inner and outer envelopes shall</p> <ul style="list-style-type: none"> <li>(a) be addressed to HFHK at the address provided in the Bidding Data;</li> <li>(b) bear the name and identification number of the Contract as defined in the Bidding and Contract Data; and</li> <li>(c) Provide a warning not to open before the specified time and date for</li> </ul>

Bid opening as defined in the Bidding Data.

**14.3** In addition to the identification required in Sub-Clause 14.2 the inner envelopes shall indicate the name and address of the Bidder to enable the Bid to be returned unopened in case it is declared late, pursuant to Clause 16.1.

**14.4** If the outer envelope is not sealed and marked as above, HFHK will assume no responsibility for the misplacement or premature opening of the Bid.

**15. Deadline for Submission of Bids**

**15.1** Bids shall be submitted to the indicated email address specified above no later than the time and date specified in the Bidding Data.

**15.2** HFHK may extend the deadline for submission of bids by issuing an amendment in accordance with Clause 7, in which case all rights and obligations of HFHK and the bidders previously subject to the original deadline will then be subject to the new deadline.

**16. Late Bids**

**16.1** Any Bid received by HFHK after the deadline prescribed in Clause 15 will be returned unopened to the Bidder.

**17. Modification and Withdrawal of Bids**

**17.1** Bidders may modify or withdraw their bids by giving notice in writing before the deadline prescribed in Clause 15.1

**17.2** Each Bidder's modification or withdrawal notice shall be sent via email in accordance with Clauses 14 and 15.

**17.3** No Bid may be modified after the deadline for submission of Bids.

**17.4** Withdrawal of a Bid between the deadline for submission of bids and the expiration of the period of Bid validity specified in the Bidding Data or as extended pursuant to Sub-Clause 12 will result in the bidder being disqualified from future bidding for a period of one year.

**17.5** Bidders may offer discounts or otherwise modify the prices of their bids by submitting Bid modifications in accordance with this clause, or included in the original Bid submission.

**18. Process to Be Confidential**

**18.1** Information relating to the examination, clarification, evaluation, and comparison of bids and recommendations for the award of a contract shall not be disclosed until the award to the successful Bidder is announced.

**19. Clarification of Bids**

**19.1** To assist in the examination, evaluation, and comparison of bids, HFHK may, at the HFHK's discretion, ask any Bidder for clarification of the Bidder's Bid. The request for clarification and the response shall be in writing or by cable, telex, or facsimile, but no change in the price or substance of the Bid shall be sought, offered, or permitted except as required to confirm the correction of arithmetic errors discovered by HFHK in the evaluation of the bids in accordance with Cl. 23.2.

**20. Examination of Bids and Determination of Responsiveness**

**20.1** Prior to the detailed evaluation of bids, HFHK will determine whether each Bid is substantially responsive to the requirements of the bidding documents. A substantially responsive Bid is one which conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the bidding documents, the HFHK's rights or the Bidder's obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

**20.2** If a Bid is not substantially responsive, it will be rejected by the HFHK, and may not subsequently be made responsive by correction or withdrawal of the nonconforming deviation or reservation.

**20.3** Due diligence will be conducted for the submitted bids

**21. Correction of Errors**

**21.1** Bids determined to be substantially responsive will be checked by HFHK for any arithmetic errors. Errors will be corrected by HFHK as follows:

- (a) where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and
- (b) Where there is a discrepancy between the unit rate and the line-item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern.
- (c) If a bidder refuses to accept the correction his bid will be rejected, and the bidder disqualified from future bidding for a period of one year.

**22. Evaluation and Comparison of Bids**

**22.1** HFHK will evaluate and compare only the bids determined to be substantially responsive in accordance with Clause 21.

**22.2** In evaluating the bids, HFHK will determine for each Bid the evaluated Bid price by adjusting the Bid price as follows:

- (a) making any correction for errors pursuant to Clause 22
- (b) excluding provisional sums and the provision, if any, for contingencies in the Bill of Quantities (or Activity Schedule for lump sum contracts), but including Day-work, where priced competitively;
- (c) Making appropriate adjustments to reflect discounts or other price modifications offered in accordance with Sub-Clause 17.5.

**22.3** HFHK may waive any minor informality or non-conformity which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative standing of any Bidder. Variations, deviations, and alternative offers and other factors which are in excess of the requirements of the bidding documents or otherwise result in unsolicited benefits for HFHK will not be considered in Bid evaluation.

<b>23. Award Criteria</b>	<b>23.1</b> Subject to Clause 25, HFHK will award the Contract to the Bidder whose Bid has been determined to be substantially responsive to the bidding documents and who has offered the lowest evaluated Bid price, provided that such Bidder has been qualified in accordance with the Clause 2 provisions.
<b>24. HFHK's Right to Accept any Bid and to Reject any or all Bids</b>	<b>24.1</b> Notwithstanding Clause 24, HFHK reserves the right to accept or reject any Bid, and to cancel the bidding process and reject all bids, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or bidders or any obligation to inform the affected Bidder or bidders of the grounds for the HFHK's action.
<b>25. Notification of Award and Signing of Agreement</b>	<p><b>25.1</b> The Bidder whose Bid has been accepted will be notified of the award by the HFHK prior to expiration of the Bid validity period by registered letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the HFHK will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").</p> <p><b>25.2</b> The notification of award will constitute the formation of the Contract.</p> <p><b>25.3</b> HFHK will send the successful Bidder the Agreement form provided in the bidding documents incorporating all agreements between HFHK and the successful Bidder. It will be sent to the successful Bidder within 15 days following the notification of award. Within 15 days of receipt, the successful Bidder will sign the Agreement and deliver it to HFHK.</p> <p><b>25.4</b> Upon receipt of the signed Agreement from the Bidder, HFHK will promptly notify the other bidders that their bids have been unsuccessful.</p>
<b>26 Performance Security</b>	<p><b>26.1</b> If required and stated in the Bid Data sheet, within 18 (eighteen) days of the receipt of notification of award from the Purchaser, the successful Bidder shall furnish the performance security in accordance with the Conditions of Contract, in the Performance Security Form provided in the bidding documents, or in another form acceptable to the Purchaser.</p> <p><b>26.2</b> Failure of the successful Bidder to comply with the requirement of ITB Clause 27 shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security, in which event the Purchaser may make the award to the next lowest evaluated Bidder or call for new bids.</p>
<b>27 Advance Payment</b>	<b>27.1</b> HFHK will not provide an Advance Payment but will provide interim payments and this will be subject to measured works. In order to receive the interim Payment, the Bidder shall make an estimate of executed work which MUST be certified by HFHK Engineer

Section 2

## BIDDING DATA

HFHK WORKS

This section should be filled out by HFHK before issuance of the bidding documents.

## **Instruction to Bidders Clause Reference**

1. All bidders shall provide bidding document, qualification information, a preliminary description of the proposed work method and schedule as necessary and all documents listed in clause 5
2. In preparing the bid, bidders are expected to examine the documents constituting this ITB in details. Inadequate packing of information required will reduce legitimacy of your bid
3. HFHK reserves the right to negotiate, accept or reject any or all proposals and quotations at its sole discretion and to pursue or act further on any responses it considers advantageous.
4. The contract will be awarded to the administrative and technically compliant tender that is the most economically advantageous, considering the quality of the services offered and the price of the tender.
5. Tenders will be evaluated on the criteria listed below.

### **a. Stage 1: Preliminary Bid Responsiveness Assessment**

This will involve assessing whether bidders for work have complied with submission requirements and have also attached certified copies of mandatory eligibility and statutory documents. Evaluation at this stage will be conducted on Yes/No, and bidders are expected to show evidence of ALL required items to proceed to the next stage of evaluation

- a) Copy of Business certificate of Incorporation/Registration
- b) KRA Pin certificate and tax compliance
- c) Tender security from a reputable bank or insurance Company approved by IRA amounting as indicated in the tender data sheet.
- d) Valid current Tax Compliance certificate from Kenya Revenue Authority
- e) Latest CR12 within 6 months
- f) National Construction Authority NCA 4 and above registrations as Water works and Building works contractor
- g) Certificate of registration with the MWS&I as water development contractor
- h) Valid NCA practicing license for water works and building works
- i) Valid Solar PV Energy/electrical technician license with EPRA
- j) Valid Business permit/trade license
- k) Registration certificate with Engineers Board of Kenya (EBK) (Company/Key Staff)
- l) Dully filled, signed and stamped standard form B – Qualification information (past experiences, contractor equipment etc.
- m) Construction Schedule or workplan (No specific format provided)
- n) Dully filled, signed and stamped standard form E – Bid security form
- o) Annex A – supplier profile and registration form (filled, stamped and signed)
- p) Annex B- HFHK Conflict of Interest Policy (filled, stamped and signed)
- q) Annex C-HFHK Safeguarding Policy (filled, stamped and signed)

- r) Audited Accounts for the last three years. 2023 - 2025
- s) Original copy of pre-tender site visit certificate

Bidders who will not show evidence of all required items will not proceed to the next stage of technical evaluation

b. Stage 2: Technical Evaluation Stage

Bids will be evaluated to ensure that they are substantially responsive to the technical specifications and contract conditions stated in the Tender Document.

Bidding documents under this evaluation will be scored against the following criteria

	Scoring Criteria		Bidders Score
Item	Requirements	Maximum Possible Points	
1	Annual volume of relevant drillings works during the past three years and above Kshs 50,000,000.00 – Attach contracts	15	
2	Annual volume of relevant drilling works during the past three years and above Kshs 25,000,000.00 and not exceeding 50,000,000.00 – Attach contracts	8	
3	Annual volume of relevant drilling works during the past three years of below Kshs 25,000,000.00 - – Attach contracts	4	
	No submission of project record	0	

**NOTE: Score for value of works will be awarded based on submitted contracts for past and ongoing works / purchase orders/completion certificates for past and ongoing works.**

**Schedule-4: Works of Similar Nature and Complexity (Max-25)**

	Scoring Criteria		Bidders Score
Item	Requirements	Maximum Possible Points	
1	Experience as prime contractor in the construction of at least <b>Five</b> Projects of similar nature and complexity in the last <b>Three Years</b> . (drilling and equipping of boreholes). Evidence of completed works must be attached (Completion certificates) 5 points for each completion certificate attached	25	

2	Experience as prime contractor in the construction of at least <b>Five</b> Projects of similar nature and complexity in the last <b>Five Years</b> . (Water works that are not similar in nature). Evidence of completed works must be attached and Ongoing works cited should be at least 80 percent complete - 3 points for each completion certificate	15	
3	Any other five unrelated Engineering Works (Buildings, Roads, Bridges etc.) in the last five years. 1 point for each completion certificate	5	
4	No submission of project record	0	

**NOTE: Score for value of works will be awarded and prorated based on submitted contracts for past and ongoing works / purchase orders/completion certificates for past and ongoing works.**

#### **1.1 Contractors Equipment for Works (Max-20)**

##### **Schedule-5: Contractors' Equipment (Max-20)**

	<b>Scoring Criteria</b>			<b>Bidders Score</b>
<b>Item</b>	<b>Requirements</b>	<b>Maximum Possible Points</b>	<b>Listing</b>	<b>Proof of Ownership (Logbook or Valid Lease Agreement)</b>
1.	Drilling Rig - one (1) unit	10	0.5	9.5
2.	Truck one (1) unit;	2	0.5	1.5
3.	Test pumping unit mounted on Ashok Leyland	3	0.5	2.5
4.	Pickup Truck mounted with a compressor, Standby generator	3	0.5	1.5
5.		2	0.5	2.5
	<b>Total</b>	<b>20</b>		

**NOTE: Score for Equipment will be awarded based on submitted Logbooks (in the name of the Bidder or Owner in the CR12 provided) or Lease agreement between the Bidder and Leaser.**

#### **1.2 Contractor's Staff (Technical Competence) (ax-20)**

Bidder must attach detailed and updated Curriculum Vitae (CVs) and other testimonials including Academic Certificates (Degree, Diploma etc), Registration Certificates from professional Bodies and Recommendations from past assignments as necessary for each staff.

**Schedule-6.1: Contractors Key Staff Education (Max-10)**

		Scoring Criteria					Registration with relevant bodies (Engineering body/ NCA)	Bidder Score
#	Requirements	Maximum Possible Points	Degree in Civil/Water Eng.	Diploma in Civil/Water Eng.	Certificate in Civil/Water Eng.			
1	Site Agent (Civil/Water Engineer)	3	2	0	0	1		
2	One (1) Site Foremen (concrete Works)	2	1	1	0	1		
3	One (1) Site Foremen (Plumbing technician)	2	1	1	1	1		
4	Solar PV systems installation and steel fabrication technicians	3	1	0	0	1		
	<b>Total</b>	<b>10</b>						

**Schedule-6.2: Contractors Key Staff Experience (Max-10)**

Scoring Criteria									Bidders Score	
#	Requirements	Maximum Possible Points	Over 5 Years		3-5 Years		3 Years			
			Relevant Experience	General Exp.	Relevant Experience	General Experience	Relevant Exp.	General Experience		
1	Site Agent (Water Engineer)	3	3	0	0	0	0	0		

2	One (1) Site Foremen (concrete Works)	2			1	1	0	0	
3	One (1) Site Foremen (Plumbing technician)	2			1	1	0	0	
4	Solar PV systems installation and steel fabrication technicians	3	3	0	0	0	0	0	
	<b>Total</b>	<b>10</b>							

**NOTES on Relevant Experience**

- Relevant experience refers to the proposed key staff having worked in at least 3 projects of a similar nature in similar position in the last 5 years.
- The minimum registration requirement for the site agent must be either EBK, EIK or KTRB
- The minimum registration requirement for foremen will be NCA.

**1.3 Work Plan and Method Statement (Max-20)**

**Schedule-7: Work Plan and Method Statement (Max-20)**

	Scoring Criteria	Maximum Possible Points	Bidder's Score
Item	Description		
1	Detailed and relevant Schedule of works (work plan) as described in covering all items in the scope of works right from contract signing and including Defects Liability Period (DLP) and within the performance period as specified in the bid documents.	5	
2	Detailed and relevant Method Statement covering all items in the scope of works including but not limited to Mobilization, works execution methodology for each item of works including DLP.	7	
3	Detailed Project Site management	2	

4	Occupational Safety and Health management	2	
5	Environmental Management	2	
6	Quality Management	2	
	<b>Total</b>	<b>20</b>	

#### **NOTES on Works Plan and Method Statement**

Scores will be awarded based on the adequacy of the submitted documents in reference to the scope and works requirements.

#### **Stage 3: Financial Evaluation Stage**

The technical evaluation pass mark shall be 70 points and bidders who shall attain the pass mark will be subjected to tender price comparisons. Bidders who shall score below 70 points will be discontinued from further evaluation

#### **Stage 4: Contract Award**

Award the Contract to the bidder whose bid is determined to be substantially responsive to the tender documents and offers the lowest financial offer.

6. This shall be a **Lump Sum Contract** based on Priced Bill of Quantities
7. The currency in which the prices shall be quoted in **Kes**
8. The period of Bid validity shall be **\_180 days** days after the deadline for Bid submission specified in the Bidding Data.
9. The number of copies of the Bid to be completed and returned - 1
10. The bids will be completed

#### **11. Submission-Instructions**

Completed applications should be submitted in a sealed envelope clearly marked with the tender reference and addressed to:

#### **The National Director**

Habitat for Humanity Kenya

CVS Plaza, 3rd Floor

Lenana Road

Nairobi, Kenya

**Tender Box Location:** CVS Plaza, 3rd Floor Reception

**Telephone:** 0101 454 380

**Deadline:** 4:00 PM on **26th February 2026**

***Failure to comply with the above will lead to disqualification***

12. The Bidder, at the Bidder's own responsibility and risk, is mandated to visit and examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Bidder's own expense Project Site Locations and GPS Coordinates are:

- Kyuasini Primary school GPS -01.1.0258°S and 37.7676°E)
- Mukusu Secondary School GPS -0.9145°S and 37.64098°E)

- Mukameni Primary school (GPS -01.001722°S and 37.58447°E)

13. The deadline for submission of bids shall be **on 26<sup>th</sup> February 2026 at 1700hrs EAT**. The bids shall be opened on a date and venue specified below;

Date: 27<sup>th</sup> February 2025

Time: 2 p.m

Venue: CVS Plaza Third Floor Kasuku Lane off Lenana Road, Kilimani, Nairobi

14. A Performance Security is required in the format provided in this document for a value of not less than *(Usually 5% (five percent) of the contract value)*. This should be valid for 30 days past the contract completion period including any defects liability period or any warranty period.

15. The Interim Payment shall be limited to the total value of executed works certified by the HFHK Engineer minus 10% the Contract Price (Retention).

**Section 3****CONDITIONS OF CONTRACT****Table of Clauses**

1. Works	24. Defects Liability period
2. Language and Law	25. Completion and Taking Over
3. Communications	26. Final Account
4. Confidentiality and Non-Disclosure	27. Contract Price
5. Compliance with HFHK Policies	28. Performance Security
6. Access to Site	29. Payment Guarantee
7. Contractor to Construct the Works	30. Bill of Quantities
8. The Works to Be Completed by the Completion Date	31. Changes in the Quantities
9. Safety	32. Day Works
10. Program	33. Right to Audit/Inspect
11. Personnel	34. Payment Certificates
12. Sub-contract-ing and other contractors	35. Payments
13. Contractor's Risks	36. Interim Payment
14. Indemnity	37. Retention Moneys
15. Insurance	38. Tax
16. Cost of Repairs	39. Compensation Events
17. Property	40. Termination-action
18. Early Warning	41. Payment upon Termination
19. Extension of the Completion Date	42. Release from Performance
20. Delays Ordered by the Project Manager	43. Resolution of Disputes
21. Liquidated Damages	
22. Correction of Defects	
23. Uncorrected Defects	

## Conditions of Contract

1. Definitions 1.1 Terms that are defined in the Contract Data are not also defined in the Conditions of Contract but keep their defined meanings. Boldface type is used to identify defined terms.

**Activity Schedule** means the priced and completed schedule forming part of the Bid.

**Bill of Quantities** means the priced and completed Bill of Quantities forming part of the Bid.

**Certificate of practical completion** means a certificate issued by the HFHK Engineer to the Contractor to signify a state of completion where, in the opinion of the HFHK Engineer, the Works are substantially complete and can effectively and conveniently be used for the intended purposes.

**Compensation Events** are those defined in Clause 21 hereunder.

**The Completion Date** is the date of completion of the Works as certified by HFHK, in accordance with Sub-Clause 28.1.

**The Contract** is the Contract between HFHK and the Contractor to execute, complete, and maintain the Works. The name and identification number of the Contract is given in the Contract Data.

**The Contractor** is a person or corporate body whose Bid to carry out the Works has been accepted by HFHK.

**The Contractor's Bid** is the completed bidding document submitted by the Contractor to HFHK.

**The Contract Price** is the price stated in the Letter of Acceptance subject to such additions or deductions as may be made in accordance with the provisions of the Contract, and represents the total remuneration payable to the Contractor for the execution and completion of the Works and the remedying of any defects therein.

**Days** are calendar days; **months** are calendar months.

**Day works** are additional, varied work inputs subject to payment on a time basis for the Contractor's employees and Equipment, in addition to payments for associated Materials and Plant.

**A Defect** is any part of the Works not completed in accordance with the Contract or to the reasonable satisfaction of the HFHK Engineer

**The Defects Liability Period** is the period of six (6) months commencing from the Required Completion Date, as stated in the

Contract Data, during which the Contractor shall remain responsible, at its own cost, for remedying any defects, deficiencies, shrinkages, or other faults in the Works that may appear or become apparent and are attributable to materials, workmanship, or failure to comply with the terms of this Contract.

**Drawings** include calculations and other information provided or approved by HFHK for the execution of the Contract.

**Equipment** is the Contractor's machinery and vehicles brought temporarily to the Site to construct the Works.

**Final Certificate** means the formal certificate issued by the HFHK Engineer following the expiry of the Defects Liability Period, confirming that the Contractor has duly completed all contractual obligations, including the rectification of any defects, deficiencies, or outstanding works.

**HFHK**, as specified in the Contract Data, is the party who employs the Contractor to carry out the Works. The name of HFHK's representative authorized to deal with the Contractor is also given in the Contract Data.

The **HFHK Engineer** is the person named in the Contract Data (or any other competent person appointed by HFHK and notified to the Contractor, to act in replacement of the Project Manager) who is responsible for supervising the execution of the Works and administering the Contract.

The **Initial Contract Price** is the Contract price listed in HFHK's Letter of Acceptance.

**Materials** are all supplies, including consumable, used by the Contractor for incorporation in the Works.

The **Required Completion Date** is the date on which it is required that the Contractor shall complete the Works. The Required Completion Date is specified in the Contract Data. The Completion Date may be revised only by HFHK by issuing an extension of time or an acceleration order.

The **Site** is the area defined as such in the Contract Data.

**Specification** means the Specification of the Works included in the Contract and any modification or addition made or approved by HFHK.

The **Start Date** is given in the Contract Data. It is the latest date when the Contractor shall commence execution of the Works. It does not necessarily coincide with any of the Site Possession Dates.

A **Subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract, which includes work on the Site.

**Temporary Works** are works designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the Works.

A **Variation** is an instruction given by HFHK that varies the original Work requirement.

The **Works** are what the Contract requires the Contractor to construct, install, and turn over to HFHK, as defined in the Contract Data.

**1.2** This shall be a "*Lump Sum Contract*" **based on priced Activity Schedule**", as specified in the Contract Data. However, if a Government law or decree passed between the date falling twenty-eight (28) days before the submission of bids for the Contract and the Required Completion Date results in an increase in the price of labour and material, HFHK will adjust the Initial Contract Price accordingly, provided that the Contractor shall submit documents satisfactory to the HFHK Engineer proving that the requested increases are a result of Government laws or decrees.

<b>2. Works</b>	<b>2.1</b> The Contractor shall execute the Works, in accordance with the Contract and applicable laws.
<b>3. Language and Law</b>	<b>3.1</b> The language of the Contract and the law governing the Contract are stated in the Contract Data.
<b>4. Communications</b>	<b>4.1</b> Communications between parties that are referred to in the Conditions shall be effective only when in writing. A notice shall be effective only when it is delivered. <b>4.2</b> The HFHK Engineer, or any duly authorized HFHK personnel, may issue instructions in writing to the Contractor as may be necessary for the proper execution of the Works in accordance with the Contract. The Contractor shall comply with such instructions without delay.
<b>5. Confidentiality and Non-Disclosure</b>	<b>5.1</b> The Contractor shall not, without the prior written consent of HFHK, disclose, divulge, or otherwise make available to any third party any of the terms or conditions of this Contract, or any confidential, proprietary, or commercially sensitive information relating to the Project or to HFHK, whether obtained directly or indirectly, except where such disclosure is required by law, regulation, or order of a competent authority, in which event the Contractor shall, to the extent permitted, notify HFHK in writing prior to such disclosure.
<b>6. Compliance with HFHK Policies</b>	<b>6.1</b> The Contractor hereby covenants and agrees to comply in all respects with the policies, procedures, codes of conduct, and other requirements of HFHK, as may be amended from time to time. <b>6.2</b> Compliance with such policies shall be deemed a material obligation

		under this Contract.
<b>7. Access to Site</b>	<b>7.1</b>	HFHK shall give non-exclusive access to the places where the Works are to be executed and any other places where activities associated with the Works are carried out.
<b>8. Contractor to Construct the Works</b>	<b>8.1</b>	The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.
<b>9. The Works to Be Completed by the Completion Date</b>	<b>9.1</b>	The Contractor shall commence execution of the Works on the Start Date and shall carry out the Works in accordance with the Program submitted by the Contractor, as updated with the approval of the HFHK Engineer, and complete them by the Required Completion Date.
<b>10. Safety</b>	<b>10.1</b>	The Contractor shall be responsible for the safety of all activities on the Site.
<b>11. Program</b>	<b>11.1</b>	Within the time stated in the Contract Data, the Contractor shall submit to the HFHK Engineer for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the Works. The Contractor shall update the Program at intervals no longer than the period stated in the Contract Data. The HFHK Engineer's approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the HFHK Engineer again at any time. A revised Program shall show the effect of Variations and Compensation Events.
<b>12. Personnel</b>	<b>12.1</b>	The Contractor shall employ the key personnel named in the Schedule of Key Personnel, as referred to in the Contract Data, to carry out the functions stated in the Schedule of other personnel approved by Project Manager. The HFHK Engineer shall approve any proposed replacement of key personnel only if their relevant qualifications and abilities are substantially equal to or better than those of the personnel listed in the Schedule.
	<b>12.2</b>	If the HFHK Engineer asks the Contractor to remove a person who is a member of the Contractor's staff or work force, stating the reasons, the Contractor shall ensure that the person leaves the Site within seventy-two (72) hours and has no further connection with the work in the Contract.
	<b>12.3</b>	Key personnel identified in the Contract Data shall not be removed, replaced, or reassigned by the Contractor without the prior written consent of HFHK. In the event that replacement becomes necessary due to circumstances beyond the Contractor's control, the Contractor shall propose substitute personnel possessing qualifications, experience, and expertise equal to or superior to those of the individual being replaced, subject to HFHK's prior written approval, which shall not be unreasonably withheld.
<b>13. Sub-contracting and other contractors</b>	<b>13.1</b>	The Contractor may subcontract with the approval of the HFHK Engineer but may not assign the Contract without the approval of HFHK in writing.
	<b>13.2</b>	Subcontracting shall not alter the Contractor's obligations.
	<b>13.3</b>	The Contractor shall not subcontract more than fifty percent (50%) of the

**14. Contractor's Risks**

**15. Indemnity**

**16. Insurance**

**17. Cost of Repairs**

**18. Property**

Works. Any such subcontracting must be approved by HFHK in writing.

**13.4** The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and HFHK.

**14.1** From the Starting Date until the Final Certificate has been issued, the Contractor shall bear all risks related to personal injury, death, and loss of or damage to property. This includes, without limitation, the Works, Plant, Materials, Equipment, and any adjacent property.

**15.1** The Contractor shall indemnify, defend, and hold harmless HFHK, its officers, employees, and agents from and against any and all claims, demands, actions, damages, losses, liabilities, costs, and expenses (including reasonable legal fees and disbursements) arising out of, in connection with, or resulting from the performance, non-performance, or purported performance of the Works by the Contractor, its subcontractors, agents, or personnel, except to the extent that such claims, damages, losses, or expenses are caused by the gross negligence or wilful misconduct of HFHK.

**16.1** The Contractor shall provide, in the joint names of HFHK and the Contractor, insurance cover from the Start Date to the end of the Defects Liability Period, in the amounts stated in the Contract Data for the following events which are due to the Contractor's risks:

- (a) loss of or damage to the Works, Equipment, Plant, and Materials;
- (b) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and
- (c) Personal injury or death. Third party liability.

**16.2** Policies and certificates for insurance shall be delivered by the Contractor to the HFHK Engineer for approval within fifteen (15) days of receipt by the Contractor of HFHK's Letter of Acceptance. All such insurance shall provide for compensation required to rectify the loss or damage incurred. If the Contractor fails to provide the required certificates, the contract shall be considered as annulled.

The said Contractor shall be disqualified from participating in bidding for contracts for a period of one year. However, HFHK at its discretion may decide to extend the period for submission of insurance certificates or take out the insurance and deduct the cost of premiums from the Contractor's earnings.

**16.3** Alterations to the terms of insurance shall not be made without the approval of HFHK.

**17.1** Loss or damage to the Works or Materials to be incorporated in the Works between the Start Date and the end of the Defects Correction periods shall be remedied by the Contractor at the Contractor's cost if the loss or damage arises from the Contractor's acts or omissions.

**18.1** All Materials and Construction Equipment on the Site, Plant, Temporary Works, and Works shall be deemed to be the property of HFHK if the

	Contract is terminated because of the Contractor's default.
<b>19. Early Warning</b>	<p><b>19.1</b> The Contractor shall inform the HFHK Engineer at the earliest opportunity of specific likely future events or circumstances that may adversely affect the quality of the work increase the Contract Price or delay the execution of the Works. The HFHK Engineer may require the Contractor to provide an estimate of the expected effect of the future event or circumstance on the Contract Price and Completion Date. The estimate shall be provided by the Contractor as soon as reasonably possible.</p> <p><b>19.2</b> The Contractor shall cooperate with the HFHK Engineer in making and considering proposals for how the effect of such an event or circumstance can be avoided or reduced by anyone involved in the work and in carrying out any resulting instruction of the Project Manager.</p>
<b>20. Extension of the Completion Date</b>	<p><b>20.1</b> The HFHK Engineer shall extend the Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Required Completion Date without the Contractor taking steps to accelerate the remaining work, which would cause the Contractor to incur additional cost.</p>
<b>21. Delays Ordered by the Project Manager</b>	<p><b>21.1</b> The HFHK Engineer may instruct the Contractor to delay the start or progress of any activity within the Works. Delays or suspension of work by the HFHK Engineer which increase the Contractor's costs shall be subject to equitable adjustments by HFHK.</p>
<b>22. Liquidated Damages</b>	<p><b>22.1</b> The Contractor shall pay liquidated damages to HFHK at the rate per day stated in the Contract Data for each day that the Completion Date is later than the Required Completion Date. The total amount of liquidated damages shall not exceed the amount defined in the Contract Data. HFHK may deduct liquidated damages from any payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.</p>
<b>23. Correction of Defects</b>	<p><b>23.1</b> The HFHK Engineer shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion, and is defined in the Contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.</p> <p><b>23.2</b> Every time notice of a Defect is given the Contractor shall correct the notified Defect within the length of time specified by the HFHK Engineer's notice</p>
<b>24. Uncorrected Defects</b>	<p><b>24.1</b> If the Contractor has not corrected a Defect within the time specified in the HFHK Engineer's notice, the HFHK Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount, or HFHK shall recuperate these amounts by deduction from the amounts due to the contractor.</p>
<b>25. Defects Liability period</b>	<p><b>25.1</b> The period for notifying defects or damage in the Works as stated in the Contract Data shall start from the Required Completion Date. The HFHK Engineer shall notify the Contractor in writing of any defects in the Works during this period. During the Defects Notification Period, the Contractor shall rectify any defects that the Employer has notified within the stipulated period and at its own cost.</p>
<b>26. Completion and Taking Over</b>	<p><b>26.1</b> The Contractor shall request the HFHK Engineer to issue the Certificate of Practical Completion, and the HFHK Engineer will issue such a certificate when he determines that the work is satisfactorily completed.</p> <p><b>26.2</b> The Contractor shall notify the HFHK Engineer at least seven (7) days prior</p>

	<p>to the anticipated completion of the Works and readiness for taking over in accordance with the Contract. Upon receipt of such notice, the HFHK Engineer shall inspect the Works and, if satisfied that the Works are complete (except for minor omissions, outstanding work, and defects which do not affect the safe use of the Works for their intended purpose), shall certify and issue the Certificate of Practical Completion to the Contractor. This certificate shall state the date of completion and include an attached list of minor omissions, outstanding work, and defects to be rectified.</p>
<b>27. Final Account</b>	<p><b>26.3</b> Should the HFHK Engineer determine that the Works are not ready for taking over, they shall reject the Contractor's notice and provide written reasons, including details of any defects, deficiencies, or unfulfilled obligations requiring rectification or completion before a Certificate of Practical Completion can be issued.</p> <p><b>26.4</b> HFHK shall take over the site and the Works within seven (7) days of the HFHK Engineer's issuing of a Certificate of Practical Completion.</p> <p><b>27.1</b> The Contractor shall supply the HFHK Engineer with a detailed account of the total amount that the Contractor considers payable under the Contract before the end of the Defects Liability Period. The HFHK Engineer shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within fifteen (15) days of receiving the Contractor's account if it is correct and complete. If it is not, the HFHK Engineer shall issue within fifteen (15) days a schedule that states the scope of the corrections or additions that are necessary. If the Final Account is still unsatisfactory after it has been resubmitted, the HFHK Engineer shall decide on the amount payable to the Contractor and issue a payment certificate.</p>
<b>28. Contract Price</b>	<p><b>28.1</b> The Contract Price shall be the amount agreed upon between HFHK and the Contractor to execute the Works on the Completion Date and indicated in the Letter of Acceptance.</p> <p><b>28.2</b> The Contract Price may vary in accordance with the Contract, including subject to measurement and/or Variations of the Works.</p>
<b>29. Performance Security</b>	<p><b>29.1</b> The Contractor shall, within fourteen (14) days of receiving the Letter of Acceptance, provide a Performance Security in the format prescribed in the Standard Form section, for a value of not less than five percent (5%) of the Contract Price or as set out in the Bidding Data.</p> <p><b>29.2</b> The Performance Security shall remain valid for a period of thirty (30) days beyond the end of the Completion Date, including any applicable Defects Liability Period and/or warranty period.</p>
<b>30. Payment Guarantee</b>	<p><b>30.1</b> The Contractor shall, in addition to the Performance Security required, furnish to HFHK a separate and valid bank guarantee, payable on demand and issued by a reputable bank acceptable to HFHK, in an amount equivalent to ten percent (10%) of the Contract Price, for the specific purpose of securing HFHK's payment obligations under the Contract.</p> <p><b>30.2</b> The said bank guarantee shall remain valid until the expiry of the Defects Liability Period and shall be released to the Contractor only upon the issuance of the Final Certificate, by HFHK, confirming that all obligations under the Contract have been fully discharged, including the satisfactory</p>

completion, to the written satisfaction of the HFHK Engineer or their duly appointed designee, of all remedial works, rectifications, or repairs identified during the Defects Liability Period.

**31. Bill of Quantities**

**31.1** The Bill of Quantities (for lump-sum Contracts Entire Clause 17 shall be replaced with a new Clause as indicated in the Contract Data) shall contain items for the construction, installation, testing, and commissioning work to be done by the Contractor.

For Lump Sum contracts, payment activities schedule shall be listed.

**31.2** The Bill of Quantities shall be used to calculate the Contract Price. The Contractor is paid for the quantity of the work actually done at the rate in the Bill of Quantities for each item.

**32. Changes in the Quantities**

**32.1** If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than twenty-five percent (25%), provided the change exceeds one percent (1%) of the Initial Contract Price, the HFHK Engineer shall adjust the rate to allow for the change. (For lump-sum contracts, this clause shall be substituted by a new clause as indicated in Contract Data).

**33. Day Works**

**33.1** Day works shall be executed by the Contractor's employees using Equipment and shall be subject to payment based on the time actually spent by the Contractor's labour and the use of Equipment, in accordance with the applicable Dayworks Schedule or agreed rates.

**33.2** In addition to payments for labour and Equipment, the Contractor shall be entitled to payment for all associated Materials and Plant used in connection with the Day works.

**33.3** Day works shall only be undertaken when instructed in writing by the HFHK Engineer or, in cases of urgency, with retrospective written confirmation provided within three (3) days of the urgency.

**33.4** The Contractor shall maintain and submit detailed daily records of labour, Equipment, Materials, and Plant used in the execution of Day works, and no payment shall be made unless such records are verified and approved by the HFHK Engineer.

**34. Right to Audit/Inspect**

**34.1** HFHK, its duly authorized representatives, agents, or external auditors shall have the right, at any reasonable time and upon the provision of reasonable prior notice, to access, inspect, and audit all books, records, accounts, correspondence, documents, and other information of the Contractor that relate to the performance of the Works under this Contract. The Contractor shall grant unhindered access to the Site, as well as to any such records and documents, and shall provide all necessary assistance to facilitate the conduct of such inspection or audit.

**35. Payment Certificates**

**35.1** The Contractor shall submit to the HFHK Engineer bi-weekly statements of the estimated value of the work executed less the cumulative amount certified previously.

**35.2** The HFHK Engineer shall check the Contractor's executed work and certify the amount to be paid to the Contractor.

**35.3** The value of work executed shall be determined by the HFHK Engineer.

**35.4** The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed. (For lump sum contracts, this Clause shall be substituted by a new Clause as indicated in the Contract Data).

**35.5** The value of work executed shall include the valuation of Variations and Compensation Events.

**36. Payments**

**36.1** Payments shall be adjusted for deductions for interim payments and retention. HFHK shall pay the Contractor the amounts certified by the HFHK Engineer within twenty-eight (28) days of the date of each certificate. If HFHK makes a late payment, the Contractor shall be paid interest on the late payment in the next payment. Interest shall be calculated from the date by which the payment should have been made, up to the date when the late payment is made, at the rate of interest prevailing at the local banks for construction loans.

**36.2** Items of the Works for which no rate or price has been entered in will not be paid for by HFHK and shall be deemed covered by other rates and prices in the Contract.

**37. Interim Payment**

**37.1** HFHK shall make interim payment to the Contractor of the amounts stated in the Contract Data after certification of executed scope of works by the Contractor.

**38. Retention Moneys**

**38.1** An amount, specified in the Contract Data, will be retained from each payment to the Contractor to assure performance of the work. This money will be paid out to the Contractor upon completion and acceptance of the work and within fifteen (15) days of the issue by the HFHK Engineer of the Defects Liability Certificate.

**39. Tax**

**39.1** The Contractor shall be liable for all taxes in accordance with the laws of HFHK's country. However, the HFHK Engineer shall adjust the Contract Price if taxes, duties, and other levies are changed between the date falling twenty-eight (28) days before the submission of bids for the Contract and the date of the Final Certificate. The adjustment shall be the change in the amount of tax payable by the Contractor, provided such charges are already not reflected in the Contract Price.

**40. Compensation Events**

**40.1** The following shall be Compensation Events:

**40.1.1** HFHK does not give access to a part of the Site by the Site Possession Date stated in the Contract Data.

**40.1.2** The HFHK Engineer orders a delay or does not issue Drawings, Specifications, or instructions required for execution of the Works on time.

**40.1.3** The HFHK Engineer instructs the Contractor to uncover or to carry out tests upon completed work, which is then found to have no Defects.

**41. Termination-action**

- 40.1.4** Other contractors, public authorities, utilities, or HFHK cause delay or extra cost to the Contractor.
- 40.1.5** The interim payment due is delayed.
- 40.1.6** The HFHK Engineer unreasonably delays issuing a certificate of completion.
- 40.2** If such an event occurs, then the Contract Price shall be equitably adjusted.
- 41.1** HFHK or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract
- 41.2** Fundamental breaches of Contract shall include, but shall not be limited to, the following:
  - 41.2.1** the Contractor stops work for fifteen (15) days when no stoppage of work is shown on the current Program and the stoppage has not been authorized by the HFHK Engineer;
  - 41.2.2** The HFHK Engineer instructs the Contractor to delay the progress of the Works, and the instruction is not withdrawn within fifteen (15) days; or agreement reached on payments due contractor for cost of delay;
  - 41.2.3** HFHK or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;
  - 41.2.4** a payment certified by the HFHK Engineer is not paid by HFHK to the Contractor within thirty (30) days of the date of the HFHK Engineer's certificate;
  - 41.2.5** the HFHK Engineer gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within 30 days determined by the HFHK Engineer; or
  - 41.2.6** The Contractor has delayed the completion of the Works by the number of days for which the maximum amount of liquidated damages can be paid, as defined in the Contract Data
  - 41.3** When either party to the Contract gives notice of a breach of Contract to the HFHK Engineer for a cause other than those listed under Sub-Clause 30.2 above, the HFHK Engineer shall decide whether the breach is fundamental or not.
  - 41.4** Notwithstanding the above, HFHK may terminate the Contract for convenience by giving the Contractor a thirty (30) day notice in writing.
  - 41.5** If the Contract is terminated, the Contractor shall stop work immediately, make the Site safe and secure, and leave the Site within fifteen (15) days of the completion of the notice period.
- 42. Payment upon Termination**
- 42.1** If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the HFHK Engineer shall issue a certificate for the value of the work done and Materials ordered less any interim payments received up to the date of the issue of the certificate and less the percentage to apply to the value of the work not completed, as indicated in the Contract Data. Additional Liquidated Damages shall not apply. If the total amount due to HFHK exceeds any payment due to the Contractor, the difference shall be a debt payable to HFHK.
- 42.2** If the Contract is terminated for HFHK's convenience or because of a fundamental breach of Contract by HFHK, the HFHK Engineer shall issue a certificate for the value of the work done, Materials ordered, the reasonable cost of removal of Equipment, repatriation of the Contractor's

personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works, and less interim payments received up to the date of the certificate

**43. Release from Performance**

**43.1** If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either HFHK or the Contractor, the HFHK Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards for which an agreement has been reached.

**44. Resolution of Disputes**

**44.1** HFHK and the Contractor shall make every effort to resolve amicably by direct informal negotiation any disagreement or dispute arising between them under or in connection with the Contract.

**44.2** If after thirty (30) days from the commencement of such informal negotiations, HFHK and the Contractor have been unable to resolve amicably a Contract dispute, either party may require that the dispute be referred for resolution to three independent qualified contractors, one chosen by HFHK and one chosen by the Contractor and the third chosen by an appropriate professional body, such as the Chamber of Commerce. The three should arrive at a solution satisfactory to HFHK and the Contractor.

**44.3** In case of further disagreement either party can take the matter to arbitration in accordance with the Law governing the Contract. The place where arbitration will take place will be stated in the Contract Data.

**Section 4****CONTRACT DATA**

Except where otherwise indicated, all Contract Data should be filled in by HFHK (HFHK) prior to issuance of the bidding documents. Schedules and reports to be provided by HFHK should be annexed.

<u>No.</u>	<u>Reference</u>	<u>Contract Clause</u>
1.	HFHK is:	[1.1]
	<p>Name: <b>HABITAT FOR HUMANITY KENYA</b>            Address: <b>P.O Box 38948 – 00623 NAIROBI, KENYA</b>            Name of Authorized Representative: <b>DR. EILEEN MOKAYA</b></p>	
	The HFHK Engineer is:	[1.1]
	<p>Name: <b>LEVY NOAH</b>            Address: <b>P.O Box 38948 – 00623 NAIROBI, KENYA</b>            Name of Authorized Representative: <b>LEVY NOAH</b></p>	
2.	The name and identification number of the Contract is	[1.1]

<b>Tender Reference Number</b>	<b>Tender Description</b>	<b>Quantity</b>
HFHK/BMZ/MAC/001/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT KYASINI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 1
HFHK/BMZ/MAC/002/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKUSU SECONDARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 2
HFHK/BMZ/MAC/003/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKAMENI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 3

3. The Works consist of;

<b>Tender Reference Number</b>	<b>Tender Description</b>	<b>Quantity</b>
HFHK/BMZ/MAC/001/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT KYASINI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 1
HFHK/BMZ/MAC/002/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKUSU SECONDARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 2

HFHK/BMZ/MAC/003/02/2026	DRILLING DEVELOPMENT AND TEST PUMPING OF 1NO. BOREHOLE AT MUKAMENI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY	LOT 3
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4. The Start Date shall be **15/04/2026** [1.1]

5. The Required Completion Date for the whole of the Works shall be **15/06/2026** [1.1]

6. Project Site Locations and GPS Coordinates **in Machakos County** . [1.1]

7. This shall be a **Lump Sum Contract** based on Priced Bill of Quantities [1.2]

8. The language of the Contract documents is **ENGLISH** [2]

9. The law that applies to the Contract is the law of **KENYA** [2]

10. The following documents are also part of the Contract: [5]

- The Schedule of Key Personnel

12. The period for submission of the Program is seven **(7) days** from the date of signature of Agreement. [11]

13. The Defects Liability Period is six **(6) months**. [15]

14. In case of lump sum contracts, clause 17 shall be replaced by the following new clause 17. [17]

17 Activity Schedule

17.1 The Contractor shall provide updated Activity Schedules within seven (7) days of being instructed by HFHK. The activities on the Activity Schedule shall be coordinated with the activities on the Program.

17.2 The Contractor shall show delivery of Materials to the site separately on the Activity Schedule if Payment for Materials on site shall be made separately."

15. In case of lump sum contracts, clause 18.1 shall be replaced by the following: [18]

18.1 The Activity Schedule shall be amended by the Contractor to accommodate changes of program or method of working made at the Contractor's own discretion. Prices in the Activity Schedule shall not be altered when the Contractor made such changes to the Activity Schedule."

19.4 The value of work executed shall comprise the value of completed activities in the Activity Schedule."

17. The Site Possession Date shall be **14/04/2026** [21]  
*[If the Site is made available by section, the different dates should be listed here.]*

20. The amount of interim payment will be based on measured and certified works by HFHK project manager [24]

21. The amount of retention money will be **10%** of the total contract amount.
23. The place of arbitration is **NAIROBI**

[34]

**Table of Standard Forms**

<b>A. Contractor's Bid</b>	<b>25</b>
<b>B. Qualification Information</b>	<b>26</b>
<b>C. Letter of Acceptance</b>	<b>28</b>
<b>D. Agreement</b>	<b>29</b>
<b>E. Bid Security</b>	<b>30</b>
<b>F. Performance Security</b>	<b>32</b>

**Standard Form A:****Contractor's Bid****Notes on Form of Contractor's Bid**

The Bidder shall fill in and submit this Bid form with the Bid.

\_\_\_\_\_ *[date]*

To: \_\_\_\_\_ *[name of HFHK]*  
Address: \_\_\_\_\_ *[insert address]*

We offer to execute the \_\_\_\_\_ *[name and identification number of Contract]* in accordance with the Conditions of Contract accompanying this Bid for the Contract Price of \_\_\_\_\_ *[amount in numbers and words]* (\_\_\_\_\_) *[name of currency]* \_\_\_\_\_).

This Bid and your written acceptance of it shall constitute a binding Contract between us. We understand that you are not bound to accept the lowest or any Bid you receive.

We hereby confirm that this Bid complies with the Bid validity required by the bidding documents and specified in the Bidding Data.

Authorized Signature: \_\_\_\_\_

Name and Title of Signatory: \_\_\_\_\_

Name of Bidder: \_\_\_\_\_

Address: \_\_\_\_\_

## Standard Form B:

## Qualification Information

## Notes on Form of Qualification Information

The information to be filled in by bidders in the following pages will be used for purposes of post qualification as provided for in the Instructions to Bidders. This information will not be incorporated in the Contract.

#### 1. Individual Bidders or Individual Members of Joint Venture

1.1 Constitution or legal status of Bidder *[attach copy]*

Place of registration: \_\_\_\_\_

Principal place of business: \_\_\_\_\_

1.2 Work performed as prime Contractor on works of a similar nature and volume over the last two years. Also list details of work under way or committed, including expected completion date.

Project name and country	Name of client and contact person	Type of work performed and year of completion	Value of contract
		-	
		-	
		-	
		-	
		-	
		-	
		-	
		-	
		-	
		-	
[etc.]			

1.3 Major items of Contractor's Equipment proposed for carrying out the Works. List all information requested below.

Item of equipment	Description, make, and age (years)	Condition (new, good, poor) and number available	Owned, leased (from whom?), or to be purchased (from whom?)

[etc.]	_____	_____	_____
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1.4 Qualifications and experience of key personnel proposed for administration and execution of the Contract.

Position	Name	Years of experience (general)	Years of experience in proposed position
Project Manager	_____	_____	_____
-	_____	_____	_____
-	_____	_____	_____
-	_____	_____	_____
-	_____	_____	_____
-	_____	_____	_____
-	_____	_____	_____
[etc.]	-	_____	_____
	_____	_____	_____

1.5 Proposed subcontracts and firms involved.

Sections of the Works	Value of subcontract	Subcontractor (name and address)	Experience in similar work
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
[etc.]	_____	_____	_____
	_____	_____	_____

1.6 Information on current litigation in which the Bidder is involved.

Other party(ies)	Cause of dispute	Amount involved
_____	_____	_____
_____	_____	_____
_____	_____	_____

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1.7 Proposed Program (work method and schedule). Descriptions, drawings, and charts, as necessary, to comply with the requirements of the bidding documents.

**Notes on Standard Form of Letter of Acceptance**

The Letter of Acceptance will be the basis for formation of the Contract as described in Clauses 26 of the Instructions to Bidders. This Standard Form of Letter of Acceptance should be filled in and sent to the successful Bidder only after evaluation of bids has been completed.

**Standard Form C:**

**Letter of Acceptance**  
[letterhead paper of HFHK]

[date]

To: \_\_\_\_\_  
[name of the Contractor]

\_\_\_\_\_  
[address of the Contractor]

This is to notify you that your Bid dated \_\_\_\_\_ for execution of the [name of the Contract and identification number, as given in the Contract Data] for the Contract Price of  
\_\_\_\_\_ [amount in numbers and words] \_\_\_\_\_ [name of currency], as corrected and modified in accordance with the Instructions to Bidders is hereby accepted by Danish Refugee Council.

You are hereby instructed to proceed with the execution of the said Works in accordance with the Contract documents.

\_\_\_\_\_  
Authorized Signature: \_\_\_\_\_  
Name and Title of Signatory: \_\_\_\_\_  
Name of Agency \_\_\_\_\_

Attachment: Agreement

Notes on Standard Form of Agreement

The Agreement should incorporate any corrections or modifications to the Bid resulting from price corrections and price adjustment during the evaluation process as provided for in the Instructions to Bidders.

**Standard Form D:**

**Agreement**

**AGREEMENT**

**This Agreement**, made the \_\_\_\_\_ day of \_\_\_\_\_ 2026, between

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\_\_\_\_\_ *[name and address of HFHK]* (hereinafter called "HFHK") and \_\_\_\_\_

---

---

\_\_\_\_\_ *[name and address of Contractor]*

---

(hereinafter called "the Contractor") of the other part.

**Whereas** HFHK is desirous that the Contractor execute \_\_\_\_\_

---

\_\_\_\_\_ *[name and*

*identification number of Contract]* (hereinafter called "the Works") and HFHK has accepted the Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

**Now this Agreement witnesseth** as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.
2. In consideration of the payments to be made by HFHK to the Contractor as hereinafter mentioned, the Contractor hereby covenants with HFHK to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract.
3. HFHK hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying of defects wherein the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

**In Witness** whereof the parties thereto have caused this Agreement to be executed the day and year first before written.

The Common Seal of

---

\_\_\_\_\_ was  
hereunto affixed in the presence of:

Signed, Sealed, and Delivered by the  
said \_\_\_\_\_ in the  
presence of:

Binding Signature of HFHK \_\_\_\_\_

Binding Signature of Contractor \_\_\_\_\_

**Standard Form E:****Bid Security Form**

Whereas *[name of the Bidder]* (hereinafter called "the Bidder") has submitted its bid dated *[date of submission of bid]* for the supply of *[name and/or description of the works]* (hereinafter called "the Bid").

KNOW ALL PEOPLE by these presents that we *[name of bank]* of *[name of country]*, having our registered office at *[address of bank]* (hereinafter called "the Bank"), are bound unto *[name of Purchaser]* (hereinafter called "the Purchaser") in the sum of for which payment well and truly to be made to the said Purchaser, the Bank binds itself, its successors, and assigns by these presents. Sealed with the Common Seal of the said Bank this \_\_\_\_\_ day of \_\_\_\_\_.

THE CONDITIONS of this obligation are:

1. If the Bidder withdraws its Bid during the period of bid validity specified by the Bidder on the Bid Form;

or

2. If the Bidder, having been notified of the acceptance of its Bid by the Purchaser during the period of bid validity:

- (a) fails or refuses to execute the Contract Form, if required; or
- (b) fails or refuses to furnish the performance security, in accordance with the Instructions to Bidders;

we undertake to pay to the Purchaser up to the above amount upon receipt of its first written demand, without the Purchaser having to substantiate its demand, provided that in its demand the Purchaser will note that the amount claimed by it is due to it, owing to the occurrence of one or both of the two conditions, specifying the occurred condition or conditions.

This guarantee will remain in force up to and including thirty (30) days after the period of bid validity, and any demand in respect thereof should reach the Bank not later than the above date.

---

*[signature of the bank]*

**Standard Form F:****Performance Security Form**

To: *[name of Purchaser]*

WHEREAS *[name of Supplier]* (hereinafter called "the Supplier") has undertaken, in pursuance of Contract No. *[reference number of the contract]* dated \_\_\_\_\_ to supply *[description of works]* (hereinafter called "the Contract").

AND WHEREAS it has been stipulated by you in the said Contract that the Supplier shall furnish you with a bank guarantee by a reputable bank for the sum specified therein as security for compliance with the Supplier's performance obligations in accordance with the Contract.

AND WHEREAS we have agreed to give the Supplier a guarantee:

THEREFORE, WE hereby affirm that we are Guarantors and responsible to you, on behalf of the Supplier, up to a total of *[amount of the guarantee in words and figures]*, and we undertake to pay you, upon your first written demand declaring the Supplier to be in default under the Contract and without cavil or argument, any sum or sums within the limits of *[amount of guarantee]* as aforesaid, without your needing to prove or to show grounds or reasons for your demand or the sum specified therein.

This guarantee is valid until the \_\_\_\_\_ day of \_\_\_\_\_

Signature and seal of the Guarantors

---

*[name of bank or financial institution]*

---

*[address]*

---

*[date]*

These Notes for Preparing Specifications are intended only as information for HFHK or the person drafting the bidding documents. They should **not** be included in the final documents.

1. A set of precise and clear specifications is a prerequisite for bidders to respond realistically and competitively to the requirements of HFHK without qualifying or conditioning their bids. In the context of competitive bidding, the specifications must be drafted to permit the widest possible competition and, at the same time, present a clear statement of the required standards of workmanship, materials, and performance of the goods and services to be procured. Only if this is done will the objectives of economy, efficiency, and fairness in procurement be realized, responsiveness of bids be ensured, and the subsequent task of Bid evaluation facilitated. The specifications should require that all goods and materials to be incorporated in the Works be new, unused, of the most recent or current models, and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.
2. Samples of specifications from previous similar projects in the same country are useful in this respect. The use of metric units is encouraged by the World Bank. Most specifications are normally written specially by HFHK to suit the Contract Works in hand. There is no standard set of Specifications for universal application in all sectors in all countries, but there are established principles and practices, which are reflected in these documents.
3. There are considerable advantages in standardizing General Specifications for repetitive Works in recognized public sectors, such as highways, ports, railways, urban housing, irrigation, and water supply, in the same country or region where similar conditions prevail. The General Specifications should cover all classes of workmanship, materials, and equipment commonly involved in construction, although not necessarily to be used in a particular Works Contract. Deletions or addenda should then adapt the General Specifications to the particular Works.
4. Care must be taken in drafting specifications to ensure that they are not restrictive. In the specification of standards for goods, materials, and workmanship, recognized international standards should be used as much as possible. Where other particular standards are used, whether national standards of the Borrower's country or other standards, the specifications should state that goods, materials, and workmanship that meet other authoritative standards, and which ensure substantially equal or higher quality than the standards mentioned, will also be acceptable. The following clause may be inserted in the Special Conditions or Specifications.

**Sample Clause**  
**Equivalency of Standards and Codes**

Wherever reference is made in the Contract to specific standards and codes to be met by the goods and materials to be furnished, and work performed or tested, the provisions of the latest current edition or revision of the relevant standards and codes in effect shall apply, unless otherwise expressly stated in the Contract. Where such standards and codes are national, or relate to a particular country or region, other authoritative standards that ensure a substantially equal or higher quality than the standards and codes specified will be accepted subject to HFHK's prior review and written consent. Differences between the standards specified and the proposed alternative standards shall be fully described in writing by the Contractor and submitted to HFHK at least 28 days prior to the date when the Contractor desires HFHK's consent. In the event HFHK determines that such proposed deviations do not ensure substantially equal or higher quality, the Contractor shall comply with the standards specified in the documents.

**Section 7****DRAWINGS**

Insert here a list of Drawings. The actual Drawings, including site plans, should be attached to this section or annexed in a separate folder.

These Notes for Preparing a Bill of Quantities are intended only as information for HFHK or the person drafting the bidding documents. They should be included in the final documents.

In lump sum contracts, delete "Bill of Quantities" and replace with "Schedule of Activities" throughout this section.

<b>Objectives</b>	<ol style="list-style-type: none"><li>1. The objectives of the Bill of Quantities are<ol style="list-style-type: none"><li>(a) to provide sufficient information on the quantities of Works to be performed to enable bids to be prepared efficiently and accurately; and</li><li>(b) when a Contract has been entered into, to provide a priced Bill of Quantities for use in the periodic valuation of Works executed.</li></ol></li><li>2. In order to attain these objectives, Works should be itemized in the Bill of Quantities in sufficient detail to distinguish between the different classes of Works, or between Works of the same nature carried out in different locations or in other circumstances which may give rise to different considerations of cost. Consistent with these requirements, the layout and content of the Bill of Quantities should be as simple and brief as possible.</li></ol>
<b>Day-work Schedule</b>	<ol style="list-style-type: none"><li>3. A Day-work Schedule should be included only if the probability of unforeseen work, outside the items included in the Bill of Quantities, is high. To facilitate checking by HFHK of the realism of rates quoted by the bidders, the Day-work Schedule should normally comprise the following:<ol style="list-style-type: none"><li>(a) A list of the various classes of labour, materials, and Constructional Plant for which basic day-work rates or prices are to be inserted by the Bidder, together with a statement of the conditions under which the Contractor will be paid for work executed on a day-work basis.</li><li>(b) Nominal quantities for each item of Day-work, to be priced by each Bidder at Day-work rates as Bid. The rate to be entered by the Bidder against each basic Day-work item should include the Contractor's profit, overheads, supervision, and other charges.</li></ol></li></ol>
<b>Provisional Sums</b>	<ol style="list-style-type: none"><li>4. A general provision for physical contingencies (quantity overruns) may be made by including a provisional sum in the Summary Bill of Quantities. Similarly, a <u>contingency allowance for possible price increases should be provided as a provisional sum in the Summary Bill of Quantities</u>. The inclusion of such provisional sums often facilitates budgetary approval by avoiding the need to request periodic supplementary approvals as the</li></ol>

future need arises. Where such provisional sums or contingency allowances are used, the Contract Data should state the manner in which they will be used, and under whose authority (usually HFHK's).

5. The estimated cost of specialized work to be carried out, or of special goods to be supplied, by other contractors (refer to Clause 8 of the Conditions of Contract) should be indicated in the relevant part of the Bill of Quantities as a particular provisional sum with an appropriate brief description. A separate procurement procedure is normally carried out by HFHK to select such specialized contractors. To provide an element of competition among the bidders in respect of any facilities, amenities, attendance, etc., to be provided by the successful Bidder as prime Contractor for the use and convenience of the specialist contractors, each related provisional sum should be followed by an item in the Bill of Quantities inviting the Bidder to quote a sum for such amenities, facilities, attendance, etc.

BOQ FOR DRILLING DEVELOPMENT AND TESTPUMPING OF 1NO. BOREHOLE AT KYASINI PRIMARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY

1. BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING					
ITEM No.	DESCRIPTION	UNIT	QTY	RATE (KShs)	TOTAL AMOUNT (KShs)
	Provision for contractor-executed geophysical survey to verify subsurface conditions prior to drilling.	Sum	1		
1	Mobilization/Demobilization of drilling unit, equipment, materials, personnel and all other required supplies.	Sum	1		-
1a	Disposal of excavated and all other materials/debris from the site, reinstate the site to the Supervisor's satisfaction. Erecting/dismantling of drilling unit.	Sum	1		-
2	Erecting/dismantling of Test Pumping Unit.	Sum	Sum		-
3	Rotary Drilling of 203mm (8") diameter borehole through all types of strata taking any remedial measures to overcome cavingin, or over drilling to accommodate sloughed material and keeping proper drilling records from:	Sum	Sum		
3a	• 0 - 100m below surface.	m	100		-
3b	• 100 - 200m	m	100		-
	Final drilling depth is <u>PROVISIONAL</u> , actual depth to be determined by the site's geological formation and recommendations by the Supervising Hydrogeologist.				
4	Supply and installation of 152mm (6") diameter plain black steel casings 4.8mm gauge.	m	140		-
5	Supply and installation of 152mm (8") diameter machine-cut black steel screen casings 4.8mm gauge.	m	60		-
6	Supply and installation of 2mm to 4mm well-rounded gravel filter pack.	Ton	7		-
7	Allow for standby time	Hr	5		-
8a	Allow for reaming, boring, supply and installation permanent surface casings on request by the Supervising Hydrogeologist.	m	12		-
8b	Allow for the removal of the above temporary casings.	m	12		-
9	Development works. (Until there is no grit in the water)	Hr	3		-
10	Test pumping with 30kW motor and the appropriate pump to ascertain borehole yield for at least 24 hours including installation and withdrawal of pumping unit.	Hr	24		-
11	Recovery measurements.	Hr	3hrs		-
12	Construction of mass concrete plinth around well head of 1.5 x 1.5 x 0.5 m. (Normal borehole slab).	No	1		-
13	Borehole capping. A borehole well cap to be securely fitted to the 6inch/152mm casing.	No	1		-
15	Full water quality analysis (Physical, Chemical and Microbial), drilling logs, charts, test pumping and detailed final borehole completion report.	Sum	1		-
<b>TOTAL COST</b>					-
<b>COLLECTION SUMMARY</b>					
SN	COMPONENT	Unit	Qty	Amount	

1	BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING		No	1	-
	<b>GRAND TOTAL</b>				-
	<b>ADD 16% VAT</b>	16%	-	-	
	<b>GRAND TOTAL INCLUSIVE OF 16% VAT</b>				-

BOQ FOR DRILLING DEVELOPMENT AND TESTPUMPING OF 1NO BOREHOLE AT MUKAMENI PRIMARY SCHOOL MASINGA SUB-COUNTY MACHAKOS COUNTY

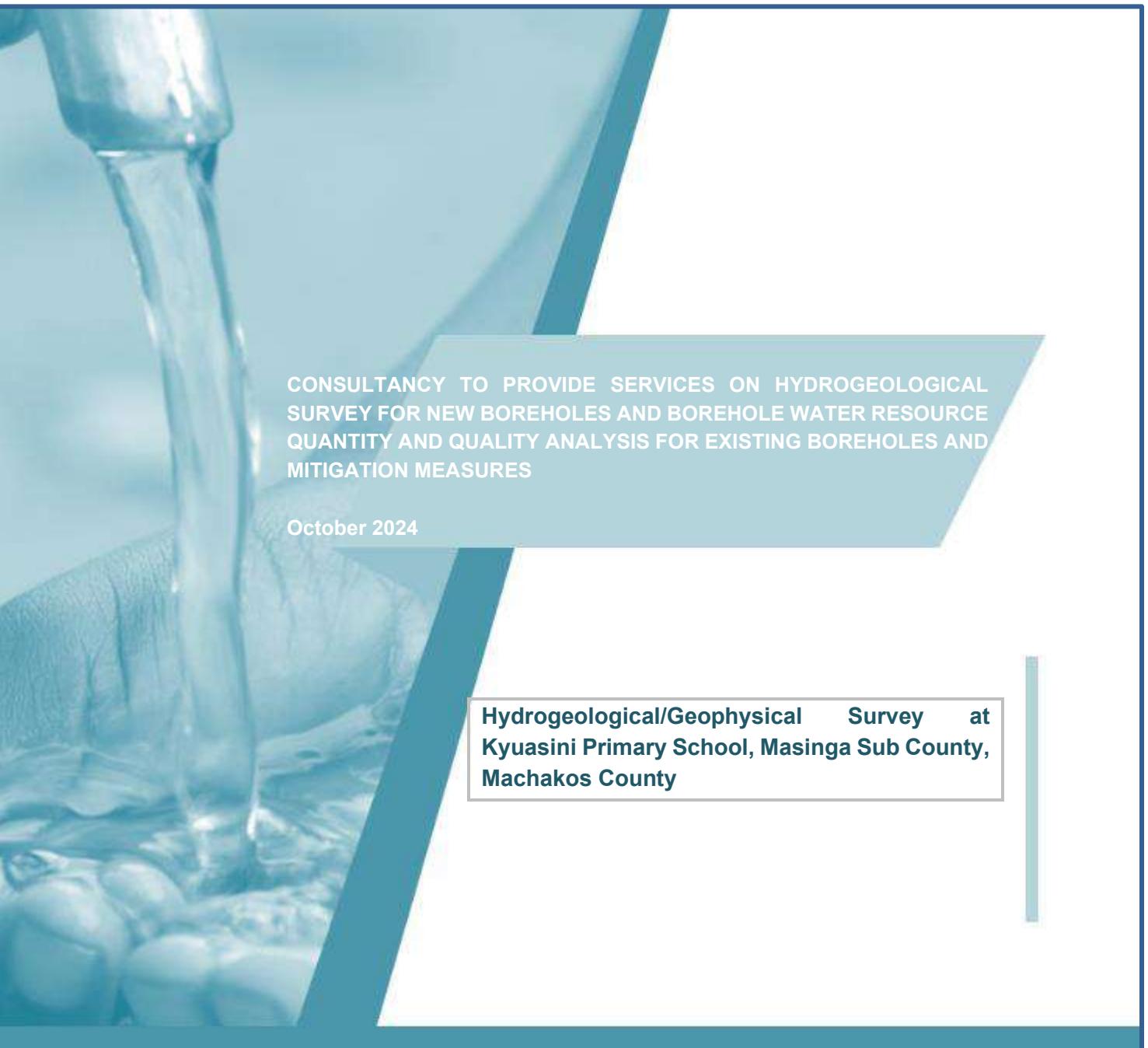
1. BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING					
ITEM No.	DESCRIPTION	UNIT	QTY	RATE (KShs)	TOTAL AMOUNT (KShs)
	Provision for contractor-executed geophysical survey to verify subsurface conditions prior to drilling.	Sum	1		
1	Mobilization/Demobilization of drilling unit, equipment, materials, personnel and all other required supplies.	Sum	1		-
1b	Disposal of excavated and all other materials/debris from the site, reinstate the site to the Supervisor's satisfaction. Erecting/dismantling of drilling unit.	Sum	1		-
2	Erecting/dismantling of Test Pumping Unit.	Sum	Sum		-
3	Rotary Drilling of 203mm (8") diameter borehole through all types of strata taking any remedial measures to overcome cavingin, or over drilling to accommodate sloughed material and keeping proper drilling records from:	Sum	Sum		
3a	• 0 - 100m below surface.	m	100		-
3b	• 100 - 250m	m	150		-
	Final drilling depth is <u>PROVISIONAL</u> , actual depth to be determined by the site's geological formation and recommendations by the Supervising Hydrogeologist.				
4	Supply and installation of 152mm (6") diameter plain black steel casings 4.8mm gauge.	m	175		-
5	Supply and installation of 152mm (8") diameter machine-cut black steel screen casings 4.8mm gauge.	m	75		-
6	Supply and installation of 2mm to 4mm well-rounded gravel filter pack.	Ton	8		-
7	Allow for standby time	Hr	5		-
8a	Allow for reaming, boring, supply and installation permanent surface casings on request by the Supervising Hydrogeologist.	m	12		-
8b	Allow for the removal of the above temporary casings.	m	12		-
9	Development works. (Until there is no grit in the water)	Hr	3		-
10	Test pumping with 30kW motor and the appropriate pump to ascertain borehole yield for at least 24 hours including installation and withdrawal of pumping unit.	Hr	24		-
11	Recovery measurements.	Hr	3hrs		-
12	Construction of mass concrete plinth around well head of 1.5 x 1.5 x 0.5 m. (Normal borehole slab).	No	1		-
13	Borehole capping. A borehole well cap to be securely fitted to the 6inch/152mm casing.	No	1		-
15	Full water quality analysis (Physical, Chemical and Microbial), drilling logs, charts, test pumping and detailed final borehole completion report.	Sum	1		-
<b>TOTAL COST</b>					-
SN	COMPONENT	Unit	Qty	Amount	
1	<b>BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING</b>	No	1		-

<b>GRAND TOTAL</b>				-
<b>ADD 16% VAT</b>		16%	-	-
<b>GRAND TOTAL INCLUSIVE OF 16% VAT</b>				-

BOQ FOR DRILLING DEVELOPMENT AND TESTPUMPING OF 1NO. BOREHOLE AT MUKUSU SECONDARY SCHOOL, MASINGA SUB-COUNTY, MACHAKOS COUNTY

1. BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING					
ITEM No.	DESCRIPTION	UNIT	QTY	RATE (KShs)	TOTAL AMOUNT (KShs)
	Provision for contractor-executed geophysical survey to verify subsurface conditions prior to drilling.	Sum	1		
1	Mobilization/Demobilization of drilling unit, equipment, materials, personnel and all other required supplies.	Sum	1		-
1a	Disposal of excavated and all other materials/debris from the site, reinstate the site to the Supervisor's satisfaction. Erecting/dismantling of drilling unit.	Sum	1		-
2	Erecting/dismantling of Test Pumping Unit.	Sum	Sum		-
3	Rotary Drilling of 203mm (8") diameter borehole through all types of strata taking any remedial measures to overcome cavingin, or over drilling to accommodate sloughed material and keeping proper drilling records from:	Sum	Sum		
3a	• 0 - 100m below surface.	m	100		-
3b	• 100 - 220m	m	120		-
	Final drilling depth is <u>PROVISIONAL</u> , actual depth to be determined by the site's geological formation and recommendations by the Supervising Hydrogeologist.				
4	Supply and installation of 152mm (6") diameter plain black steel casings 4.8mm gauge.	m	154		-
5	Supply and installation of 152mm (8") diameter machine-cut black steel screen casings 4.8mm gauge.	m	66		-
6	Supply and installation of 2mm to 4mm well-rounded gravel filter pack.	Ton	7.5		-
7	Allow for standby time	Hr	5		-
8a	Allow for reaming, boring, supply and installation permanent surface casings on request by the Supervising Hydrogeologist.	m	12		-
8b	Allow for the removal of the above temporary casings.	m	12		-
9	Development works. (Until there is no grit in the water)	Hr	3		-
10	Test pumping with 30kW motor and the appropriate pump to ascertain borehole yield for at least 24 hours including installation and withdrawal of pumping unit.	Hr	24		-
11	Recovery measurements.	Hr	3hrs		-
12	Construction of mass concrete plinth around well head of 1.5 x 1.5 x 0.5 m. (Normal borehole slab).	No	1		-
13	Borehole capping. A borehole well cap to be securely fitted to the 6inch/152mm casing.	No	1		-
15	Full water quality analysis (Physical, Chemical and Microbial), drilling logs, charts, test pumping and detailed final borehole completion report.	Sum	1		-
<b>TOTAL COST</b>					-
SN	COMPONENT	Unit	Qty	Amount	
1	<b>BOREHOLE DRILLING, CONSTRUCTION AND TEST PUMPING</b>	No	1		-





**CONSULTANCY TO PROVIDE SERVICES ON HYDROGEOLOGICAL SURVEY FOR NEW BOREHOLES AND BOREHOLE WATER RESOURCE QUANTITY AND QUALITY ANALYSIS FOR EXISTING BOREHOLES AND MITIGATION MEASURES**

October 2024

**Hydrogeological/Geophysical Survey at Kyuasini Primary School, Masinga Sub County, Machakos County**

CONSULTANT	CLIENT
 <p><b>AFRIQUE WATER</b> &amp; GEOTECHNICAL SERVICES LTD</p> <p>P.O BOX 52240-00200 NAIROBI. Tel No: +254720547608 Email: <a href="mailto:v.okello@afriquewater.com">v.okello@afriquewater.com</a></p>	 <p>Habitat for Humanity Kenya, CVS Plaza, Kasuku Lane, Off Lenana Road P.O Box 36948-00623, Nairobi Kenya. <b>Beneficiary</b> <b>KYUASINI WATER COMMUNITY PROJECT</b></p>

## EXECUTIVE SUMMARY

This present report describes the results of borehole site investigations at Kyausini Primary School, GPS - **01.02577°S and 37.76756°E**. The study was commissioned by **Habitat for Humanity Kenya**. The Client intends to drill a borehole within the Primary School to be used as a source of water for domestic purposes and for the institution. Water Demand of 50 m<sup>3</sup>/day is projected to be sufficient.

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites (± garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr. Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 04.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **KYS 003 VES3 (GPS -01.02577°S and 37.76756°E)**. The hole should be drilled to an approximate depth of **200 metres**. The selected site is known to Kyausini Primary School Management.

An alternative site is recommended for drilling at **KYS 001 VES 1-GPS -01.02570954°S and 37.7674144°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens. To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized. The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

*The Client should note that before drilling commences, a groundwater abstraction permit must be obtained from the Regional Manager, Water Resources Authority, in Mombasa.*

*To be attached to the report and Application form (WRMA 001A duly signed & fully completed) should include client's documents:*

*Copy of Title Deed of the Farm,*

*Copy of Site Plan,*

*Copy PIN Number/KRA Certificate,*

*Banking Slip and Copy of Official Receipt of Paid Fee.*

# Table of content

1. Introduction.....	1
1.1 Scope of Work .....	1
1.2 Project Location .....	1
1.3 Climate.....	1
1.4 Water Demand.....	2
1.5 Approach by the Consultant .....	2
2. Geology.....	5
2.1 Introduction.....	5
2.2 Masinga Geology .....	5
3. Hydrogeology .....	6
3.1    Introduction .....	6
3.2    Groundwater Occurrence in Basement Aquifers .....	7
3.2.1    Weathered Layers .....	7
3.2.2    Faults and Fissure Zones .....	8
3.3    Recharge .....	8
3.7    Existing Boreholes .....	8
4. GEOPHYSICAL INVESTIGATION METHODS .....	12
4.1    Introduction .....	12
4.2    Resistivity Method.....	12
4.2.1 Basic Principles of the Resistivity Method .....	12
4.2.2 Resistivity Sounding Technique.....	13
4.2.3 Resistivity Profiles.....	14
4.3    Geo-electrical Layer Response .....	15
5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION .....	17
5.1    Fieldwork.....	17
5.1.1 Vertical electrical method.....	17
5.2 Results and Discussion .....	17
5.3 Evaluation .....	19
6. CONCLUSIONS AND RECOMMENDATIONS .....	21

6.1 Geology and Hydrogeology of Investigated Area: .....	21
6.2 Proposed Borehole Drilling: .....	21
6.3 Additional Recommendations and Legal Requirements .....	22
<b>7. REFERENCES.....</b>	<b>23</b>
<b>REFERENCES.....</b>	<b>23</b>

## List of Figures

<i>Figure 1.1: Location Map of the Study Area .....</i>	<i>4</i>
<i>Figure 3.1: Groundwater Occurrence in Basement System Rocks .....</i>	<i>6</i>
<i>Figure 3.1: Existing Boreholes (Source, WRA Data Base).....</i>	<i>11</i>
<i>Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes .....</i>	<i>13</i>
<i>Figure 5.1: VES Location Map.....</i>	<i>18</i>

## List of Tables

<b>Table 3.1 - Boreholes within the Vicinity of the Investigated Area .....</b>	<b>9</b>
<b>Table 5a - Hydrogeological Interpretation of VES 2.....</b>	<b>18</b>
<b>Table 5b - Hydrogeological Interpretation of VES 3 .....</b>	<b>19</b>

## ABBREVIATIONS AND GLOSSARY OF TERMS

### ABBREVIATIONS (S.I. Units throughout, unless indicated otherwise)

agl	above ground level
amsl	above mean sea level
bgl	below ground level
d	day
E	East
EC	electrical conductivity ( $\mu\text{S}/\text{cm}$ )
h	head
hr	hour
K	hydraulic conductivity (m/day)
l	litre
m	metre
MWI	Ministry of Water and Irrigation
N	North
PWL	pumped water level
Q	discharge ( $\text{m}^3/\text{hr}$ )
Q/s	specific capacity (discharge - drawdown ratio; in $\text{m}^3/\text{hr}/\text{m}$ )
s	drawdown (m)
S	South
sec	second
SWL	static water level
T	transmissivity ( $\text{m}^2/\text{day}$ )
VES	Vertical Electrical Sounding
W	West
WAB	Water Appointment Board
WSL	water struck level
$\mu\text{S}/\text{cm}$	micro-Siemens per centimetre: Unit for electrical conductivity
$^{\circ}\text{C}$	degrees Celsius: Unit for temperature
$\Omega\text{m}$	Ohmm: Unit for apparent resistivity
$\text{pa}$	Apparent resistivity
"	Inch

### GLOSSARY OF TERMS

<b>Alluvium</b>	General term for detrital material deposited by flowing water.
<b>Aquifer</b>	A geological formation or structure, which stores and transmits water and which is able to supply water to wells, boreholes or springs.
<b>Colluvium</b>	General term for detrital material deposited by hillslope gravitational processes, with or without water as an agent. Usually of mixed texture.
<b>Conductivity</b>	Transmissivity per unit length (m/day).
<b>Confined aquifer</b>	A formation in which the groundwater is isolated from the atmosphere by impermeable geologic formations. Confined water is generally at greater pressure than atmospheric, and will therefore rise above the struck level in a borehole.

<b>Denudation</b>	Surface erosion.
<b>Evapotranspiration</b>	Loss of water from a land area through transpiration from plants and evaporation from the surface.
<b>Fault</b>	A larger fracture surface along which appreciable displacement has taken place.
<b>Granitization</b>	The process by which solid rocks are converted into rocks of granitic character without melting into a magmatic stage.
<b>Gneiss</b>	Irregularly banded rock, with predominant quartz and feldspar over micaceous minerals. A product of regional metamorphism, especially of the higher grade.
<b>Gradient</b>	The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head.
<b>Heterogeneous</b>	Not uniform in structure or composition throughout.
<b>Hydraulic head</b>	Energy contained in a water mass, produced by elevation, pressure or velocity.
<b>Hydrogeological</b>	Those factors that deal with subsurface waters and related geological aspects of surface waters.
<b>Infiltration</b>	Process of water entering the soil through the ground surface.
<b>Joint</b>	Fractures along which no significant displacement has taken place.
<b>Migmatite</b>	Rocks in which a granitic component (granite, aplite, pegmatite, etc.) is intimately mixed with a metamorphic component (schist or gneiss).
<b>Percolation</b>	Process of water seeping through the unsaturated zone, generally from a surface source to the saturated zone.
<b>Perched aquifer</b>	Unconfined groundwater separated from an underlying main aquifer by an unsaturated zone. Downward percolation hindered by an impermeable layer.
<b>Permeability</b>	The capacity of a porous medium for transmitting fluid.
<b>Permeation</b>	Passage of geochemically mobile components through a rock. >Permeation gneiss: Gneiss formed or modified by permeation.
<b>Phenocrysts</b>	The larger crystals in a porphyritic rock.
<b>Piezometric level</b>	An imaginary water table, representing the total head in a confined aquifer, and is defined by the level to which water would rise in a well.
<b>Porosity</b>	The portion of bulk volume in a rock or sediment that is occupied by openings, whether isolated or connected.
<b>Porphyritic</b>	Containing large, visible crystals or phenocrysts in a finer groundmass.

<b>Pumping test</b>	A test that is conducted to determine aquifer and/or well characteristics.
<b>Recharge</b>	General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, lateral groundwater flow) to the aquifer zones.
<b>Regolith</b>	General term for the layer of weathered, fragmented and unconsolidated rock material that overlies the fresh bedrock.
<b>Specific capacity</b>	The rate of discharge from a well per unit drawdown.
<b>Static water level</b>	The level of water in a well that is not being affected by pumping. (Also known as "rest water level")
<b>Transmissivity</b>	A measure for the capacity of an aquifer to conduct water through its saturated thickness (m <sup>2</sup> /day).
<b>Unconfined</b>	Referring to an aquifer situation whereby the water table is exposed to the atmosphere through openings in the overlying materials (as opposed to >confined conditions).
<b>Yield</b>	Volume of water discharged from a well.

# 1. Introduction

## 1.1 Scope of Work

In October 2024, Afrique Water & Geotechnical Services Ltd was commissioned by **Habitat for Humanity Kenya**, to carry out borehole site investigations at Kyuasini Primary School (Fig. 1.1). This report aims at fulfilling the activities under phase 1 of the assignment which can be summarised as follows:

- Carry out the geophysical investigation according to the investigation strategy and interpret results: select the most suitable borehole drilling sites in the project area, also considering the legal framework and the requirements of the Water Act 2016.
- Present a Geophysical Report showing the results of the geophysical investigation, including the raw data sets, the qualitative interpretation of the type curves in terms of layer sequence (for VES investigations) and inversions results, and the identification of the drilling locations and precise description of drilling strategy.
- Compile a hydrogeological/geophysical report.

The main objective of this assignment is to identify a suitable site for drilling a production borehole with sufficient quantity and portable quality that can supply water within Kyuasini Primary School, the surrounding community and institutions.

The address of the Client's is:

Habitat for Humanity Kenya,  
CVS Plaza, Kasuku Lane, Off Lenana Road  
P.O Box 36948-00623,  
Nairobi Kenya..

## 1.2 Project Location

The project area is located at Thatha Sub Location (**GPS: -0.9145 °S and 037.64098°E**) approximately **2km** North west of Thatha Market. The exact location is indicated in figure 1.1 below.

## 1.3 Climate

Climate in Machakos County is mild, and generally warm and temperate. During the winter season, there is a significant decrease in precipitation levels within Machakos as compared to the summer months. This location is classified as Cwb by Köppen and Geiger. The mean yearly temperature observed in Machakos is recorded to be 18.9 °C. The annual rainfall is 829 mm.

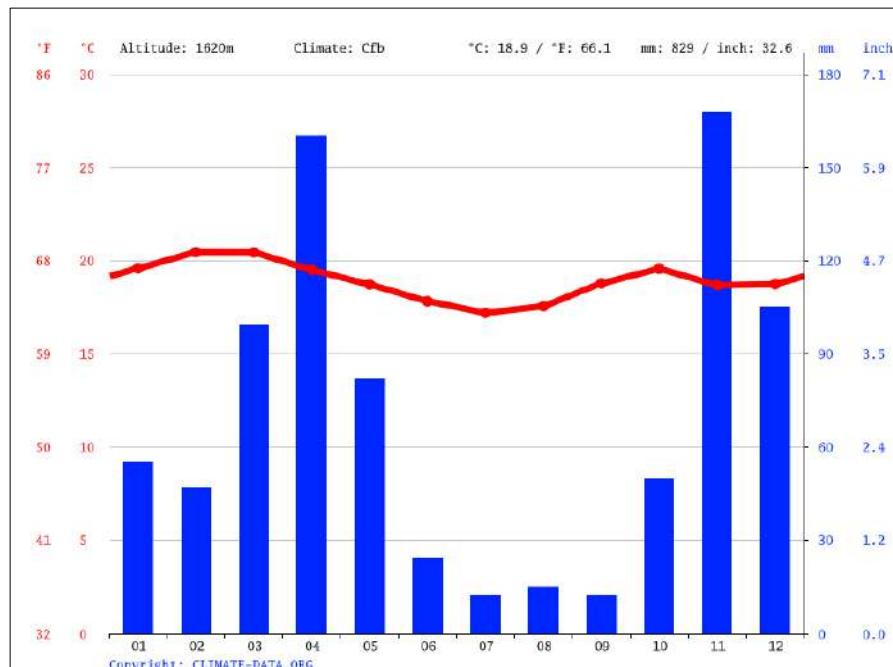
The region of Machakos is characterized by a temperate climate, and the summer season presents some challenges in terms of precise categorization.

Precipitation is the lowest in July, with an average of 12 mm | 0.5 inch. The month of November experiences the highest amount of precipitation, with an average value of 168 mm | 6.6 inch.

At an average temperature of 20.5 °C, February is the hottest month of the year. The month of July is characterized by the lowest temperatures, which have an average reading of 17.2 °C.

Between the driest and wettest months, the difference in precipitation is 156 mm. The fluctuation of temperatures over the course of a year is referred to as temperature variation.

It has been observed that November exhibits the highest relative humidity, with a percentage of 77.85. On the other hand, September experiences the lowest relative humidity at an approximate rate of 58.90. According to the data, April is observed as the month with maximum rainy days (23.13) while September has recorded minimum rainfall during its tenure (2.30).



Source: Climate-Data.org.

Figure 1.1: Climate data for Machakos County

## 1.4 Water Demand

In the absence of a reliable piped water supply, the client has selected drilling 1No. borehole as the best available option. The proposed water source is for domestic use only at the institution. The estimated water demand within university is 50m<sup>3</sup>/day.

## 1.5 Approach by the Consultant

The borehole site investigations were carried out according to a multi-step approach:

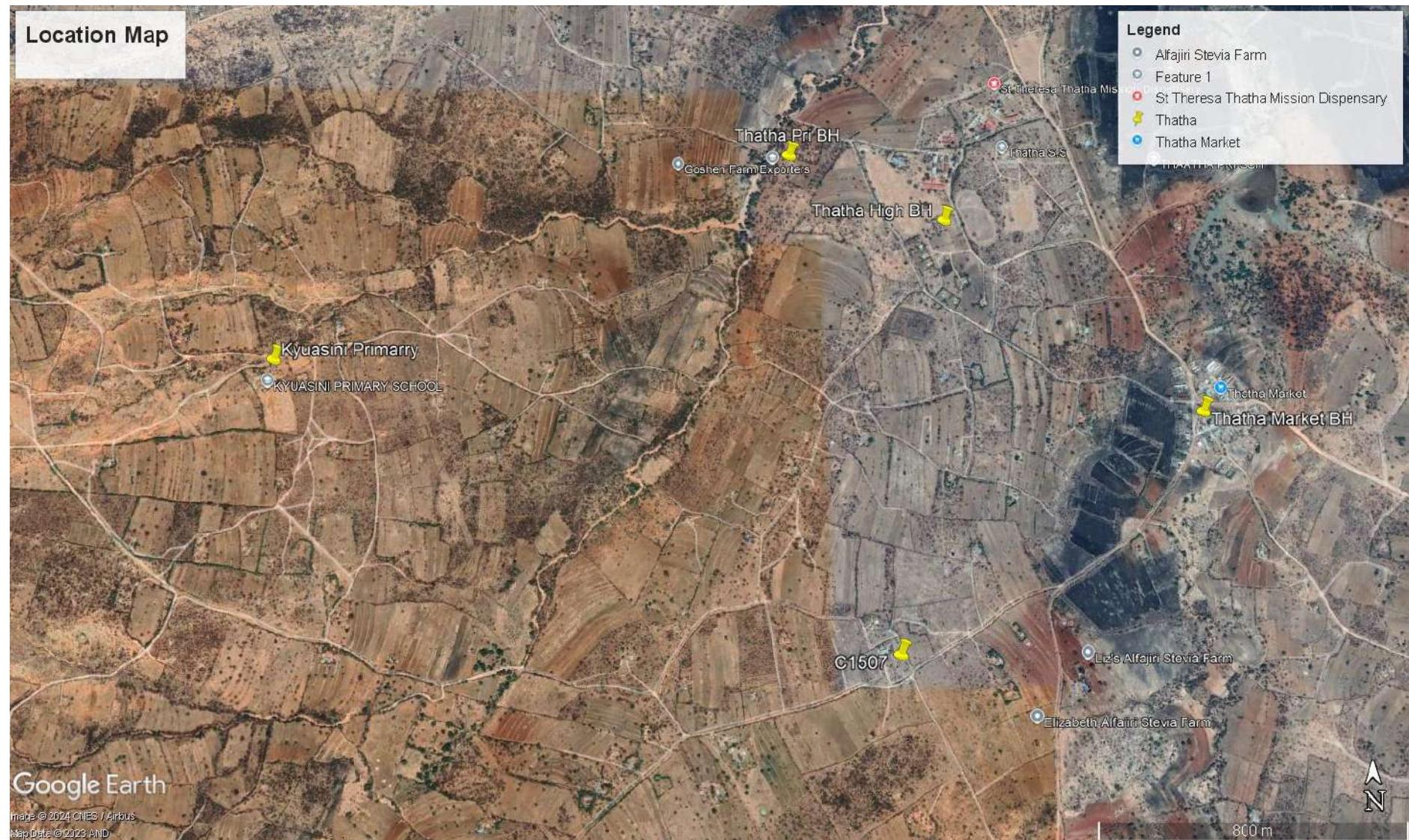
- A desk study and data-acquisition phase: topographic maps, existing studies and borehole site investigations, geological reports and maps, borehole records, etc.
- Geological and geomorphological field reconnaissance, including preliminary identification of potential drilling sites, structural features.

- c) Geophysical measurements in the most prospective areas.
- d) Analysis of geophysical data.
- e) Compilation, analysis, and evaluation of the gathered data and information.
- f) Site selection and reporting.

The Consultant's hydrogeologist mobilized to the Project Area on 02.10.24, and completed the fieldwork on the same date.

The hydrogeological and geophysical field investigations were combined with a broad desk study, during which the available relevant geological and hydrogeological data was collected, analysed, collated and evaluated. Methods and measurements used in the field are introduced and described in Chapter 4.

The recommended (preliminary) sites were marked in the field.



**Figure 1.1: Location Map of the Study Area**

## 2. Geology

### 2.1 Introduction

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys.

### 2.2 Masinga Geology

The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi.

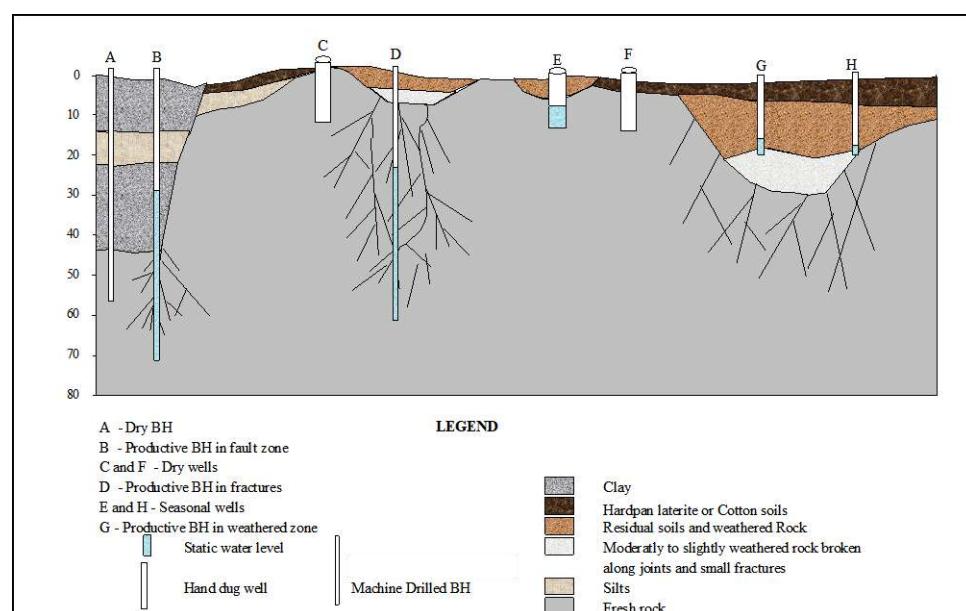
The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

## 3. Hydrogeology

### 3.1 Introduction

The study area is marked by generally unfavourable hydrogeological conditions, which are determined by a combination of largely impermeable bedrock, generally thin soils, and lack of recharge due to a structural rainfall deficit. However, the prospects for groundwater development are fair along the faults and general lines of weakness. Here, weathering has not only resulted in secondary porosity, but has also created a storage media in the regolith, saprolite and saprock. Along the streams recharge is provided by the infiltration of surface discharge, and underflow through the alluvium, faults and the weathered zones.

The area is underlain exclusively by Basement System formations, covered by a layer of weathered rocks, soils and local alluvial deposits. Unaltered metamorphic rocks, such as biotite and quartzo-felspathic gneisses and granulites, are generally hard and compact, and possess no primary porosity. However, depending on the parent material, water may be struck in the weathered zone (regolith, saprolite and saprock). The underlying fresh Basement is in most cases dry, and significant volumes of groundwater can only be expected in fracture zones (cracks, joints, fissures, and faults). An overview of groundwater occurrence in Basement rocks is given in Figure 3.1.



**Figure 3.1: Groundwater Occurrence in Basement System Rocks**

Groundwater may further be found in areas covered by recent sedimentary deposits, specifically within the alluvial plains of the larger seasonal or perennial rivers.

The best chances of striking significant amounts of water occur in fracture zones with a sufficiently large catchment area to provide the necessary recharge. The survey was aimed at identifying such zones in the vicinity of the study area.

Other semi-permanent aquifers may be found in form of connate water (i.e. water trapped during the formation of a sedimentary deposit), or fossil water (water stored during past, more humid conditions). It should be noted that the latter are likely to produce a brackish quality.

## 3.2 Groundwater Occurrence in Basement Aquifers

### 3.2.1 Weathered Layers

Over the years, chemical and mechanical disintegration processes have formed a cover of weathered material over the unaltered bedrock. This weathering is enhanced -and often triggered- by the presence of water. As a result, the thickness of the *regolith* is usually greatest in the topographically low areas. Upon maturation of the profile, the occurrence of water will locally create deep zones of alteration. These will in turn be able to divert more and more water from the surrounding catchment. It is thus evident that deep weathering is linked to the occurrence of groundwater and vice versa.

The upper horizons of the weathered layer are usually clayey, consisting of completely decomposed rock, in which original structures can no longer be found. Feldspar and mica minerals are disintegrated into clay minerals, resulting in high porosities, but extremely low permeabilities. The thickness of this layer is extremely variable, with a common range between 0 and 25 m.

Between the decomposed top soil and the fresh bedrock the weathered zone consists of more coarsely disintegrated and less altered rock material, which is known as the saprolite. This layer comprises *in situ* weathered material, which still resembles the parent rock in structure and appearance. It is however much softer, and often brittle. In drilling logs it is often referred to as "rotten rock", as it is easily penetrated.

Below the saprolite a layer of partly weathered material occurs, which more closely resembles the bedrock. This is the saprock zone, which has hydraulical properties similar to the saprolite. The thickness of this zone may locally exceed 10 metres.

Although the saprolite and saprock usually have higher permeabilities than the fresh rock and the clayey top soil, its properties largely depend on the nature of the parent material. If the latter contains large portions of clay-producing minerals, the resulting aquifers will be low yielding. On the other hand, coarse-grained and quartz-rich rocks will produce a sandy saprolite with relatively good groundwater potential.

The quartz-feldspathic and quartz-biotite gneisses observed within the investigated area are marked by relatively fair properties in this respect. The calcite in the rocks is likely to be entirely removed, thus increasing the secondary porespace. In addition, the rocks were observed to be relatively coarse and very rich in quartz, thus giving rise to shallow but predominantly sandy weathering.

The combined saprolite/saprock layer covering the fresh Basement rocks is relatively thick in the valleys and depressions. A typical depth of 60 m should be expected. On steep slopes and hill tops, however, the weathering is likely to be thin, i.e. about 20 to 30 m.

In the floodplains, groundwater may be found within the saprolite and saprock layers, at various depths ranging from 5 to 60 m bgl. The best prospects occur where local recharge is supplemented with water from an alluvial drainage system, as could be the case along the floodplains.

### 3.2.2 Faults and Fissure Zones

Individual aquifers formed exclusively within the weathered layer rarely produce yields in excess of 2-3 m<sup>3</sup>/hr. Higher yields (say >5 m<sup>3</sup>/hr) can be achieved from boreholes located in "open" faults and fissure zones. The potential of structurally altered rocks is twofold:

- ◆ Along faulted or fissured rocks weathering can penetrate much deeper, thus creating sub-vertical zones filled with relatively coarse, weathered material. These zones generally have a much higher transmissivity than their surroundings.
- ◆ Recharge occurs over large areas: major faults may extend well beyond the surface catchment, thus intercepting adjacent aquifers or surface sources.

Although faults are often associated with water bearing zones, it should be noted that they may also act as impermeable barrier zones ("closed faults"). In this case the structure acts as a "groundwater dam" and significant storage may build up on its upstream side. Drilling inside such a closed fault system, however, would in most cases be futile.

Thirdly, there are faults or fissure zones that, despite having all the properties of a water bearing zone, are not productive due to a lack of recharge (dry, open fractures).

### 3.3 Recharge

Recharge is the process through which water is added to the groundwater reservoir. Some aquifers do not receive any recharge at all; in this case, the water is connate or fossil, and pumping results in irreversible depletion. Usually, aquifers with little recharge and consequently long residence times are marked by high levels of mineralisation and salinity. Unless the underground water body is of vast extent, it is essential that not more water is abstracted than the annual amount of replenishment.

### 3.7 Existing Boreholes

The locations of the existing boreholes are illustrated in Figure 3.1 and the technical details tabulated in Table 3.1 below.

**Table 3.1 - Boreholes within the Vicinity of the Investigated Area**

ID	DLONG	DLAT	OWNER	LOCALITY	COMPDATE	TDEPTH	M_WSL	WRL	YIELD	DRAWDOWN
1	2	3	4	5	6	7	8	9	10	11
C1375	37.350	-0.900	T.BURSELL	TANA RANCH	1951.03.01	46.0	27.0	23.0	2.70	
C1479	37.333	-0.900	T.BURSELL	TANA RANCH	1951.05.01	73.0	24.0	20.0	0.30	
C4710	37.400	-1.016			1980.01.01	186.0	180.0	58.0	16.30	
C128	37.850	-1.050			1941.03.01	22.0	18.0	13.0	0.90	
C2196	37.883	-1.016			1954.05.01	67.0	61.0	24.0	0.78	2.0
C3760	37.600	-1.083			1971.07.01	198.0	61.0	28.0	0.30	77.4
C3766	37.633	-1.083			1971.08.01	152.0	91.0	23.0	1.50	119.0
C1507	37.783	-1.033	AFR.SET.BOARD	YATTA	1951.08.14	111.0	44.0	38.0	0.72	
C1571	37.633	-0.966	AFR.SET.BOARD	YATTA	1951.10.16	34.0	29.0	23.0	4.56	
C1595	37.666	-1.100	A.S&L.U.B	YATTA	1951.09.29	82.0	64.0	30.0	10.90	
C2041	37.716	-0.933	A.L.U&SB	KATHINGIRI	1953.10.15	122.0	117.0	76.0	0.18	41.0
C1973	37.600	-1.066	A.L.U&SB	YATTA	1953.05.27	121.0	111.0	16.0	2.82	92.0
C4162	37.483	-0.916	CATHOLC MISSION	DITHINI	1975.10.23	200.0	111.0	40.0	0.30	139.0
C13258	37.664	-0.965	DWD (KAIRUNGU W P)	KIOMO KAIRUNGU	2001.06.02	90.0	74.0	11.2	14.60	39.4
C6793	37.550	-0.883	FOSTER PARENTS INT.	MBONDENI H/C	1986.02.07	70.0	56, 61	43.0	0.00	23.0

**NOTES:**

1. Ministry of Water and Irrigation Borehole Identification Number.
2. Longitude (Decimal Degrees)
3. Latitude ((Decimal Degrees)
4. Borehole Owner
5. Locality
6. Borehole Completion Date
7. Total Depth (m)
8. Main Water Struck Level (m)
9. Water Rest Level (m)
10. Yield (m<sup>3</sup>/hr)
11. Drawdown (m)

Records of some of the boreholes and their geologic log were analysed and evaluated. Results of the data inventory are presented in Table 3.1 above, while the location of the boreholes is shown in Figure 3.2 below. In the present study the borehole data have been used to identify aquifer characteristics and their variations with depth.

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr.

Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

- **Specific Capacity**

The specific capacities of the 3 boreholes has been calculated using the formula  $Sc = Q/Sw$ , where  $Sc$  is specific Capacity,  $Q$  is the discharge and  $Sw$  is the drawdown. To obtain an insight to the general characteristics, the average specific capacity of the aquifer in general has been assumed as the average of the 3 sample boreholes with drawdown values, resulting in an average specific capacity of **0.05235235 $m^2/hr$** .

- **Transmissivity**

During pump test, the borehole is pumped at a constant rate and the amount of drawdown is noted. Specific capacity **Sc** is then defined as the pumping rate **Q** divided by Drawdown **Sw**.

$$Sc = Q / Sw \text{ (Discharge per unit of Drawdown).}$$

The following equation, based on the Cooper-Jacob (1946) solution for flow to a borehole in a confined aquifer, computes the Specific Capacity, **Q / Sw** of a borehole:

$$Q / Sw = T / 0.183 \log \{2.25 T t / R w^2 S\}$$

Where **Rw** is radius of borehole [m], **S** is storativity [Dimensionless Coefficient], **T** is transmissivity [m/day] and **t** is time [day]. Using the equation, Driscoll (1986) developed approximate formulas for estimating transmissivity from specific capacity in Confined and Unconfined aquifers:

$$T = 1.385 [Q / Sw] \dots \text{Confined aquifer}$$

$$T = 1.042 [Q / Sw] \dots \text{Unconfined aquifer.}$$

Taking the average discharge and pumping drawdown of the 5 sampled boreholes:

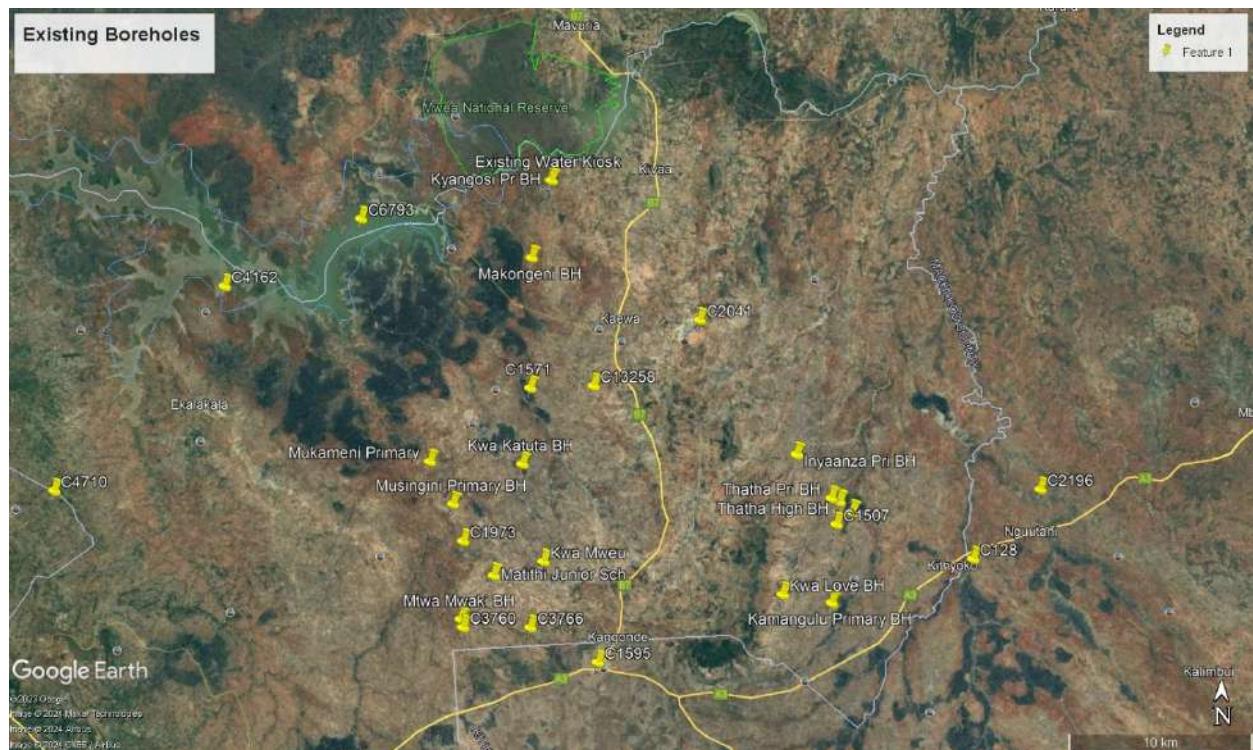
$$\text{Specific Capacity } Sc = 0.052352352m^2/hr$$

$$\frac{\text{Transmissivity}}{1.740192114m/day} = T = 1.385 [0.052352352m^2/hr] =$$

- **Hydraulic Conductivity**

The hydraulic conductivity **K** is computed from transmissivity **T** using **K = T / b**.

Where **b** is the saturated thickness of the aquifer. Boreholes should be screened only in the most productive parts of the aquifer if total screen length is to correspond to **b**. For the current sample boreholes in the study area, the total thickness of the main aquifers could not be determined.



**Figure 3.1: Existing Boreholes (Source, WRA Data Base)**

# 4. GEOPHYSICAL INVESTIGATION METHODS

## 4.1 Introduction

Great varieties of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity sounding technique was applied, using an ABEM DC resistivity set comprising a Terrameter/Resistivity Meter, connecting cables and crocodile clips, stainless steel non-polarising current electrodes and copper potential electrodes.

This dedicated equipment measures both  $V$  and  $I$  and presents a calculated resistance (see Section 4.2). In order to improve the validity of the data the equipment takes an average of 4, 16 or exceptionally, 64 readings (determined by the operator). This allows the effects of noise to be minimised.

In Appendix I, graphical plots of the apparent resistivity versus electrode spacing  $AB/2$  are presented, together with raw field data and the resulting geophysical interpretation model.

## 4.2 Resistivity Method

### 4.2.1 Basic Principles of the Resistivity Method

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. The resistance  $R$  of a certain material is directly proportional to its length  $L$  and cross sectional area  $A$ , expressed as:

$$R = \rho_a * L/A \quad (\Omega) \quad (1),$$

where  $\rho_a$  is known as the specific resistivity, characteristic of the material and independent of its shape or size. With Ohm's Law:

$$R = \delta V/I \quad (\Omega) \quad (2),$$

where  $\delta V$  is the potential difference across the resistor and  $I$  is the electric current through the resistor, the specific resistivity may be determined by:

$$\rho_a = (A/L) * (\delta V/I) \quad (\Omega m) \quad (3)$$

The electrical properties of rocks in the upper part of the earth's crust are determined by the lithology, porosity, the degree of pore space saturation and the salinity of the pore

water. These factors all contribute to the resistivity of a material (the reciprocal of the electrical conductivity).

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. Vertical electrical soundings are point measurements that provide information on the vertical resistivity layering at a certain location. Resistivity profiles, on the other hand, are carried out to obtain information on lateral changes in apparent resistivity along a cross section.

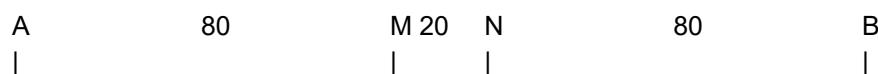
#### 4.2.2 Resistivity Sounding Technique

When carrying out a resistivity sounding, also called vertical electrical sounding (VES), an electrical current ( $I$ ) is passed into the ground through two metal pins, the current electrodes. Subsurface variations in electrical conductivity determine the pattern of current flow in the ground and thus the distribution of electrical potential. A measure of this is obtained in terms of the voltage drop ( $\delta V$ ) between a second pair of metal stakes, the potential electrodes placed near the centre of the array. The ratio ( $\delta V/I$ ) provides a direct measurement of the ground resistance and from this, and the electrode spacing, the apparent resistivity ( $\rho_a$ ) of the ground is calculated.

The measuring setup consists of a resistivity instrument (usually placed in the middle of the array), connected to two current electrodes (AB), and two potential electrodes (MN) towards the centre. Usually a so-called "Schlumberger" array is used for vertical electrical soundings, while profiles are generally carried out in "Wenner" configuration (Figure 4.1).

**Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes**

a) Schlumberger Array:  $AM = NB > MN$



b) Wenner Array:  $AM = MN = NB$



A series of measurements made with an expanding array of current electrodes (Schlumberger Array) allows the flow of current to penetrate progressively greater depths. The *apparent resistivity* as a function of the electrode separation AB provides information on the vertical variation in resistivity. The depth of penetration varies according to the electrode array, but is also affected by the nature of the material beneath the array.

The point at which a change in earth layering is observed depends on the resistivity contrast, but is generally of the order of a quarter of the current electrode spacing AB

(Milsom 1989). By contrast, in an homogeneous medium the depth penetration is of the order 0.12 AB (Roy & Apparao 1971).

The calculated apparent resistivity is plotted against current electrode half separation on a bi-logarithmic graph paper to constitute the so-called sounding curve. The curve depicts a layered earth model composed of individual layers of specific thickness and resistivity.

Interpretation of field data can be done with hand-fitted curves, but this method is time consuming, and practically limited to 3-layer solutions. Modern interpretation is computer-aided, using a curve fitting procedure based on a mathematical convolution method developed by Ghosh (1971).

While the resistivity method is a useful tool in groundwater investigations and borehole site surveys, its applicability and reliability should not be overestimated. The modelling of field data is often attended by problems of equivalence and suppression. Each curve has an infinite number of possible solutions with different layer resistivities and depths (this is known as equivalence). Mathematical convolution can easily lead to a well-fitting solution, which nonetheless does not correspond to reality. In general, the number of possible solutions is reduced by mutual correlation of several sounding curves, knowledge of the local geology and drilling data.

When deposits with similar resistivities border each other, it is usually not possible to make a differentiation. Intermediate layers, occurring between deposits of contrasting conductivity, may go undetected, as they tend to be obscured within the rising or falling limb of the sounding graph (suppression). Additional data, in the form of borehole records, air photography and geological field observations, are required to produce a realistic interpretation.

It should be noted that the layered earth model is very much a simplification of the many different layers, which may be present. The various equivalent solutions, which can be generated by a computer programme, should therefore be carefully analysed. In general, resistivity soundings should never be interpreted in isolation as this may lead to erroneous results.

#### 4.2.3 Resistivity Profiles

Resistivity profiles are usually carried in Wenner configuration, i.e. an electrode set-up with a uniform distance between potential and current electrodes (see Fig. 5.1). The entire array is moved across the area of interest. By doing so, lateral changes in apparent resistivity are measured, which reflect variations in the lithology, the depth of weathering or the water content.

So-called "anomalies" may indicate the intersection of a fault (usually a negative anomaly), quartzite band (positive anomaly) or buried riverbed (anomaly depends on nature of surrounding deposits). Usually such lineaments, which may also be observed on aerial photographs, are linked to the occurrence of groundwater.

It must be noted that resistivity differences in a single profile array may largely reflect variations at the surface rather than underground. For this reason, it is usually not sufficient to carry out single-spaced profiles. The depth of penetration increases at greater electrode separations. A series of profiles at variable electrode separations will provide an indication of vertical resistivity trends. Moreover, by repeating the same profile at a different

configuration, it will become clear if the observed resistivity patterns are caused by surface phenomena or underground features.

### 4.3 Geo-electrical Layer Response

Vertical electrical soundings (VES) provide quantitative information on electrical resistivity as a function of depth. The computer-interpretation of the sounding data produces a layered model of the underground. The derived resistivity layers are used to infer the presence of water-bearing strata, their texture and salinity.

Water-bearing and/or weathered rocks have lower resistivities than unsaturated (dry) and/or fresh rocks. The higher the porosity of the saturated rock, the lower its resistivity, and the higher the salinity (or electrical conductivity EC) of the saturating fluids, the lower the resistivity. In the presence of clays and conductive minerals the resistivity of the rock is also reduced. The relation between the formation resistivity ( $\rho$ ) and the salinity is given by the "Formation Factor" (F):

$$\rho = F \times \rho_w = F \times 10,000 / EC \text{ } (\mu\text{S/cm}), \quad \text{where: } \rho_w = \text{resistivity of water}$$

In sediments or unconsolidated layers produced by weathering, the formation factor varies between 1 (for sandy clays) and 7 (for coarse sands).

**Example:** If a certain aquifer is considered with an average formation factor of 3, then an EC of 300  $\mu\text{S/cm}$  will give a formation resistivity of 100  $\Omega\text{m}$ . The same material, when containing water with an EC of 1,500  $\mu\text{S/cm}$ , will have a resistivity of only 20  $\Omega\text{m}$ . Brackish water is marked by an EC of 2,000 to 10,000  $\mu\text{S/cm}$ , and a  $\rho_w$  of 5 to 1. Deposits containing brackish water will therefore in most cases adopt a low formation resistivity (usually less than 10  $\Omega\text{m}$ ). Saline water with an EC of about 30,000  $\mu\text{S/cm}$  will reduce the resistivity of a formation to about 2 Ohms.

Clayey formations with fresh water will respond similarly to deposits with brackish or saline water: the fact that the same resistivity can be obtained for completely different hydrogeological units is known as the "equivalence-problem".

Fresh and dry Basement rocks are marked by very high resistivities, with a common range from 1,000 to 10,000 Ohms. Moderately to slightly weathered but dry layers are less resistive, and usually show values between 100 and 500 Ohms, depending on the portion of clays, the degree of weathering and the water content. The resistivity further decreases if the deposits are water-bearing, to 20 to 200  $\Omega\text{m}$ . The resistivity of impermeable clay layers (alluvial or produced by intensive weathering of clay-forming minerals) usually varies between 2 and 10 Ohmm, while similar figures are recorded for aquifers with brackish to saline water.

The greatest difficulty in the interpretation of resistivity measurements in Basement rocks is formed by:

- Equivalence*: the similar geophysical properties of layers with contrasting hydrogeological characteristics (e.g. clay layers and layers with brackish water),
- Absence of distinct layer boundaries*: the decreasing degree of weathering with depth is usually not well-defined, but gradual. This will result in a gradual increase in resistivity, and not in a distinct set of geophysical layers.

c) *Suppression #1*: Potential aquifer layers of moderate thickness may fail to show a significant response in the recorded resistivity data (especially where these are deep). Thin aquifers embedded within a very thick deposit can easily remain undetected by surface geophysics. They will however show up in down-hole geophysical logs.

d) *Suppression #2*: The resistivity contrast between the (clayey) weathered zone and the fresh bedrock may be so high, that an intermediate saprock aquifer cannot be distinguished in the graphic plot of the sounding.

Despite the problems of suppression attributed to the large resistivity contrast between fresh and weathered basement (point *d*), this is also a favourable attribute. Because of the large difference, the depth of weathering can be measured quite accurately. Considering that aquifers often occur towards the boundary of the weathered zone and the bedrock, the drilling depth can be determined, even if the actual aquifer does not show up as distinct geophysical layer.

# 5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION

## 5.1 Fieldwork

Combined geophysical and hydrogeological fieldwork was carried out on 04.10.2024. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

### 5.1.1 Vertical electrical method

A total of 3 electrical soundings (VES) were carried out at **Kyuasini Primary School**. The geophysical investigations were mainly aimed at the determination of the following parameters:

- a) lateral and vertical extent of the water body,
- b) texture of the aquifer deposits (grain-size distribution),
- c) depth and nature of the layers underlying the groundwater store.

## 5.2 Results and Discussion

Vertical electrical soundings (VES) provide quantitative depth-resistivity information for a particular site. VES sites were selected at representative points in relation to geomorphological observations, and locations of particular interest for groundwater resources development.

The measurements were executed in an expanding Schlumberger array, with electrode spreads AB/2 between 250 and 320 m. This separation gives fairly reliable interpretations down to a depth of respectively 120 to 200m, but only approximate solutions for resistivity layering at deeper levels. Depths beyond this level are only indicative, and do not give the precise position of the interpreted layers. However, the selected configuration provided adequate information on the depth of weathering.

The locations of the geophysical soundings and topographical features are shown in figure 5.1. Apparent resistivity curves were interpreted using IXD program, combined with raw field data and interpreted geo-electrical models are included in Annex 1.

The main aim of the measurements was to determine the degree of fracturing at depth, which should be directly related to the layer transmissivity and thus the potential yield. As a general rule, it can be assumed that the soundings with the lowest basal resistivities in the expected water bearing range represent the most favourable drilling sites. However, this does not apply if the resistivity is excessively low (say < 20 Ohmm): figures close to 10 Ohmm are indicative of high clay contents and/or brackish water.

The sounding curves (in Annex 1), all display a similar stratigraphy of miscellaneous shallow deposits, underlain by sandy clay (potentially water-bearing) and heavy clays (dry).

The Consultant carried out geophysical investigations at four locations within the Primary School. Detailed analysis of the geophysical models for recommended sites are discussed below while all the raw data is attached to annex 1 of this report.

### Geophysical Interpretation of the VES Models

#### KYS 001 VES 1-GPS -01.02570954°S and 37.7674144°E,

The Geophysical model shows that the top layer is composed of dry top soil with a thickness 0.62m. This formation is underlain by moist top soil and heavy clays between 0.62- 3.6mbgl and 3.6-8.5mbgl respectively. A sandy clay formation is encountered between from 8.5mbgl to 16mbgl. This formation is underlain by a slightly weathered Basement rock from 16mbgl to 66mbgl. The first aquifer shall be struck between 66mbgl and 97mbgl within the weathered/fractured Basement formation. The second aquifer shall be struck from 127mbgl to 177mbgl. This formation is underlain by a confining layer of fresh Basement below 177mbgl.

**Drilling of alternative site is recommended to maximum depth of 200mbgl at this location. The main aquifer is expected between 127mbgl and 177mbgl within the highly fractured/weathered Basement formation. The site is known to Kyuasini School Management.**



Figure 5.1: VES Location Map

Table 5a - Hydrogeological Interpretation of VES 2

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-0.62	178	Dry Top Soil	No
0.62-3.6	40	Moist Top Soil	No
3.6-8.5	7.9	Heavy Clay	No
8.5-16	34	Sandy Clay	Probably

16-66	328	Slightly Weathered Basement	No
66-97	172	Weathered/Fractured Basement	Yes-1 <sup>st</sup> Aquifer
97-127	327	Slightly Weathered to Fresh Basement	No
127-177	211	Weathered/Fractured Basement	Yes-Main Aquifer
>177	924	No	

**KYS 003 VES3 (GPS -01.02577°S and 37.76756°E)**

Geophysical model in Table 5b below shows that the top layer is covered by 0.93m of dry top soil. This formation is underlain by moist sandy soil layer from 0.93mbgl to 12.8mbgl. A slightly weathered Basement formation occurs from 12.8mbgl to 27.8mbgl. The first aquifer shall be struck between 27.8mbgl and 40.9mbgl within the fractured/weathered Basement formation. This layer shall be underlain by fresh Basement formation between 40.9mbgl and 78.4mbgl. The second aquifer shall be struck between 78.4 and 181mbgl composed fractured/weathered Basement. This layer is underlain by a confining layer of fresh Basement rock below 181mbgl.

**Drilling at this location is recommended to a maximum depth of 200mbgl. Main aquifer is expected to be struck between 78.4mbgl and 181mbgl. The site is known to Kyuasini Primary School Management.**

**Table 5b - Hydrogeological Interpretation of VES 3**

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-0.93	32	Top Soil	No
0.93-12.8	12.3	Moist Sandy Clay	No
12.8-27.8	227	Slightly Weathered Basement	No
27.8-40.9	120	Fractured/ Weathered Basement	1 <sup>st</sup> Aquifer
40.9-78.4	520	Fresh Basement	No
78.4-181	164	Fractured/Weathered Basement	2 <sup>nd</sup> Aquifer-Main
>181	616	Fresh Basement	No

### 5.3 Evaluation

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **KYS 003 VES3 (GPS -01.02577°S and 37.76756°E)**. The hole should be drilled to an approximate depth of **200 metres**. The selected site is known to Kyuasini Primary School Management.

An alternative site is recommended for drilling at **KYS 001 VES 1-GPS -01.02570954°S and 37.7674144°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens.

The chemical water quality is likely to be reasonable. Most mineral concentrations are expected to be relatively high, but acceptable for human consumption.

## 6.CONCLUSIONS AND RECOMMENDATIONS

Summarized conclusions and recommendations from the hydrogeological investigations undertaken at the project study area at Mukameni Primary School are described in the following sections.

### 6.1 Geology and Hydrogeology of Investigated Area:

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from  $0.0\text{m}^3/\text{hr}$  to  $16.3\text{m}^3/\text{hr}$ . The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of  $7.11\text{m}^3/\text{hr}$ . Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 04.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **KYS 003 VES3 (GPS -01.02577°S and 37.76756°E)**. The hole should be drilled to an approximate depth of **200 metres**. The selected site is known to Kyuasini Primary School Management.

An alternative site is recommended for drilling at **KYS 001 VES 1-GPS -01.02570954°S and 37.7674144°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mils steel casings and screens.

### 6.2 Proposed Borehole Drilling:

- ⇒ The study recommends that a borehole be drilled within the premises to an approximate depth of **200metres**: this site shall provide a sustainable yield of approximately **3- 5 m<sup>3</sup>/hr**.
- ⇒ To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized.
- ⇒ The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

## 6.3 Additional Recommendations and Legal Requirements

- A piezometer (1inch pipe) line and a water meter should be installed to monitor water levels and groundwater abstraction.
- The hydraulical properties of the borehole and the surrounding aquifer should be determined during a step-drawdown test, followed by a 24-hour constant discharge test. After stopping the pump, recovery of the water level should be measured for 12 hours, or, alternatively, a 95% recovery to the static level. Using test-pumping results, the sustainable yield can be calculated. The maximum discharge is restricted to 70% of the rate applied during the constant discharge test.
- Samples taken during test pumping must be submitted to a recognized laboratory for chemical and bacteriological analysis.

In Annex II, further recommendations are given on borehole construction and completion methods.

Prior to drilling, it is required to apply for an authorization to sink a production borehole from the Water Resources Authority. Three copies of the report should be submitted to WRA.

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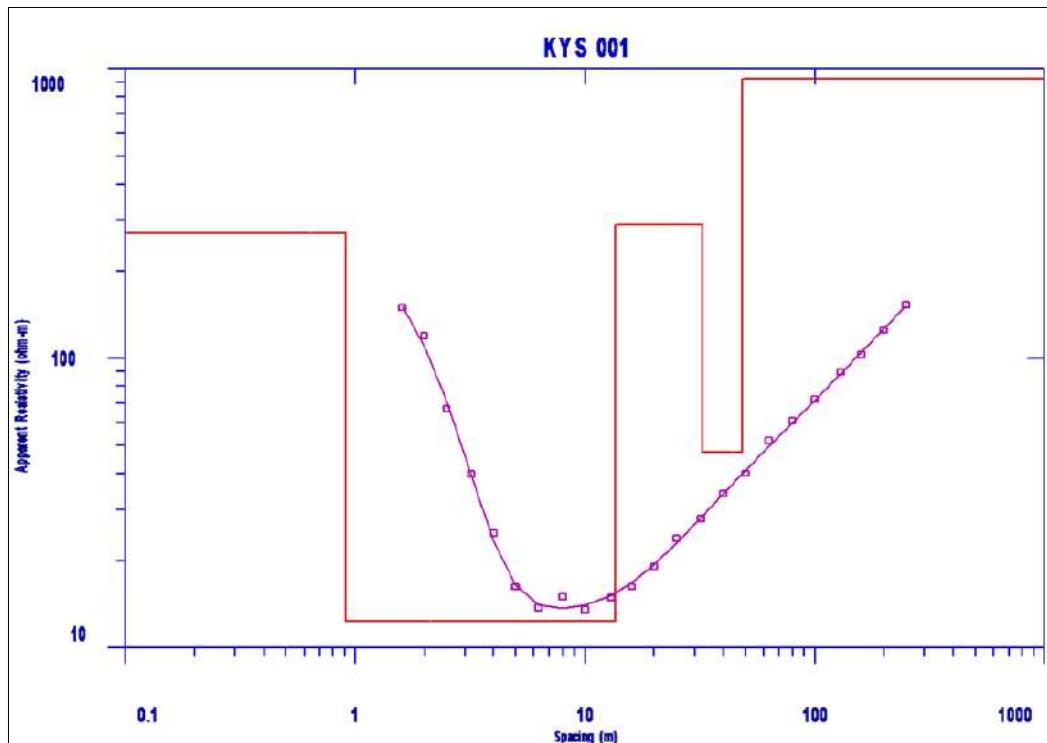
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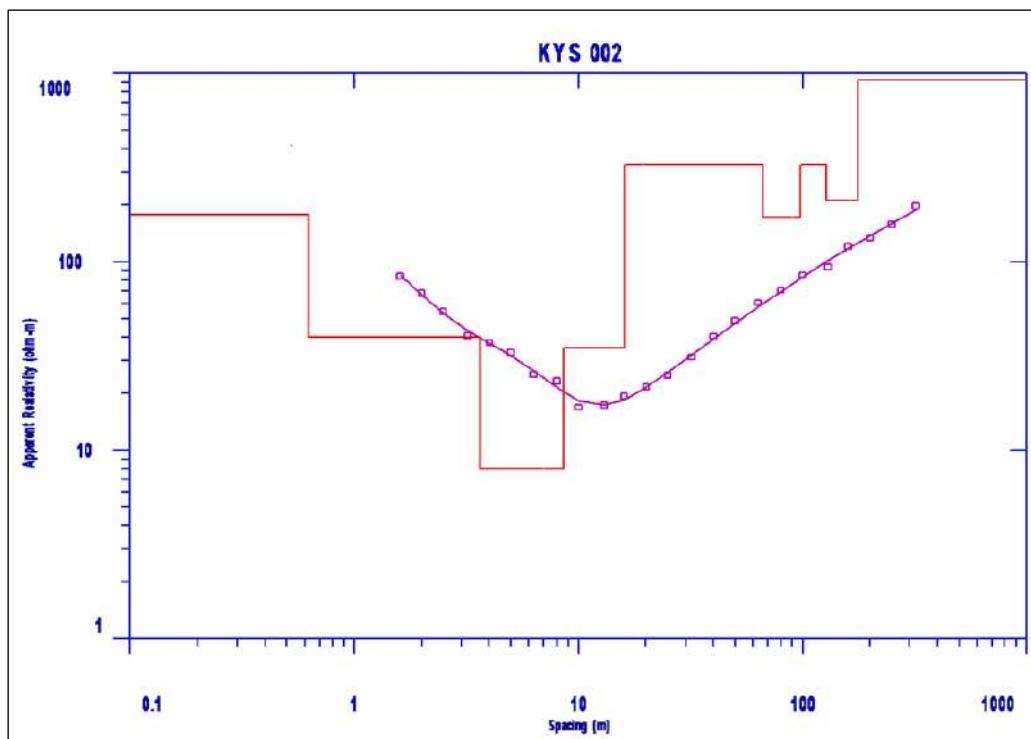
## **APPENDICES**

**APPENDIX I: VERTICAL ELECTRICAL SOUNDINGS**



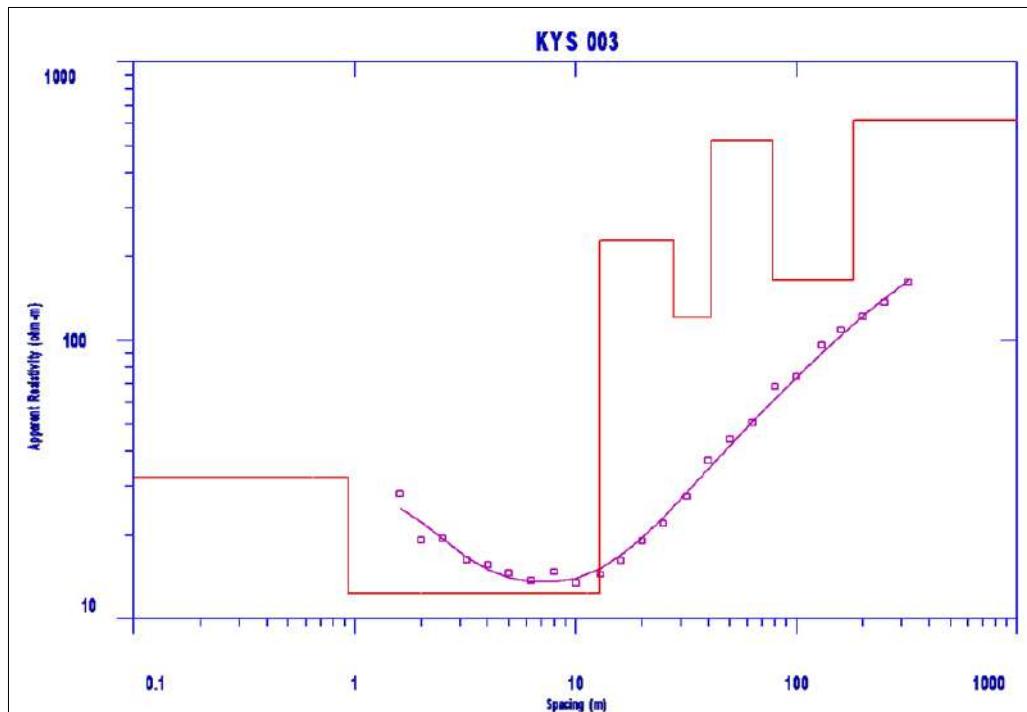
Resistivity	Depth
1.6	150.03
2	119.45
2.5	66.89
3.2	39.85
4	24.85
5	16.25
6.3	13.76
8	15
10	13.57
13	14.91
16	16.25
20	19.11
25	23.89
32	28
40	34
50	40
63	52
80	61
100	72
130	90
160	103
200	125
250	153

Resistivity	Depth
270.97	0.90831
12.41	13.518
289.25	32.637
47.317	45.734
926.4	



Resistivity	Depth
1.6	83.85
2	68.25
2.5	54.6
3.2	40.37
4	37.44
5	33.05
6.3	25.35
8	23.4
10	16.87
13	17.35
16	19.4
20	21.65
25	25.06
32	31.2
40	40.3
50	48.6
63	60.7
80	70.7
100	85
130	94
160	121
200	134
250	158
320	198

Resistivity	Depth
178.36	0.62203
39.976	3.6192
7.9728	8.554
34.805	16.037
328.61	66.631
172.14	97.921
327.51	127.45
211.8	177.38
924.09	



Resistivity	Depth
1.6	28.21
2	19.17
2.5	19.48
3.2	16.3
4	15.69
5	14.59
6.3	13.74
8	14.78
10	13.51
13	14.47
16	16.18
20	19.05
25	22.04
32	27.6
40	37
50	44.2
63	50.5
80	68.3
100	74
130	96
160	109
200	122
250	137
320	162

Resistivity	Depth
32.183	0.93505
12.332	12.863
227.61	27.819
120.56	40.935
520.84	78.42
164.57	181.69
616.62	

**APPENDIX II: BOREHOLE DRILLING AND CONSTRUCTION**

## Drilling Technique

Drilling should be carried out at a diameter of not less than 8.5", preferably using DTH machine. The drilling rig should be able to drill to a depth of at least **200m**, at the specified diameter. The rig and the drilling method adopted must be suitable for drilling through the Basement formations.

Drilling additives to be used (e.g. foam or polymer) must be non-toxic and bio-degradable. In no circumstances will bentonic additives considered to be acceptable, as they may plug the aquifer zones and are extremely difficult to remove during development.

Percussion tools will considerably prolong the required time for drilling, which may be undesirable if water is required soon. The savings initially believed to be made by opting for percussion drilling are often offset against the continuing costs for labour, fuel, etc., and the time input of the Client and his representatives. In addition, it should be noted that access to the site may be difficult during the rainy season. As a result, the drilling activities could come to a stand-still.

Geological rock samples should be collected at 2 metre intervals. Struck and rest water levels should be carefully recorded, as well as water quality and estimates of the yield of individual aquifers encountered.

Great care should be taken that the water quality of the different aquifers is accurately determined. Upon the first strike, drilling fluids should be effectively flushed, and after sufficient time, a water sample should be taken of the air-blown yield. On site analysis using an EC meter, and preferably a portable laboratory, is recommended.

## Well Design

The design of the well should ensure that screens are placed against the optimum aquifer zones. The final design should be made by an experienced hydrogeologist.

## Casing and Screens

The well should be cased and screened with good quality screens. Considering the limited depth of the boreholes and the prevailing alkaline to brackish water quality, it is recommended to use mild steel casings and screens of 6" diameter or mild steel casings.

## Gravel Pack

The use of a gravel pack is recommended within the aquifer zone, because the aquifer could contain sands or silts, which are finer than the screen slot size. A 10" diameter borehole screened at 6" will leave an annular space of approximately 4", which is sufficient to allow the insertion of fine, quartzitic gravel. The grain size of the gravel pack should be within the range of 2 to 4 mm, and granules should be rounded to well-rounded. Over 95% should be siliceous.

Gravel pack should be washed down with copious volumes of water to avoid bridging. The best method, which is unfortunately rarely used, is insertion with a tremie pipe.

## Well Construction

Once the design has been agreed, construction can proceed. In installing screen and casing, centralizers at 6 metre intervals should be used to ensure centrality within the borehole. This is particularly important

to insert the artificial gravel pack all around the screen. If installed, gravel packed sections should be sealed off at the top and bottom with clay or bentonite seals (2 m). In this case it is also recommended to install a 3 m long, cement grout surface plug, to prevent contamination (bacteriological as well as industrial) from entering the borehole.

The remaining annular space should be backfilled with inert material (drill cuttings may be used), and the top five metres grouted with cement to ensure that no surface water at the well head can enter the well bore and thus prevent contamination.

### Well Development

Once screen, pack, seals and backfill have been installed, the well should be developed. Development aims at repairing the damage done to the aquifer during the course of drilling by removing clays and other additives from the borehole walls. Secondly, it alters the physical characteristics of the aquifer around the screen and removes fine particles.

The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable. Instead, it is recommended that the Contractor employs air or water jetting, air-lifting or mechanical plunging. These proposed methods physically agitate the gravel pack and adjacent aquifer material, and are extremely efficient methods of developing and cleaning wells.

Well development is an expensive element in the completion of a well, but is usually justified in longer well-life, greater efficiencies, lower operational and maintenance costs and a more constant yield. To avoid sediment ingress, and ensure a long lifespan of both the borehole and the pumping unit, the permanent pump should be installed at least 2 m above, and certainly not within, the screen section.

### Well Testing

After development and preliminary tests, a step-drawdown test and a 24-hour long-duration well test at constant discharge rate should be carried out. Well tests have to be performed on all newly-completed wells: apart from providing information on the quality of drilling, design and development, it also enables the hydrogeologist to compute sustainable abstraction rates, design drawdown, and other important well and aquifer parameters.

During the test, the well is pumped from a measured static water level (SWL) at a known yield. Simultaneously, the discharge rate and the pumped water level (PWL) as a function of time are recorded. After stopping the pump, recovery is measured until the water level has returned within 5% of the original level, in comparison with the total pumped drawdown.

The specific capacity and the efficiency of a borehole are determined during a step-drawdown test. Simultaneously, target yields for the constant discharge test can be set. The step-drawdown test usually comprises 4 to 6 steps of 60 to 90 minutes each. The pumping rates are increased step-by-step, e.g. by gradually opening a gate valve. Recovery may be measured after the last step, but this is not really necessary if a constant discharge test is conducted as well. However, before starting the constant discharge test, 95% of the pumped drawdown must be recovered, or, alternatively, no increase in level must be observed for a period of more than 4 hours.

The constant discharge test allows calculation of specific aquifer parameters, such as transmissivity, hydraulic conductivity and storage coefficient. In addition, the sustainable volume of abstraction, the design drawdown and the final pump specification and setting can be determined. The minimum duration of the test should be 24 hours, followed by 12 hours of recovery observations, or alternatively until 95% of the total drawdown has been regained.

### Legal Requirements

It is a legislated condition imposed by the Water Appointment Board (through the Water Amendment Bill 1992), that all boreholes in Kenya be equipped with a flow meter and a means by which water levels can be measured. These measures have been designed to allow the collection of data, which will enable both the authorities and the borehole operators to learn more about the reliability and limitations of their groundwater resources.

Flow meters are readily available in Kenya, e.g. of the helical-flow type such as manufactured by Kent (UK) or Arad (Israel). The easiest method of water level monitoring is through a narrow (1.25" to 2") dipper line which is installed along the rising main. An electric dipper should be used to measure water levels directly, with an accuracy of approximately 1 cm. An electrical dipper with a length of 100 metres would cost about US \$ 550 in Europe, but more than double this amount in Kenya.

### Pumping Plant

Several options are open to the Client:

a) Windpumps: High quality windpumps are made in Kenya, but obviously the site needs to experience sufficient wind, while substantial storage capacity should be ensured. The advantage of windpumps is that they are environmentally friendly and cheap in maintenance. The Kijito range manufactured in Thika, require a minimum of maintenance and have proved themselves under hostile conditions, e.g. in North-eastern Province.

A Kijito windpump can produce 5 to 90 m<sup>3</sup>/day, depending on the pump chamber and rotor size, and the average windspeed. The price, including installation, ranges from KShs 600,000 for the small, 12 ft rotor blade to 900,000 for the largest, 24ft rotor diameter (subject to changes by manufacturer).

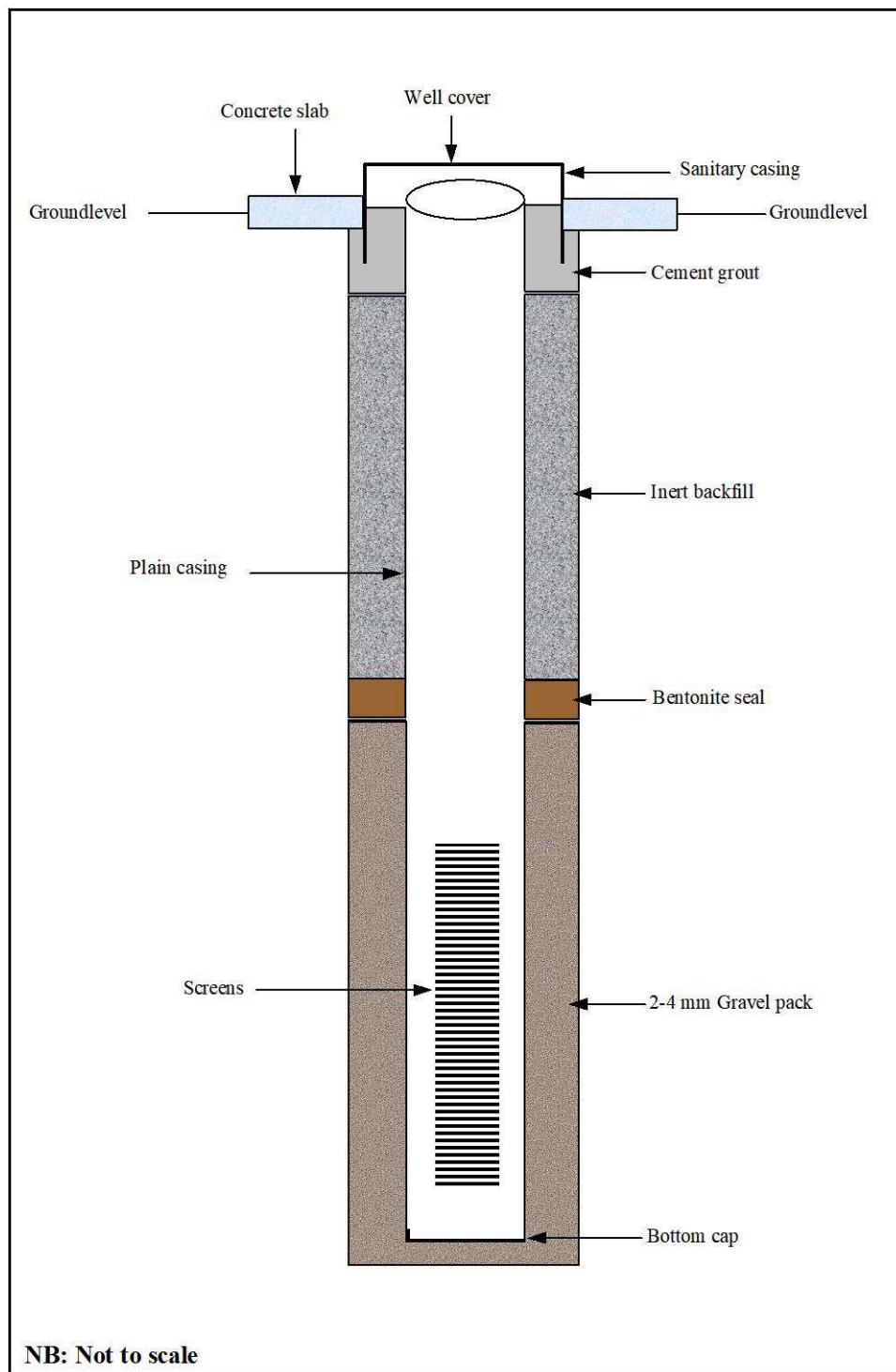
b) Submersible pumps: Currently, these are arguably the most popular borehole pumps in Kenya. Electrical submersibles are efficient and require little maintenance, though of course they do require electrical power on site, e.g. from a generator set.

c) Electrical solar submersible pumps: These are as yet relatively little used in Kenya, mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers.

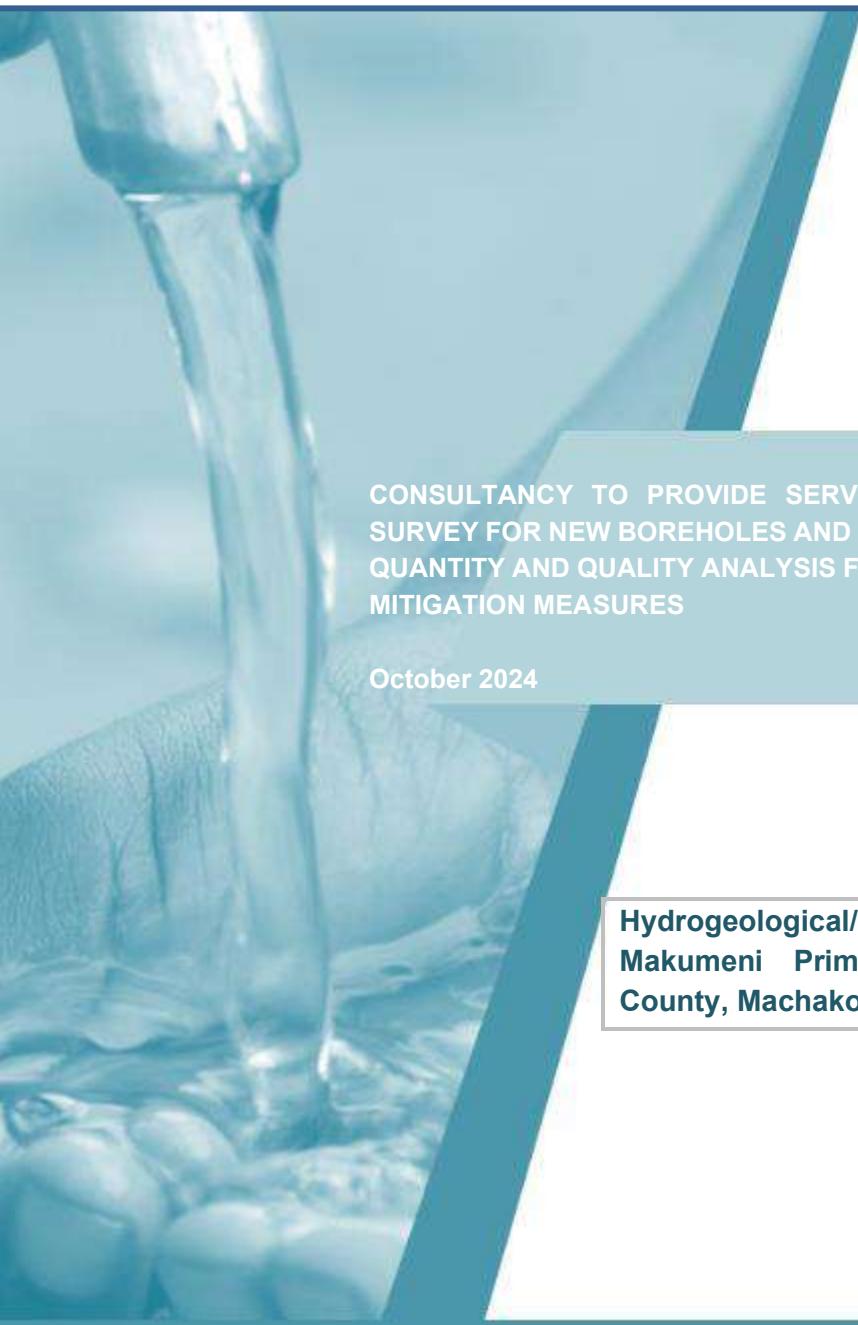
d) Turbine or Mono pumps: Given the yield requirements of the Client, both turbine and Mono-type pumps would be needlessly expensive.

d) Reciprocating pumps: Formerly the most popular type of pump used in Kenya. With the introduction of electrical submersibles and modern windpumps, reciprocating pumps (e.g.

manufactured by Deming, Southern Cross, etc.) have gradually fallen out of favour. However, when it comes to simplicity and robustness, coupled with a wide range of power plant (almost any suitable diesel driving belt), there is little to beat a reciprocating pump.



*Schematic Design for Borehole completion*



**CONSULTANCY TO PROVIDE SERVICES ON HYDROGEOLOGICAL SURVEY FOR NEW BOREHOLES AND BOREHOLE WATER RESOURCE QUANTITY AND QUALITY ANALYSIS FOR EXISTING BOREHOLES AND MITIGATION MEASURES**

October 2024

**Hydrogeological/Geophysical Survey at Makumeni Primary School, Masinga Sub County, Machakos County**

CONSULTANT	CLIENT
 <p><b>AFRIQUE WATER</b> &amp; GEOTECHNICAL SERVICES LTD</p> <p>P.O BOX 52240-00200 NAIROBI. Tel No: +254720547608 Email: <a href="mailto:v.okello@afriquewater.com">v.okello@afriquewater.com</a></p>	 <p>Habitat for Humanity Kenya, CVS Plaza, Kasuku Lane, Off Lenana Road P.O Box 36948-00623, Nairobi Kenya. <b>Beneficiary</b> <b>MUKAMENI WATER COMMUNITY PROJECT</b></p>

## EXECUTIVE SUMMARY

This present report describes the results of borehole site investigations at Mukameni Primary School, GPS **-01.001722°S and 37.58447°E**. The study was commissioned by **Habitat for Humanity Kenya**. The Client intends to drill a borehole within the Primary School to be used as a source of water for domestic purposes and for the institution. Water Demand of 50 m<sup>3</sup>/day is projected to be sufficient.

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites (± garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr. Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 02.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKM 002 VES 2 GPS -01.001722°S and 37.58447°E**). The hole should be drilled to an approximate depth of **250 metres**. The selected site is known to Mukameni Primary School Management.

An alternative site is recommended for drilling at **MKM 001 VES 1-GPS --01.00198356°S and 37.58378101°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens.

The hole should be installed with good-quality, locally available mild steel casings and screens. To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized. The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

*The Client should note that before drilling commences, a groundwater abstraction permit must be obtained from the Regional Manager, Water Resources Authority, in Mombasa.*

*To be attached to the report and Application form (WRMA 001A dully signed & fully completed) should include client's documents:*

*Copy of Title Deed of the Farm,*

*Copy of Site Plan,*

*Copy PIN Number/KRA Certificate,*

*Banking Slip and Copy of Official Receipt of Paid Fee.*

# Table of content

1. Introduction.....	1
1.1 Scope of Work .....	1
1.2 Project Location .....	1
1.3 Climate.....	1
1.4 Water Demand.....	2
1.5 Approach by the Consultant .....	2
2. Geology.....	5
2.1 Introduction.....	5
2.2 Masinga Geology .....	5
3. Hydrogeology .....	6
3.1    Introduction .....	6
3.2    Groundwater Occurrence in Basement Aquifers .....	7
3.2.1    Weathered Layers .....	7
3.2.2    Faults and Fissure Zones .....	8
3.3    Recharge .....	8
3.7    Existing Boreholes .....	8
4. GEOPHYSICAL INVESTIGATION METHODS .....	12
4.1    Introduction .....	12
4.2    Resistivity Method.....	12
4.2.1 Basic Principles of the Resistivity Method .....	12
4.2.2 Resistivity Sounding Technique.....	13
4.2.3 Resistivity Profiles.....	14
4.3    Geo-electrical Layer Response .....	15
5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION .....	17
5.1    Fieldwork.....	17
5.1.1 Vertical electrical method.....	17
5.2 Results and Discussion .....	17
5.3 Evaluation .....	19
6. CONCLUSIONS AND RECOMMENDATIONS .....	20

6.1 Geology and Hydrogeology of Investigated Area: .....	20
6.2 Proposed Borehole Drilling: .....	20
6.3 Additional Recommendations and Legal Requirements .....	21
<b>7. REFERENCES.....</b>	<b>22</b>
<b>REFERENCES.....</b>	<b>22</b>

## List of Figures

<i>Figure 1.1: Location Map of the Study Area .....</i>	<i>4</i>
<i>Figure 3.1: Groundwater Occurrence in Basement System Rocks .....</i>	<i>6</i>
<i>Figure 3.1: Existing Boreholes (Source, WRA Data Base).....</i>	<i>11</i>
<i>Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes .....</i>	<i>13</i>
<i>Figure 5.1: VES Location Map.....</i>	<i>18</i>

## List of Tables

<b>Table 3.1 - Boreholes within the Vicinity of the Investigated Area .....</b>	<b>9</b>
<b>Table 5a - Hydrogeological Interpretation of VES 4.....</b>	<b>18</b>
<b>Table 5b - Hydrogeological Interpretation of VES 5 .....</b>	<b>19</b>

## ABBREVIATIONS AND GLOSSARY OF TERMS

### ABBREVIATIONS (S.I. Units throughout, unless indicated otherwise)

agl	above ground level
amsl	above mean sea level
bgl	below ground level
d	day
E	East
EC	electrical conductivity ( $\mu\text{S}/\text{cm}$ )
h	head
hr	hour
K	hydraulic conductivity (m/day)
l	litre
m	metre
MWI	Ministry of Water and Irrigation
N	North
PWL	pumped water level
Q	discharge ( $\text{m}^3/\text{hr}$ )
Q/s	specific capacity (discharge - drawdown ratio; in $\text{m}^3/\text{hr}/\text{m}$ )
s	drawdown (m)
S	South
sec	second
SWL	static water level
T	transmissivity ( $\text{m}^2/\text{day}$ )
VES	Vertical Electrical Sounding
W	West
WAB	Water Appointment Board
WSL	water struck level
$\mu\text{S}/\text{cm}$	micro-Siemens per centimetre: Unit for electrical conductivity
$^{\circ}\text{C}$	degrees Celsius: Unit for temperature
$\Omega\text{m}$	Ohmm: Unit for apparent resistivity
$\text{pa}$	Apparent resistivity
"	Inch

### GLOSSARY OF TERMS

<b>Alluvium</b>	General term for detrital material deposited by flowing water.
<b>Aquifer</b>	A geological formation or structure, which stores and transmits water and which is able to supply water to wells, boreholes or springs.
<b>Colluvium</b>	General term for detrital material deposited by hillslope gravitational processes, with or without water as an agent. Usually of mixed texture.
<b>Conductivity</b>	Transmissivity per unit length (m/day).
<b>Confined aquifer</b>	A formation in which the groundwater is isolated from the atmosphere by impermeable geologic formations. Confined water is generally at greater pressure than atmospheric, and will therefore rise above the struck level in a borehole.

<b>Denudation</b>	Surface erosion.
<b>Evapotranspiration</b>	Loss of water from a land area through transpiration from plants and evaporation from the surface.
<b>Fault</b>	A larger fracture surface along which appreciable displacement has taken place.
<b>Granitization</b>	The process by which solid rocks are converted into rocks of granitic character without melting into a magmatic stage.
<b>Gneiss</b>	Irregularly banded rock, with predominant quartz and feldspar over micaceous minerals. A product of regional metamorphism, especially of the higher grade.
<b>Gradient</b>	The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head.
<b>Heterogeneous</b>	Not uniform in structure or composition throughout.
<b>Hydraulic head</b>	Energy contained in a water mass, produced by elevation, pressure or velocity.
<b>Hydrogeological</b>	Those factors that deal with subsurface waters and related geological aspects of surface waters.
<b>Infiltration</b>	Process of water entering the soil through the ground surface.
<b>Joint</b>	Fractures along which no significant displacement has taken place.
<b>Migmatite</b>	Rocks in which a granitic component (granite, aplite, pegmatite, etc.) is intimately mixed with a metamorphic component (schist or gneiss).
<b>Percolation</b>	Process of water seeping through the unsaturated zone, generally from a surface source to the saturated zone.
<b>Perched aquifer</b>	Unconfined groundwater separated from an underlying main aquifer by an unsaturated zone. Downward percolation hindered by an impermeable layer.
<b>Permeability</b>	The capacity of a porous medium for transmitting fluid.
<b>Permeation</b>	Passage of geochemically mobile components through a rock. >Permeation gneiss: Gneiss formed or modified by permeation.
<b>Phenocrysts</b>	The larger crystals in a porphyritic rock.
<b>Piezometric level</b>	An imaginary water table, representing the total head in a confined aquifer, and is defined by the level to which water would rise in a well.
<b>Porosity</b>	The portion of bulk volume in a rock or sediment that is occupied by openings, whether isolated or connected.
<b>Porphyritic</b>	Containing large, visible crystals or phenocrysts in a finer groundmass.

<b>Pumping test</b>	A test that is conducted to determine aquifer and/or well characteristics.
<b>Recharge</b>	General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, lateral groundwater flow) to the aquifer zones.
<b>Regolith</b>	General term for the layer of weathered, fragmented and unconsolidated rock material that overlies the fresh bedrock.
<b>Specific capacity</b>	The rate of discharge from a well per unit drawdown.
<b>Static water level</b>	The level of water in a well that is not being affected by pumping. (Also known as "rest water level")
<b>Transmissivity</b>	A measure for the capacity of an aquifer to conduct water through its saturated thickness (m <sup>2</sup> /day).
<b>Unconfined</b>	Referring to an aquifer situation whereby the water table is exposed to the atmosphere through openings in the overlying materials (as opposed to >confined conditions).
<b>Yield</b>	Volume of water discharged from a well.

# 1. Introduction

## 1.1 Scope of Work

In October 2024, Afrique Water & Geotechnical Services Ltd was commissioned by **Habitat for Humanity Kenya**, to carry out borehole site investigations at Mukameni Primary School (Fig. 1.1). This report aims at fulfilling the activities under phase 1 of the assignment which can be summarised as follows:

- Carry out the geophysical investigation according to the investigation strategy and interpret results: select the most suitable borehole drilling sites in the project area, also considering the legal framework and the requirements of the Water Act 2016.
- Present a Geophysical Report showing the results of the geophysical investigation, including the raw data sets, the qualitative interpretation of the type curves in terms of layer sequence (for VES investigations) and inversions results, and the identification of the drilling locations and precise description of drilling strategy.
- Compile a hydrogeological/geophysical report.

The main objective of this assignment is to identify a suitable site for drilling a production borehole with sufficient quantity and portable quality that can supply water within Mukameni Primary School and the surrounding community and institutions.

The address of the Client's is:

Habitat for Humanity Kenya,  
CVS Plaza, Kasuku Lane, Off Lenana Road  
P.O Box 36948-00623,  
Nairobi Kenya..

## 1.2 Project Location

The project area is located at Musigini Sub Location approximately. (-01.00198356°S and 037.5837811°E) 3.8km south west of Masinga Town. The exact location is indicated in figure 1.1 below.

## 1.3 Climate

Climate in Machakos County is mild, and generally warm and temperate. During the winter season, there is a significant decrease in precipitation levels within Machakos as compared to the summer months. This location is classified as Cwb by Köppen and Geiger. The mean yearly temperature observed in Machakos is recorded to be 18.9 °C. The annual rainfall is 829 mm.

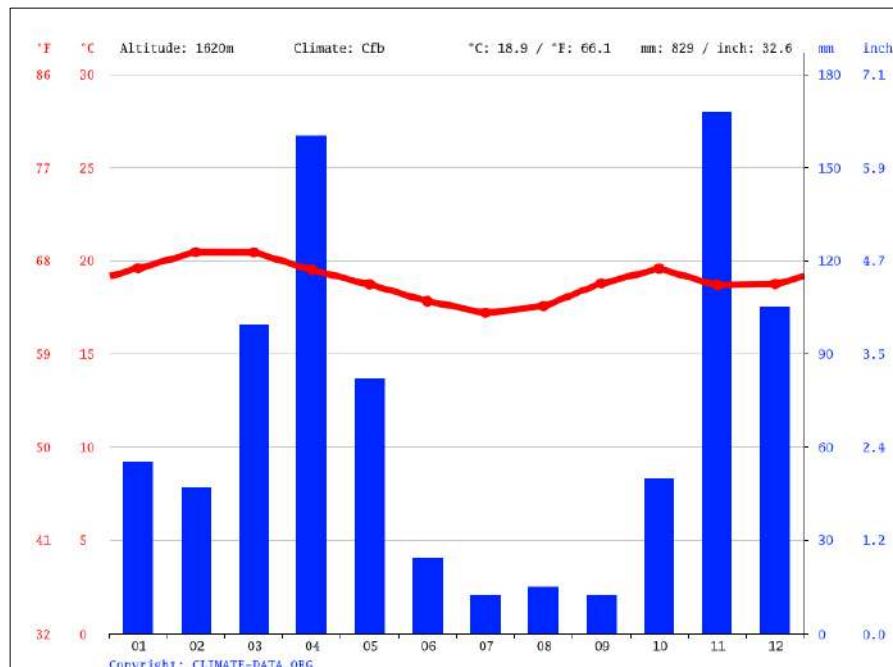
The region of Machakos is characterized by a temperate climate, and the summer season presents some challenges in terms of precise categorization.

Precipitation is the lowest in July, with an average of 12 mm | 0.5 inch. The month of November experiences the highest amount of precipitation, with an average value of 168 mm | 6.6 inch.

At an average temperature of 20.5 °C, February is the hottest month of the year. The month of July is characterized by the lowest temperatures, which have an average reading of 17.2 °C.

Between the driest and wettest months, the difference in precipitation is 156 mm. The fluctuation of temperatures over the course of a year is referred to as temperature variation.

It has been observed that November exhibits the highest relative humidity, with a percentage of 77.85. On the other hand, September experiences the lowest relative humidity at an approximate rate of 58.90. According to the data, April is observed as the month with maximum rainy days (23.13) while September has recorded minimum rainfall during its tenure (2.30).



Source: Climate-Data.org.

Figure 1.1: Climate data for Machakos County

## 1.4 Water Demand

In the absence of a reliable piped water supply, the client has selected drilling 1No. borehole as the best available option. The proposed water source is for domestic use only at the institution. The estimated water demand within university is 50m<sup>3</sup>/day.

## 1.5 Approach by the Consultant

The borehole site investigations were carried out according to a multi-step approach:

- A desk study and data-acquisition phase: topographic maps, existing studies and borehole site investigations, geological reports and maps, borehole records, etc.
- Geological and geomorphological field reconnaissance, including preliminary identification of potential drilling sites, structural features.

- c) Geophysical measurements in the most prospective areas.
- d) Analysis of geophysical data.
- e) Compilation, analysis, and evaluation of the gathered data and information.
- f) Site selection and reporting.

The Consultant's hydrogeologist mobilized to the Project Area on 02.10.24, and completed the fieldwork on the same date.

The hydrogeological and geophysical field investigations were combined with a broad desk study, during which the available relevant geological and hydrogeological data was collected, analysed, collated and evaluated. Methods and measurements used in the field are introduced and described in Chapter 4.

The recommended (preliminary) sites were marked in the field.



**Figure 1.1: Location Map of the Study Area**

## 2. Geology

### 2.1 Introduction

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys.

### 2.2 Masinga Geology

The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi.

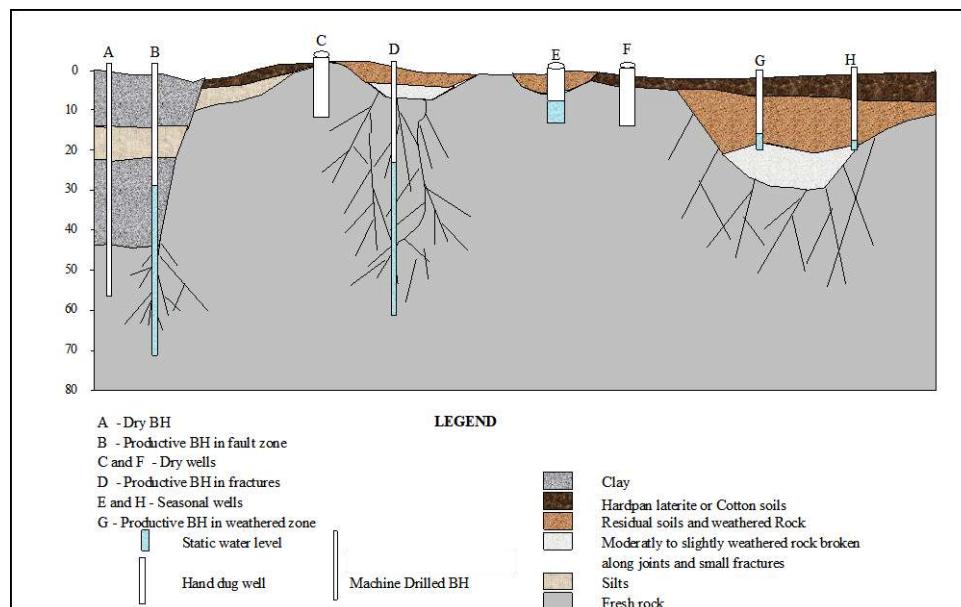
The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

## 3. Hydrogeology

### 3.1 Introduction

The study area is marked by generally unfavourable hydrogeological conditions, which are determined by a combination of largely impermeable bedrock, generally thin soils, and lack of recharge due to a structural rainfall deficit. However, the prospects for groundwater development are fair along the faults and general lines of weakness. Here, weathering has not only resulted in secondary porosity, but has also created a storage media in the regolith, saprolite and saprock. Along the streams recharge is provided by the infiltration of surface discharge, and underflow through the alluvium, faults and the weathered zones.

The area is underlain exclusively by Basement System formations, covered by a layer of weathered rocks, soils and local alluvial deposits. Unaltered metamorphic rocks, such as biotite and quartzo-felspathic gneisses and granulites, are generally hard and compact, and possess no primary porosity. However, depending on the parent material, water may be struck in the weathered zone (regolith, saprolite and saprock). The underlying fresh Basement is in most cases dry, and significant volumes of groundwater can only be expected in fracture zones (cracks, joints, fissures, and faults). An overview of groundwater occurrence in Basement rocks is given in Figure 3.1.



**Figure 3.1: Groundwater Occurrence in Basement System Rocks**

Groundwater may further be found in areas covered by recent sedimentary deposits, specifically within the alluvial plains of the larger seasonal or perennial rivers.

The best chances of striking significant amounts of water occur in fracture zones with a sufficiently large catchment area to provide the necessary recharge. The survey was aimed at identifying such zones in the vicinity of the study area.

Other semi-permanent aquifers may be found in form of connate water (i.e. water trapped during the formation of a sedimentary deposit), or fossil water (water stored during past, more humid conditions). It should be noted that the latter are likely to produce a brackish quality.

## 3.2 Groundwater Occurrence in Basement Aquifers

### 3.2.1 Weathered Layers

Over the years, chemical and mechanical disintegration processes have formed a cover of weathered material over the unaltered bedrock. This weathering is enhanced -and often triggered- by the presence of water. As a result, the thickness of the *regolith* is usually greatest in the topographically low areas. Upon maturation of the profile, the occurrence of water will locally create deep zones of alteration. These will in turn be able to divert more and more water from the surrounding catchment. It is thus evident that deep weathering is linked to the occurrence of groundwater and vice versa.

The upper horizons of the weathered layer are usually clayey, consisting of completely decomposed rock, in which original structures can no longer be found. Feldspar and mica minerals are disintegrated into clay minerals, resulting in high porosities, but extremely low permeabilities. The thickness of this layer is extremely variable, with a common range between 0 and 25 m.

Between the decomposed top soil and the fresh bedrock the weathered zone consists of more coarsely disintegrated and less altered rock material, which is known as the saprolite. This layer comprises *in situ* weathered material, which still resembles the parent rock in structure and appearance. It is however much softer, and often brittle. In drilling logs it is often referred to as "rotten rock", as it is easily penetrated.

Below the saprolite a layer of partly weathered material occurs, which more closely resembles the bedrock. This is the saprock zone, which has hydraulical properties similar to the saprolite. The thickness of this zone may locally exceed 10 metres.

Although the saprolite and saprock usually have higher permeabilities than the fresh rock and the clayey top soil, its properties largely depend on the nature of the parent material. If the latter contains large portions of clay-producing minerals, the resulting aquifers will be low yielding. On the other hand, coarse-grained and quartz-rich rocks will produce a sandy saprolite with relatively good groundwater potential.

The quartz-feldspathic and quartz-biotite gneisses observed within the investigated area are marked by relatively fair properties in this respect. The calcite in the rocks is likely to be entirely removed, thus increasing the secondary porespace. In addition, the rocks were observed to be relatively coarse and very rich in quartz, thus giving rise to shallow but predominantly sandy weathering.

The combined saprolite/saprock layer covering the fresh Basement rocks is relatively thick in the valleys and depressions. A typical depth of 60 m should be expected. On steep slopes and hill tops, however, the weathering is likely to be thin, i.e. about 20 to 30 m.

In the floodplains, groundwater may be found within the saprolite and saprock layers, at various depths ranging from 5 to 60 m bgl. The best prospects occur where local recharge is supplemented with water from an alluvial drainage system, as could be the case along the floodplains.

### 3.2.2 Faults and Fissure Zones

Individual aquifers formed exclusively within the weathered layer rarely produce yields in excess of 2-3 m<sup>3</sup>/hr. Higher yields (say >5 m<sup>3</sup>/hr) can be achieved from boreholes located in "open" faults and fissure zones. The potential of structurally altered rocks is twofold:

- ◆ Along faulted or fissured rocks weathering can penetrate much deeper, thus creating sub-vertical zones filled with relatively coarse, weathered material. These zones generally have a much higher transmissivity than their surroundings.
- ◆ Recharge occurs over large areas: major faults may extend well beyond the surface catchment, thus intercepting adjacent aquifers or surface sources.

Although faults are often associated with water bearing zones, it should be noted that they may also act as impermeable barrier zones ("closed faults"). In this case the structure acts as a "groundwater dam" and significant storage may build up on its upstream side. Drilling inside such a closed fault system, however, would in most cases be futile.

Thirdly, there are faults or fissure zones that, despite having all the properties of a water bearing zone, are not productive due to a lack of recharge (dry, open fractures).

## 3.3 Recharge

Recharge is the process through which water is added to the groundwater reservoir. Some aquifers do not receive any recharge at all; in this case, the water is connate or fossil, and pumping results in irreversible depletion. Usually, aquifers with little recharge and consequently long residence times are marked by high levels of mineralisation and salinity. Unless the underground water body is of vast extent, it is essential that not more water is abstracted than the annual amount of replenishment.

## 3.7 Existing Boreholes

The locations of the existing boreholes are illustrated in Figure 3.1 and the technical details tabulated in Table 3.1 below.

**Table 3.1 - Boreholes within the Vicinity of the Investigated Area**

ID	DLONG	DLAT	OWNER	LOCALITY	COMPDATE	TDEPTH	M_WSL	WRL	YIELD	DRAWDOWN
1	2	3	4	5	6	7	8	9	10	11
C1375	37.350	-0.900	T.BURSELL	TANA RANCH	1951.03.01	46.0	27.0	23.0	2.70	
C1479	37.333	-0.900	T.BURSELL	TANA RANCH	1951.05.01	73.0	24.0	20.0	0.30	
C4710	37.400	-1.016			1980.01.01	186.0	180.0	58.0	16.30	
C128	37.850	-1.050			1941.03.01	22.0	18.0	13.0	0.90	
C2196	37.883	-1.016			1954.05.01	67.0	61.0	24.0	0.78	2.0
C3760	37.600	-1.083			1971.07.01	198.0	61.0	28.0	0.30	77.4
C3766	37.633	-1.083			1971.08.01	152.0	91.0	23.0	1.50	119.0
C1507	37.783	-1.033	AFR.SET.BOARD	YATTA	1951.08.14	111.0	44.0	38.0	0.72	
C1571	37.633	-0.966	AFR.SET.BOARD	YATTA	1951.10.16	34.0	29.0	23.0	4.56	
C1595	37.666	-1.100	A.S&L.U.B	YATTA	1951.09.29	82.0	64.0	30.0	10.90	
C2041	37.716	-0.933	A.L.U&SB	KATHINGIRI	1953.10.15	122.0	117.0	76.0	0.18	41.0
C1973	37.600	-1.066	A.L.U&SB	YATTA	1953.05.27	121.0	111.0	16.0	2.82	92.0
C4162	37.483	-0.916	CATHOLC MISSION	DITHINI	1975.10.23	200.0	111.0	40.0	0.30	139.0
C13258	37.664	-0.965	DWD (KAIRUNGU W P)	KIOMO KAIRUNGU	2001.06.02	90.0	74.0	11.2	14.60	39.4
C6793	37.550	-0.883	FOSTER PARENTS INT.	MBONDENI H/C	1986.02.07	70.0	56, 61	43.0	0.00	23.0

**NOTES:**

1. Ministry of Water and Irrigation Borehole Identification Number.
2. Longitude (Decimal Degrees)
3. Latitude ((Decimal Degrees)
4. Borehole Owner
5. Locality
6. Borehole Completion Date
7. Total Depth (m)
8. Main Water Struck Level (m)
9. Water Rest Level (m)
10. Yield (m<sup>3</sup>/hr)
11. Drawdown (m)

Records of some of the boreholes and their geologic log were analysed and evaluated. Results of the data inventory are presented in Table 3.1 above, while the location of the boreholes is shown in Figure 3.2 below. In the present study the borehole data have been used to identify aquifer characteristics and their variations with depth.

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr.

Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

- **Specific Capacity**

The specific capacities of the 3 boreholes has been calculated using the formula  $Sc = Q/Sw$ , where  $Sc$  is specific Capacity,  $Q$  is the discharge and  $Sw$  is the drawdown. To obtain an insight to the general characteristics, the average specific capacity of the aquifer in general has been assumed as the average of the 3 sample boreholes with drawdown values, resulting in an average specific capacity of  $0.05235235^2 m^2/hr$ .

- **Transmissivity**

During pump test, the borehole is pumped at a constant rate and the amount of drawdown is noted. Specific capacity **Sc** is then defined as the pumping rate **Q** divided by Drawdown **Sw**.

$$Sc = Q / Sw \text{ (Discharge per unit of Drawdown).}$$

The following equation, based on the Cooper-Jacob (1946) solution for flow to a borehole in a confined aquifer, computes the Specific Capacity, **Q / Sw** of a borehole:

$$Q / Sw = T / 0.183 \log \{2.25 T t / R w^2 S\}$$

Where **Rw** is radius of borehole [m], **S** is storativity [Dimensionless Coefficient], **T** is transmissivity [m/day] and **t** is time [day]. Using the equation, Driscoll (1986) developed approximate formulas for estimating transmissivity from specific capacity in Confined and Unconfined aquifers:

$$T = 1.385 [ Q / Sw ] \dots \text{Confined aquifer}$$

$$T = 1.042 [ Q / Sw ] \dots \text{Unconfined aquifer.}$$

Taking the average discharge and pumping drawdown of the 5 sampled boreholes:

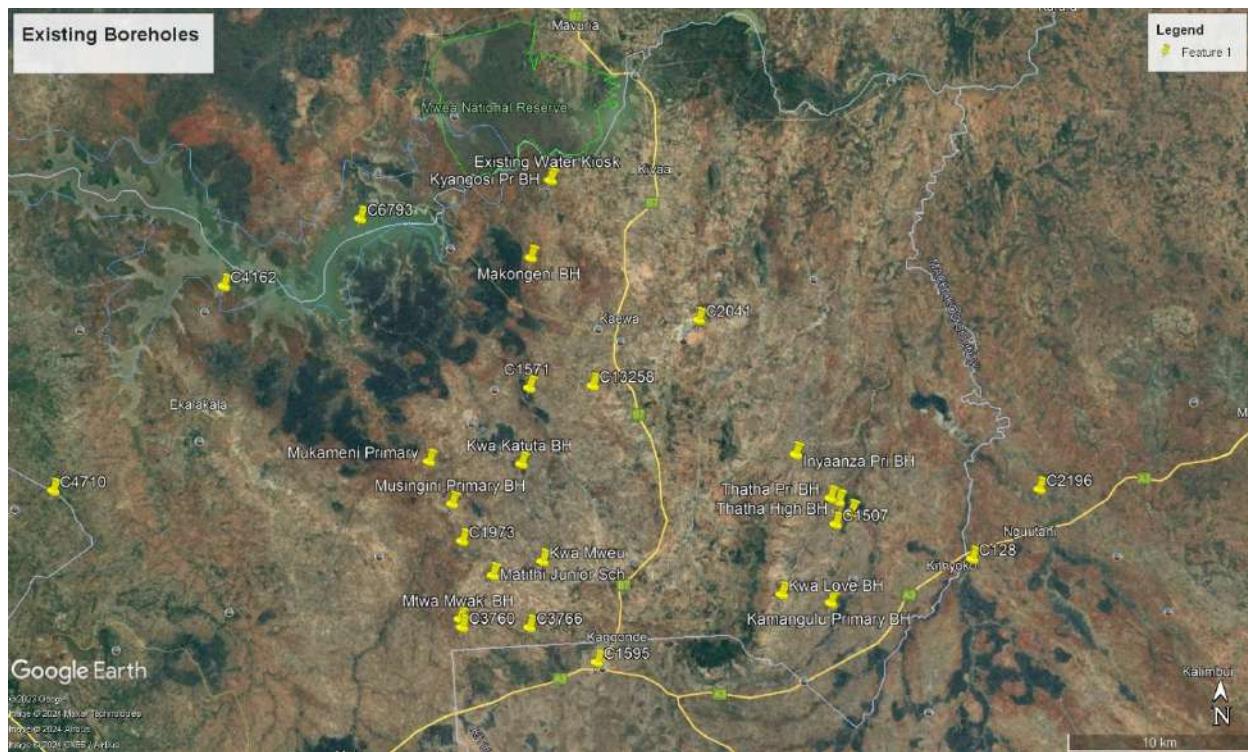
$$\text{Specific Capacity } Sc = 0.052352352 m^2/hr$$

$$\frac{\text{Transmissivity}}{T} = 1.385 [0.052352352 m^2/hr] = 1.740192114 m/day$$

- **Hydraulic Conductivity**

The hydraulic conductivity **K** is computed from transmissivity **T** using  $K = T / b$ .

Where **b** is the saturated thickness of the aquifer. Boreholes should be screened only in the most productive parts of the aquifer if total screen length is to correspond to **b**. For the current sample boreholes in the study area, the total thickness of the main aquifers could not be determined.



**Figure 3.1: Existing Boreholes (Source, WRA Data Base)**

# 4. GEOPHYSICAL INVESTIGATION METHODS

## 4.1 Introduction

Great varieties of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity sounding technique was applied, using an ABEM DC resistivity set comprising a Terrameter/Resistivity Meter, connecting cables and crocodile clips, stainless steel non-polarising current electrodes and copper potential electrodes.

This dedicated equipment measures both  $V$  and  $I$  and presents a calculated resistance (see Section 4.2). In order to improve the validity of the data the equipment takes an average of 4, 16 or exceptionally, 64 readings (determined by the operator). This allows the effects of noise to be minimised.

In Appendix I, graphical plots of the apparent resistivity versus electrode spacing  $AB/2$  are presented, together with raw field data and the resulting geophysical interpretation model.

## 4.2 Resistivity Method

### 4.2.1 Basic Principles of the Resistivity Method

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. The resistance  $R$  of a certain material is directly proportional to its length  $L$  and cross sectional area  $A$ , expressed as:

$$R = \rho_a * L/A \quad (\Omega) \quad (1),$$

where  $\rho_a$  is known as the specific resistivity, characteristic of the material and independent of its shape or size. With Ohm's Law:

$$R = \delta V/I \quad (\Omega) \quad (2),$$

where  $\delta V$  is the potential difference across the resistor and  $I$  is the electric current through the resistor, the specific resistivity may be determined by:

$$\rho_a = (A/L) * (\delta V/I) \quad (\Omega m) \quad (3)$$

The electrical properties of rocks in the upper part of the earth's crust are determined by the lithology, porosity, the degree of pore space saturation and the salinity of the pore water. These factors all contribute to the resistivity of a material (the reciprocal of the electrical conductivity).

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. Vertical electrical soundings are point measurements that provide information on the vertical resistivity layering at a certain location. Resistivity profiles, on the other hand, are carried out to obtain information on lateral changes in apparent resistivity along a cross section.

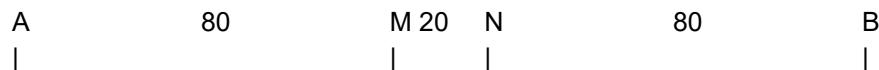
#### 4.2.2 Resistivity Sounding Technique

When carrying out a resistivity sounding, also called vertical electrical sounding (VES), an electrical current ( $I$ ) is passed into the ground through two metal pins, the current electrodes. Subsurface variations in electrical conductivity determine the pattern of current flow in the ground and thus the distribution of electrical potential. A measure of this is obtained in terms of the voltage drop ( $\delta V$ ) between a second pair of metal stakes, the potential electrodes placed near the centre of the array. The ratio ( $\delta V/I$ ) provides a direct measurement of the ground resistance and from this, and the electrode spacing, the apparent resistivity ( $\rho_a$ ) of the ground is calculated.

The measuring setup consists of a resistivity instrument (usually placed in the middle of the array), connected to two current electrodes (AB), and two potential electrodes (MN) towards the centre. Usually a so-called "Schlumberger" array is used for vertical electrical soundings, while profiles are generally carried out in "Wenner" configuration (Figure 4.1).

**Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes**

a) Schlumberger Array:  $AM = NB > MN$



b) Wenner Array:  $AM = MN = NB$



A series of measurements made with an expanding array of current electrodes (Schlumberger Array) allows the flow of current to penetrate progressively greater depths. The *apparent resistivity* as a function of the electrode separation AB provides information on the vertical variation in resistivity. The depth of penetration varies according to the electrode array, but is also affected by the nature of the material beneath the array.

The point at which a change in earth layering is observed depends on the resistivity contrast, but is generally of the order of a quarter of the current electrode spacing AB (Milsom 1989). By contrast, in an homogeneous medium the depth penetration is of the order 0.12 AB (Roy & Apparao 1971).

The calculated apparent resistivity is plotted against current electrode half separation on a bi-logarithmic graph paper to constitute the so-called sounding curve. The curve depicts a layered earth model composed of individual layers of specific thickness and resistivity.

Interpretation of field data can be done with hand-fitted curves, but this method is time consuming, and practically limited to 3-layer solutions. Modern interpretation is computer-aided, using a curve fitting procedure based on a mathematical convolution method developed by Ghosh (1971).

While the resistivity method is a useful tool in groundwater investigations and borehole site surveys, its applicability and reliability should not be overestimated. The modelling of field data is often attended by problems of equivalence and suppression. Each curve has an infinite number of possible solutions with different layer resistivities and depths (this is known as equivalence). Mathematical convolution can easily lead to a well-fitting solution, which nonetheless does not correspond to reality. In general, the number of possible solutions is reduced by mutual correlation of several sounding curves, knowledge of the local geology and drilling data.

When deposits with similar resistivities border each other, it is usually not possible to make a differentiation. Intermediate layers, occurring between deposits of contrasting conductivity, may go undetected, as they tend to be obscured within the rising or falling limb of the sounding graph (suppression). Additional data, in the form of borehole records, air photography and geological field observations, are required to produce a realistic interpretation.

It should be noted that the layered earth model is very much a simplification of the many different layers, which may be present. The various equivalent solutions, which can be generated by a computer programme, should therefore be carefully analysed. In general, resistivity soundings should never be interpreted in isolation as this may lead to erroneous results.

#### 4.2.3 Resistivity Profiles

Resistivity profiles are usually carried in Wenner configuration, i.e. an electrode set-up with a uniform distance between potential and current electrodes (see Fig. 5.1). The entire array is moved across the area of interest. By doing so, lateral changes in apparent resistivity are measured, which reflect variations in the lithology, the depth of weathering or the water content.

So-called "anomalies" may indicate the intersection of a fault (usually a negative anomaly), quartzite band (positive anomaly) or buried riverbed (anomaly depends on nature of surrounding deposits). Usually such lineaments, which may also be observed on aerial photographs, are linked to the occurrence of groundwater.

It must be noted that resistivity differences in a single profile array may largely reflect variations at the surface rather than underground. For this reason, it is usually not sufficient to carry out single-spaced profiles. The depth of penetration increases at greater electrode separations. A series of profiles at variable electrode separations will provide an indication of vertical resistivity trends. Moreover, by repeating the same profile at a different configuration, it will become clear if the observed resistivity patterns are caused by surface phenomena or underground features.

## 4.3 Geo-electrical Layer Response

Vertical electrical soundings (VES) provide quantitative information on electrical resistivity as a function of depth. The computer-interpretation of the sounding data produces a layered model of the underground. The derived resistivity layers are used to infer the presence of water-bearing strata, their texture and salinity.

Water-bearing and/or weathered rocks have lower resistivities than unsaturated (dry) and/or fresh rocks. The higher the porosity of the saturated rock, the lower its resistivity, and the higher the salinity (or electrical conductivity EC) of the saturating fluids, the lower the resistivity. In the presence of clays and conductive minerals the resistivity of the rock is also reduced. The relation between the formation resistivity ( $\rho$ ) and the salinity is given by the "Formation Factor" (F):

$$\rho = F \times \rho_w = F \times 10,000 / EC \text{ } (\mu\text{S/cm}), \quad \text{where: } \rho_w = \text{resistivity of water}$$

In sediments or unconsolidated layers produced by weathering, the formation factor varies between 1 (for sandy clays) and 7 (for coarse sands).

**Example:** If a certain aquifer is considered with an average formation factor of 3, then an EC of 300  $\mu\text{S/cm}$  will give a formation resistivity of 100  $\Omega\text{m}$ . The same material, when containing water with an EC of 1,500  $\mu\text{S/cm}$ , will have a resistivity of only 20  $\Omega\text{m}$ . Brackish water is marked by an EC of 2,000 to 10,000  $\mu\text{S/cm}$ , and a  $\rho_w$  of 5 to 1. Deposits containing brackish water will therefore in most cases adopt a low formation resistivity (usually less than 10  $\Omega\text{m}$ ). Saline water with an EC of about 30,000  $\mu\text{S/cm}$  will reduce the resistivity of a formation to about 2 Ohms.

Clayey formations with fresh water will respond similarly to deposits with brackish or saline water: the fact that the same resistivity can be obtained for completely different hydrogeological units is known as the "equivalence-problem".

Fresh and dry Basement rocks are marked by very high resistivities, with a common range from 1,000 to 10,000 Ohms. Moderately to slightly weathered but dry layers are less resistive, and usually show values between 100 and 500 Ohms, depending on the portion of clays, the degree of weathering and the water content. The resistivity further decreases if the deposits are water-bearing, to 20 to 200  $\Omega\text{m}$ . The resistivity of impermeable clay layers (alluvial or produced by intensive weathering of clay-forming minerals) usually varies between 2 and 10 Ohmm, while similar figures are recorded for aquifers with brackish to saline water.

The greatest difficulty in the interpretation of resistivity measurements in Basement rocks is formed by:

- a) *Equivalence*: the similar geophysical properties of layers with contrasting hydrogeological characteristics (e.g. clay layers and layers with brackish water),
- b) *Absence of distinct layer boundaries*: the decreasing degree of weathering with depth is usually not well-defined, but gradual. This will result in a gradual increase in resistivity, and not in a distinct set of geophysical layers.
- c) *Suppression #1*: Potential aquifer layers of moderate thickness may fail to show a significant response in the recorded resistivity data (especially where these are deep). Thin aquifers embedded within a very thick deposit can easily remain undetected by surface geophysics. They will however show up in down-hole geophysical logs.

d) *Suppression #2:* The resistivity contrast between the (clayey) weathered zone and the fresh bedrock may be so high, that an intermediate saprock aquifer cannot be distinguished in the graphic plot of the sounding.

Despite the problems of suppression attributed to the large resistivity contrast between fresh and weathered basement (point d), this is also a favourable attribute. Because of the large difference, the depth of weathering can be measured quite accurately. Considering that aquifers often occur towards the boundary of the weathered zone and the bedrock, the drilling depth can be determined, even if the actual aquifer does not show up as distinct geophysical layer.

# 5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION

## 5.1 Fieldwork

Combined geophysical and hydrogeological fieldwork was carried on 02.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

### 5.1.1 Vertical electrical method

A total of 4 electrical soundings (VES) were carried out at **Mukameni Primary School**. The geophysical investigations were mainly aimed at the determination of the following parameters:

- a) lateral and vertical extent of the water body,
- b) texture of the aquifer deposits (grain-size distribution),
- c) depth and nature of the layers underlying the groundwater store.

## 5.2 Results and Discussion

Vertical electrical soundings (VES) provide quantitative depth-resistivity information for a particular site. VES sites were selected at representative points in relation to geomorphological observations, and locations of particular interest for groundwater resources development.

The measurements were executed in an expanding Schlumberger array, with electrode spreads AB/2 between 250 and 320 m. This separation gives fairly reliable interpretations down to a depth of respectively 120 to 200m, but only approximate solutions for resistivity layering at deeper levels. Depths beyond this level are only indicative, and do not give the precise position of the interpreted layers. However, the selected configuration provided adequate information on the depth of weathering.

The locations of the geophysical soundings and topographical features are shown in figure 5.1. Apparent resistivity curves were interpreted using IXD program, combined with raw field data and interpreted geo-electrical models are included in Annex 1.

The main aim of the measurements was to determine the degree of fracturing at depth, which should be directly related to the layer transmissivity and thus the potential yield. As a general rule, it can be assumed that the soundings with the lowest basal resistivities in the expected water bearing range represent the most favourable drilling sites. However, this does not apply if the resistivity is excessively low (say < 20 Ohmm): figures close to 10 Ohmm are indicative of high clay contents and/or brackish water.

The sounding curves (in Annex 1), all display a similar stratigraphy of miscellaneous shallow deposits, underlain by sandy clay (potentially water-bearing) and heavy clays (dry).

The Consultant carried out geophysical investigations at four locations within the Primary School. Detailed analysis of the geophysical models for recommended sites are discussed below while all the raw data is attached to annex 1 of this report.

### Geophysical Interpretation of the VES Models

#### MKM 001 VES 1-GPS -01.00198356°S and 37.58378101°E, Near the Playground

The Geophysical model shows that the top layer is composed of dry top soil with a thickness 0.62m. This formation is underlain by Moist Sandy soil from 1mbgl to 5mbgl. A wet sandy clay formation occurs from 5.1mbgl to 12.45mbgl. This formation is further underlain by fresh Basement rock between 12.45 to 121mbgl. The main aquifer shall be struck within the highly fractured/weathered formation from 121.7 to 245mbgl. The aquiferous layer is underlain by a confining layer of fresh Basement rock below 254mbgl.

**Drilling of alternative site is recommended to maximum depth of 250mbgl at this location. The main aquifer is expected between 121.7mbgl and 245mbgl within the highly fractured/weathered Basement formation. The site is known to Mukameni School Management.**



Figure 5.1: VES Location Map

Table 5a - Hydrogeological Interpretation of VES 1

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-1	243	Dry Top Soil	No
1-5.1	118.6	Moist Sandy Soil	No
5.1-12.45	45.4	Wet Sandy Clay	No
12.45-121	3693	Fresh Basement	No
121.7-245	482	Highly fractured Basement	Yes-Main Aquifer
>254	2308	Fresh Basement	No

**MKM 002 VES 2 (GPS -01.001722°S and 37.58447°E)**

Geophysical model in Table 5b below shows that the top layer is covered by 2.1m of dry top soil. This formation is underlain by moist sandy soil layer from 2.1mbgl to 9mbgl. A slightly weathered Basement formation occurs from 9mbgl to 19mbgl underlain by fresh Basement between 19.9mbgl to 91.7mbgl. An aquiferous layer shall be struck between 91.7mbgl and 248mbgl composed highly weathered/fractured Basement formation. This layer is underlain by a confining layer of fresh Basement rock.

**Drilling at this location is recommended to a maximum depth of 250mbgl. Main aquifer is expected to be struck between 9.7mbgl and 248mbgl. The site is known to Mukameni Primary School Management.**

**Table 5b - Hydrogeological Interpretation of VES 2**

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-2.1	296	Dry Top Soil	No
2.1-9	73.8	Moist Soil	No
9-19.9	129	Slightly weathered Basement	NO
19.9-91.7	8026	Fresh Basement	No
91.7-248	473	Highly weathered/fractured Basement	Yes-Main Aquifer
>248	1937	Fresh Basement	No

### 5.3 Evaluation

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKM 002 VES 2 GPS -01.001722°S and 37.58447°E**). The hole should be drilled to an approximate depth of **250 metres**. The selected site is known to Mukameni Primary School Management.

An alternative site is recommended for drilling at **MKM 001 VES 1-GPS --01.00198356°S and 37.58378101°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens.

The chemical water quality is likely to be reasonable. Most mineral concentrations are expected to be relatively high, but acceptable for human consumption.

## 6. CONCLUSIONS AND RECOMMENDATIONS

Summarized conclusions and recommendations from the hydrogeological investigations undertaken at the project study area at Mukameni Primary School are described in the following sections.

### 6.1 Geology and Hydrogeology of Investigated Area:

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr. Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 02.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKM 002 VES 2 GPS -01.001722°S and 37.58447°E**). The hole should be drilled to an approximate depth of **250 metres**. The selected site is known to Mukameni Primary School Management.

An alternative site is recommended for drilling at **MKM 001 VES 1-GPS --01.00198356°S and 37.58378101°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mils steel casings and screens.

### 6.2 Proposed Borehole Drilling:

- ⇒ The study recommends that a borehole be drilled within the premises to an approximate depth of **250metres**: this site shall provide a sustainable yield of approximately **3- 5 m<sup>3</sup>/hr**.
- ⇒ To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized.
- ⇒ The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

## 6.3 Additional Recommendations and Legal Requirements

- A piezometer (1inch pipe) line and a water meter should be installed to monitor water levels and groundwater abstraction.
- The hydraulical properties of the borehole and the surrounding aquifer should be determined during a step-drawdown test, followed by a 24-hour constant discharge test. After stopping the pump, recovery of the water level should be measured for 12 hours, or, alternatively, a 95% recovery to the static level. Using test-pumping results, the sustainable yield can be calculated. The maximum discharge is restricted to 70% of the rate applied during the constant discharge test.
- Samples taken during test pumping must be submitted to a recognized laboratory for chemical and bacteriological analysis.

In Annex II, further recommendations are given on borehole construction and completion methods.

Prior to drilling, it is required to apply for an authorization to sink a production borehole from the Water Resources Authority. Three copies of the report should be submitted to WRA.

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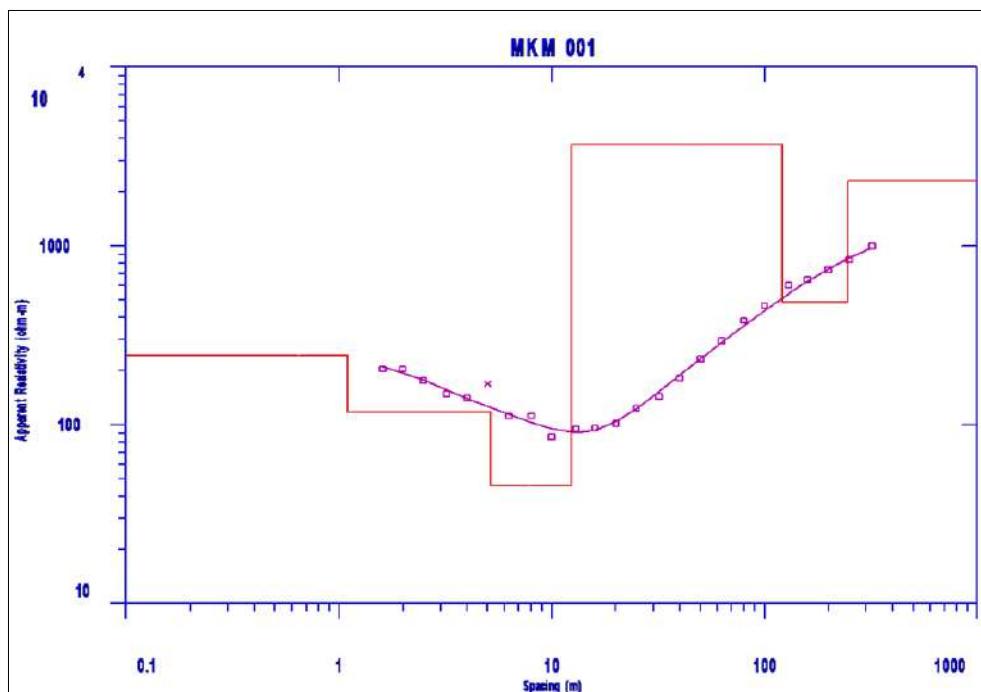
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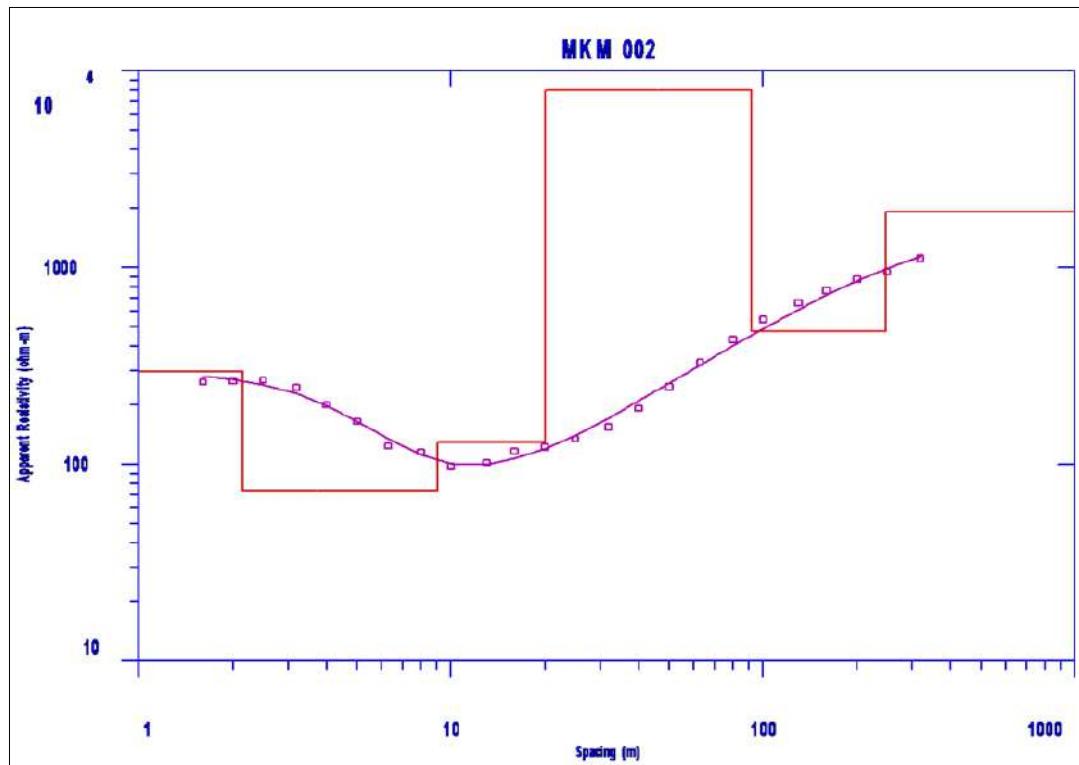
## **APPENDICES**

**APPENDIX I: VERTICAL ELECTRICAL SOUNDINGS**



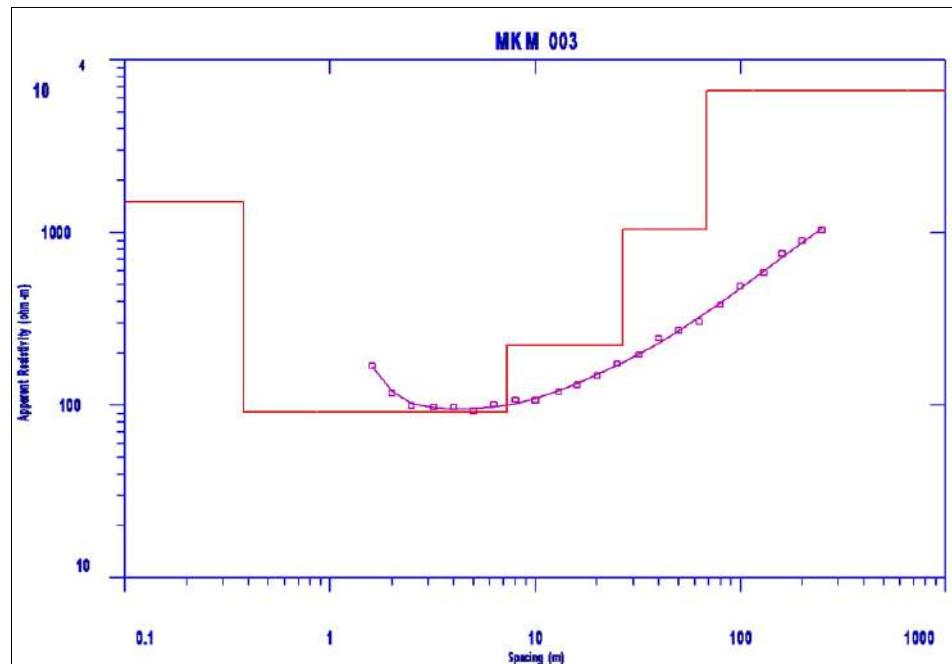
Depth	Resistivity
1.6	205.01
2	205.01
2.5	176.99
3.2	148.97
4	141.59
5	169.62
6.3	112.09
8	112.09
10	85.84
13	94.99
16	95.87
20	101.77
25	123.89
32	144.1
40	182
50	233
63	295
80	383
100	462
130	602
160	651
200	733
250	837
320	1000

Resistivity	Depth
243.5	1.0957
118.62	5.1739
45.449	12.457
3693.9	121.71
482.35	245.2
2308.8	



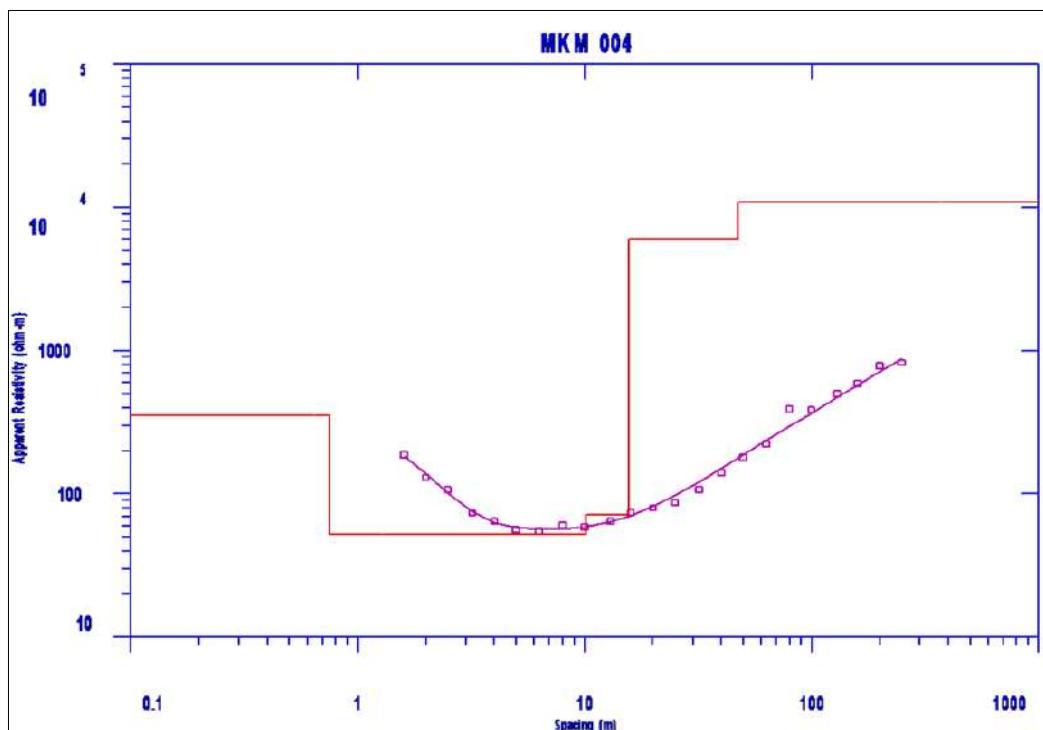
Depth	Resistivity
1.6	262.16
2	265.03
2.5	267.9
3.2	245.9
4	200.93
5	165.52
6.3	124.38
8	115.77
10	97.59
13	102.38
16	116.73
20	122.47
25	134.91
32	155
40	193
50	247
63	331
80	431
100	547
130	663
160	763
200	875
250	951
320	1120

Resistivity	Depth
295.9	2.1507
73.835	9.0465
129.69	19.968
8026.2	91.797
473.7	248.46
1937.4	



Depth	Resistivity
1.6	170.3
2	117.83
2.5	99.42
3.2	97.58
4	97.58
5	92.98
6.3	101.26
8	107.71
10	106.79
13	119.67
16	131.64
20	149.13
25	173.99
32	197
40	244
50	272
63	304
80	383
100	492
130	586
160	756
200	899
250	1042

Resistivity	Depth
1516.4	0.37715
91.06	7.2542
223.64	26.635
1045.4	68.05
6675.4	



Depth	Resistivity
1.6	186.48
2	130.53
2.5	106.8
3.2	73.46
4	64.42
5	56.51
6.3	54.81
8	60.46
10	58.77
13	64.42
16	74.03
20	79.68
25	87.59
32	106.8
40	141
50	179
63	224
80	393
100	386
130	500
160	591
200	784
250	823

Resistivity	Depth
352.61	0.75126
52.426	10.081
71.743	15.692
6062.7	47.317
10916	



**APPENDIX II: BOREHOLE DRILLING AND CONSTRUCTION**

## Drilling Technique

Drilling should be carried out at a diameter of not less than 8.5", preferably using DTH machine. The drilling rig should be able to drill to a depth of at least **250m**, at the specified diameter. The rig and the drilling method adopted must be suitable for drilling through the Basement formations.

Drilling additives to be used (e.g. foam or polymer) must be non-toxic and bio-degradable. In no circumstances will bentonic additives considered to be acceptable, as they may plug the aquifer zones and are extremely difficult to remove during development.

Percussion tools will considerably prolong the required time for drilling, which may be undesirable if water is required soon. The savings initially believed to be made by opting for percussion drilling are often offset against the continuing costs for labour, fuel, etc., and the time input of the Client and his representatives. In addition, it should be noted that access to the site may be difficult during the rainy season. As a result, the drilling activities could come to a stand-still.

Geological rock samples should be collected at 2 metre intervals. Struck and rest water levels should be carefully recorded, as well as water quality and estimates of the yield of individual aquifers encountered.

Great care should be taken that the water quality of the different aquifers is accurately determined. Upon the first strike, drilling fluids should be effectively flushed, and after sufficient time, a water sample should be taken of the air-blown yield. On site analysis using an EC meter, and preferably a portable laboratory, is recommended.

## Well Design

The design of the well should ensure that screens are placed against the optimum aquifer zones. The final design should be made by an experienced hydrogeologist.

## Casing and Screens

The well should be cased and screened with good quality screens. Considering the limited depth of the boreholes and the prevailing alkaline to brackish water quality, it is recommended to use mild steel casings and screens of 6" diameter or mild steel casings.

## Gravel Pack

The use of a gravel pack is recommended within the aquifer zone, because the aquifer could contain sands or silts, which are finer than the screen slot size. A 10" diameter borehole screened at 6" will leave an annular space of approximately 4", which is sufficient to allow the insertion of fine, quartzitic gravel. The grain size of the gravel pack should be within the range of 2 to 4 mm, and granules should be rounded to well-rounded. Over 95% should be siliceous.

Gravel pack should be washed down with copious volumes of water to avoid bridging. The best method, which is unfortunately rarely used, is insertion with a tremie pipe.

## Well Construction

Once the design has been agreed, construction can proceed. In installing screen and casing, centralizers at 6 metre intervals should be used to ensure centrality within the borehole. This is particularly important

to insert the artificial gravel pack all around the screen. If installed, gravel packed sections should be sealed off at the top and bottom with clay or bentonite seals (2 m). In this case it is also recommended to install a 3 m long, cement grout surface plug, to prevent contamination (bacteriological as well as industrial) from entering the borehole.

The remaining annular space should be backfilled with inert material (drill cuttings may be used), and the top five metres grouted with cement to ensure that no surface water at the well head can enter the well bore and thus prevent contamination.

### Well Development

Once screen, pack, seals and backfill have been installed, the well should be developed. Development aims at repairing the damage done to the aquifer during the course of drilling by removing clays and other additives from the borehole walls. Secondly, it alters the physical characteristics of the aquifer around the screen and removes fine particles.

The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable. Instead, it is recommended that the Contractor employs air or water jetting, air-lifting or mechanical plunging. These proposed methods physically agitate the gravel pack and adjacent aquifer material, and are extremely efficient methods of developing and cleaning wells.

Well development is an expensive element in the completion of a well, but is usually justified in longer well-life, greater efficiencies, lower operational and maintenance costs and a more constant yield. To avoid sediment ingress, and ensure a long lifespan of both the borehole and the pumping unit, the permanent pump should be installed at least 2 m above, and certainly not within, the screen section.

### Well Testing

After development and preliminary tests, a step-drawdown test and a 24-hour long-duration well test at constant discharge rate should be carried out. Well tests have to be performed on all newly-completed wells: apart from providing information on the quality of drilling, design and development, it also enables the hydrogeologist to compute sustainable abstraction rates, design drawdown, and other important well and aquifer parameters.

During the test, the well is pumped from a measured static water level (SWL) at a known yield. Simultaneously, the discharge rate and the pumped water level (PWL) as a function of time are recorded. After stopping the pump, recovery is measured until the water level has returned within 5% of the original level, in comparison with the total pumped drawdown.

The specific capacity and the efficiency of a borehole are determined during a step-drawdown test. Simultaneously, target yields for the constant discharge test can be set. The step-drawdown test usually comprises 4 to 6 steps of 60 to 90 minutes each. The pumping rates are increased step-by-step, e.g. by gradually opening a gate valve. Recovery may be measured after the last step, but this is not really necessary if a constant discharge test is conducted as well. However, before starting the constant discharge test, 95% of the pumped drawdown must be recovered, or, alternatively, no increase in level must be observed for a period of more than 4 hours.

The constant discharge test allows calculation of specific aquifer parameters, such as transmissivity, hydraulic conductivity and storage coefficient. In addition, the sustainable volume of abstraction, the design drawdown and the final pump specification and setting can be determined. The minimum duration of the test should be 24 hours, followed by 12 hours of recovery observations, or alternatively until 95% of the total drawdown has been regained.

### Legal Requirements

It is a legislated condition imposed by the Water Appointment Board (through the Water Amendment Bill 1992), that all boreholes in Kenya be equipped with a flow meter and a means by which water levels can be measured. These measures have been designed to allow the collection of data, which will enable both the authorities and the borehole operators to learn more about the reliability and limitations of their groundwater resources.

Flow meters are readily available in Kenya, e.g. of the helical-flow type such as manufactured by Kent (UK) or Arad (Israel). The easiest method of water level monitoring is through a narrow (1.25" to 2") dipper line which is installed along the rising main. An electric dipper should be used to measure water levels directly, with an accuracy of approximately 1 cm. An electrical dipper with a length of 100 metres would cost about US \$ 550 in Europe, but more than double this amount in Kenya.

### Pumping Plant

Several options are open to the Client:

a) Windpumps: High quality windpumps are made in Kenya, but obviously the site needs to experience sufficient wind, while substantial storage capacity should be ensured. The advantage of windpumps is that they are environmentally friendly and cheap in maintenance. The Kijito range manufactured in Thika, require a minimum of maintenance and have proved themselves under hostile conditions, e.g. in North-eastern Province.

A Kijito windpump can produce 5 to 90 m<sup>3</sup>/day, depending on the pump chamber and rotor size, and the average windspeed. The price, including installation, ranges from KShs 600,000 for the small, 12 ft rotor blade to 900,000 for the largest, 24ft rotor diameter (subject to changes by manufacturer).

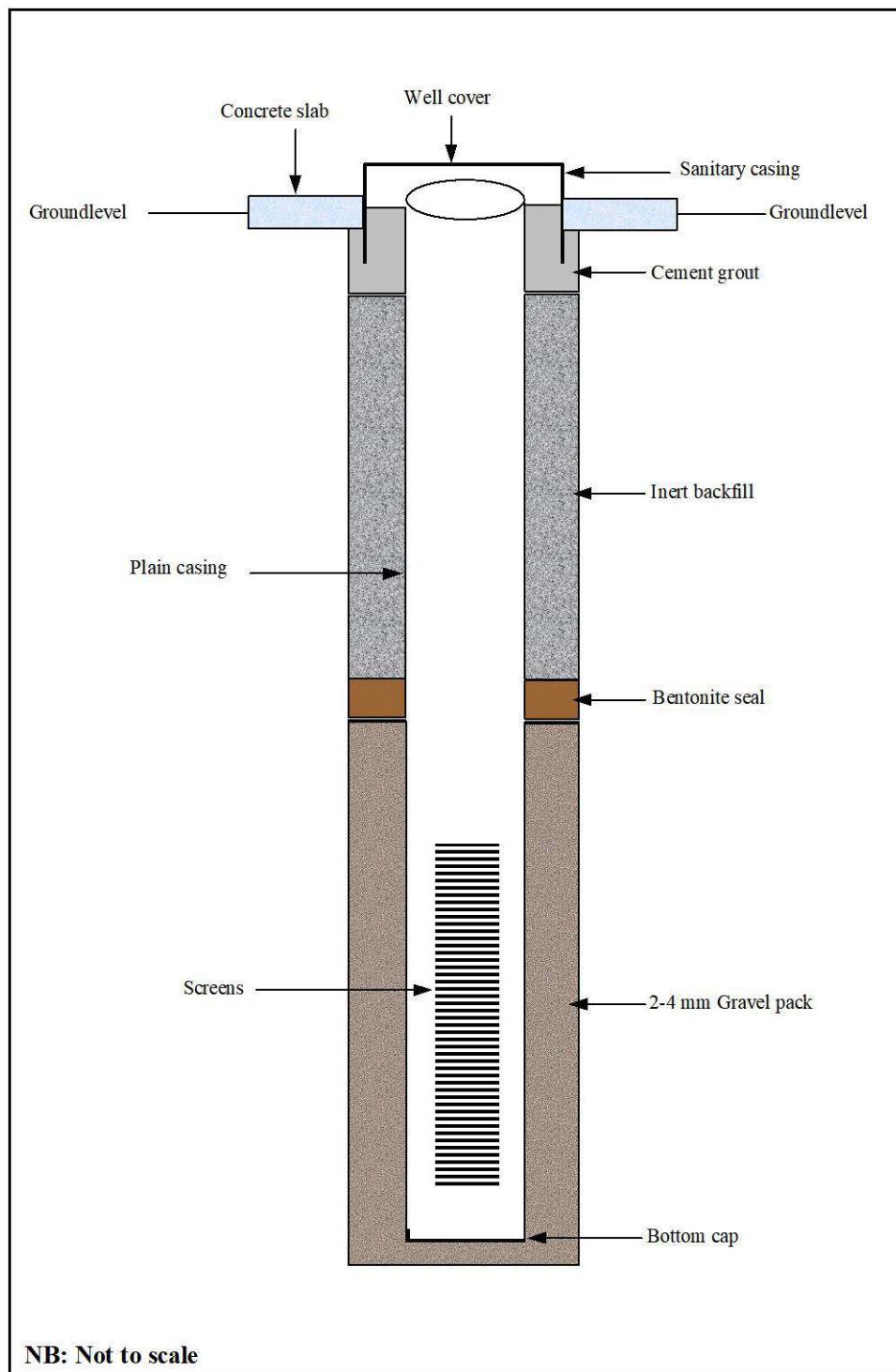
b) Submersible pumps: Currently, these are arguably the most popular borehole pumps in Kenya. Electrical submersibles are efficient and require little maintenance, though of course they do require electrical power on site, e.g. from a generator set.

c) Electrical solar submersible pumps: These are as yet relatively little used in Kenya, mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers.

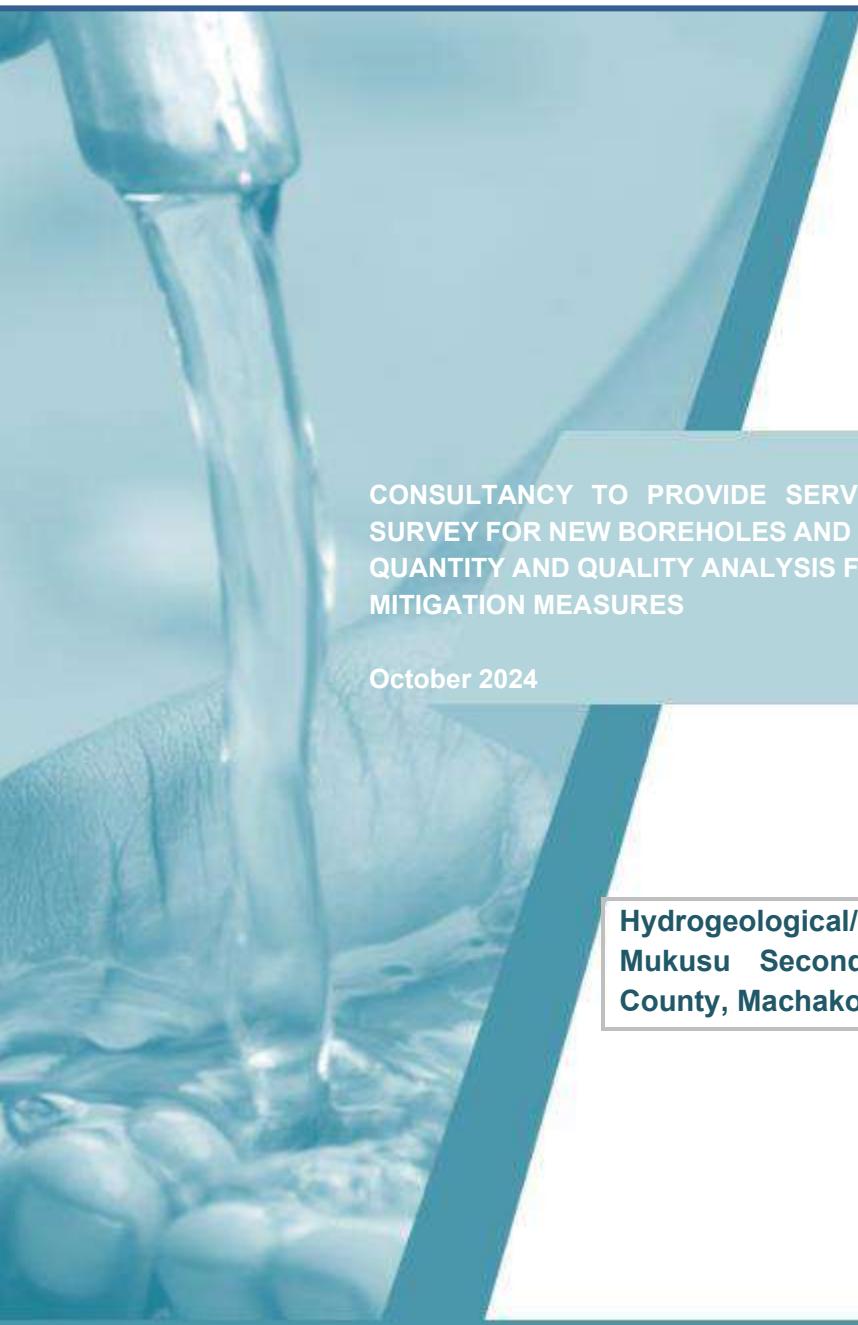
d) Turbine or Mono pumps: Given the yield requirements of the Client, both turbine and Mono-type pumps would be needlessly expensive.

d) Reciprocating pumps: Formerly the most popular type of pump used in Kenya. With the introduction of electrical submersibles and modern windpumps, reciprocating pumps (e.g.

manufactured by Deming, Southern Cross, etc.) have gradually fallen out of favour. However, when it comes to simplicity and robustness, coupled with a wide range of power plant (almost any suitable diesel driving belt), there is little to beat a reciprocating pump.



*Schematic Design for Borehole completion*



**CONSULTANCY TO PROVIDE SERVICES ON HYDROGEOLOGICAL SURVEY FOR NEW BOREHOLES AND BOREHOLE WATER RESOURCE QUANTITY AND QUALITY ANALYSIS FOR EXISTING BOREHOLES AND MITIGATION MEASURES**

October 2024

**Hydrogeological/Geophysical Survey at Mukusu Secondary School, Masinga Sub County, Machakos County**

CONSULTANT	CLIENT
 <p><b>AFRIQUE WATER</b> &amp; GEOTECHNICAL SERVICES LTD</p> <p>P.O BOX 52240-00200 NAIROBI. Tel No: +254720547608 Email: <a href="mailto:v.okello@afriquewater.com">v.okello@afriquewater.com</a></p>	 <p>Habitat for Humanity Kenya, CVS Plaza, Kasuku Lane, Off Lenana Road P.O Box 36948-00623, Nairobi Kenya. <b>Beneficiary</b> <b>MUKUSU WATER COMMUNITY PROJECT</b></p>

## EXECUTIVE SUMMARY

This present report describes the results of borehole site investigations at Mukusu Secondary School, GPS - **GPS -01.9145°S and 37.64098°E**. The study was commissioned by **Habitat for Humanity Kenya**. The Client intends to drill a borehole within the Secondary School to be used as a source of water for domestic purposes and for the institution. Water Demand of 50 m<sup>3</sup>/day is projected to be sufficient.

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites (± garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr. Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 03.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKS 005 VES 5 (GPS -01.9145°S and 37.64098°E)**. The hole should be drilled to an approximate depth of **220 metres**. The selected site is known to Mukusu Secondary School Management.

An alternative site is recommended for drilling at **MKS 004 VES 4-GPS -0.91394198°S and 37.64152176°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens. To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized. The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

*The Client should note that before drilling commences, a groundwater abstraction permit must be obtained from the Regional Manager, Water Resources Authority, in Mombasa.*

*To be attached to the report and Application form (WRMA 001A duly signed & fully completed) should include client's documents:*

*Copy of Title Deed of the Farm,*

*Copy of Site Plan,*

*Copy PIN Number/KRA Certificate,*

*Banking Slip and Copy of Official Receipt of Paid Fee.*

# Table of content

1. Introduction.....	1
1.1 Scope of Work .....	1
1.2 Project Location .....	1
1.3 Climate.....	1
1.4 Water Demand.....	2
1.5 Approach by the Consultant .....	2
2. Geology.....	5
2.1 Introduction.....	5
2.2 Masinga Geology .....	5
3. Hydrogeology .....	6
3.1    Introduction .....	6
3.2    Groundwater Occurrence in Basement Aquifers .....	7
3.2.1    Weathered Layers .....	7
3.2.2    Faults and Fissure Zones .....	8
3.3    Recharge .....	8
3.7    Existing Boreholes .....	8
4. GEOPHYSICAL INVESTIGATION METHODS .....	12
4.1    Introduction .....	12
4.2    Resistivity Method.....	12
4.2.1 Basic Principles of the Resistivity Method .....	12
4.2.2 Resistivity Sounding Technique.....	13
4.2.3 Resistivity Profiles.....	14
4.3    Geo-electrical Layer Response .....	15
5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION .....	17
5.1    Fieldwork.....	17
5.1.1 Vertical electrical method.....	17
5.2 Results and Discussion .....	17
5.3 Evaluation .....	19
6. CONCLUSIONS AND RECOMMENDATIONS .....	20

6.1 Geology and Hydrogeology of Investigated Area: .....	20
6.2 Proposed Borehole Drilling: .....	21
6.3 Additional Recommendations and Legal Requirements .....	21
<b>7. REFERENCES.....</b>	<b>22</b>
<b>REFERENCES.....</b>	<b>22</b>

## List of Figures

<i>Figure 1.1: Location Map of the Study Area .....</i>	<i>4</i>
<i>Figure 3.1: Groundwater Occurrence in Basement System Rocks .....</i>	<i>6</i>
<i>Figure 3.1: Existing Boreholes (Source, WRA Data Base).....</i>	<i>11</i>
<i>Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes .....</i>	<i>13</i>
<i>Figure 5.1: VES Location Map.....</i>	<i>18</i>

## List of Tables

<b>Table 3.1 - Boreholes within the Vicinity of the Investigated Area .....</b>	<b>9</b>
<b>Table 5a - Hydrogeological Interpretation of VES 4.....</b>	<b>18</b>
<b>Table 5b - Hydrogeological Interpretation of VES 5 .....</b>	<b>19</b>

## ABBREVIATIONS AND GLOSSARY OF TERMS

### ABBREVIATIONS (S.I. Units throughout, unless indicated otherwise)

agl	above ground level
amsl	above mean sea level
bgl	below ground level
d	day
E	East
EC	electrical conductivity ( $\mu\text{S}/\text{cm}$ )
h	head
hr	hour
K	hydraulic conductivity (m/day)
l	litre
m	metre
MWI	Ministry of Water and Irrigation
N	North
PWL	pumped water level
Q	discharge ( $\text{m}^3/\text{hr}$ )
Q/s	specific capacity (discharge - drawdown ratio; in $\text{m}^3/\text{hr}/\text{m}$ )
s	drawdown (m)
S	South
sec	second
SWL	static water level
T	transmissivity ( $\text{m}^2/\text{day}$ )
VES	Vertical Electrical Sounding
W	West
WAB	Water Appointment Board
WSL	water struck level
$\mu\text{S}/\text{cm}$	micro-Siemens per centimetre: Unit for electrical conductivity
$^{\circ}\text{C}$	degrees Celsius: Unit for temperature
$\Omega\text{m}$	Ohmm: Unit for apparent resistivity
$\text{pa}$	Apparent resistivity
"	Inch

### GLOSSARY OF TERMS

<b>Alluvium</b>	General term for detrital material deposited by flowing water.
<b>Aquifer</b>	A geological formation or structure, which stores and transmits water and which is able to supply water to wells, boreholes or springs.
<b>Colluvium</b>	General term for detrital material deposited by hillslope gravitational processes, with or without water as an agent. Usually of mixed texture.
<b>Conductivity</b>	Transmissivity per unit length (m/day).
<b>Confined aquifer</b>	A formation in which the groundwater is isolated from the atmosphere by impermeable geologic formations. Confined water is generally at greater pressure than atmospheric, and will therefore rise above the struck level in a borehole.

<b>Denudation</b>	Surface erosion.
<b>Evapotranspiration</b>	Loss of water from a land area through transpiration from plants and evaporation from the surface.
<b>Fault</b>	A larger fracture surface along which appreciable displacement has taken place.
<b>Granitization</b>	The process by which solid rocks are converted into rocks of granitic character without melting into a magmatic stage.
<b>Gneiss</b>	Irregularly banded rock, with predominant quartz and feldspar over micaceous minerals. A product of regional metamorphism, especially of the higher grade.
<b>Gradient</b>	The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head.
<b>Heterogeneous</b>	Not uniform in structure or composition throughout.
<b>Hydraulic head</b>	Energy contained in a water mass, produced by elevation, pressure or velocity.
<b>Hydrogeological</b>	Those factors that deal with subsurface waters and related geological aspects of surface waters.
<b>Infiltration</b>	Process of water entering the soil through the ground surface.
<b>Joint</b>	Fractures along which no significant displacement has taken place.
<b>Migmatite</b>	Rocks in which a granitic component (granite, aplite, pegmatite, etc.) is intimately mixed with a metamorphic component (schist or gneiss).
<b>Percolation</b>	Process of water seeping through the unsaturated zone, generally from a surface source to the saturated zone.
<b>Perched aquifer</b>	Unconfined groundwater separated from an underlying main aquifer by an unsaturated zone. Downward percolation hindered by an impermeable layer.
<b>Permeability</b>	The capacity of a porous medium for transmitting fluid.
<b>Permeation</b>	Passage of geochemically mobile components through a rock. >Permeation gneiss: Gneiss formed or modified by permeation.
<b>Phenocrysts</b>	The larger crystals in a porphyritic rock.
<b>Piezometric level</b>	An imaginary water table, representing the total head in a confined aquifer, and is defined by the level to which water would rise in a well.
<b>Porosity</b>	The portion of bulk volume in a rock or sediment that is occupied by openings, whether isolated or connected.
<b>Porphyritic</b>	Containing large, visible crystals or phenocrysts in a finer groundmass.

<b>Pumping test</b>	A test that is conducted to determine aquifer and/or well characteristics.
<b>Recharge</b>	General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, lateral groundwater flow) to the aquifer zones.
<b>Regolith</b>	General term for the layer of weathered, fragmented and unconsolidated rock material that overlies the fresh bedrock.
<b>Specific capacity</b>	The rate of discharge from a well per unit drawdown.
<b>Static water level</b>	The level of water in a well that is not being affected by pumping. (Also known as "rest water level")
<b>Transmissivity</b>	A measure for the capacity of an aquifer to conduct water through its saturated thickness (m <sup>2</sup> /day).
<b>Unconfined</b>	Referring to an aquifer situation whereby the water table is exposed to the atmosphere through openings in the overlying materials (as opposed to >confined conditions).
<b>Yield</b>	Volume of water discharged from a well.

# 1. Introduction

## 1.1 Scope of Work

In October 2024, Afrique Water & Geotechnical Services Ltd was commissioned by **Habitat for Humanity Kenya**, to carry out borehole site investigations at Mukusu Secondary School (Fig. 1.1). This report aims at fulfilling the activities under phase 1 of the assignment which can be summarised as follows:

- Carry out the geophysical investigation according to the investigation strategy and interpret results: select the most suitable borehole drilling sites in the project area, also considering the legal framework and the requirements of the Water Act 2016.
- Present a Geophysical Report showing the results of the geophysical investigation, including the raw data sets, the qualitative interpretation of the type curves in terms of layer sequence (for VES investigations) and inversions results, and the identification of the drilling locations and precise description of drilling strategy.
- Compile a hydrogeological/geophysical report.

The main objective of this assignment is to identify a suitable site for drilling a production borehole with sufficient quantity and portable quality that can supply water within Mukusu Secondary School and the surrounding community and institutions.

The address of the Client's is:

Habitat for Humanity Kenya,  
CVS Plaza, Kasuku Lane, Off Lenana Road  
P.O Box 36948-00623,  
Nairobi Kenya..

## 1.2 Project Location

The project area is located at Mukusu Sub Location approximately. **(-0.9114467°S and 037.6426808°E)** 8.2km North west of Masinga Town. The exact location is indicated in figure 1.1 below.

## 1.3 Climate

Climate in Machakos County is mild, and generally warm and temperate. During the winter season, there is a significant decrease in precipitation levels within Machakos as compared to the summer months. This location is classified as Cwb by Köppen and Geiger. The mean yearly temperature observed in Machakos is recorded to be 18.9 °C. The annual rainfall is 829 mm.

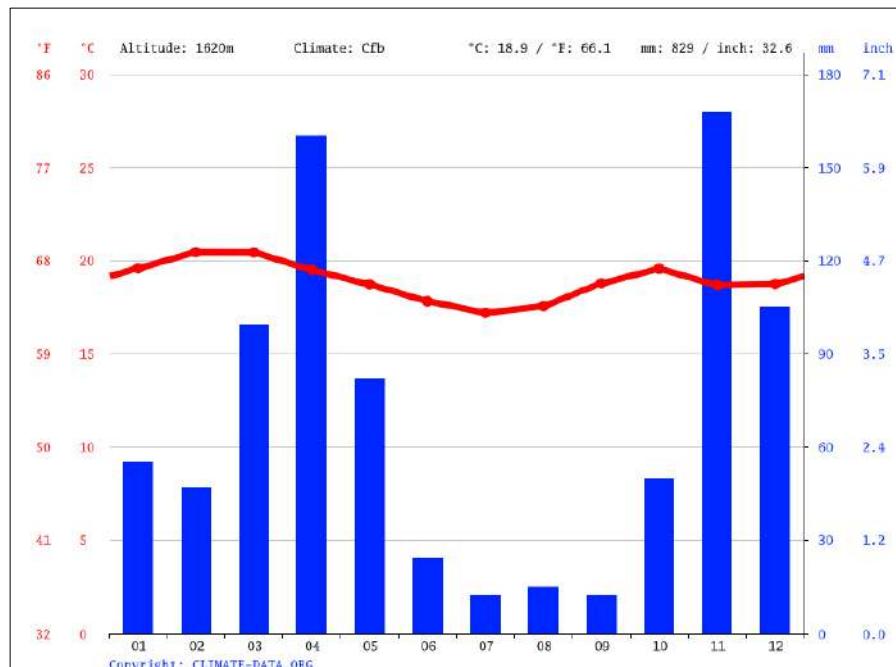
The region of Machakos is characterized by a temperate climate, and the summer season presents some challenges in terms of precise categorization.

Precipitation is the lowest in July, with an average of 12 mm | 0.5 inch. The month of November experiences the highest amount of precipitation, with an average value of 168 mm | 6.6 inch.

At an average temperature of 20.5 °C, February is the hottest month of the year. The month of July is characterized by the lowest temperatures, which have an average reading of 17.2 °C.

Between the driest and wettest months, the difference in precipitation is 156 mm. The fluctuation of temperatures over the course of a year is referred to as temperature variation.

It has been observed that November exhibits the highest relative humidity, with a percentage of 77.85. On the other hand, September experiences the lowest relative humidity at an approximate rate of 58.90. According to the data, April is observed as the month with maximum rainy days (23.13) while September has recorded minimum rainfall during its tenure (2.30).



Source: Climate-Data.org.

Figure 1.1: Climate data for Machakos County

## 1.4 Water Demand

In the absence of a reliable piped water supply, the client has selected drilling 1No. borehole as the best available option. The proposed water source is for domestic use only at the institution. The estimated water demand within university is 50m<sup>3</sup>/day.

## 1.5 Approach by the Consultant

The borehole site investigations were carried out according to a multi-step approach:

- A desk study and data-acquisition phase: topographic maps, existing studies and borehole site investigations, geological reports and maps, borehole records, etc.
- Geological and geomorphological field reconnaissance, including preliminary identification of potential drilling sites, structural features.

- c) Geophysical measurements in the most prospective areas.
- d) Analysis of geophysical data.
- e) Compilation, analysis, and evaluation of the gathered data and information.
- f) Site selection and reporting.

The Consultant's hydrogeologist mobilized to the Project Area on 02.10.24, and completed the fieldwork on the same date.

The hydrogeological and geophysical field investigations were combined with a broad desk study, during which the available relevant geological and hydrogeological data was collected, analysed, collated and evaluated. Methods and measurements used in the field are introduced and described in Chapter 4.

The recommended (preliminary) sites were marked in the field.



**Figure 1.1: Location Map of the Study Area**

## 2. Geology

### 2.1 Introduction

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys.

### 2.2 Masinga Geology

The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi.

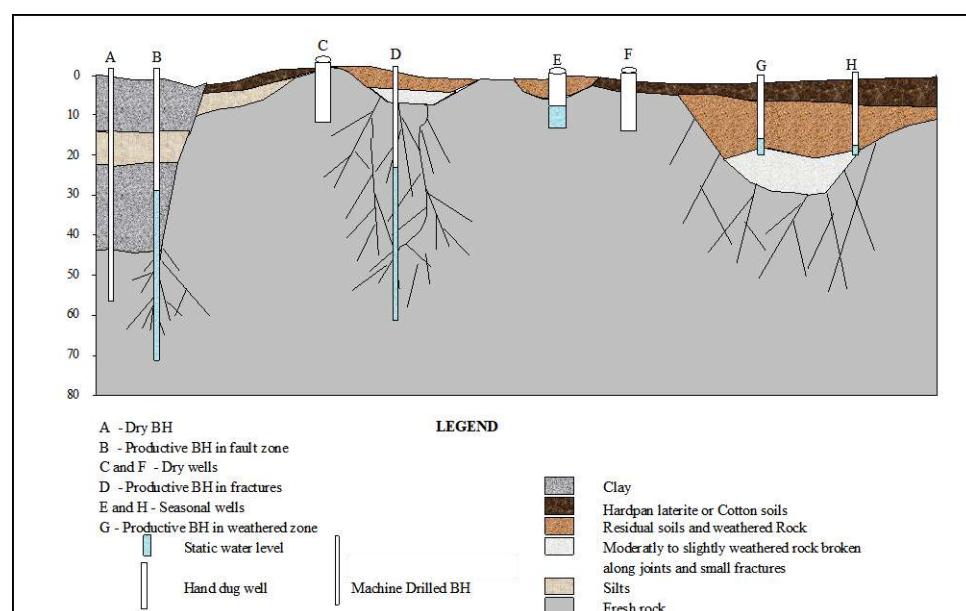
The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

## 3. Hydrogeology

### 3.1 Introduction

The study area is marked by generally unfavourable hydrogeological conditions, which are determined by a combination of largely impermeable bedrock, generally thin soils, and lack of recharge due to a structural rainfall deficit. However, the prospects for groundwater development are fair along the faults and general lines of weakness. Here, weathering has not only resulted in secondary porosity, but has also created a storage media in the regolith, saprolite and saprock. Along the streams recharge is provided by the infiltration of surface discharge, and underflow through the alluvium, faults and the weathered zones.

The area is underlain exclusively by Basement System formations, covered by a layer of weathered rocks, soils and local alluvial deposits. Unaltered metamorphic rocks, such as biotite and quartzo-felspathic gneisses and granulites, are generally hard and compact, and possess no primary porosity. However, depending on the parent material, water may be struck in the weathered zone (regolith, saprolite and saprock). The underlying fresh Basement is in most cases dry, and significant volumes of groundwater can only be expected in fracture zones (cracks, joints, fissures, and faults). An overview of groundwater occurrence in Basement rocks is given in Figure 3.1.



**Figure 3.1: Groundwater Occurrence in Basement System Rocks**

Groundwater may further be found in areas covered by recent sedimentary deposits, specifically within the alluvial plains of the larger seasonal or perennial rivers.

The best chances of striking significant amounts of water occur in fracture zones with a sufficiently large catchment area to provide the necessary recharge. The survey was aimed at identifying such zones in the vicinity of the study area.

Other semi-permanent aquifers may be found in form of connate water (i.e. water trapped during the formation of a sedimentary deposit), or fossil water (water stored during past, more humid conditions). It should be noted that the latter are likely to produce a brackish quality.

## 3.2 Groundwater Occurrence in Basement Aquifers

### 3.2.1 Weathered Layers

Over the years, chemical and mechanical disintegration processes have formed a cover of weathered material over the unaltered bedrock. This weathering is enhanced -and often triggered- by the presence of water. As a result, the thickness of the *regolith* is usually greatest in the topographically low areas. Upon maturation of the profile, the occurrence of water will locally create deep zones of alteration. These will in turn be able to divert more and more water from the surrounding catchment. It is thus evident that deep weathering is linked to the occurrence of groundwater and vice versa.

The upper horizons of the weathered layer are usually clayey, consisting of completely decomposed rock, in which original structures can no longer be found. Feldspar and mica minerals are disintegrated into clay minerals, resulting in high porosities, but extremely low permeabilities. The thickness of this layer is extremely variable, with a common range between 0 and 25 m.

Between the decomposed top soil and the fresh bedrock the weathered zone consists of more coarsely disintegrated and less altered rock material, which is known as the saprolite. This layer comprises *in situ* weathered material, which still resembles the parent rock in structure and appearance. It is however much softer, and often brittle. In drilling logs it is often referred to as "rotten rock", as it is easily penetrated.

Below the saprolite a layer of partly weathered material occurs, which more closely resembles the bedrock. This is the saprock zone, which has hydraulical properties similar to the saprolite. The thickness of this zone may locally exceed 10 metres.

Although the saprolite and saprock usually have higher permeabilities than the fresh rock and the clayey top soil, its properties largely depend on the nature of the parent material. If the latter contains large portions of clay-producing minerals, the resulting aquifers will be low yielding. On the other hand, coarse-grained and quartz-rich rocks will produce a sandy saprolite with relatively good groundwater potential.

The quartz-feldspathic and quartz-biotite gneisses observed within the investigated area are marked by relatively fair properties in this respect. The calcite in the rocks is likely to be entirely removed, thus increasing the secondary porespace. In addition, the rocks were observed to be relatively coarse and very rich in quartz, thus giving rise to shallow but predominantly sandy weathering.

The combined saprolite/saprock layer covering the fresh Basement rocks is relatively thick in the valleys and depressions. A typical depth of 60 m should be expected. On steep slopes and hill tops, however, the weathering is likely to be thin, i.e. about 20 to 30 m.

In the floodplains, groundwater may be found within the saprolite and saprock layers, at various depths ranging from 5 to 60 m bgl. The best prospects occur where local recharge is supplemented with water from an alluvial drainage system, as could be the case along the floodplains.

### 3.2.2 Faults and Fissure Zones

Individual aquifers formed exclusively within the weathered layer rarely produce yields in excess of 2-3 m<sup>3</sup>/hr. Higher yields (say >5 m<sup>3</sup>/hr) can be achieved from boreholes located in "open" faults and fissure zones. The potential of structurally altered rocks is twofold:

- ◆ Along faulted or fissured rocks weathering can penetrate much deeper, thus creating sub-vertical zones filled with relatively coarse, weathered material. These zones generally have a much higher transmissivity than their surroundings.
- ◆ Recharge occurs over large areas: major faults may extend well beyond the surface catchment, thus intercepting adjacent aquifers or surface sources.

Although faults are often associated with water bearing zones, it should be noted that they may also act as impermeable barrier zones ("closed faults"). In this case the structure acts as a "groundwater dam" and significant storage may build up on its upstream side. Drilling inside such a closed fault system, however, would in most cases be futile.

Thirdly, there are faults or fissure zones that, despite having all the properties of a water bearing zone, are not productive due to a lack of recharge (dry, open fractures).

### 3.3 Recharge

Recharge is the process through which water is added to the groundwater reservoir. Some aquifers do not receive any recharge at all; in this case, the water is connate or fossil, and pumping results in irreversible depletion. Usually, aquifers with little recharge and consequently long residence times are marked by high levels of mineralisation and salinity. Unless the underground water body is of vast extent, it is essential that not more water is abstracted than the annual amount of replenishment.

### 3.7 Existing Boreholes

The locations of the existing boreholes are illustrated in Figure 3.1 and the technical details tabulated in Table 3.1 below.

**Table 3.1 - Boreholes within the Vicinity of the Investigated Area**

ID	DLONG	DLAT	OWNER	LOCALITY	COMPDATE	TDEPTH	M_WSL	WRL	YIELD	DRAWDOWN
1	2	3	4	5	6	7	8	9	10	11
C1375	37.350	-0.900	T.BURSELL	TANA RANCH	1951.03.01	46.0	27.0	23.0	2.70	
C1479	37.333	-0.900	T.BURSELL	TANA RANCH	1951.05.01	73.0	24.0	20.0	0.30	
C4710	37.400	-1.016			1980.01.01	186.0	180.0	58.0	16.30	
C128	37.850	-1.050			1941.03.01	22.0	18.0	13.0	0.90	
C2196	37.883	-1.016			1954.05.01	67.0	61.0	24.0	0.78	2.0
C3760	37.600	-1.083			1971.07.01	198.0	61.0	28.0	0.30	77.4
C3766	37.633	-1.083			1971.08.01	152.0	91.0	23.0	1.50	119.0
C1507	37.783	-1.033	AFR.SET.BOARD	YATTA	1951.08.14	111.0	44.0	38.0	0.72	
C1571	37.633	-0.966	AFR.SET.BOARD	YATTA	1951.10.16	34.0	29.0	23.0	4.56	
C1595	37.666	-1.100	A.S&L.U.B	YATTA	1951.09.29	82.0	64.0	30.0	10.90	
C2041	37.716	-0.933	A.L.U&SB	KATHINGIRI	1953.10.15	122.0	117.0	76.0	0.18	41.0
C1973	37.600	-1.066	A.L.U&SB	YATTA	1953.05.27	121.0	111.0	16.0	2.82	92.0
C4162	37.483	-0.916	CATHOLC MISSION	DITHINI	1975.10.23	200.0	111.0	40.0	0.30	139.0
C13258	37.664	-0.965	DWD (KAIRUNGU W P)	KIOMO KAIRUNGU	2001.06.02	90.0	74.0	11.2	14.60	39.4
C6793	37.550	-0.883	FOSTER PARENTS INT.	MBONDENI H/C	1986.02.07	70.0	56, 61	43.0	0.00	23.0

**NOTES:**

1. Ministry of Water and Irrigation Borehole Identification Number.
2. Longitude (Decimal Degrees)
3. Latitude ((Decimal Degrees)
4. Borehole Owner
5. Locality
6. Borehole Completion Date
7. Total Depth (m)
8. Main Water Struck Level (m)
9. Water Rest Level (m)
10. Yield (m<sup>3</sup>/hr)
11. Drawdown (m)

Records of some of the boreholes and their geologic log were analysed and evaluated. Results of the data inventory are presented in Table 3.1 above, while the location of the boreholes is shown in Figure 3.2 below. In the present study the borehole data have been used to identify aquifer characteristics and their variations with depth.

The borehole yields in the area are generally low to moderate ranging from 0.0m<sup>3</sup>/hr to 16.3m<sup>3</sup>/hr. The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of 7.11m<sup>3</sup>/hr.

Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

- **Specific Capacity**

The specific capacities of the 3 boreholes has been calculated using the formula  $Sc = Q/Sw$ , where  $Sc$  is specific Capacity,  $Q$  is the discharge and  $Sw$  is the drawdown. To obtain an insight to the general characteristics, the average specific capacity of the aquifer in general has been assumed as the average of the 3 sample boreholes with drawdown values, resulting in an average specific capacity of **0.05235235 $m^2/hr$** .

- **Transmissivity**

During pump test, the borehole is pumped at a constant rate and the amount of drawdown is noted. Specific capacity **Sc** is then defined as the pumping rate **Q** divided by Drawdown **Sw**.

$$Sc = Q / Sw \text{ (Discharge per unit of Drawdown).}$$

The following equation, based on the Cooper-Jacob (1946) solution for flow to a borehole in a confined aquifer, computes the Specific Capacity, **Q / Sw** of a borehole:

$$Q / Sw = T / 0.183 \log \{2.25 T t / R w^2 S\}$$

Where **Rw** is radius of borehole [m], **S** is storativity [Dimensionless Coefficient], **T** is transmissivity [m/day] and **t** is time [day]. Using the equation, Driscoll (1986) developed approximate formulas for estimating transmissivity from specific capacity in Confined and Unconfined aquifers:

$$T = 1.385 [Q / Sw] \dots \text{Confined aquifer}$$

$$T = 1.042 [Q / Sw] \dots \text{Unconfined aquifer.}$$

Taking the average discharge and pumping drawdown of the 5 sampled boreholes:

$$\text{Specific Capacity } Sc = 0.052352352m^2/hr$$

$$\frac{\text{Transmissivity}}{1.740192114m/day} = T = 1.385 [0.052352352m^2/hr] =$$

- **Hydraulic Conductivity**

The hydraulic conductivity **K** is computed from transmissivity **T** using **K = T / b**.

Where **b** is the saturated thickness of the aquifer. Boreholes should be screened only in the most productive parts of the aquifer if total screen length is to correspond to **b**. For the current sample boreholes in the study area, the total thickness of the main aquifers could not be determined.



**Figure 3.1: Existing Boreholes (Source, WRA Data Base)**

# 4. GEOPHYSICAL INVESTIGATION METHODS

## 4.1 Introduction

Great varieties of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity sounding technique was applied, using an ABEM DC resistivity set comprising a Terrameter/Resistivity Meter, connecting cables and crocodile clips, stainless steel non-polarising current electrodes and copper potential electrodes.

This dedicated equipment measures both  $V$  and  $I$  and presents a calculated resistance (see Section 4.2). In order to improve the validity of the data the equipment takes an average of 4, 16 or exceptionally, 64 readings (determined by the operator). This allows the effects of noise to be minimised.

In Appendix I, graphical plots of the apparent resistivity versus electrode spacing  $AB/2$  are presented, together with raw field data and the resulting geophysical interpretation model.

## 4.2 Resistivity Method

### 4.2.1 Basic Principles of the Resistivity Method

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. The resistance  $R$  of a certain material is directly proportional to its length  $L$  and cross sectional area  $A$ , expressed as:

$$R = \rho_a * L/A \quad (\Omega) \quad (1),$$

where  $\rho_a$  is known as the specific resistivity, characteristic of the material and independent of its shape or size. With Ohm's Law:

$$R = \delta V/I \quad (\Omega) \quad (2),$$

where  $\delta V$  is the potential difference across the resistor and  $I$  is the electric current through the resistor, the specific resistivity may be determined by:

$$\rho_a = (A/L) * (\delta V/I) \quad (\Omega m) \quad (3)$$

The electrical properties of rocks in the upper part of the earth's crust are determined by the lithology, porosity, the degree of pore space saturation and the salinity of the pore

water. These factors all contribute to the resistivity of a material (the reciprocal of the electrical conductivity).

The resistivity of earth materials can be studied by measuring the electrical potential distribution produced at the earth's surface by an electric current that is passed through the earth. Vertical electrical soundings are point measurements that provide information on the vertical resistivity layering at a certain location. Resistivity profiles, on the other hand, are carried out to obtain information on lateral changes in apparent resistivity along a cross section.

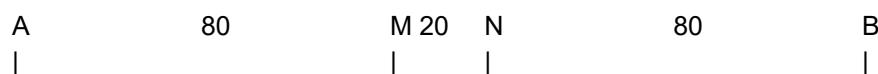
#### 4.2.2 Resistivity Sounding Technique

When carrying out a resistivity sounding, also called vertical electrical sounding (VES), an electrical current ( $I$ ) is passed into the ground through two metal pins, the current electrodes. Subsurface variations in electrical conductivity determine the pattern of current flow in the ground and thus the distribution of electrical potential. A measure of this is obtained in terms of the voltage drop ( $\delta V$ ) between a second pair of metal stakes, the potential electrodes placed near the centre of the array. The ratio ( $\delta V/I$ ) provides a direct measurement of the ground resistance and from this, and the electrode spacing, the apparent resistivity ( $\rho_a$ ) of the ground is calculated.

The measuring setup consists of a resistivity instrument (usually placed in the middle of the array), connected to two current electrodes (AB), and two potential electrodes (MN) towards the centre. Usually a so-called "Schlumberger" array is used for vertical electrical soundings, while profiles are generally carried out in "Wenner" configuration (Figure 4.1).

**Figure 4:1: Examples of Schlumberger and Wenner Configurations for Resistivity Measurements, where: AB = current electrodes; MN = potential electrodes**

a) Schlumberger Array:  $AM = NB > MN$



b) Wenner Array:  $AM = MN = NB$



A series of measurements made with an expanding array of current electrodes (Schlumberger Array) allows the flow of current to penetrate progressively greater depths. The *apparent resistivity* as a function of the electrode separation AB provides information on the vertical variation in resistivity. The depth of penetration varies according to the electrode array, but is also affected by the nature of the material beneath the array.

The point at which a change in earth layering is observed depends on the resistivity contrast, but is generally of the order of a quarter of the current electrode spacing AB

(Milsom 1989). By contrast, in an homogeneous medium the depth penetration is of the order 0.12 AB (Roy & Apparao 1971).

The calculated apparent resistivity is plotted against current electrode half separation on a bi-logarithmic graph paper to constitute the so-called sounding curve. The curve depicts a layered earth model composed of individual layers of specific thickness and resistivity.

Interpretation of field data can be done with hand-fitted curves, but this method is time consuming, and practically limited to 3-layer solutions. Modern interpretation is computer-aided, using a curve fitting procedure based on a mathematical convolution method developed by Ghosh (1971).

While the resistivity method is a useful tool in groundwater investigations and borehole site surveys, its applicability and reliability should not be overestimated. The modelling of field data is often attended by problems of equivalence and suppression. Each curve has an infinite number of possible solutions with different layer resistivities and depths (this is known as equivalence). Mathematical convolution can easily lead to a well-fitting solution, which nonetheless does not correspond to reality. In general, the number of possible solutions is reduced by mutual correlation of several sounding curves, knowledge of the local geology and drilling data.

When deposits with similar resistivities border each other, it is usually not possible to make a differentiation. Intermediate layers, occurring between deposits of contrasting conductivity, may go undetected, as they tend to be obscured within the rising or falling limb of the sounding graph (suppression). Additional data, in the form of borehole records, air photography and geological field observations, are required to produce a realistic interpretation.

It should be noted that the layered earth model is very much a simplification of the many different layers, which may be present. The various equivalent solutions, which can be generated by a computer programme, should therefore be carefully analysed. In general, resistivity soundings should never be interpreted in isolation as this may lead to erroneous results.

#### 4.2.3 Resistivity Profiles

Resistivity profiles are usually carried in Wenner configuration, i.e. an electrode set-up with a uniform distance between potential and current electrodes (see Fig. 5.1). The entire array is moved across the area of interest. By doing so, lateral changes in apparent resistivity are measured, which reflect variations in the lithology, the depth of weathering or the water content.

So-called "anomalies" may indicate the intersection of a fault (usually a negative anomaly), quartzite band (positive anomaly) or buried riverbed (anomaly depends on nature of surrounding deposits). Usually such lineaments, which may also be observed on aerial photographs, are linked to the occurrence of groundwater.

It must be noted that resistivity differences in a single profile array may largely reflect variations at the surface rather than underground. For this reason, it is usually not sufficient to carry out single-spaced profiles. The depth of penetration increases at greater electrode separations. A series of profiles at variable electrode separations will provide an indication of vertical resistivity trends. Moreover, by repeating the same profile at a different

configuration, it will become clear if the observed resistivity patterns are caused by surface phenomena or underground features.

### 4.3 Geo-electrical Layer Response

Vertical electrical soundings (VES) provide quantitative information on electrical resistivity as a function of depth. The computer-interpretation of the sounding data produces a layered model of the underground. The derived resistivity layers are used to infer the presence of water-bearing strata, their texture and salinity.

Water-bearing and/or weathered rocks have lower resistivities than unsaturated (dry) and/or fresh rocks. The higher the porosity of the saturated rock, the lower its resistivity, and the higher the salinity (or electrical conductivity EC) of the saturating fluids, the lower the resistivity. In the presence of clays and conductive minerals the resistivity of the rock is also reduced. The relation between the formation resistivity ( $\rho$ ) and the salinity is given by the "Formation Factor" (F):

$$\rho = F \times \rho_w = F \times 10,000 / EC \text{ (\mu S/cm)}, \quad \text{where: } \rho_w = \text{resistivity of water}$$

In sediments or unconsolidated layers produced by weathering, the formation factor varies between 1 (for sandy clays) and 7 (for coarse sands).

**Example:** If a certain aquifer is considered with an average formation factor of 3, then an EC of 300  $\mu$ S/cm will give a formation resistivity of 100  $\Omega$ m. The same material, when containing water with an EC of 1,500  $\mu$ S/cm, will have a resistivity of only 20  $\Omega$ m. Brackish water is marked by an EC of 2,000 to 10,000  $\mu$ S/cm, and a  $\rho_w$  of 5 to 1. Deposits containing brackish water will therefore in most cases adopt a low formation resistivity (usually less than 10  $\Omega$ m). Saline water with an EC of about 30,000  $\mu$ S/cm will reduce the resistivity of a formation to about 2 Ohms.

Clayey formations with fresh water will respond similarly to deposits with brackish or saline water: the fact that the same resistivity can be obtained for completely different hydrogeological units is known as the "equivalence-problem".

Fresh and dry Basement rocks are marked by very high resistivities, with a common range from 1,000 to 10,000 Ohms. Moderately to slightly weathered but dry layers are less resistive, and usually show values between 100 and 500 Ohms, depending on the portion of clays, the degree of weathering and the water content. The resistivity further decreases if the deposits are water-bearing, to 20 to 200  $\Omega$ m. The resistivity of impermeable clay layers (alluvial or produced by intensive weathering of clay-forming minerals) usually varies between 2 and 10 Ohmm, while similar figures are recorded for aquifers with brackish to saline water.

The greatest difficulty in the interpretation of resistivity measurements in Basement rocks is formed by:

- Equivalence:* the similar geophysical properties of layers with contrasting hydrogeological characteristics (e.g. clay layers and layers with brackish water),
- Absence of distinct layer boundaries:* the decreasing degree of weathering with depth is usually not well-defined, but gradual. This will result in a gradual increase in resistivity, and not in a distinct set of geophysical layers.

c) *Suppression #1*: Potential aquifer layers of moderate thickness may fail to show a significant response in the recorded resistivity data (especially where these are deep). Thin aquifers embedded within a very thick deposit can easily remain undetected by surface geophysics. They will however show up in down-hole geophysical logs.

d) *Suppression #2*: The resistivity contrast between the (clayey) weathered zone and the fresh bedrock may be so high, that an intermediate saprock aquifer cannot be distinguished in the graphic plot of the sounding.

Despite the problems of suppression attributed to the large resistivity contrast between fresh and weathered basement (point *d*), this is also a favourable attribute. Because of the large difference, the depth of weathering can be measured quite accurately. Considering that aquifers often occur towards the boundary of the weathered zone and the bedrock, the drilling depth can be determined, even if the actual aquifer does not show up as distinct geophysical layer.

# 5. GEOPHYSICAL FIELDWORK, RESULTS AND EVALUATION

## 5.1 Fieldwork

Combined geophysical and hydrogeological fieldwork was carried out on 03.10.2024. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

### 5.1.1 Vertical electrical method

A total of 5 electrical soundings (VES) were carried out at **Mukusu Primary and Mukusu Secondary Schools**. The geophysical investigations were mainly aimed at the determination of the following parameters:

- a) lateral and vertical extent of the water body,
- b) texture of the aquifer deposits (grain-size distribution),
- c) depth and nature of the layers underlying the groundwater store.

## 5.2 Results and Discussion

Vertical electrical soundings (VES) provide quantitative depth-resistivity information for a particular site. VES sites were selected at representative points in relation to geomorphological observations, and locations of particular interest for groundwater resources development.

The measurements were executed in an expanding Schlumberger array, with electrode spreads AB/2 between 250 and 320 m. This separation gives fairly reliable interpretations down to a depth of respectively 120 to 200m, but only approximate solutions for resistivity layering at deeper levels. Depths beyond this level are only indicative, and do not give the precise position of the interpreted layers. However, the selected configuration provided adequate information on the depth of weathering.

The locations of the geophysical soundings and topographical features are shown in figure 5.1. Apparent resistivity curves were interpreted using IxD program, combined with raw field data and interpreted geo-electrical models are included in Annex 1.

The main aim of the measurements was to determine the degree of fracturing at depth, which should be directly related to the layer transmissivity and thus the potential yield. As a general rule, it can be assumed that the soundings with the lowest basal resistivities in the expected water bearing range represent the most favourable drilling sites. However, this does not apply if the resistivity is excessively low (say < 20 Ohmm): figures close to 10 Ohmm are indicative of high clay contents and/or brackish water.

The sounding curves (in Annex 1), all display a similar stratigraphy of miscellaneous shallow deposits, underlain by sandy clay (potentially water-bearing) and heavy clays (dry).

The Consultant carried out geophysical investigations at four locations within the Primary and secondary Schools. Detailed analysis of the geophysical models for recommended sites are discussed below while all the raw data is attached to annex 1 of this report.

### Geophysical Interpretation of the VES Models

#### MKS 004 VES 4-GPS -0.91394198°S and 37.64152176°E,

The Geophysical model shows that the top layer is composed of dry top soil with a thickness 1m. This formation is underlain by Moist Sandy soil from 1mbgl to 4.4mbgl. A wet sandy clay formation occurs from 4.4mbgl to 14.3mbgl. This formation is further underlain by fresh Basement rock between 14.3 to 107mbgl. The main aquifer shall be struck within the highly fractured/weathered formation from 107 to 168mbgl. The aquiferous layer is underlain by a confining layer of fresh Basement rock below 168mbgl.

**Drilling of alternative site is recommended to maximum depth of 200mbgl at this location. The main aquifer is expected between 107mbgl and 168mbgl within the highly fractured/weathered Basement formation. The site is known to Mukusu Secondary School Management.**

*Figure 5.1: VES Location Map*

*Table 5a - Hydrogeological Interpretation of VES 4*

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-1	496	Dry Top Soil	No
1-4.4	141	Moist Top Soil	No
4.4-14.3	23	Wet Sandy Clay	Probably
14.3-107	666	Fresh Basement	No
107-168	375	Weathered/Fractured Basement	Yes-Main Aquifer
>168	2206	Fresh Basement	No

#### MKS 005 VES 5 (GPS -01.9145°S and 37.64098°E)

Geophysical model in Table 5b below shows that the top layer is covered by 0.75m of dry top soil. This formation is underlain by moist top soil layer from 0.75mbgl to 4.06mbgl. A wet sandy clay shall be encountered from 4.06-12.1mbgl. A slightly weathered Basement formation occurs from 12.1mbgl to 33mbgl underlain by fresh Basement between 33mbgl to 66mbgl. An aquiferous layer shall be struck between 66mbgl and 209mbgl composed highly weathered/fractured Basement formation. This layer is underlain by a confining layer of fresh Basement rock below 209mbgl.

**Drilling at this location is recommended to a maximum depth of 220mbgl. Main aquifer is expected to be struck between 66mbgl and 209mbgl. The site is known to Mukusu Secondary School Management.**



**Table 5b - Hydrogeological Interpretation of VES 5**

Depth (m)	Resistivity (Ohmm)	Interpretation	Aquiferous?
0-0.75	708	Dry Top Soil	No
0.75-4.06	54	Moist Top Soil	No
4.06-12.1	34	Wet Sandy Clay	Moist
12.1-33	272	Weathered Basement	1 <sup>st</sup> Aquifer
33-66	2003	Fresh Basement	No
66-209	221	Weathered/Fractured Basement	Yes-Main Aquifer
>209	1540	Fresh Basement	No

### 5.3 Evaluation

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKS 005 VES 5 (GPS -01.9145°S and 37.64098°E)**. The hole should be drilled to an approximate depth of **220 metres**. The selected site is known to Mukusu Secondary School Management.

An alternative site is recommended for drilling at **MKS 004 VES 4-GPS -0.91394198°S and 37.64152176°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mild steel casings and screens.

The chemical water quality is likely to be reasonable. Most mineral concentrations are expected to be relatively high, but acceptable for human consumption.

## 6.CONCLUSIONS AND RECOMMENDATIONS

Summarized conclusions and recommendations from the hydrogeological investigations undertaken at the project study area at Mukusu Secondary School are described in the following sections.

### 6.1 Geology and Hydrogeology of Investigated Area:

The geology of the study area is complex, as it lies on the boundary between two different geological Systems. Masinga area is covered mainly by Basement System rocks with alluvial material in the river valleys. The geology of this area is composed of mainly mica (biotite, muscovite) and /or hornblende schists and gneisses that occasionally show the presence of staurolite, almandine garnet, kyanite and sillimanite. Present also are amphibolites ( $\pm$  garnets), migmatites, granitoid gneisses and granites, intrusive and meta-intrusive mafic and ultramafic rocks that include diorites, gabbros, anorthosites, peridotites and picrites. These mafic and ultramafic rock bodies are noted especially in the Machakos-Masinga Area, and Mwingi. The ultramafic bodies in this sub-area are relatively few as compared to the occurrence of the mafic gabbroic and anorthositic bodies. Some meta-andesitic volcanic rocks of limited extent have been documented east of Thika

The borehole yields in the area are generally low to moderate ranging from  $0.0\text{m}^3/\text{hr}$  to  $16.3\text{m}^3/\text{hr}$ . The 15boreholes whose data was available have an average depth of 104.93mbgl. The tested average discharge from the 15boreholes whose data was available from WRA with a yield of  $7.11\text{m}^3/\text{hr}$ . Shallow Aquifers in the project area stuck between 13mbgl and 30mbgl. Medium aquifers are struck between 38mbgl and 76mbgl.

Combined geophysical and hydrogeological fieldwork was carried on 03.10.24. The main aim of the geophysical investigations was to get an insight into the hydrogeological conditions prevailing in the vicinity of the within the project site. Furthermore, an attempt was made to find the extent of the water bearing layers.

Based on the available hydrogeological data and the geophysical investigation results, it is recommended that a borehole be drilled at a minimum diameter of 8.5" at the location of **MKS 005 VES 5 (GPS -01.9145°S and 37.64098°E)**. The hole should be drilled to an approximate depth of **220 metres**. The selected site is known to Mukusu Secondary School Management.

An alternative site is recommended for drilling at **MKS 004 VES 4-GPS -0.91394198°S and 37.64152176°E**. The site is also known to the school management.

The hole should be installed with good-quality, locally available mils steel casings and screens.

## 6.2 Proposed Borehole Drilling:

- ⇒ The study recommends that a borehole be drilled within the premises to an approximate depth of **220metres**: this site shall provide a sustainable yield of approximately **3- 5 m<sup>3</sup>/hr**.
- ⇒ To achieve and maintain a high yield, and maximize the efficiency of the borehole, the importance of proper design and construction methods cannot be overemphasized.
- ⇒ The water quality of the proposed borehole is expected to be fair to good. The alkalinity and hardness will be moderately high, but not excessive.

## 6.3 Additional Recommendations and Legal Requirements

- A piezometer (1inch pipe) line and a water meter should be installed to monitor water levels and groundwater abstraction.
- The hydraulical properties of the borehole and the surrounding aquifer should be determined during a step-drawdown test, followed by a 24-hour constant discharge test. After stopping the pump, recovery of the water level should be measured for 12 hours, or, alternatively, a 95% recovery to the static level. Using test-pumping results, the sustainable yield can be calculated. The maximum discharge is restricted to 70% of the rate applied during the constant discharge test.
- Samples taken during test pumping must be submitted to a recognized laboratory for chemical and bacteriological analysis.

In Annex II, further recommendations are given on borehole construction and completion methods.

Prior to drilling, it is required to apply for an authorization to sink a production borehole from the Water Resources Authority. Three copies of the report should be submitted to WRA.

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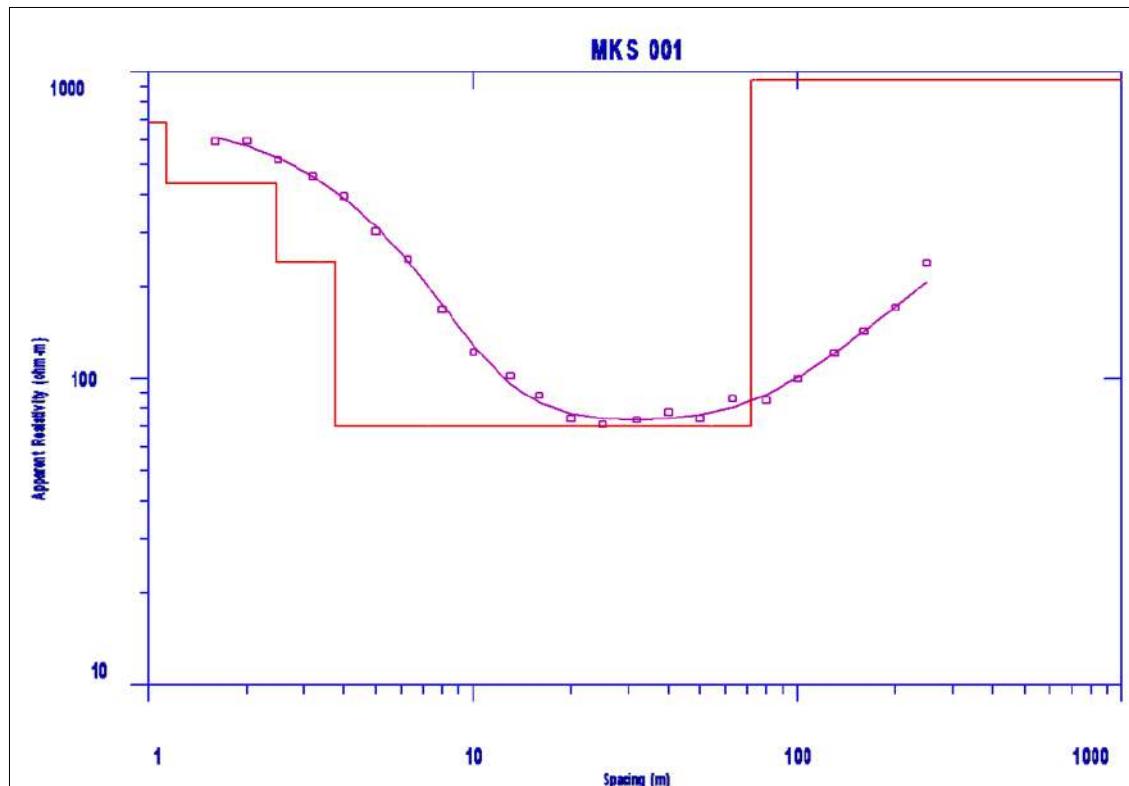
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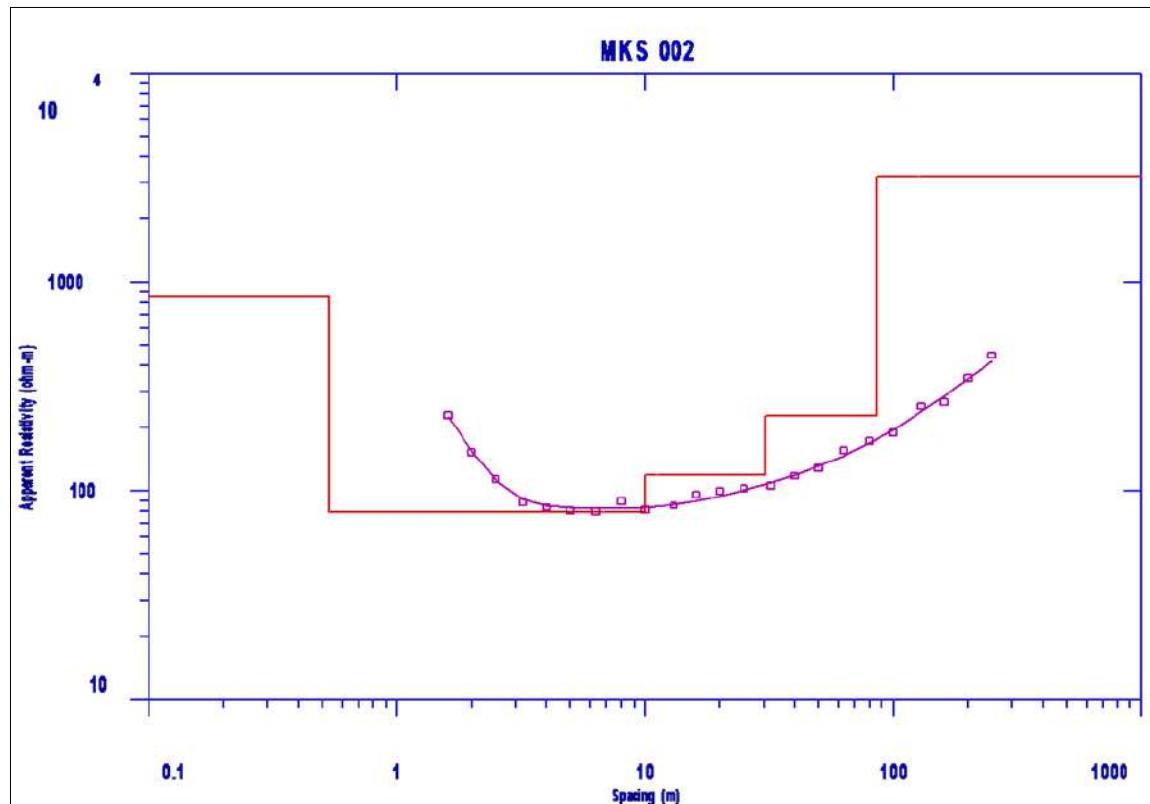
## **APPENDICES**

**APPENDIX I: VERTICAL ELECTRICAL SOUNDINGS**



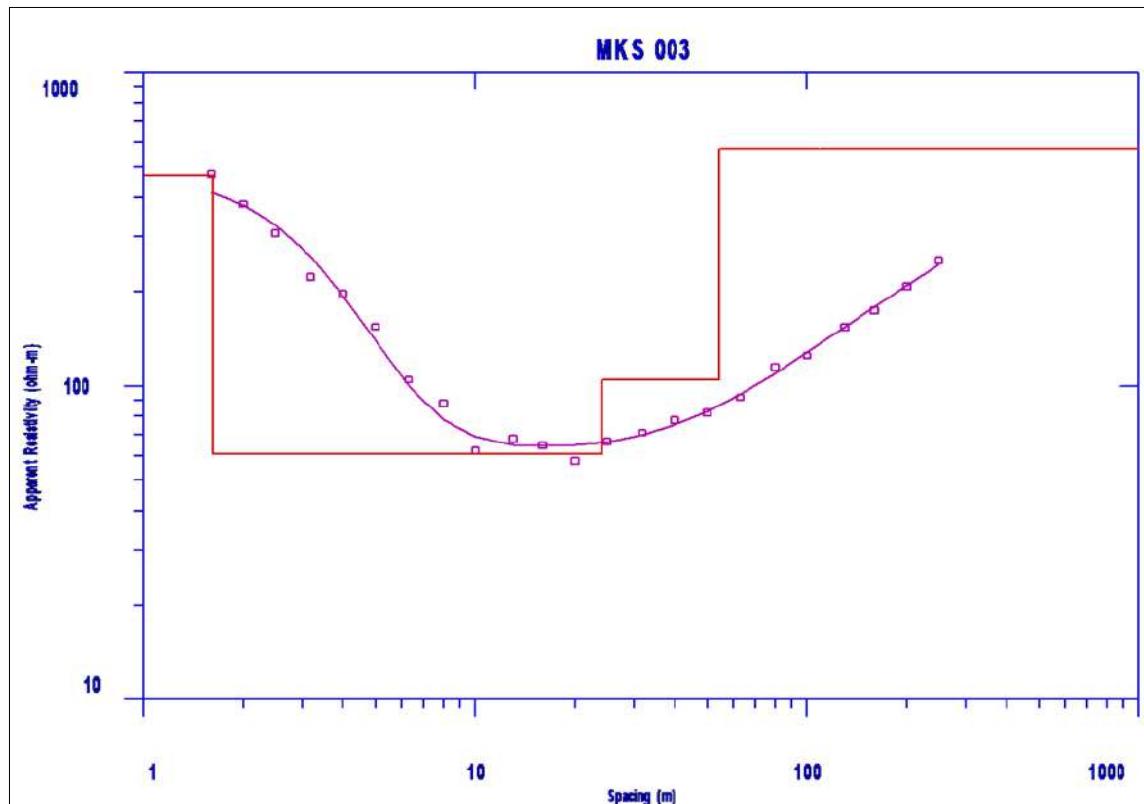
Resistivity	Depth
1.6	593.8
2	597.1
2.5	519.57
3.2	457.72
4	395.04
5	302.67
6.3	245.77
8	168.24
10	122.06
13	102.27
16	88.24
20	74.22
25	70.93
32	73.4
40	78
50	74
63	86
80	85
100	100
130	121
160	143
200	171
250	239

Resistivity	Depth
683.91	1.1377
431.36	2.4775
240.21	3.7463
70.004	71.682
940.21	



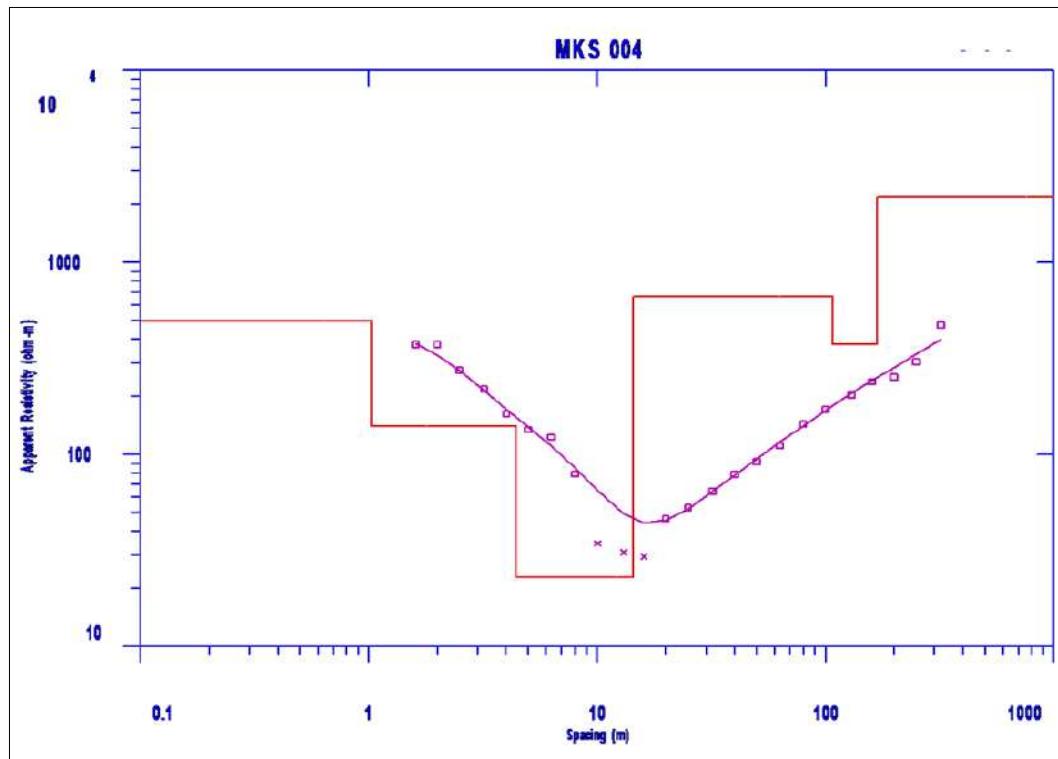
Resistivity	Depth
1.6	229.98
2	153.32
2.5	113.57
3.2	88.02
4	83.29
5	80.45
6.3	79.5
8	88.96
10	81.39
13	85.18
16	95.59
20	99.38
25	103.16
32	106
40	118
50	129
63	156
80	173
100	190
130	254
160	267
200	348
250	446

Resistivity	Depth
848.52	0.53194
79.413	10.025
119.52	30.361
228.86	85.227
3211.7	



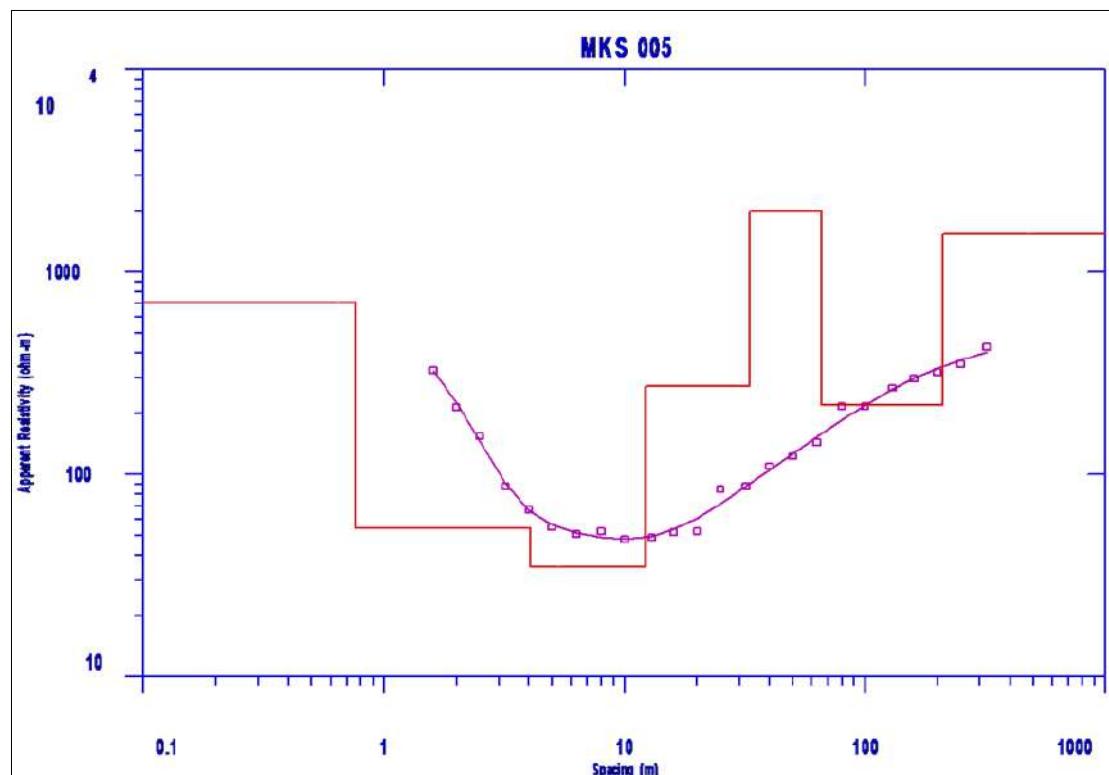
Resistivity	Depth
1.6	474.81
2	379.85
2.5	307.07
3.2	222.76
4	197.02
5	154.42
6.3	104.72
8	87.86
10	62.12
13	67.8
16	64.79
20	57.69
25	66.56
32	71
40	78
50	82
63	92
80	115
100	125
130	154
160	174
200	208
250	252

Resistivity	Depth
471.08	1.6192
60.702	24.124
104.59	54.53
571.19	



Resistivity	Depth
1.6	372.21
2	373.05
2.5	275.37
3.2	219.79
4	163.37
5	134.74
6.3	122.95
8	79.16
10	34.53
13	31.16
16	29.47
20	46.32
25	53.05
32	64
40	79
50	92
63	111
80	144
100	172
130	204
160	239
200	253
250	304
320	471

Resistivity	Depth
496.07	1.0257
141.12	4.4216
23.023	14.352
666.32	107.2
375.47	168.2
2206.4	



Resistivity	Depth
1.6	327.59
2	215.05
2.5	154.93
3.2	87.1
4	67.06
5	54.73
6.3	50.87
8	52.41
10	47.79
13	48.56
16	51.64
20	52.41
25	84.79
32	87.1
40	110
50	123
63	144
80	217
100	217
130	268
160	299
200	321
250	352
320	427

Resistivity	Depth
708.1	0.75563
54.06	4.0652
34.948	12.162
272.87	33.07
2003.3	66.072
221.17	209.7
1540.1	

**APPENDIX II: BOREHOLE DRILLING AND CONSTRUCTION**

## Drilling Technique

Drilling should be carried out at a diameter of not less than 8.5", preferably using DTH machine. The drilling rig should be able to drill to a depth of at least **220m**, at the specified diameter. The rig and the drilling method adopted must be suitable for drilling through the Basement formations.

Drilling additives to be used (e.g. foam or polymer) must be non-toxic and bio-degradable. In no circumstances will bentonic additives considered to be acceptable, as they may plug the aquifer zones and are extremely difficult to remove during development.

Percussion tools will considerably prolong the required time for drilling, which may be undesirable if water is required soon. The savings initially believed to be made by opting for percussion drilling are often offset against the continuing costs for labour, fuel, etc., and the time input of the Client and his representatives. In addition, it should be noted that access to the site may be difficult during the rainy season. As a result, the drilling activities could come to a stand-still.

Geological rock samples should be collected at 2 metre intervals. Struck and rest water levels should be carefully recorded, as well as water quality and estimates of the yield of individual aquifers encountered.

Great care should be taken that the water quality of the different aquifers is accurately determined. Upon the first strike, drilling fluids should be effectively flushed, and after sufficient time, a water sample should be taken of the air-blown yield. On site analysis using an EC meter, and preferably a portable laboratory, is recommended.

## Well Design

The design of the well should ensure that screens are placed against the optimum aquifer zones. The final design should be made by an experienced hydrogeologist.

## Casing and Screens

The well should be cased and screened with good quality screens. Considering the limited depth of the boreholes and the prevailing alkaline to brackish water quality, it is recommended to use mild steel casings and screens of 6" diameter or mild steel casings.

## Gravel Pack

The use of a gravel pack is recommended within the aquifer zone, because the aquifer could contain sands or silts, which are finer than the screen slot size. A 10" diameter borehole screened at 6" will leave an annular space of approximately 4", which is sufficient to allow the insertion of fine, quartzitic gravel. The grain size of the gravel pack should be within the range of 2 to 4 mm, and granules should be rounded to well-rounded. Over 95% should be siliceous.

Gravel pack should be washed down with copious volumes of water to avoid bridging. The best method, which is unfortunately rarely used, is insertion with a tremie pipe.

## Well Construction

Once the design has been agreed, construction can proceed. In installing screen and casing, centralizers at 6 metre intervals should be used to ensure centrality within the borehole. This is particularly important

to insert the artificial gravel pack all around the screen. If installed, gravel packed sections should be sealed off at the top and bottom with clay or bentonite seals (2 m). In this case it is also recommended to install a 3 m long, cement grout surface plug, to prevent contamination (bacteriological as well as industrial) from entering the borehole.

The remaining annular space should be backfilled with inert material (drill cuttings may be used), and the top five metres grouted with cement to ensure that no surface water at the well head can enter the well bore and thus prevent contamination.

### Well Development

Once screen, pack, seals and backfill have been installed, the well should be developed. Development aims at repairing the damage done to the aquifer during the course of drilling by removing clays and other additives from the borehole walls. Secondly, it alters the physical characteristics of the aquifer around the screen and removes fine particles.

The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable. Instead, it is recommended that the Contractor employs air or water jetting, air-lifting or mechanical plunging. These proposed methods physically agitate the gravel pack and adjacent aquifer material, and are extremely efficient methods of developing and cleaning wells.

Well development is an expensive element in the completion of a well, but is usually justified in longer well-life, greater efficiencies, lower operational and maintenance costs and a more constant yield. To avoid sediment ingress, and ensure a long lifespan of both the borehole and the pumping unit, the permanent pump should be installed at least 2 m above, and certainly not within, the screen section.

### Well Testing

After development and preliminary tests, a step-drawdown test and a 24-hour long-duration well test at constant discharge rate should be carried out. Well tests have to be performed on all newly-completed wells: apart from providing information on the quality of drilling, design and development, it also enables the hydrogeologist to compute sustainable abstraction rates, design drawdown, and other important well and aquifer parameters.

During the test, the well is pumped from a measured static water level (SWL) at a known yield. Simultaneously, the discharge rate and the pumped water level (PWL) as a function of time are recorded. After stopping the pump, recovery is measured until the water level has returned within 5% of the original level, in comparison with the total pumped drawdown.

The specific capacity and the efficiency of a borehole are determined during a step-drawdown test. Simultaneously, target yields for the constant discharge test can be set. The step-drawdown test usually comprises 4 to 6 steps of 60 to 90 minutes each. The pumping rates are increased step-by-step, e.g. by gradually opening a gate valve. Recovery may be measured after the last step, but this is not really necessary if a constant discharge test is conducted as well. However, before starting the constant discharge test, 95% of the pumped drawdown must be recovered, or, alternatively, no increase in level must be observed for a period of more than 4 hours.

The constant discharge test allows calculation of specific aquifer parameters, such as transmissivity, hydraulic conductivity and storage coefficient. In addition, the sustainable volume of abstraction, the design drawdown and the final pump specification and setting can be determined. The minimum duration of the test should be 24 hours, followed by 12 hours of recovery observations, or alternatively until 95% of the total drawdown has been regained.

### Legal Requirements

It is a legislated condition imposed by the Water Appointment Board (through the Water Amendment Bill 1992), that all boreholes in Kenya be equipped with a flow meter and a means by which water levels can be measured. These measures have been designed to allow the collection of data, which will enable both the authorities and the borehole operators to learn more about the reliability and limitations of their groundwater resources.

Flow meters are readily available in Kenya, e.g. of the helical-flow type such as manufactured by Kent (UK) or Arad (Israel). The easiest method of water level monitoring is through a narrow (1.25" to 2") dipper line which is installed along the rising main. An electric dipper should be used to measure water levels directly, with an accuracy of approximately 1 cm. An electrical dipper with a length of 100 metres would cost about US \$ 550 in Europe, but more than double this amount in Kenya.

### Pumping Plant

Several options are open to the Client:

a) Windpumps: High quality windpumps are made in Kenya, but obviously the site needs to experience sufficient wind, while substantial storage capacity should be ensured. The advantage of windpumps is that they are environmentally friendly and cheap in maintenance. The Kijito range manufactured in Thika, require a minimum of maintenance and have proved themselves under hostile conditions, e.g. in North-eastern Province.

A Kijito windpump can produce 5 to 90 m<sup>3</sup>/day, depending on the pump chamber and rotor size, and the average windspeed. The price, including installation, ranges from KShs 600,000 for the small, 12 ft rotor blade to 900,000 for the largest, 24ft rotor diameter (subject to changes by manufacturer).

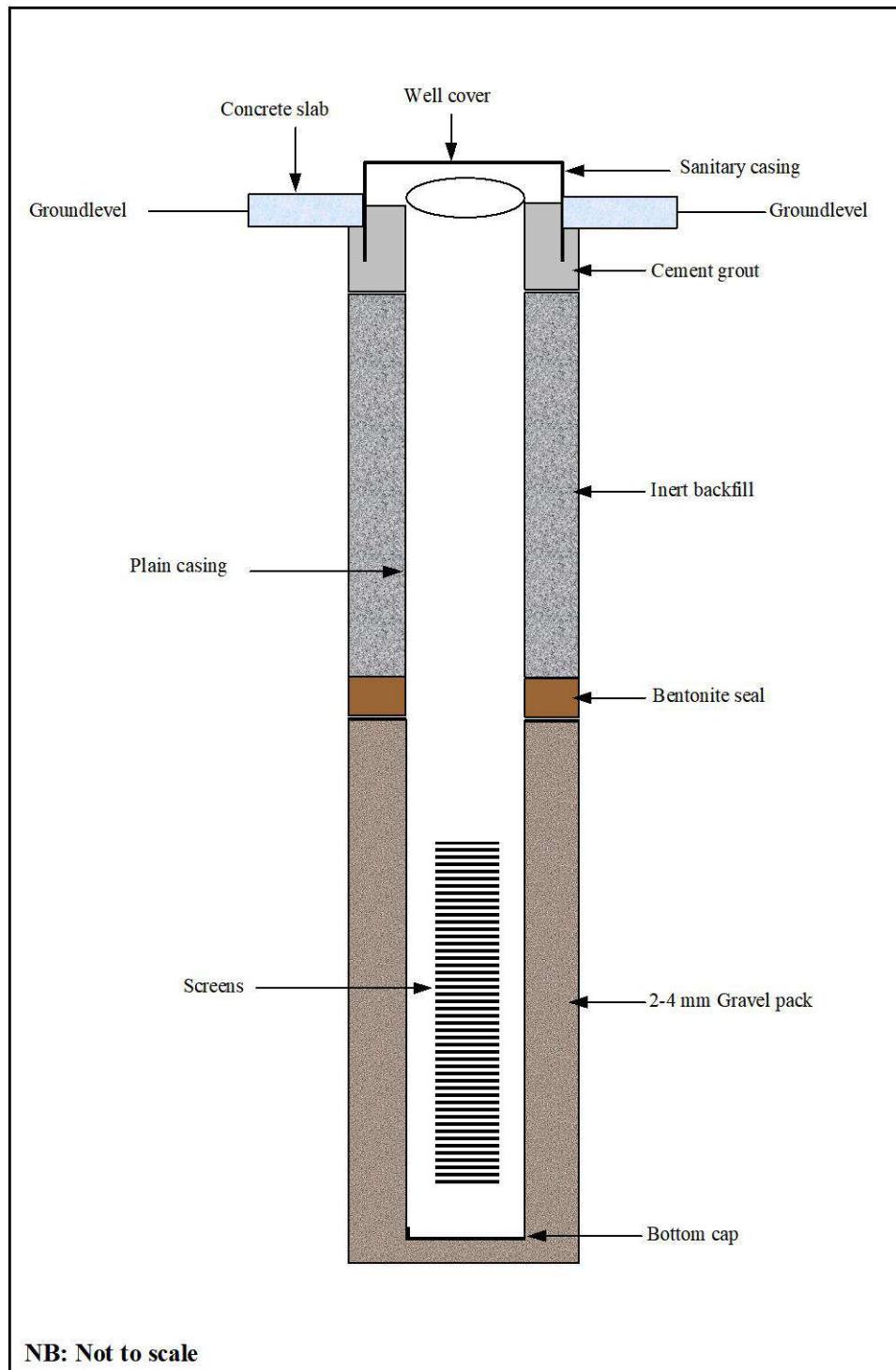
b) Submersible pumps: Currently, these are arguably the most popular borehole pumps in Kenya. Electrical submersibles are efficient and require little maintenance, though of course they do require electrical power on site, e.g. from a generator set.

c) Electrical solar submersible pumps: These are as yet relatively little used in Kenya, mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers.

d) Turbine or Mono pumps: Given the yield requirements of the Client, both turbine and Mono-type pumps would be needlessly expensive.

d) Reciprocating pumps: Formerly the most popular type of pump used in Kenya. With the introduction of electrical submersibles and modern windpumps, reciprocating pumps (e.g.

manufactured by Deming, Southern Cross, etc.) have gradually fallen out of favour. However, when it comes to simplicity and robustness, coupled with a wide range of power plant (almost any suitable diesel driving belt), there is little to beat a reciprocating pump.



*Schematic Design for Borehole completion*

# Safeguarding Policy



**This policy applies to all Habitat for Humanity International (“HFHI”) entities, including headquarters, area offices, branches and consolidating entities. Legally independent national organizations and affiliates are expected to adopt their own policies that incorporate the provisions of this policy or otherwise ensure that the intent of this policy is covered in the entity’s existing policies. National organizations and branches must complete the attached Acknowledgment Form, which should be sent to the entity’s respective area office finance director.**

In accordance with its foundational mission principles, Habitat for Humanity is committed to the highest ethical standards and opposes all forms of discrimination, exploitation and abuse. Our intent is to create and maintain a work and life environment that is safe, productive and respectful for our colleagues and for all we serve. The purpose of this Safeguarding Policy is to:

- Define safeguarding as “Preventing and responding to harm caused by physical or sexual abuse or exploitation, harassment, or bullying of the people in the communities we serve (especially vulnerable adults and children) and also the people who we work or partner with”;
- Increase understanding of safeguarding risks and define responsibilities for appropriate safeguarding behavior by all HFH representatives, including but not limited to board members, staff members, contractors, interns, AmeriCorps members (including VISTA members), volunteers, implementing partners, and suppliers;
- Confirm our commitment to include safeguarding principles during strategic and project planning, in order to assess and address the potential safeguarding risks associated with Habitat for Humanity’s overall operations and project activities.
- Establish processes for required safeguarding protocols during recruitment and training of HFH representatives;
- Define processes for HFH representatives to report concerns regarding suspected safeguarding misconduct to promote a culture of accountability and transparency;
- Establish standardized processes for investigating and managing reported allegations of safeguarding misconduct; and
- Reinforce Habitat for Humanity’s zero-tolerance culture for any HFH representative who violates safeguarding principles.

## **REMEMBER**

*Safeguarding is preventing and responding to harm caused by physical or sexual abuse or exploitation, harassment, or bullying of the people in the communities we serve (especially vulnerable adults and children) and also the people who we work or partner with*

These ‘safeguarding’ principles (in conjunction with the [HFH Ethics Covenant](#), [Whistleblower Policy](#), and [Policy on Harassment, Bullying and Discrimination](#)) guide our work as we strive to do good (and never harm) to each colleague, partner, beneficiary, and community member that we encounter while providing aid or promoting transformational and sustainable community development through shelter.

## (1) Habitat for Humanity's Safeguarding Behavior Commitments

Habitat for Humanity is opposed to any form of discrimination, exploitation and abuse, including slavery, coerced conscription, prostitution, trafficking of persons for any purpose, vulnerable adult or child abuse, and dangerous or exploitative child labor. In the design and implementation of programs and policies, we seek always to work without bias, to do no harm and to reduce (rather than contribute to) the consequences of discrimination, exploitation and abuse.

As described in our **Ethics Covenant**, all HFH representatives commit to respecting and safeguarding the rights and dignities of all people, and protecting our staff members, volunteers, partners, beneficiaries, research participants, and community members (especially vulnerable adults and children) from exploitation and abuse. This includes the following general standards of behavior:

- We will respect, promote and safeguard the rights and dignities of all people (with particular attention to beneficiaries, vulnerable adults and children) without discrimination or bullying of any kind.<sup>1</sup>
- We will treat all intended and actual beneficiaries with respect, courtesy and dignity.
- We will not engage in any form of humiliating, degrading, or exploitative behavior toward beneficiaries in any circumstances.
- We will not engage in any abuse of authority, position or influence by withholding humanitarian assistance or manipulating selection or targeting processes for beneficiaries.
- We will not condone, endorse or participate in any illegal activities conducive to theft, corruption, conflicts of interest, or other activities seeking illegal economic gains.<sup>2</sup>
- We will help to create and maintain an environment that prevents sexual exploitation and abuse, safeguards the rights of beneficiaries, research participants, and community members (especially vulnerable adults and children), and promotes the implementation of Habitat for Humanity's code of conduct. (*Note: Managers at all levels have particular responsibilities to support and develop systems that maintain this environment. A significant failure to support and develop such systems will result in disciplinary consequences, up to and including termination.*)

### REMEMBER

*These standards apply at all times, even when on leave or off duty*

In addition, as an organization, Habitat for Humanity will consider safeguarding principles during strategic and project planning, in order to assess the potential safeguarding risks (especially to vulnerable adults and children) that are associated with our overall operations and project activities. In addition to any specific remediating actions identified after investigation of safeguarding misconduct allegations (discussed in Section (4)), the implementation of safeguarding activities will be assessed throughout the monitoring and evaluation of projects,

HFHI will appoint a **Safeguarding Officer** who, with support from a cross-functional safeguarding team, will be responsible for monitoring the appropriate implementation of Habitat for Humanity's Safeguarding Policy and overall safeguarding framework.

### A. Prevention of Sexual Exploitation and Abuse

Sexual exploitation and abuse (SEA) occurs when people in power exploit or abuse vulnerable populations for sexual purposes. All HFH representatives are prohibited from engaging in sexual exploitation or abuse.

- **Sexual exploitation:** Any actual or attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.

<sup>1</sup> See the HFH Harassment, Bullying and Discrimination Policy for further details.

<sup>2</sup> See the HFH Fraud Policy and Conflict of Interest Policy for further details.

- **Sexual abuse:** Any actual or threatened physical intrusion of a sexual nature, whether by force or under unequal power dynamics or otherwise coercive conditions.

In alignment with the HFH **Ethics Covenant**, all HFH representatives commit to the following safeguarding principles and SEA prevention standards (as established by the United Nations) both at work and away from work:

- We will never engage in sexual exploitation or abuse.
- We will never engage in sexual activity with a child (person under the age of 18) regardless of the age of majority or age of consent locally. Mistaken belief in the age of a child is not a defense.
- We will never exchange money, employment, goods or services (including assistance that is due to beneficiaries) for sex, sexual favors or other forms of humiliating, degrading or exploitative behavior.
- We will not engage in a sexual relationship with a beneficiary, since it is based on inherently unequal power dynamics and undermines the credibility and integrity of Habitat for Humanity's charitable mission.

Such activities constitute gross misconduct and are grounds for termination of the individual's employment or relationship with Habitat for Humanity. In addition, Habitat for Humanity will actively support the prosecution of individuals in cases of proven misconduct.

## B. Child Protection

Habitat for Humanity believes that all children, in all circumstances, have the right to feel and be safe and to live free from harm, exploitation and abuse. Habitat for Humanity strives to be a child-safe organization and to reduce the risk of child abuse in all aspects of our operations.

1. **Prevention of child abuse, exploitation or neglect:** All HFH representatives are prohibited from engaging in child abuse, exploitation, or neglect.

### REMEMBER

*HFH representatives commit to never engage in sexual exploitation or abuse.*

### REMEMBER

*A child is anyone who is not yet 18 years old.*

- **Physical Abuse:** Physical abuse occurs when a person purposefully injures or threatens to injure a child or young person (such as by punching, kicking, burning, etc.). Physical injury may take the form of bruises, cuts, burns or fractures. It is not always the case that the physical injuries will be visible.
- **Emotional Abuse:** Emotional abuse occurs when persistent ill treatment on a child affects their self-esteem. This may include name-calling, rejection, threatening, intimidating or any other acts, which can affect the child's physical and emotional growth, and self-esteem.
- **Sexual Abuse:** Sexual abuse occurs when there has been any (or likely) sexual exploitation of a child by an adult. Sexual abuse includes any actual, attempted or threatened sexual activity involving children (such as intercourse, fondling, oral sex, indecent exposure, exposing the child to pornography, etc.).
- **Commercial Sexual Exploitation of Children (CSEC):** CSEC occurs when a child is sexually abused or exploited in return for cash or any other goods or services. Examples of CSEC include children in prostitution, children involved as subjects in child pornography and child sex tourism.
- **Neglect:** Neglect occurs when a child's basic needs have consistently not been met to the extent that it has a detrimental effect on the child's health and personal development. These basic needs include food, clothing, shelter and supervision.

Such activities constitute gross misconduct and are grounds for termination of the individual's employment or relationship with Habitat for Humanity. In addition, a significant failure to report suspicions that such activities may be occurring by another HFH representative will not be tolerated and can result in disciplinary consequences, up to and including termination (as discussed in Section (2)). Furthermore, Habitat for Humanity will actively support the prosecution of individuals in cases of proven misconduct.

**2. Proactive child protection:** Habitat for Humanity will design its programs and execute its mission in alignment with the following standards:

- We will keep the health and safety of children paramount at all times.
- We will consider child safeguarding in project planning and implementation to determine potential risks to children that are associated with project activities and operations.
- We will work to ensure that personal dignity and respect for children is maintained through all projects, programs and departments.
- We will apply measures to reduce the risk of child abuse, exploitation, or neglect, including, but not limited to:
  - Limiting unsupervised interactions with children;
  - Prohibiting exposure to pornography; and
  - Complying with Habitat for Humanity data responsibility standards, as well as applicable laws, regulations, or customs regarding the photographing, filming, or other image-generating activities of children.
- We will ensure compliance with local child welfare and protection legislation or international standards (whichever gives greater protection) and with U.S. law where applicable.

**C. Prohibition of Prostitution, Trafficking and Forced Labor**

1. **Prostitution:** Habitat for Humanity expressly prohibits sex trafficking and the procurement of commercial sex acts by any HFH representative. We will never exchange money, employment, goods or services (including assistance that is due to beneficiaries) for sex, sexual favors or other forms of humiliating, degrading or exploitative behavior. These standards apply at all times (including when on leave or off duty) and even when commercial sex acts are legal in the local context.
2. **Pornography:** Habitat for Humanity expressly prohibits all HFH representatives from accessing, possessing, or circulating pornographic content using HFH computers, HFH email accounts, HFH-related electronic distribution lists, or an internet connection paid for by Habitat for Humanity. This includes sharing of emails or group texts (including jokes) containing explicit images with HFH colleagues, and these standards apply at all times, even when on leave or off duty. Such actions violate Habitat for Humanity's commitment to create and maintain an environment that prevents harassment and sexual exploitation or abuse, and therefore will result in disciplinary consequences, up to and including termination, against the individuals involved.
3. **Human Trafficking and Forced Labor:** Habitat for Humanity expressly prohibits human trafficking (sometimes referred to as "modern slavery") and the use of forced labor by any HFH representative. As a result, Habitat for Humanity will never:
  - Destroy, confiscate, or otherwise deny a staff access to their identity or immigration documents;
  - Fail to offer transportation for a staff to return to their home country where appropriate (such as when they were recruited by Habitat for Humanity to work outside of their home country and where return transportation was agreed in their benefits or contract);
  - Solicit a person for employment using materially false or fraudulent pretenses, representations, or promises regarding that employment;
  - Charge staff recruitment fees; or
  - Provide or arrange housing for a staff that fails to meet reasonable local housing and safety standards.
4. **Dangerous or Exploitative Child Labor:** While Habitat for Humanity actively welcomes volunteers, all HFH organizations must have standards to safeguard the labor provided by children. These standards are designed not only to prevent the economic exploitation of children, but also to protect their health, safety and morals.

At minimum, HFHI requires affiliates, national organizations, implementing partners and suppliers to comply with the child labor standards consistent with United Nations requirements, such as those detailed in Appendix C. In many countries, Habitat for Humanity organizations must also comply with the more stringent child labor standards established by their local jurisdiction (e.g. the Occupational Safety and Health Administration in the United States).

Parental or guardian permission is required for any child under the age of legal majority (usually 18 or 19) to work at a Habitat for Humanity job site.

## **(2) Habitat for Humanity's Required Reporting Protocols for Potential Safeguarding Misconduct**

### **A. Expectations for reporting**

All HFH representatives (especially managers) have a responsibility to report potential safeguarding misconduct.

- (1) HFH representatives are expected to be able to recognize and be alert for the signs of potential safeguarding misconduct, such as abuse, exploitation or neglect.
- (2) Habitat for Humanity's **Whistleblower Policy** expressly prohibits retaliation and protects individuals – including their anonymity and safety – who share good faith concerns of misconduct from retaliation or any threat of retaliation by any other HFH representative. Any person who engages in retaliation will be subject to discipline, up to and including termination of employment. (*Note: Intentional submission of false allegations is a fraudulent activity and will be handled in accordance with Habitat for Humanity's policies.*)
- (3) Significant failure to make a timely report of potential safeguarding misconduct (especially by managers) will be subject to discipline, up to and including termination of employment.

### **B. Protocols for reporting**

Any HFH representative who receives a safeguarding complaint or who has knowledge or reasonable suspicion of safeguarding misconduct (whether by a HFH representative or another aid worker) must:

- (1) **Immediately:** Notify his or her direct supervisor via established reporting protocols. If the individual has reason to believe that his or her direct supervisor may be involved in the misconduct (or feels significantly uncomfortable raising such concerns to his or her supervisor), he or she must immediately notify:
  - A higher level supervisor in his or her reporting line; or
  - The **HFHI Safeguarding Officer**, the **HFHI Internal Audit department**, or use the **MySafeWorkplace reporting tool**.
- (2) **Within 48 hours:** Also ensure that the concerns of safeguarding misconduct are entered into the **MySafeWorkplace reporting tool**, Habitat for Humanity's confidential, anonymous reporting hotline and central tracking repository for allegations of serious misconduct.
- (3) Due to the sensitivity of such situations, the individual who receives a safeguarding complaint **SHOULD NOT START ANY INVESTIGATIONS** (including gathering preliminary evidence or questioning the survivor, the accused or any potential witnesses after the initial complaint is received), but rather report the concerns to the **MySafeWorkplace reporting tool** and coordinate any follow-up actions with the HFHI Safeguarding Investigation Committee using the protocols in Section (4) below.

#### **REMEMBER**

*If you see something, say something.*

*Note: These reporting protocols do not replace, but instead supplement, the local reporting community-based feedback mechanisms (such as a dedicated local complaint email address, a local hotline, a community suggestion or complaint box, etc.) that each Habitat for Humanity organization must also have implemented to receive such concerns directly from beneficiaries and other external stakeholders. All safeguarding complaints*

*raised through community-based feedback mechanisms must be added to MySafeWorkplace within 48 hours as discussed in Section (2)B(2) above.*

### **(3) Protocols for Survivor Assistance**

Habitat for Humanity's support to alleged victims of safeguarding misconduct (or survivors) will be provided regardless of the status or outcome of an investigation. Furthermore, the HFH **Whistleblower Policy** expressly prohibits retaliation and protects individuals who share good faith concerns of misconduct from retaliation or any threat of retaliation by any other HFH representative. Upon receipt of an allegation of safeguarding misconduct, Habitat for Humanity will consider providing any or all of the following forms of survivor assistance, as appropriate depending on the nature of the allegations, the circumstances involved, and the informed consent of the survivor:

- A. Immediate material care:** Direct and/or funding support to provide for temporary needs such as trauma-informed medical care, food, clothing, or emergency and safe shelter as necessary.
- B. Psychosocial support:** Referrals and funding support to obtain appropriate psychosocial services through a local counseling organization. For example, HFHI's staff have access to such counseling through HFHI's global Employee Assistance Program. Comparable services or alternative culturally sensitive psychosocial support will be made available to survivors through appropriate local service providers.
- C. Legal and advocacy support:** Support to obtain victim advocacy services or legal counseling in order to make an informed decision about whether to pursue legal recourse. *(Note: Habitat for Humanity's legal counsel will not directly represent a survivor, as such an activity would pose an inherent conflict of interest.)*

In considering any of the above forms of support, Habitat for Humanity will consult with both the survivor and with appropriate local specialists. All decisions related to survivor assistance will be documented.

### **(4) Investigation Protocols**

Above all else, Habitat for Humanity's investigation protocols for potential safeguarding misconduct will be focused on keeping the survivor safe, minimizing harm, and conducting a thorough, impartial investigation. Safeguarding investigations will be performed only by qualified individuals who are:

- Independent from the allegations received;
- Free from the appearance or existence of bias; and
- Specifically trained in appropriate safeguarding investigation procedures.

To ensure all safeguarding investigations are handled with appropriate due diligence and professional care, HFHI has established a Safeguarding Investigation Committee to oversee all such investigations comprised of key stakeholders, including individuals who have been specifically trained in SEA investigation protocols. The basic processes that must occur during a safeguarding investigation include the following items. Further details of the role of the Safeguarding Investigation Committee and Habitat for Humanity's expected processes when conducting appropriate safeguarding investigations are available in the HFH Investigation Policy.

- A. Complaint assessment:** Upon receiving an allegation, the Safeguarding Investigation Committee (in consultation with management of the relevant Habitat for Humanity organization, where appropriate) will assess the appropriateness of an investigation based on the severity and information provided. In considering this response, Habitat for Humanity will assess factors such as: whether there is an allegation of a criminal offense, the immediate safety concerns of the survivor and other individuals involved, and risks such as loss of evidence and damage of property.

As there may be circumstances where the performance of an investigation would increase the harm to the survivor, any such actions will be taken only after full consideration of the safety and the informed consent of

the survivor, as well as Habitat for Humanity's overall duty of care to the community. The basis for all decisions related to investigation performance or non-performance will be documented.

**B. Investigation process:** After assessment of the allegations, as well as the needs and preferences of the survivor, reports of safeguarding misconduct will be either:

- (1) Investigated promptly by, or under the supervision of, HFHI Internal Audit, HFHI Human Resources, and/or the HFHI Legal department in the manner established by the HFH Investigation Policy and processes. Where appropriate during the investigation, Habitat for Humanity will consult with both the survivor and with appropriate local specialists, especially related to ensuring the safety of the survivor during and after the investigation process.
- (2) Referred to the appropriate local governmental authority for investigation or inquiry regarding the potential misconduct or violations of law.

While an investigation is going on and after an investigation, Habitat for Humanity will take appropriate steps to ensure that the survivor is provided with an environment free of exploitation, abuse, harassment or bullying. This may include reassignment of the subject of a complaint to a comparable work assignment on a temporary or permanent basis.

**C. Confidentiality:** All investigations will be performed in a manner designed to protect confidentiality and will not be disclosed or discussed with anyone other than those who have a legitimate need to know the details of the case.

**D. Documentation:** Where the investigation is performed by HFH investigators, all investigation procedures, findings and recommendations will be thoroughly documented in accordance with Habitat for Humanity's policies.

- (1) Documentation of investigation procedures will be retained in a central repository for each Habitat organization and in alignment with the HFH Record Retention Policy. To protect confidentiality, access to the information will be restricted as discussed above.
- (2) A written report or memo summarizing the investigation findings and recommendations will be prepared and provided to management for their use in initiating any appropriate remediating actions. Investigation recommendations will specifically include, but are not limited to, any recommendations related to necessary discipline of HFH representatives, any potential requirements to report findings to local authorities, and necessary improvements to any processes or controls to prevent or reduce future occurrences of the safeguarding misconduct.
- (3) Within 48 hours after the investigation finalization, a copy of the report should be uploaded to the case previously created to track the incident in Habitat for Humanity's **MySafeWorkplace reporting tool**.

**E. Communications with the survivor:** Habitat for Humanity will provide the survivor with periodic updates on the status of the investigation. In addition, Habitat for Humanity will provide the survivor with a summary of the investigation findings when the investigation is completed.

**F. Management remediating actions:** Upon receipt of the investigation report or memo, management will promptly initiate any necessary remediating actions related to investigation findings, including but not limited to:

- (1) **Internal disciplinary procedures:** If the investigation confirms the allegations of safeguarding misconduct, Habitat for Humanity will discipline the person who engaged in the safeguarding violation in accordance with the organization's normal disciplinary procedures. For staff members, disciplinary actions will be based upon the seriousness of the offense and could range from a written warning to termination of employment. For other HFH representatives (donors, board members, volunteers,

implementing partners, suppliers, etc.), the disciplinary actions will also depend on the seriousness of the offense and may result in the termination of their relationship with Habitat for Humanity.

- (2) **Pursuing legal recourse:** In addition to internal discipline, if the investigation confirms the allegations of safeguarding misconduct, Habitat for Humanity is committed to supporting and/or pursuing appropriate legal recourse in instances where a crime may have been committed. Since local laws vary on the definitions and illegality of certain behaviors (e.g. abuse, harassment, prostitution, adultery, etc.), Habitat for Humanity will consult with both the survivor and with appropriate local legal counsel, in considering whether to pursue legal recourse. The basis for all such decisions will be documented.
- (3) **Other internal remediating activities:** Habitat for Humanity's senior management (and Board where applicable) will be responsible for ensuring Habitat for Humanity promptly implements all necessary improvements to any processes or controls to prevent or reduce future occurrences of the safeguarding misconduct.

## **(5) Reporting of Safeguarding Incidents**

Habitat for Humanity is a global network and no incident happens in isolation. To increase awareness of risks and decrease the possibility of such incidents, Habitat for Humanity is committed to ensuring consistent, transparent reporting of confirmed safeguarding misconduct within the following parameters:

- A. Where required by local authorities:** Habitat for Humanity will comply with all relevant requirements related to mandatory reporting of alleged or confirmed safeguarding misconduct to local authorities. Each Habitat for Humanity organization is responsible for knowing the mandatory reporting requirements in its local jurisdiction. Examples may include instances where exploitative or abusive behavior involves a child.

All such reporting will occur after a joint consultation between the local Habitat for Humanity entity, the local legal counsel, and HFHI's key safeguarding stakeholders (e.g. the HFHI Legal, Human Resources, and/or Internal Audit departments).

- B. Where required or appropriate due to a contractual, legal or other donor obligation:** There are circumstances where it is required or appropriate for Habitat for Humanity to report alleged or confirmed safeguarding misconduct to external parties such as donors, regulators, or other governing bodies. Decisions related to "whether and what" to report externally under such circumstances will be guided by:
  - (1) Any requirements defined in Habitat for Humanity's contractual commitments to external parties (e.g. reporting requirements based on a grant agreement, etc.); and
  - (2) Any requirements for mandatory reporting of "serious incidents" that are established by charity watchdogs or other governing bodies in the relevant jurisdiction, such as required by the UK Charities Commission and other comparable organizations.

- C. As appropriate in order to raise awareness and demonstrate public accountability:** Habitat for Humanity's approach for voluntary sharing of information related to safeguarding misconduct allegations and investigations is guided by the parallel philosophies of transparency (to donors, regulators and the public) and confidentiality (for the protection of survivors).
  - (1) Habitat for Humanity may choose to report certain issues to donors or governing bodies where no clear contractual or legal requirement exists but where Habitat for Humanity determines the disclosure to be in the best interest of the public trust.
  - (2) Habitat for Humanity will ensure that the HFHI Board of Directors receives regular updates on safeguarding allegations and investigations to facilitate effective process oversight.
  - (3) At least annually, Habitat for Humanity will make available to the general public high-level information on safeguarding trends to increase awareness and public transparency.

Wherever possible, information will be presented in a way that protects the survivor's anonymity for confidentiality and safety reasons (except where relevant law might require disclosure).

## **(6) Safeguarding Protocols during Recruitment**

To uphold the principles of Safeguarding and Beneficiary and Child Protection, the following steps will be taken during Habitat for Humanity's recruitment processes, particularly for HFH representatives whose work brings them in direct contact with beneficiaries and/ or children:

### **A. Interview and selection process**

Job descriptions will contain reference to the HFH **Ethics Covenant** and Habitat for Humanity's expectations for ethical behavior (including safeguarding). Applicants are notified about required background and reference checks during selection processes. For positions that involve direct contact with beneficiaries, children or child related-projects, any gaps in employment history will be clarified and specific questions about safeguarding (e.g. child safety, situations working directly with beneficiaries or children) may be asked as part of the interview process.

### **B. Criminal background checks**

In alignment with the HFH Background Screening Policy, background checks are undertaken for all staff and certain other HFH representatives, such as those who are in direct contact with beneficiaries or children. Habitat for Humanity reserves the right to not hire staff (or engage with volunteers or contractors) with a prior conviction or misdemeanor directly or indirectly related to sexual assault or beneficiary or child abuse.

### **C. Reference checks**

All potential full-time staff undergo at least two comprehensive reference and character checks prior to being offered any position. Such checks are to be documented and filed accordingly. For full-time staff positions that involve direct contact with beneficiaries, children or child-related projects, specific questions regarding the applicant's suitability to work directly with beneficiaries or children may be asked as part of verbal reference and character checks.

Habitat for Humanity may expand the scope of individuals who receive background screening (as described above) based on additional risk factors or donor requirements in order to meet the intent of these safeguarding principles.

## **(7) Safeguarding training**

### **A. Onboarding**

At the time of onboarding, all HFH Board members, staff, contractors, and implementing partners will be required to read and acknowledge the HFH **Ethics Covenant** and Safeguarding Policy. In addition, all HFH staff will complete training related to ethics, safeguarding principles and appropriate behavior for HFH representatives.

### **B. Periodic training**

Refresher and supplementary training will be provided on a periodic basis through Habitat for Humanity's standard methods for training and behavior reinforcement, such as staff meetings, in-person training sessions and online training. In addition, for positions that involve direct contact with beneficiaries, children or child related-projects, additional in-depth training may be required. (*Note: As part of their responsibilities for creating and maintaining a safeguarding environment, managers are responsible for ensuring that the staff reporting to them complete all required training.*)

## **(8) Additional Resources**

This policy is intended to supplement and provide further context to the HFH **Ethics Covenant** and policies such as:

- HFHI's Employee Handbook
- Policy on Harassment, Bullying and Discrimination
- Whistleblower Policy
- Fraud Policy
- Volunteer Code of Conduct
- Background Screening Policy
- Gift Acceptance Policy and Procedures
- US Policy Handbook

It does not supersede or replace these documents, or other relevant HFHI resources or guidance documents (such as the [MySafeWorkplace reporting tool](#) and the [Community Based Feedback Mechanisms](#) guidance).

## Appendix A: Individual Acknowledgment

This Safeguarding Policy describes Habitat for Humanity's commitment to oppose all forms of discrimination, exploitation and abuse (especially of beneficiaries, vulnerable adults and children). I acknowledge that I have read and reviewed the requirements contained in the policy and agree that I will follow them.

I further commit to report any suspected safeguarding misconduct and to help to create and maintain an environment that prevents sexual exploitation and abuse, safeguards the rights of beneficiaries, research participants, and community members (especially vulnerable adults and children), and promotes the implementation of Habitat for Humanity's Ethics Covenant and Code of Conduct. (*Note: Managers at all levels have particular responsibilities to support and develop systems that maintain this environment.*)

I understand that I should consult with the HFHI Safeguarding Officer, Human Resources department, the Legal department or the Internal Audit department regarding any questions not answered in this policy.

---

SIGNATURE

---

DATE RECEIVED

---

NAME (TYPED OR PRINTED)

## Appendix B: Policy Acknowledgment Form for National Organizations: Safeguarding Policy

Entity name: \_\_\_\_\_

Country: \_\_\_\_\_

### INSTRUCTIONS

1. The policy acknowledgement form must be read and signed by the entity's CEO, CFO or designee. If the entity is able to comply with or meet the intent of the policy, then a copy of the policy acknowledgment form must be forwarded to the appropriate area office. The entity should maintain the original form for documentation purposes.
2. If the entity is not able to comply with or meet the intent of the policy, an exception must be requested. The exception request must be documented below and include: a) the section of the policy for which the exception is being requested; b) references to any local laws or business justifications; and c) the proposed alternative. The original of the policy acknowledgment form must be sent to the appropriate area office for review and agreement. The area office will send the original form to HFHI Internal Audit and Legal departments for final approval. The completed/approved form will be returned to the appropriate area office and the originating entity, HFHI Internal Audit, HFHI Legal department, and the area office. The entity must keep copies of the approved exception.

I hereby certify that I have read the attached policy and therefore:

I acknowledge and confirm that the attached policy has been adopted in substance by this organization.

I acknowledge and confirm that the attached policy has been adopted in substance by this organization, except for the specific paragraph(s) noted below.

### Entity acknowledgment:

\_\_\_\_\_  
Entity CEO (Print Name)   Entity CFO (Print Name)

\_\_\_\_\_  
Entity CEO (Signature)

\_\_\_\_\_  
Entity CFO (Signature)

\_\_\_\_\_  
Date

\_\_\_\_\_  
Date

**For exceptions:** Note policy section number and text for which the exception is being requested, justification for the exception, and proposed alternative:

Name (print or type):		Department:
Signature:	Full phone number:	Date:
<b>Recommend approval:</b> (area office officials must ensure sufficient detail is provided by the national office to support recommendation)		

### HFHI Legal department approval:

Name (print or type):		Department:
Signature:	Full phone number:	Date:

## Appendix C: Minimum Habitat for Humanity Child Labor Requirements

Based on United Nations guidance, the standards below are designed not only to prevent the economic exploitation of children, but also to protect their health, safety and morals. While these standards primarily discuss work on the jobsite, MyHabitat has additional resources addressing how to engage appropriately and safely with children in other areas of the Habitat for Humanity mission:

- Youth Involvement with Habitat for Humanity Worksites and Neighborhood Revitalization Initiative Activities (US resource)
- Practical guidance for engaging youth volunteers on build sites and in ReStores (US resource)

### **Dangerous work - Minimum age: 18 years**

Would include working from a height of greater than six feet or 180 cm, roofing, using power tools or electrically or gas powered equipment, the use of powder actuated tools, demolition or excavation.

### **REMEMBER**

*These are Habitat's minimum child labor requirements. Child labor standards may be more restrictive in your local jurisdiction. Consult My.Habitat resources and your local Legal department contact for more details.*

### **General work - Minimum age: 15 years**

Would include all other construction work, not considered light work or dangerous work, including carpentry, siding, plastering, flooring, laying foundations, masonry work, brick making, and finishing work. The use of hand tools would be part of general construction work.

### **Light work - Minimum age: 13 years**

Does not include general construction, or working on a site where general construction is taking place. Would include lot clearing, meal preparation, painting, landscaping, transporting supplies (weight limit appropriate to the child's capacity and not more than 5 – 7 kilos), babysitting, and other similar work. It would also include any other activities (i) which are not likely to be harmful to the health or development of children and (ii) which is not such as to prejudice their attendance at school or their capacity to benefit from the instruction received. It should include:

- simple and well-defined tasks;
- lack of physical or mental effort that could endanger the child's health or development;
- the limited number of daily and weekly hours of work;
- regular breaks and weekly rest of at least 48 hours;
- no night work.

In situations where homeowner children under the age of 13 accompany their parent or guardian to the job site, these children should do no work or, where unavoidable, only the lightest assistance of volunteer support (such as offering refreshments) or site preparation (such as picking up trash) under parental/guardian supervision.

Affiliate and national organizations should work with relevant subject matter experts in their area to develop alternative ways for children of homeowners to assist their families to complete sweat equity hours or to engage children from the community in the Habitat for Humanity mission.

## **Appendix D: Form summarizing type of info that should be submitted to MSWP re safeguarding or other misconduct**

- 1. Date of this report**
- 2. Country**
- 3. City/Province**
- 4. Date concern was identified or date and time of incident**
- 5. Specific location of concern/ incident**
- 6. Person(s) involved**

	Person's Name	Job Title or Relationship to HFH
1		
2		
3		

- 7. Description of concern/ incident**

- 8. Other witnesses (especially HFH staff) involved**

	Person's Name	Job Title or Relationship to HFH
1		
2		
3		

- 9. Was the incident the first of its kind? If not, indicate approximate dates of previous incidents/report.**

- 10. What HFH programs, grants, partners or donors may be impacted by this report?**

- 11. Name and title of person preparing this report (printed):**

- 12. Relationship of the person preparing this report to the person involved in this incident:**

- 13. Signature of person preparing this report:**

**NOTE:** Forward a copy of this report to:

- [mysafeworkplace@habitat.org](mailto:mysafeworkplace@habitat.org)
- Your designated HFH Human Resources contact
- The HFHI Safeguarding Officer

## Appendix E: Key Terms

Term	Definition
<b>HFH Representative</b>	An individual acting on behalf of Habitat for Humanity, including but not limited to board members, staff members, contractors, interns, AmeriCorps members (including VISTA members), volunteers, implementing partners, and suppliers
<b>Target Populations</b>	Individuals or groups that the humanitarian activities of the respective disaster response program or humanitarian operations are intended to serve.
<b>Beneficiary</b>	An individual who applies to receive or who receives from HFH (or its staff and volunteers) shelter assistance or another form of protection, service, or other intervention.
<b>Child</b>	A child or children are defined as persons who have not attained 18 years of age.
<b>Vulnerable Adult</b>	A person over the age of 18 with a physical, mental or life status that causes particular vulnerability (such as a physical or mental disability).
<b>Harassment</b>	Any comment or behavior that is offensive, demeaning, humiliating, derogatory, or is otherwise inappropriate or fails to respect the dignity of an individual. It can be committed by or against a beneficiary, partner, staff, official, or any other person involved in any way in the disaster response program or humanitarian operation.
<b>Human Rights</b>	International standards that recognize and protect the dignity and integrity of every individual without distinction.
<b>Sexual Abuse</b>	Any actual or threatened physical intrusion of a sexual nature (including inappropriate touching), whether by force or under unequal power dynamics or otherwise coercive conditions.
<b>Sexual Exploitation</b>	Any actual or attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another.
<b>Sexual Harassment</b>	Any unwelcome sexual advance, comment, expressed or implied sexual demand, touch, joke, gesture, or any other communication or conduct of a sexual nature (whether verbal, written or visual) that occurs between a HFH staff member and any any person whom they interact in their HFH role. For further details, see the HFH Policy on Harassment, Bullying and Discrimination.
<b>Child Abuse, Exploitation, or Neglect</b>	Constitutes any form of physical abuse; emotional ill-treatment; sexual abuse; neglect or insufficient supervision; trafficking; or commercial, transactional, labor, or other exploitation resulting in actual or potential harm to the child's health, well-being, survival, development, or dignity. It includes, but is not limited to any act or failure to act which results in death, serious physical or emotional harm to a child, or an act or failure to act which presents an imminent risk of serious harm to a child.
<b>Child Labor</b>	Exploitive work that deprives children of their childhood, their potential and their dignity, and that is harmful to physical and mental development. It refers to work that is mentally, physically, socially or morally dangerous and harmful to children; and interferes with their schooling.
<b>Child Emotional Abuse</b>	Constitutes injury to the psychological capacity or emotional stability of the child caused by acts, threats of acts, or coercive tactics. Emotional abuse may include, but is not limited to Humiliation, control, isolation, withholding of information, or any other deliberate activity that makes the child feel diminished or embarrassed.
<b>Exploitation</b>	Constitutes the abuse of a child where some form of remuneration is involved or whereby the perpetrators benefit in some manner. Exploitation represents a form of coercion and violence that is detrimental to the child's physical or mental health, development, education, or well-being.
<b>Child Neglect</b>	Constitutes failure to provide for a child's basic needs.
<b>Child Physical Abuse</b>	Constitutes acts or failures to act resulting in injury (not necessarily visible), unnecessary or unjustified pain or suffering without causing injury, harm or risk of harm to a child's health or welfare, or death. Such acts may include, but are not limited to, punching, beating, kicking, biting, throwing, stabbing, choking, or burning. These acts are considered abuse regardless of whether they were intended to hurt the child.
<b>Child Sexual Abuse</b>	Any form of sexual abuse (discussed above), indecent exposure, or exploitation through prostitution or the production of pornographic materials, which involves a child.

## Appendix F: Change history

Date	Modification	Approved by
Approved: June 21, 2019  Effective: July 1, 2019	New policy combining and replacing existing: <ul style="list-style-type: none"><li>- Policy on the Prohibition of the Promotion or Advocacy of the Legalization or Practice of Prostitution or Sex Trafficking (October 2005)</li><li>- Policy of Protection from Sexual Exploitation and Abuse in Humanitarian Crises (June 2005)</li><li>- HFHI Child Labor Policy (2005)</li></ul>	Jonathan Reckford – Chief Executive Officer Valerie Norton – Chief People Officer Hilary Harp – SVP Legal and General Counsel Juan Montalvo – VP of Internal Audit  IBOD

### **Supplier Engagement General Understanding (SEGU)**

SEGU is a binding understanding between HFHK and the vendor that defines the general terms of engagement that enables flawless operations and helps to mitigate conflicts.

The vendor commits to operating within the following general terms:

- i. The vendor shall only supply upon receiving an authorized purchase order/ contract. Orders received outside of this parameter (e.g. verbal orders) are not legitimate and HFHK shall not take liability and therefore such orders are not payable.
- ii. HFHK shall not honor Purchase Orders executed after the expiry of validity period. As a standard, POs are valid for 30 days only. However, under special circumstances, the validity period can be extended to a maximum of 60 days. Validity period shall always be indicated on the face of the authorized purchase order. After the validity period the LPO cannot be executed and thus not payable.
- iii. Vendor should not alter the prices or the quality of supplies after issuance of Purchase Order/contract.
- iv. All documents submitted by vendor to HFHK shall bear the same name. HFHK shall not make payment to a name that differs from the quotation, invoice and other supplier documents.
- v. The vendor shall issue a monthly statement to HFHK for reconciliation purposes. For contract vendor, statement shall be issued per phase or/and at the end of contract.
- vi. Vendor shall be duly registered with Kenya Revenue Authority including the mandatory use of the electronic Tax Invoice Management System (eTIMS). The vendor shall be fully compliant with the Income Tax Act, Tax Procedures Act and any other tax-related laws.
- vii. Vendors dealing in supplies that are subject to VAT shall be compliant with VAT Act including VAT registration and issuing HFHK with invoices/documents that are VAT compliant. Where the supplier is not VAT-registered for the reason of threshold, the vendor shall communicate that fact to HFHK through a signed letter on their letter head.
- viii. The vendor shall bill HFHK through an invoice. The invoice shall be uniquely identified via invoice number.
- ix. The vendor shall supply the ordered goods within working hours. This ensures the staff/ stakeholders supposed to confirm the delivery are available to confirm and for transparency purposes.
- x. The vendor shall issue the invoice with all support documents. HFHK shall not process payment for invoices lacking complete support documents. The following support documents are the responsibility of the vendor:
  - a. Delivery notes for all goods supplied to HFHK. Delivery note shall be signed by the HFHK staff/stakeholder who received the goods to confirm that the goods were supplied and received. Signing means indicating the full name, the date of supply and appending the signature.
  - b. The certificate of service with the service recipient confirms that the vendor has provided the services and that the services were satisfactory in terms of quality.

- c. Vehicle movement logs by vendors offering transport /car hire services showing vehicle movements from point to point. The log must be signed by the HFHK staff/ stakeholder who was been ferried.
- d. Guest registration for vendors providing accommodation services. The registration form must indicate the full names of the guest, date of checking in and checking out. The form must be properly signed by the staff/stakeholder being accommodated.
- e. Conference registration listing for vendors offering conference services. The listing shall be confirmed by the HFHK staff/ representative with full names, date of service and signature appended.
- xi. Vendors should adhere to safeguarding policies. The vendor shall train at their own cost all their stakeholders on safeguarding and therefore all parties interacting with HFHK shall be required to strictly observe safeguarding. To this end, the vendor shall study the policy and return a signed copy to confirm adherence.
- xii. Vendors shall observe and adhere to conflict-of-interest policy. Therefore, the vendor shall be issued with the policy and return a signed copy to confirm adherence.
- xiii. HFHK shall continuously evaluate vendor's performance based on adherence to terms stipulated in SEGU, contracts terms and general performance. Poor performance shall disqualify the vendor from current or/and future engagements.

Having read and understood the above terms of engagement, I/WE append our signatures as confirmation and commitment to full adherence.

Name of Vendor \_\_\_\_\_

Name of Vendor Signature \_\_\_\_\_

Name of Vendor representative\_\_\_\_\_

Vendor Representative Signature\_\_\_\_\_

Date of commitment \_\_\_\_\_



## CONFLICT OF INTEREST POLICY

Habitat for Humanity Kenya (HFHK) is committed to the highest standards of ethical, moral and legal conduct. All HFHK representatives (including members of the board of directors, staff, interns, contractors and volunteers) have a duty to act in the best interest of HFHK. Actual or potential conflicts of interest and related-party transactions create reputational, financial, and legal risks for Habitat. Such activities must be avoided or managed in an effective way to ensure good governance and avoid even the appearance of impropriety.

The purpose of this policy is to establish and confirm the standards for the management of actual or potential conflicts of interest for all HFHK in order to protect the reputation, operations, and resources of HFHK. An actual or potential conflict of interest occurs when a HFHK representative may receive a direct or indirect personal benefit to themselves (or to a related party) as a result of a HFHK transaction.

### **(1) Habitat for Humanity Kenya's Expectations Related to Conflicts of Interest**

HFHK representative has an actual or potential conflict of interest if he or she is in a position to influence a decision where they also have the potential for personal benefit in the HFHK transaction because of the existence of a Related Party relationship (as described in Section 1.A below). Common examples of instances where Related Party relationships may lead to potential conflicts of interest are described in Section 2.

#### **A. Defining Related Parties and Personal Benefit**

When evaluating whether an actual or potential conflict of interest may exist, a HFHK representative is considered to have the potential for personal benefit in a transaction when it impacts them directly or indirectly through a related party involving family, close friends, business, or investments. An individual, group or business that is related (in some way) to a HFHK representative is considered a "Related Party". Common examples of Related Parties that may lead to personal benefit include:

1. A close family member of a HFHK representative, such as:

- Spouse
- Parent
- Sibling
- In-law
- Child
- Grandchild

- Other family members, such as aunts, uncles, nieces, and nephews.
- Any other individual sharing the same home as the HFHK representative.

2. A close personal friend of a HFHK representative where the relationship could exert undue influence on either party.

3. An entity where a HFHK representative (or their family member or close personal friend) is a director, officer, general partner, agent or staff.

4. An individual with whom a HFHK representative or family member has a business relationship (i.e. general partner, principal, or employer).

5. An entity where a HFHK representative (or their family member or close personal friend) is a principal officer, decision-maker or financial beneficiary.

6. An entity where a HFHK representative (or their family member or close personal friend) owns at least 5% of the voting stock or controlling interest (or has any other substantial interest or dealings).

#### **B. Duty to Disclose Conflicts of Interest.**

Any Habitat representative who has an actual or potential conflict of interest involving any existing or potential HFHK transaction must complete the following steps to manage the conflict of interest and protect the interests of all parties:

##### **1. Board members and officers**

You must disclose the existence of the actual or potential conflict of interest (including a description of its nature) in writing to the full board as soon as possible after the conflict of interest arises. The disclosure shall identify all the material facts and circumstances surrounding the conflict of interest that would be necessary for the board to make an informed decision regarding whether to proceed with the transaction.

After disclosure, you must not participate in any discussion of the transaction and must abstain from voting on the matter. You should also ensure that your absence from the meeting and discussion (as well as your abstention from the vote) are recorded in the board minutes.

##### **2. Staff**

You must disclose the existence of the conflict of interest to your immediate supervisor as soon as possible after the conflict of interest arises.

You must not proceed to participate or engage in any business transaction on behalf of HFHK when you have an actual or potential conflict of interest.

#### **C. Protocols to Manage Conflicts of Interest**

Each actual or potential conflict of interest should be individually evaluated so that Habitat for Humanity Kenya makes an informed decision regarding whether to proceed with the transaction, by weighing any benefits of the transaction against possible reputational risks to the organization.

## **1. Board members and staff**

The HFHK representative may make a presentation at the board meeting about their actual or potential conflict of interest. After the presentation, he/she shall leave the meeting during the discussion of, and any votes or decisions on, the transaction involving the possible conflict of interest.

If appropriate, the chairperson of the board appoint a disinterested person or committee to investigate alternatives to the proposed transaction or arrangement.

After exercising due diligence, the board shall determine whether the Habitat for Humanity Kenya can obtain (with reasonable efforts) a more advantageous transaction or arrangement from a person or entity that would not give rise to a conflict of interest.

If a more advantageous transaction or arrangement is not reasonably possible under circumstances not producing a conflict of interest, the board shall assess by a majority vote of the disinterested directors (with a quorum present) whether the transaction is:

- In HFHK's best interest;
- For its own benefit; and
- Whether it is fair and reasonable.

Based on the above assessment, the board it shall make its decision as to whether to enter into the transaction.

## **2. Staff**

The supervisor of a staff with a potential or actual conflict of interest must acknowledge receipt of the disclosed conflict of interest in writing and then work with the National Director to ensure that adequate safeguards are put in place to protect the interests of all parties involved in the given situation.

## **D. Consequences for Inappropriately Disclosed or Managed Conflicts of Interest**

Failure to appropriately disclose or manage actual or potential conflicts of interest can cause reputational damage to the Habitat for Humanity brand and can lead to fraud. Violation of this Conflict of Interest Policy may result in disciplinary proceedings, up to and including termination of the individual's employment or relationship with Habitat for Humanity.

### **(2) Areas of Conflicts of Interest**

Common areas where actual or potential conflicts of interest arise in the HFHK network include hiring, board appointments, purchases, contracts, awards, selection of HFHK beneficiaries and other HFHK transactions. All potential and actual conflicts of interest should be managed in accordance with the protocols described in Section 1 and the further details provided below.

## **A. Nepotism**

Nepotism occurs when an individual uses their power or influence in a particular situation to favor their relatives or friends. In the Habitat for Humanity Kenya context, the potential for nepotism arises in situations such as employment, board appointments, and selection of HFHK homeowners or beneficiaries.

### **1. Hiring**

Habitat for Humanity Kenya does not prohibit the employment or volunteering of relatives or other persons with close personal relationships to current HFHK representatives. However, to guard against perceptions of favoritism and to ensure a fair, impartial hiring process and work environment, the following must occur:

The hiring process should be open and transparent. Family members should disclose their relationships with any prospective candidate and excuse themselves from any decision making processes (including establishing the position description and employment benefits) involving the family member.

Family members cannot report to each other to minimize the likelihood of conflict, discomfort or mistrust by other staff. This includes instances where family members would be in the same reporting line, such as when one family member's supervisor would report to another family member.

Family members cannot be in positions where they are making decisions that affect their own family members (e.g. salary setting, hiring, promotions, time off).

To ensure effective stewardship of funds, family members cannot be in positions where opportunities exist to approve financial transactions of other family members (e.g. purchases, travel advances, reimbursements).

Staff members who are related should not be in significant management positions within the same department.

There may be some specific jobs which, by their nature, should not be filled by anyone with family members working for Habitat for Humanity Kenya.

In addition, any individual who is an HFHK beneficiary or is related to an HFHK beneficiary should disclose the relationship in writing prior to their employment with or service to Habitat for Humanity.

**2. Beneficiary Selection and Board Appointment:** A conflict of interest may exist where the family member or close personal friend of a HFHK representative is being considered for selection as a HFHK beneficiary or to be appointed to the HFHK board. Such potential conflicts of interest should be managed in accordance with the protocols described in Section 1.

## **B. Business Gifts and Entertainment**

Business-related gifts to HFHK representatives (including services, discounts, entertainment, travel, meals, promotional materials or samples) must be examined individually and with a bias against the activity. A HFHK representative or their family must not accept gifts from an actual or potential supplier, vendor,

donor, beneficiary, business, or from professional persons with whom they carry out or to whom they may refer HFHK business (or anyone acting on their behalf), unless the following conditions are met:

**The gift is sent to the workplace, not home.**

The gift is occasional and valued at no more than \$50. If valued at more than \$50, the gift must be made available in a team space or common area for others to share (e.g., fruit baskets, boxes of candy).

Meals and other business entertainment (such as attending an event with a current or potential HFHK donor) are subject to the same standard and should be modest, infrequent and, to the extent possible, on a reciprocal basis. Any meals or entertainment which have the potential to exceed these conditions must be disclosed in advance and evaluated for appropriateness according to the protocols described in Section 1.

No HFHK representative should solicit any personal gifts, gratuities, or favors (such as employment of a family member) from existing or potential vendors.

**C. Outside Personal Business Interests and Employment**

Any outside personal activity that interferes with or influences the performance of a HFHK representative's duties for Habitat for Humanity Kenya, divides his/her loyalty, allows for a possible conflict of interest, or results in a situation involving double compensation is prohibited.

A HFHK representative must not accept payment from another organization or individual for doing work that HFHK pays him/her to do in the course of his/her service. For example, if a fee or gift is offered to a HFHK representative for the preparation or delivery of a presentation about Habitat for Humanity Kenya (or any aspect of its operations), the fee or gift should either be declined or transferred directly to HFHK

For HFHK staff, outside business activities such as simultaneous employment, financial interests (such as those described in the scenarios detailed in Section 1.A) and personal service on public bodies (other than outside Board service described in Section G) may be acceptable provided that all of the following conditions are met:

**The business activity is disclosed to HFHK**

The HFHK staff's ownership and/or participation in the business is minimal and does not interfere with his/her HFHK responsibilities.

No competitive or other commercial relationship exists between the HFHK staff's outside business activity and HFHK.

There is a potential conflict of interest if a Habitat representative takes advantage of a business opportunity that rightfully belongs to Habitat for Humanity Kenya. All such conflicts must be disclosed and managed in accordance with Section 1 of this policy.

Owning securities in a publicly traded company with which Habitat for Humanity Kenya does business is not a conflict of interest, as long as the ownership interest is minimal.

## **D. Procurement**

Purchasing decisions must be managed in accordance with this policy and with the HFHK Procurement Policy.

1. A HFHK representative who has any influence on, or financial interest in, transactions involving purchases, contracts or leases by HFHK is required to disclose any possible conflict of interest to and remove themselves from all decision-making related to the transaction using the protocols described in Section 1 of this policy. This includes any Preferred Vendors (as defined in the HFHK Procurement Policy).
2. Habitat for Humanity Kenya must not procure items from a parent, affiliate or subsidiary organization if Habitat is unable (or appears to be unable) to be impartial in conducting the procurement action.
3. If further guidance is needed about conflicts or procurement actions, HFHK staff can submit a confidential or anonymous question via MySafeWorkplace®. A free tool, MySafeWorkplace® can be accessed online or via telephone 24 hours a day, 7 days a week at the contact information shown in Section 4 below.

## **E. Use of HFHK Suppliers or Resources**

If a HFHK representative has occasion to use HFHK suppliers or contractors for personal purposes, he/she is expected to personally pay full market value for services rendered and materials provided. Similarly, if a HFHK representative uses HFHK resources for personal business or other personal purposes, he/she is expected to reimburse Habitat for Humanity Kenya for the full market value of those resources. (Note: Occasional personal use of certain HFHK resources – such as computers or printers -- may occur without triggering the need for such reimbursement.)

Any fees for outside board service must either be declined or paid to Habitat for Humanity.

## **F. Hiring of HFHK Board Members**

There is a potential conflict of interest if a HFHK board member applies for an employment position with the HFHK entity on which he/she serves as board member. All open HFHK job positions should be publically advertised in compliance with applicable labor laws (such as those related to equal employment opportunities). As part of the external recruiting process, any HFHK board member who wishes to be considered for employment must resign from the board prior to submitting an application for employment, which should be considered as part of the broader pool of qualified applicants.

In addition, no HFHK board member can apply for any position for which he/she helped design the position description, joined in recruitment activities, or participated in discussions related to establishing the compensation and benefits.

## **G. Outside Board Service**

In certain instances, a HFHK representative may be asked by Habitat for Humanity Kenya to serve on the board of another organization (either another HFHK organization or an unrelated organization) as part of his/her scope of HFHK job responsibilities. In such instances, where a HFHK representative is specifically designated to serve on HFHK's behalf, his/her duty of loyalty is divided between the board and HFHK. Guidance for how to manage such a situation is available on My. Habitat and/or through your local Legal department contact.

A HFHK staff must obtain his/her supervisor's written approval before agreeing to serve on HFHK's behalf on an outside board of directors. Approval must then be reported in writing to the National Director.

### **(3) Annual and Additional Disclosures**

1. In addition to the transaction-specific disclosures described in Section 1, all HFHK board members, officers, and key members of management must complete and sign an annual Conflict of Interest Disclosure Questionnaire to disclose any actual or potential conflicts and/or to reaffirm that they have no conflicts of interest. See Appendix C for an example.
2. Additional Resources This policy is intended to supplement and provide further context to the Habitat for Humanity Ethics Covenant and policies such as:

- Fraud Policy
- Procurement Policy
- HFHK Employee Manual

It does not supersede or replace these guidance documents.

Any suspected violations of this policy may be reported through the procedures outlined in the HFH Ethics Covenant or through the MySafeWorkplace® anonymous hotline:

- Online at the MySafeWorkplace® website.

Inside the United States, call (800) 461-9330. · Outside the United States, call collect at +1 (720) 514-4400 or find a local toll-free phone number from the MySafeWorkplace® website.

### **Appendix A: Individual Acknowledgment**

The Conflict of Interest Policy describes important information about Habitat for Humanity Kenya's expectation that, where possible, all HFHK representatives avoid conflicts of interest. Where it is not possible to avoid the conflict of interest, I understand that I should disclose the actual or potential conflict of interest using the protocols described in this policy and then recuse myself from any subsequent decision-making processes related to the transaction. I acknowledge that I have read and reviewed the requirements contained in the policy and agree that I will follow them.

I also understand that I should consult with the National Director regarding any questions not answered in this policy.

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SIGNATURE

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DATE RECEIVED

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