NORTHERN WATER SERVICES BOARD

P.O BOX 495 GARISSA

TENDER DOCUMENT

FOR

DRILLING OF LAGDIMA PRIMARY SCHOOL (WAJIR WEST) WAJIR HIGH SCHOOL (WAJIR EAST) AND ELDAS PRIMARY SCHOOL BOREHOLE IN WAJIR COUNTY

TENDER NO: NWSB/T/042/2018 – 2019

LOT 2

MARCH 2019

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ABBREVIATIONS AND ACRONYMS

CDS	Contract Data Sheet
GCC	General Conditions of Contract
IFT	Invitation for Tender
ITT	Instruction to Tenderers
PE	Procuring Entity
PM	Project Manager
PPADA 2015	Public Procurement and Aseet Disposal Act, 2015
PPDR 2006	Public Procurement and Disposal Regulations, 2006
PPOA	Public Procurement Oversight Authority
STD	Standard Tender Documents
SOR	Statement of Requirements
SP	Service Provider
TDS	Tender Data Sheet
VAT	Value Added Tax

INTRODUCTION

NORTHERN WATER SERVICES BOARD (NWSB)
TENDER NOTICE

TENDER REF NO. NWSB/T/042/2018-2019 – Lot 2

TENDER NAME. DRILLING OF LAGDIMA PRIMARY SCHOOL, WAJIR HIGH SCHOOL AND ELDAS PRIMARY SCHOOL BOREHOLE

Northern Water Services Board has received funding from the Government of Kenya towards the drilling of Lagdima Primary School, Wajir High and Eldas Primary in Wajir County.

The works will include drilling, casing and capping. Bidders should meet the following conditions

i. Registered as a drilling contractor with NCA Water Works/Ministry of Water and Santation Class B (up to 300m)

ii. Have Rotary Rigs capable of both air and mud drilling to depth of 300 meters

iii. Evidence of past experience in similar works of same nature and complexity.

iv. Have certificate of incorporation and tax compliance certificate.

Interested eligible candidates may obtain further information from and inspect the tender documents at **Northern Water Service Board, P.o Box 495-70100, Kismayu Road, Maji House Garissa, Tel 046 210 3598, Fax : 046 210 3197** during normal working hours from the Procurement office.

A Complete set of tender documents can be obtained by interested candidates upon payment of non-refundable fees of ***Kshs 1,000.00*** *per set of documents* in cash or banker's cheque payable to Northern Water Services Board or down load from our web free of charge www.nwsb.go.ke . All bidders who download the document should register with office to info@nwsb.go.ke for purposes of receiving any further clarifications or addendums.

The completed tender document in plain sealed envelope clearly marked "**TENDER FOR DRILLING OF LAGDIMA PRIMARY SCHOOL,WAJIR HIGH AND ELDAS PRIMARY BOREHOLES accompanied by a Bid security of Kshs 50,000.00 (Fifty thousand only)** should be addressed and sent to:

The Chief Executive Officer
Northern Water Services Board
P.O. Box 495-70100
GARISSA

Or may be deposited in tender box situated on the ground floor at Northern Water Services Board office Garissa so as to be received on or before **16th April 2019 at 11.00 am**. Prices quoted should be inclusive of all taxes and shall remain valid for 120 days from the closing date of the tender.

The tenders will be opened immediately thereafter in NWSB conference room in presence of bidders or their representatives who may wish to attend.

SECTION II: INSTRUCTIONS TO TENDERERS (ITT)

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A. Introduction

1. Scope of Tender

1.1 The Procuring Entity indicated in the **Tender Data Sheet** (TDS) invites Tenders for the construction of works as specified in the **Tender Data Sheet** and Sections VI (Technical Specifications) and VII (Drawings).

1.2 The successful Tenderer will be expected to complete the works by the required completion date specified in the **Tender Data Sheet.**

1.3 The objectives of the works are listed in the **Tender Data Sheet**. These are mandatory requirements. Any subsequent detail is offered to support these objectives and must not be used to dilute their importance.

2. Source of Funds

2.1 The Government of Kenya through Northern Water Services Board received a funds from the **GoK** towards the cost of the Project named in the **Tender Data Sheet.** The Government of Kenya intends to apply a part of the proceeds of this grant to payments under the Contract described in the **Tender Data Sheet**.

2.2 Payments will be made directly by the Procuring Entity (or by financing institution specified in the **Tender Data Sheet** upon request of the Procuring Entity to so pay) and will be subject in all respects to the terms and conditions of the resulting contract placed by the Procuring Entity.

3. Eligible Tenderers

3.1 A Tenderer may be a natural person, private or public company, government-owned institution, subject to sub-Clause 3.4 or any combination of them with a formal intent to enter into an agreement or under an existing agreement in the form of a joint venture, consortium, or association. In the case of a joint venture, consortium, or association, unless otherwise specified in the **Tender Data Sheet**, all parties shall be jointly and severally liable.

3.2 The Invitation for Tenders is open to all suppliers as defined in the Public Procurement and Disposal Act, 2005 and the Public Procurement and Disposal Regulations, 2006 except as provided hereinafter.

3.3 National Tenderers shall satisfy all relevant licensing and/or registration with the appropriate statutory bodies in Kenya, such as the Ministry of Public Works or the Energy Regulatory Commission.

3.4 A Tenderer shall not have a conflict of interest. All Tenderers found to have a conflict of interest shall be disqualified. A Tenderer may be considered to have a conflict of interest with one or more parties in this Tendering process, if they:

a) Are associated or have been associated in the past directly or indirectly with employees or agents of the Procuring Entity or a member of a board or committee of the Procuring Entity;

b) Are associated or have been associated in the past, directly or

indirectly with a firm or any of its affiliates which have been engaged by the Procuring Entity to provide consulting services for the preparation of the design, specifications and other documents to be used for the procurement of the works under this Invitation for Tenders;

c) Have controlling shareholders in common; or

d) Receive or have received any direct or indirect subsidy from any of them; or

e) Have the same legal representative for purposes of this Tender; or

f) Have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Tender of another Tenderer, or influence the decisions of the Procuring Entity regarding this Tendering process; or

g) Submit more than one Tender in this Tendering process, However, this does not limit the participation of subcontractors in more than one Tender, or as Tenderer and subcontractor simultaneously.

3.5 A Tenderer will be considered to have a conflict of interest if they participated as a consultant in the preparation of the design or technical specification of the project and related services that are the subject of the Tender.

3.6 Tenderers shall not be under a declaration of ineligibility for corrupt and fraudulent practices issued by the Government of Kenya in accordance with GCC sub-Clause 3.2.

3.7 Government owned enterprises in Kenya may participate only if they are legally and financially autonomous, if they operate under commercial law, are registered by the relevant registration board or authorities and if they are not a dependent agency of the Government.

3.7 Tenderers shall provide such evidence of their continued eligibility satisfactory to the Procuring Entity, as the Procuring Entity shall reasonably request.

4. One Tender per Tenderer

4.1 A firm shall submit only one Tender, in the same Tendering process, either individually as a Tenderer or as a partner in a joint venture pursuant to ITT Clause 5.

4.2 No firm can be a subcontractor while submitting a Tender individually or as a partner of a joint venture in the same Tendering process.

4.3 A firm, if acting in the capacity of subcontractor in any Tender, may participate in more than one Tender but only in that capacity.

4.4 A Tenderer who submits or participates in more than one Tender (other than as a subcontractor or in cases of alternatives that have been permitted or requested) will cause all the Tenders in which the Tenderer has participated to be disqualified.

5. Alternative Tenders by Tenderers

5.1 Tenderers shall submit offers that comply with the requirements of the Tendering documents, including the basic Tenderer's technical design as indicated in the specifications and Drawings and Bill of Quantities. Alternatives will not be considered, unless specifically allowed for in the **Tender Data Sheet**. If so allowed, sub-Clause 5.2 and 5.3 shall govern.

5.2 When alternative times for completion are explicitly invited, a statement to that effect will be included in the **Tender Data Sheet** as will the method of evaluating different times for completion.

5.3 If so allowed in the **Tender Data Sheet**, Tenderers wishing to offer technical alternatives to the requirements of the Tendering documents must also submit a Tender that complies with the requirements of the Tendering documents, including the basic technical design as indicated in the specifications. In addition to submitting the basic Tender, the Tenderer shall provide all information necessary for a complete evaluation of the alternative by the Procuring Entity, including technical specifications, breakdown of prices, and other relevant details. Only the technical alternatives, if any, of the lowest evaluated Tenderer conforming to the basic technical requirements shall be considered by the Procuring Entity.

6. Cost of Tendering

6.1 The Tenderer shall bear all costs associated with the preparation and submission of its Tender, and the Procuring Entity shall in no case be responsible or liable for those costs, regardless of the conduct or outcome of the Tendering process.

7. Site Visit and Pre-Tender Meeting

7.1 The Tenderer, at the Tenderer's own responsibility and risk, is advised to visit and examine the Site of Works and its surroundings and obtain all information that may be necessary for preparing the Tender and entering into a contract for construction of the Works. The costs of visiting the Site shall be at the Tenderer's own expense.

7.2 The Procuring Entity may conduct a site visit and a pre-Tender meeting. The purpose of the pre-Tender meeting will be to clarify issues and to answer questions on any matter that may be raised at that stage.

7.3 The Tenderer's designated representative is invited to attend a site visit and pre-Tender meeting which, if convened, will take place at the venue and time stipulated in the **Tender Data Sheet**.

7.4 The Tenderer is requested as far as possible, to submit any questions in writing or by electronic means to reach the procuring Entity before the pre-Tender meeting. It may not be practicable at the meeting to answer all questions, but questions and responses will be transmitted in accordance with sub-Clause 7.5.

7.5 Minutes of the pre-Tender meeting, including the text of the questions raised and the responses given together with any responses prepared after the pre-Tender meeting will be transmitted within the time stated in the **Tender Data Sheet** to all purchasers of the Tendering documents. Any modification of the Tendering documents listed in sub-Clause 8.1 that may become necessary as a result of the pre-Tender meeting shall be made by the Procuring Entity exclusively through the issue of an Addendum pursuant to ITT sub Clause 10.2 and not through the minutes of the pre-Tender meeting.

7.6 Non attendance during the site visit or pre-Tender meeting will not be a cause for disqualification of a Tenderer unless specified to the contrary in the **Tender Data Sheet**.

B. Tendering Documents

8. Content of Tendering Documents

8.1 The works required, Tendering procedures, and contract terms are prescribed in the Tendering Documents. In addition to the Section I Invitation for Tenders, Tendering documents which should be read in conjunction with any addenda issued in accordance with ITT sub Clause 10.2 include:

Section II Instructions to Tenderers
Section III Tender Data Sheet
Section IV General Conditions of Contract
Section V Contract Data Sheet
Section VI Specifications
Section VII Drawings
Section VIII Bill of Quantities
Section IX Forms of Tender

- Form of Tender
- Appendix to Tender
- Confidential Business Questionnaire
- Integrity Declaration
- Letter of Acceptance
- Form of Contract Agreement

Section X Forms of Security

- Tender Security Form
- Tender Securing Declaration
- Performance Bank or Insurance Guarantee
- Advance Payment Guarantee

Section XI Form RB 1 Application to Public Procurement Administrative Review Board

8.2 The number of copies to be completed and returned with the Tender is specified in the **Tender Data Sheet.**

8.3 The Invitation for Tenders (Section I) issued by the Procuring Entity is not part of the Tendering Documents and is included for reference purposes only. In case of discrepancies between the Invitation for Tenders and the Tendering Documents listed in sub-Clause 8.1 above, the said Tendering Documents will take precedence.

8.4 The Procuring Entity is not responsible for the completeness of the Tendering Documents and their addenda, if they were not obtained directly from the authorized staff of the Procuring Entity.

8.5 The Tenderer is expected to examine all instructions, forms, terms and specifications in the Tendering documents. Failure to furnish all information required by the Tendering Documents or to submit a

Tender substantially responsive to the Tendering documents in every respect will be at the Tenderer's risk and may result in the rejection of its Tender.

9. Clarification of Tendering Documents

9.1 A prospective Tenderer requiring any clarification of the Tendering documents may notify the Procuring Entity in writing, e-mail or facsimile at the Procuring Entity's address indicated in the **Tender Data Sheet**.

9.2 The Procuring Entity will within the period stated in the **Tender Data Sheet** respond in writing to any request for clarification provided that such request is received no later than the period indicated in the **Tender Data Sheet** prior to the deadline for the submission of Tenders prescribed in sub-Clause 22.1.

9.3 Copies of the procuring entity's response will be forwarded to all Purchasers of the Tendering documents, including a description of the inquiry, but without identifying its source.

9.4 Should the Procuring Entity deem it necessary to amend the Tendering documents as a result of a clarification, it shall do so following the procedure under ITT Clause 10.

10. Amendments of the Tendering Documents

10.1 Before the deadline for submission of Tenders, the Procuring Entity may, for any reason, whether at its own initiative or in response to a clarification requested by a prospective Tenderer, modify the Tendering documents by issuing addenda.

10.2 Any addendum issued shall be part of the Tender documents pursuant to sub-Clause 8.1 and shall be communicated in writing, by e-mail or facsimile to all who have obtained the Tendering documents directly from the Procuring Entity.

10.3 In order to allow prospective Tenderers reasonable time in which to take an addendum into account in preparing their Tenders, the Procuring Entity at its discretion shall extend, as necessary, the deadline for submission of Tenders, in accordance with sub-Clause 22.2

C. Preparation of Tenders

11. Language of Tender

11.1 The Tender, and all correspondence and documents related to the Tender exchanged by the Tenderer and the Procuring Entity shall be written in the Tender language stipulated in the **Tender Data Sheet**. Supporting documents and printed literature furnished by the Tenderer may be in another language provided they are accompanied by an accurate translation of the relevant passages in the above stated language, in which case, for purposes of interpretation of the Tender, the translation shall prevail.

12. Documents Constituting the Tender

12.1 The Tender submitted by the Tenderer shall consist of the following components:

a) The Form of Tender (in the format indicated in Section IX)

completed in accordance with ITT Clause 15, 16 and 17;

b) Information requested by Instructions to Tenderers ITT sub-Clause 13.2; 13.3 and 13.4;

c) Tender Security or Tender Securing Declaration in accordance with Instructions to Tenderers ITT Clause 19;

d) Priced Bill of Quantities;

e) Qualification Information Form and Documents;

f) Alternative offers where invited in accordance with Instructions to Tenderers ITT Clause 5;

g) Written confirmation authorizing the signatory of the Tender to commit the Tenderer in accordance with Instructions to Tenderers ITT sub Clause 19.2; and

h) And any information or other materials required be completing and submitting by Tenderers, as specified in the **Tender Data Sheet**.

13. Documents Establishing Eligibility and Qualifications of the Tenderer

13.1 Pursuant to ITT Clause 13, the Tenderer shall furnish, as part of its Tender, documents establishing the Tenderer's eligibility to Tender and its qualifications to perform the contract if its Tender is accepted.

13.2 In the event that pre-qualification of potential Tenderers has been undertaken, only Tenders from pre-qualified Tenderers will be considered for award of contract. These qualified Tenderers should submit their Tenders with any information updating the original pre-qualification applications or, alternatively, confirm in their Tenders that the originally submitted pre-qualification information remains essentially correct as of the date of Tender submission. The update or confirmation should be provided in Section IX.

13.3 If the Procuring Entity has not undertaken pre-qualification of potential Tenderers, to qualify for award of the contract, Tenderers shall meet the minimum qualifying criteria specified in the **Tender Data Sheet**:

13.4 Tenders submitted by a joint venture of two or more firms as partners shall comply with the following requirements, unless otherwise stated in the **Tender Data Sheet**:

a) The Tender shall include all the information listed in the **Tender Data Sheet** pursuant to sub-Clause 13.3 above for each joint venture partner;

b) The Tender shall be signed so as to be legally binding on all partners;

c) One of the partners will be nominated as being in charge, and this authorization shall be evidenced by submitting a power of

attorney signed by legally authorized signatories of all the partners;

d) The partner in charge shall be authorized to incur liabilities and receive instructions for and on behalf of any and all partners of a joint venture and the entire execution of the Contract, including payment, shall be done exclusively with the partner in charge;

e) All partners of the joint venture shall be liable jointly and severally for the execution of the contract in accordance with the contract terms and a statement to this effect shall be included in the authorization mentioned under (c) above as well as in the Tender and in the Agreement (in case of a successful Tender); and

f) A copy of the joint venture agreement entered into by all partner shall be submitted with the Tender. Alternatively, a Letter of Intent to execute a joint venture agreement in the event of a successful Tender shall be signed by all partners and submitted with the Tender, together with a copy of the proposed Agreement.

g) The Tender Security and Tender Securing Declaration as stated in accordance with ITT Clause 19, and in case of a successful Tender, the Agreement, shall be signed so as to be legally binding on all partners.

14. Lots Package

14.1 When Tendering for more than one contract under the lots arrangements, the Tenderer must provide evidence that it meets or exceeds the sum of all the individual requirements for the lots being tendered in regard to:

a) Average annual turnover;
b) Particular experience including key production rates;
c) Financial means, etc;
d) Personnel capabilities; and
e) Equipment capabilities.

14.2 In case the Tenderer fail to fully meet any of these criteria, it may be qualified only for those lots for which the Tenderer meets the above requirement.

15. Form of Tender

15.1 The Tenderer shall fill the Form of Tender furnished in the Tendering Documents. The Form of Tender must be completed without any alterations to its format and no substitute shall be accepted.

16. Tender Prices

16.1 The Contract shall be for the whole Works, as described in sub-Clause 1.1, based on the priced Bill of Quantities submitted by the Tenderer.

16.2 The Tenderer shall fill in rates and prices for all items of the Works described in the Bill of Quantities. Items for which no rate or price

is entered by the Tenderer will not be paid for by the Procuring Entity when executed and shall be deemed covered by the other rates and prices in the Bill of quantities.

16.3 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 Tenders, shall be included in the rates, prices and total Tender price submitted by the Tenderer.

16.4 The rates and prices quoted by the Tenderer shall be subject to adjustment during the performance of the Contract if provided for in the **Tender Data Sheet** and the provisions of the Conditions of Contract. The Tenderer shall submit with the Tender all the information required under the **Contract Data Sheet**.

17. Tender Currencies

17.1 The unit rates and prices shall be quoted by the Tenderer in the currency as specified in the **Tender Data Sheet.**

17.2 Tenderers shall indicate details of their expected foreign currency requirements in the Tender, if any. The rates of exchange to be used by the Tenderers in arriving at the local currency equivalent shall be the selling rates for similar transactions established by the authority specified in the **Tender Data Sheet** prevailing on the date 28 days prior to the latest deadline for submission of Tenders. These exchange rates shall apply for all payments so that no exchange risk will be borne by the Tenderer. In any case, payments will be computed using the rates quoted in the Tender.

17.3 Tenderers may be required by the Procuring Entity to clarify their foreign currency requirements and to substantiate that the amounts included in the rates and prices and in the Contract Data Sheet are reasonable and responsive to sub-Clause 17.1.

18. Tender Validity Period

18.1 Tenders shall remain valid for the period specified in the **Tender Data Sheet** after the Tender submission deadline prescribed by the Procuring Entity, pursuant to ITT Clause 22. A Tender valid for a shorter period shall be rejected by the Procuring Entity as non responsive.

18.2 In exceptional circumstances, prior to expiry of the original Tender validity period, the Procuring Entity may request that the Tenderers extend the period of validity for a specified additional period. The request and the Tenderers' responses shall be made in writing or by cable. A Tenderer may refuse the request without forfeiting its Tender Security or causing to be executed its Tender Securing declaration. A Tenderer agreeing to the request will not be required or permitted to otherwise modify the Tender, but will be required to extend the validity of its Tender Security or Tender Securing declaration for the period of the extension, and in compliance with ITT Clause 19 in all respects.

18.3 In the case of fixed price contracts, if the award is delayed by a period exceeding sixty (60) days beyond the expiry of the initial Tender validity period, the contract price will be increased by a factor specified in the request for extension. The Tender evaluation

shall be based on the Tender price without taking into consideration on the above correction.

19. Tender Security and Tender Securing Declaration

19.1 Pursuant to ITT Clause 12, where required in the **Tender Data Sheet**, the Tenderer shall furnish as part of its Tender, a Tender Security in original form and in the amount and currency specified in the **Tender Data Sheet** .
A Tender Securing Declaration as specified in the **Tender Data Sheet** in the format provided in section X shall be provided as a mandatory requirement.

19.2 The Tender Security or Tender Securing Declaration is required to protect the Procuring Entity against the risk of Tenderer's conduct which would warrant the security's forfeiture, pursuant to ITT sub-Clause 19.9.

19.3 The Tender Security shall be denominated in the currency of the Tender and shall be in one of the following forms:

a) A Bank Guarantee;
b) An Insurance Bond issued by an insurance firm approved by the PPOA located in Kenya

c) An irrevocable letter of credit issued by a reputable bank.

19.4 The Tender Security shall be in accordance with the Form of the Tender Security included in Section X or another form approved by the Procuring Entity prior to the Tender submission.

19.5 The Tender Security shall be payable promptly upon written demand by the Procuring Entity in case any of the conditions listed in sub-Clause 19.8 are invoked.

19.6 Any Tender not accompanied by a Tender Security in accordance with sub-Clauses 19.1 or 19.3 shall be rejected by the Procuring Entity as non-responsive, pursuant to ITT Clause 28.

19.7 The Procuring Entity shall immediately release any Tender Security if:

a) The procuring proceedings are terminated;

b) The Procuring Entity determines that none of the submitted Tenders is responsive;

c) A contract for the procurement is entered into.

19.8 The Tender Security shall be forfeited and the Tender Securing Declaration executed if the Tenderer:

a) Withdraws its Tender after the deadline for submitting Tenders

but before the expiry of the period during which Tenders must remain valid;

b) Rejects a correction of an arithmetic error pursuant to sub-Clause 29.2;

c) Refuse to enter into a written contract in accordance with ITT Clause 40;

d) Fails to furnish the Performance Security in accordance with ITT Clause 41.

19.9 The Tender Security and Tender Securing Declaration of a joint venture must be in the name of the joint venture submitting the Tender.

19.10 A Tenderer shall be suspended from being eligible for Tendering in any contract with the Procuring Entity for the period of time indicated in the Tender Securing Declaration:

a) If the Tenderer withdraws its Tender, except as provided in ITT sub-Clauses 18.2 and 29.2; or

b) In the case of a successful Tenderer, if the Tenderer fails within the specified time limit to:

(i) Sign the contract; or

(ii) Furnish the required Performance Security.

20. Format and Signing of Tender

20.1 The Tenderer shall prepare one original of the documents comprising the Tender as described in ITT Clause 12 of these Instructions to Tenderers, with the Form of Tender, and clearly marked **"ORIGINAL"**. In addition, the Tenderer shall submit copies of the Tender, in the number specified in the **Tender Data Sheet**, and clearly marked as **"COPIES"**. In the event of discrepancy between them, the original shall prevail.

20.2 The original and all copies of the Tenders 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 Tenderer. This authorization shall consist of a written confirmation as specified in the **Tender Data Sheet** and shall be attached to the Tender. The name and position held by each person signing the authorization must be typed or printed below the signature. All pages of the Tender, except for un-amended printed literature, shall be initialled by the person or persons signing the Tender.

20.3 Any interlineations, erasures, or overwriting shall be valid only if they are initialled by the person or persons signing the Tender.

20.4 The Tenderer shall furnish information as described in the Form of Tender on commissions or gratuities, if any, paid or to be paid to agents relating to this Tender and to contract execution if the Tenderer is awarded the contract

D. Submission of Tenders

21. Sealing and Marking of Tenders

21.1 The Tenderer shall seal the original and each copy of the Tender in separate envelopes, duly marking the envelopes as **"ORIGINAL"** and **"COPY"**. The envelopes shall then be sealed in an outer envelope securely sealed in such a manner that opening and resealing cannot be achieved undetected.

21.2 The inner and outer envelopes shall:

a) Be addressed to the Procuring Entity at the address given in the **Tender Data Sheet**; and

b) Bear the Project name indicated in the **Tender Data Sheet**, the Invitation for Tenders (IFB) title and number indicated in the **Tender Data Sheet**, and a statement: **"DO NOT OPEN BEFORE,"** to be completed with the time and the date specified in the **Tender Data Sheet**, pursuant to ITT sub-Clause 22.1.

21.3 In addition to the identification required in sub-Clause 21.2, the inner envelopes shall also indicate the name and address of the Tenderer to enable the Tender be returned unopened in case it is declared late, pursuant to sub-Clause 22.1 and for matching purpose under ITT Clause 23

21.4 If the outer envelope is not sealed and marked as required by ITT sub clause 21.2, the Procuring Entity shall assume no responsibility for misplacement or premature opening of the Tender.

22. Deadline for Submission of Tenders

22.1 Tenders shall be received by the Procuring Entity at the address specified under ITT sub-Clause 21.2 no later than the date and time specified in the **Tender Data Sheet.**

22.2 The Procuring Entity may, in exceptional circumstances and at its discretion, extend the deadline for the submission of Tenders by amending the Tendering documents in accordance with ITT Clause 9, in which case all rights and obligations of the Procuring Entity and Tenderers previously subject to the deadline will thereafter be subject to the new deadline.

22.3 The extension of the deadline for submission of Tenders shall not be made later than the period specified in the **Tender Data Sheet** before the expiry of the original deadline.

23. Late Tenders

23.1 The Procuring Entity shall not consider for evaluation any Tender that arrives after the deadline for submission of Tenders, in accordance with ITT Clause 22.

23.2 Any Tender received by the Procuring Entity after the deadline for submission of Tenders shall be declared late, rejected and returned unopened to the Tenderer

24. Modification, Substitution and Withdrawal of Tenders

24.1 A Tenderer may modify or substitute or withdraw its Tender after it has been submitted, provided that written notice of the modification, including substitution or withdrawal of the Tender, is received by the Procuring Entity prior to the deadline prescribed for submission of Tenders prescribed under ITT sub-Clause 22.1.

24.2 The Tenderer's modification or substitution or withdrawal notice shall be prepared, sealed, marked, and dispatched in accordance with the provisions of ITT Clauses 20 and 21 with the outer and inner envelopes additionally marked "**MODIFICATION**" or **SUBSTITUTION** or "**WITHDRAWAL"** as appropriate. The notice may also be sent by electronic mail and facsimile, but followed by a signed confirmation copy, postmarked not later than the deadline for submission of Tenders.

24.3 No Tender may be withdrawn, replaced or modified in the interval between the deadline for submission of Tenders and the expiration of the period of Tender validity specified by the Tenderer on the Tender Form. Withdrawal of a Tender during this interval shall result in the Tenderer's forfeiture of its Tender Security or execution of Tender Securing Declaration, pursuant to the ITT sub-Clause 19.9.

24.4 Withdrawal of a Tender between the deadline for submission of Tenders and the expiration of the period of Tender validity specified in the **Tender Data Sheet** or as extended pursuant to sub-Clause 22.2 shall result in the forfeiture of the Tender Security and execution of Tender Securing Declaration pursuant to ITT sub-Clause 19.9.

24.5 Tenderers may only offer discounts to, or otherwise modify the prices of their Tenders by submitting Tender modifications in accordance with this Clause, or included in the original Tender submission.

E. Opening and Evaluation of Tenders

25. Opening of Tenders

25.1 The Procuring Entity will open all Tenders including modifications, substitution or withdraw notices made pursuant to ITT Clause 24, in public, in the presence of Tenderers or their representatives who choose to attend and other parties with legitimate interest and Tender proceedings, at the place on the date and at time specified in the **Tender Data Sheet**. The Tenderers' representatives who are present shall sign a register as proof of their attendance.

25.2 Envelopes marked **"WITHDRAWAL"** shall be opened and read out first. Tenders for which an acceptable notice

of withdrawal has been submitted pursuant to ITT Clause 24 shall not be opened but returned to the Tenderer. If the withdrawal envelope does not contain a copy of the "Power of Attorney" confirming the signature as a person duly authorized to sign on behalf of the Tenderer, the corresponding Tender will be opened. Subsequently, all envelopes marked **"MODIFICATION"** shall be opened and the submissions therein read out in appropriate detail. Thereafter all envelopes marked or **"SUBSTITUTION"** opened and the submissions therein read out in appropriate detail.

25.3 All other envelopes shall be opened one at a time. The Tenderers' names, the Tender prices, the total amount of each Tender and of any alternative Tender (if alternatives have been requested or permitted), any discounts, the presence or absence of Tender security, and such other details as the appropriate tender opening committee may consider appropriate, will be announced by the Secretary of the Tender Opening Committee at the opening.

25.4 Tenders or modifications that are not opened and not read out at Tender opening shall not be considered further for evaluation, irrespective of the circumstances. In particular, any discount offered by a Tenderer which is not read out at Tender opening shall not be considered further.

25.5 Tenderers are advised to send in a representative with the knowledge of the content of the Tender who shall verify the information read out from the submitted documents. Failure to send a representative or to point out any un-read information by the sent Tenderer's representative shall indemnify the Procuring Entity against any claim or failure to read out the correct information contained in the Tenderer's Tender.

25.6 No Tender will be rejected at Tender opening except for late Tenders which will be returned unopened to the Tenderer, pursuant to ITT Clause 23.

25.7 The Secretary of the appropriate tender opening committee shall prepare minutes of the Tender opening. The record of the Tender opening shall include, as a minimum: the name of the Tenderers and whether or not there is a withdrawal, substitution or modification, the Tender price per Lot if applicable, including any discounts and alternative offers and the presence or absence of a Tender Security or Tender Securing Declaration.

25.8 The Tenderers' representatives who are present shall be requested to sign the record. The omission of a Tenderer's signature on the record shall not invalidate the contents and affect the record.

25.9 A copy of the minutes of the Tender opening shall be

furnished to individual Tenderers upon request.

26. Confidentiality

26.1 Information relating to the examination, clarification, evaluation, and comparison of Tenders and recommendations for the award of a Contract shall not be disclosed to Tenderers or any other persons not officially concerned with such process until the award to the successful Tenderer has been announced.

26.2 Any effort by a Tenderer to influence the Procuring Entity's processing of Tenders or award decisions may result in the rejection of his Tender.

26.3 Notwithstanding sub-Clause 26.2, from the time of Tender opening to the time of Contract award, if any Tenderer wishes to contact the Procuring Entity on any matter related to the Tendering process, it should do so in writing.

27. Clarification of Tenders

27.1 To assist in the examination, evaluation, comparison of Tenders and post-qualification of the Tenderer, the Procuring Entity may, at its discretion, ask a Tenderer for clarification of its Tender including breakdown of prices. Any clarification submitted by a Tenderer that is not in response to a request by the Procuring Entity shall not be considered.

27.2 The request for clarification and the response shall be in writing. No change in the prices or substance of the Tender shall be sought, offered, or permitted except to confirm the correction of arithmetic errors discovered by the Procuring Entity in the evaluation of Tenders in accordance with ITT Clause 29.

27.3 From the time of Tender opening to the time of Contract award if any Tenderer wishes to contact the Procuring Entity on any matter related to the Tender it should do so in writing.

28. Preliminary Examination of Tenders

28.1 Prior to the detailed evaluation of Tenders, the Procuring Entity will determine whether:

a) The Tender has been submitted in the required format;

b) Any Tender Security submitted is in the required form, amount and validity period;

c) The Tender has been signed by the person lawfully authorized to do so;

d) The required number of copies of the Tender have been submitted;

e) The Tender is valid for the period required;

f) All required documents and information have been

submitted; and

g) Any required samples have been submitted.

28.2 The Procuring Entity will confirm that the documents and information specified under ITT Clause 12 and ITT Clause 13 have been provided in the Tender. If any of these documents or information is missing, or is not provided in accordance with the Instructions to Tenderers, the Tender shall be rejected.

28.3 The Procuring Entity may waive any minor informality, nonconformity, or irregularity in a Tender which does not constitute a material deviation, provided such waiver does not prejudice or affect the relative ranking of any Tenderer

28.4 A substantially responsive Tender is one which conforms to all the terms, conditions, and specifications of the Tendering documents, without material deviation or reservation. A material deviation or reservation is one that:

a) Affects in any substantial way the scope, quality, or execution of the Works;

b) Limits in any substantial way, inconsistent with the Tendering documents, the Procuring Entity's rights or the Tenderer's obligations under the Contract; or

c) If rectified, would affect unfairly the competitive position of other Tenderers presenting substantially responsive Tenders.

28.5 If a Tender is not substantially responsive, it will be rejected by the Procuring Entity, and may not subsequently be made responsive by correction or withdrawal of the non-conforming deviation or reservation.

29. Correction of Errors

29.1 Tenders determined to be substantially responsive will be not be checked by the Procuring Entity for any arithmetic errors. Errors will be not corrected by the Procuring Entity as follows:

a) Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern.

29.2 The amount stated in the Tender will, be adjusted by the Procuring Entity in accordance with the above procedure for the correction of errors and, with, the concurrence of the Tenderer, shall be considered as binding upon the Tenderer. If the Tenderer does not accept the corrected amount, its Tender will then be rejected, and the Tender Security may be forfeited and the Tender Securing Declaration may be executed in accordance with sub-Clause 19.9.

30. Conversion to Single Currency

30.1 To facilitate the evaluation and comparison, the Procuring Entity will convert all Tender prices expressed in the amounts in various currencies in which the Tender prices are payable to Kenya Shillings at the selling exchange rate established for similar transactions by the Central Bank of Kenya ruling on the date specified in the **Tender Data Sheet**.

31. Comparison of Tenders

31.1 The Procuring Entity shall evaluate and compare only the Tenders determined to be substantially responsive in accordance with ITT Clause 28.

31.2 In evaluating the Tenders, the Procuring Entity will determine for each Tender the evaluated Tender price by adjusting the Tender price as follows:
Making any correction for errors pursuant to ITT Clause 29;
Excluding provisional sums and the provision, if any for contingencies in the Bill of Quantities, but including Day work , where priced competitively ; and
Making appropriate adjustments to reflect discounts or other price modifications offered in accordance with sub-Clause 24.5.

31.3 The Procuring Entity 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 Tenderer. Variations, deviations, and alternative offers and other factors, which are in excess of the requirements of the Tendering documents or otherwise result in unsolicited benefits for the Procuring Entity will not be taken into account in Tender evaluation.

32. National Preference

32.1 In the evaluation of Tenders the Procuring Entity shall apply exclusive preference to citizens of Kenya where:

a) The funding is 100% from the Government of Kenya or a Kenyan body;

b) The amounts are below the prescribed threshold of KShs.200 million;

32.2 To qualify for the preference the candidate shall provide evidence of eligibility by:

a) Proving Kenyan citizenship by production of a Kenyan Identity Card; or

b) Providing proof of being a “citizen contractor” in terms of section 3(1) of the Act, i.e. being a natural person or an incorporated company wholly owned and controlled by persons who are citizens of Kenya.

32.3 The Minister of Finance may prescribe additional preference and/or reservation schemes, for example for procurements above these thresholds. If such additional preference schemes apply, details will be given in the **Tender Data Sheet**.

33. Determination of the Lowest Evaluated Tender

33.1 The Tender with the lowest evaluated price from among those which are eligible, compliant and substantially responsive shall be the lowest evaluated Tender.

34. Post-qualification of Tenderer

34.1 If specified in the **Tender Data Sheet**, post-qualification shall be undertaken.

34.2 The Procuring Entity will determine to its satisfaction whether the Tenderer that is selected as having submitted the lowest evaluated responsive Tender is qualified to perform the contract satisfactorily, in accordance with the criteria listed in sub-Clause 13.3.

34.3 The determination will take into account the Tenderer's financial, technical, and production capabilities. It will be based upon an examination of the documentary evidence of the Tenderer's qualifications submitted by the Tenderer, pursuant to sub-Clause 13.3, as well as such other information as the Procuring Entity deems necessary and appropriate. Factors not included in these Tendering documents shall not be used in the evaluation of the Tenderer's qualifications.

34.4 An affirmative determination will be a prerequisite for award of the contract to the Tenderer. A negative determination will result in rejection of the Tenderer's Tender, in which event the Procuring Entity will proceed to the next lowest evaluated Tender to make a similar determination of that Tenderer's capabilities to perform satisfactorily.

F. Award of Contract

35. Criteria of Award

35.1 Subject to ITT Clause 35 and 36, the Procuring Entity will award the Contract to the Tenderer whose Tender has been determined to be substantially responsive to the Tendering documents and who has offered the lowest Evaluated Tender Price, provided that such Tenderer has been determined to be:

a) Eligible in accordance with the provisions of ITT Clause 3;

b) Is determined to be qualified to perform the Contract satisfactorily;

c) Successful negotiations have been concluded.

35.2 If, pursuant to sub-Clause 14.1, this Contract is being awarded on a "lot and package" basis, the lowest evaluated Tender price will be determined when evaluating this Contract in conjunction with other Contracts to be awarded concurrently, taking into account any discounts offered by the Tenderer for award of more than one Contract.

36. Clarifications

36.1 Clarifications may be undertaken with the lowest evaluated Tenderer relating to the following areas:

a) A minor alteration to the technical details of the statement of requirements;

b) Reduction of quantities for budgetary reasons, where the reduction is in excess of any provided for in the Tendering documents;

c) A minor amendment to the Contract Data Sheet;

d) Finalizing payment arrangements;

e) Mobilization arrangements;

f) Agreeing final delivery or work schedule to accommodate any changes required by the Procuring Entity;

g) The methodology or staffing; or

h) Clarifying details that were not apparent or could not be finalized at the time of Tendering.

36.2 Clarifications shall not change the substance of the tender.

37. Procuring Entity's Right to Accept any Tender and to Reject any or all Tenders

37.1 Notwithstanding ITT Clause 35, the Procuring Entity reserves the right to accept or reject any Tender, and to cancel the Tendering process and reject all Tenders, at any time prior to the award of Contract, without thereby incurring any liability to the affected Tenderer or Tenderers.

37.2 Notice of the rejection of all Tenders shall be given promptly within 14 days to all Contractors that have submitted Tenders.

37.3 The Procuring Entity shall upon request communicate to any Tenderer the grounds for its rejection of its Tenders, but is not required to justify those grounds.

38. Procuring Entities Right

38.1 The Procuring Entity reserves the right at the time

to Vary Quantities at the Time of Award

of contract award to increase or decrease the quantity of goods or related services originally specified in these Tendering documents (schedule of requirements) provided this does not exceed by the percentage indicated in the **Tender Data Sheet**, without any change in unit price or other terms and conditions of the Tender and Tendering documents.

39. Notification of Award

39.1 The Tenderer whose Tender has been accepted will be notified of the award by the Procuring Entity prior to expiration of the Tender validity period by e-mail or facsimile confirmed by registered letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") will state the sum that the Procuring Entity will pay the Contractor in consideration of the provision and maintenance of the Work(s) as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").

39.2 The notification of award will constitute the formation of the Contract, subject to the Tenderer furnishing the Performance Security in accordance with ITT Clause 41 and signing the Contract in accordance with sub-Clause 40.2

39.3 At the same time as the person submitting the successful Tender is notified, the Procuring Entity will notify each unsuccessful Tenderer, the name of the successful Tenderer and the Contract amount and will discharge the Tender Security and Tender Securing Declaration of the Tenderer pursuant to ITT sub Clause 19.7.

39.4 If, after notification of award, a Tenderer wishes to ascertain the grounds on which it's Tender or application for pre-qualification was unsuccessful, it should address its request to the secretary of the Tender Committee that authorized the award of contract. The secretary of the Tender Committee shall, within fourteen days after a request, provide written reasons as to why the Tender, proposal or application to be pre-qualified was unsuccessful. However, failure to take this opportunity to clarify the grounds for rejection does not affect the Tenderer's right to seek immediate review by the Public Procurement Administrative Review Board under Clause 45.

40. Signing of Contract

40.1 Promptly, and in no case later than 14 days, after notification, Procuring Entity shall send the successful Tenderer the Agreement and Contract Data Sheet, incorporating all agreements between the parties obtained as a result of Contract

negotiations.

40.2 Within the period specified in the notification or Tender Data Sheet but not earlier than fourteen (14) days since notification of award of contract, the successful Tenderer shall sign and date the contract and return it to the Procuring Entity.

41. Performance Security

41.1 Within thirty (30) days but after 14 days after receipt of the Letter of Acceptance, the successful Tenderer shall deliver to the Procuring Entity a Performance Security in the amount and in the form stipulated in the Tender Data Sheet and the Contract Data Sheet, denominated in the type and proportions of currencies in the Letter of Acceptance and in accordance with the Conditions of Contract.

41.2 If the Performance Security is provided by the successful Tenderer in the form of a Bank Guarantee or Insurance Bond, it shall be issued either:

a) At the Tenderer's option, by a bank or insurance firm located in Kenya, or a foreign bank or insurance firm through a correspondent bank or insurance firm located in Kenya;

b) With the consent of the Procuring entity, directly by a foreign bank acceptable to the Procuring entity.

41.3 Failure of the successful Tenderer to comply with the requirement of sub-Clause 41.1 shall constitute sufficient grounds for the annulment of the award and forfeiture of the Tender Security, in which event the Procuring Entity may make the award to the next lowest evaluated Tenderer or call for new Tenders.

42. Advance Payment

42.1 The Procuring Entity will provide an Advance Payment as stipulated in the Conditions of Contract, subject to a maximum amount, as stated in the Tender Data Sheet.

42.2 The Advance Payment request shall be accompanied by an Advance Payment Security (Guarantee) in the form provided in Section X. For the purpose of receiving the Advance Payment, the Tenderer shall make an estimate of, and include in its Tender, the expenses that will be incurred in order to commence work. These expenses will relate to the purchase of equipment, machinery, materials, and on the engagement of labour during the first month beginning with the date of the

Procuring Entity's "Notice to Commence" as specified in the Contract Data Sheet.

43. Adjudicator

43.1 The Procuring Entity proposes the person named in the Tender Data Sheet to be appointed as Adjudicator under the Contract, at an hourly fee specified in the Tender Data Sheet, plus reimbursable expenses. If the Tenderer disagrees with this proposal, the Tenderer should so state in the Tender. If, in the Letter of Acceptance, the Procuring Entity has not agreed on the appointment of the Adjudicator, the Adjudicator shall be appointed by the Appointing Authority designated in the Contract Data Sheet at the request of either party.

G. Review of Procurement Decisions

44. Right to Review

44.1 A Tenderer who claims to have suffered or risk suffering, loss or damage or injury as a result of breach of a duty imposed on a Procuring Entity or an Approving Authority by the Public Procurement and Disposal Act, 2005 and the Public Procurement and Disposal Regulations 2006, the procurement proceedings or processes, may seek administrative review as prescribed by the Act. The following matters, however, shall not be subject to the administrative review:

a) The choice of procurement method;

b) a decision by the Procuring Entity to reject all Tenders, proposals or quotations;

c) Where a contract is signed in accordance to Section 68 of the Public Procurement and Disposal Act,2005;

d) Where an appeal is frivolous.

45. Time Limit on Review

45.1 The Tenderer shall submit an application for review in the number of copies and pay fees as prescribed by the Public Procurement and Disposal Regulations 2006 within fourteen (14) days of the time the Tenderer became or should have become aware of the circumstances giving rise to the complaint or dispute.

46. Submission of Applications for Review by the Public Procurement Administrative Review Board

46.1 Any application for administrative review shall be submitted in writing to the Secretary, Public Procurement Administrative Review Board on Form RB 1 at the address shown in the Tender Data Sheet. The secretary to the review board shall immediately after filing of the request, serve a copy thereof on the Procuring Entity or Director-General as the case may be.

46.2 The application for administrative review shall be in accordance with the requirements of Regulation 73 of the Public Procurement and Disposals Regulations,2006, including:

a) Reasons for the complaint ,including any alleged breach of the Act or Regulations;

b) An explanation of how the provisions of the Act and or Regulation has been breached or omitted, including the dates and name of the responsible public officer, where known;

c) Statements or other evidence supporting the complaint where available as the applicant considers necessary in support of its request;

d) Remedies sought;

e) Any other information relevant to the complaint.

47. Decision by the Public Procurement Administrative Review Board

47.1 The Administrative Review Board shall within thirty days after receipt of an application for administrative review deliver a written decision which shall indicate:

a) Annulling anything the Procuring Entity has done in the procurement proceedings, including annulling the procurement proceedings in their entirety;

b) Giving directions to the Procuring Entity with respect to anything to be done or redone in the procurement proceedings;

c) Substituting the decision of the Review Board for any decision of the Procuring Entity in the procurement proceedings;

d) Order the payment of costs as between parties to the review.

47.2 The decision made by the Review Board shall, be final and binding on the parties unless judicial review thereof commences within fourteen (14) days from the date of the Review Board's decision.

48. Appeal on the decision of the Review Board

48.1 Any party to the review aggrieved by the decision of the Review Board may appeal to the High Court and the decision of the High Court shall be final.

SECTION III: TENDER DATA SHEET

Tender Data Sheet (TDS)

Instructions to Tenderers Clause Reference

TDS Reference Number	ITT Clause Number	Amendments of, and Supplements to, Clauses in the Instruction to Tenderers
A. Introduction		
1.	**1.1**	The Procuring Entity is **The Northern Water Services Board**
2.	**1.1**	Name of Project is Drilling Lagdima Primary School,Wajir High and Eldas Primary Borehole
3.	**1.2**	The expected completion date of the works is **6 months after signing the contract**
4.	**1.3**	The Objectives of the Project is to ***increase access of water to the Lagdima Primary School ,Wajir High and Eldas Primary in Wajir County***
5.	**2.1**	Name of financing institution is **GOK** Name of the Procuring is **Northern Water Services Board.** Financial Year is **2018/2019** Describe works under the contracts- Drilling of Lagdima Primary School ,Wajir High and Eldas primary boreholes
6.	**2.2**	The loan/ credit number is ……**N/A.**
7.	**5.1**	Alternative Tenders are ***Not Allowed***
8.	**5.2**	Alternative time for completion **Not applicable**
9.	**3.1**	Only Tenderers registered with the **NCA Water Works and Class B up to 300M depth from Ministry of Water** need apply
10.	**7.3**	**Pre-Tender meeting shall not be held**
11.	**7.5**	**N/A**
	7.6	**N/A**

<table>
<tr><th colspan="3">B. Tendering Documents</th></tr>
<tr><td>12.</td><td>8.2</td><td>The number of copies to be completed and returned with the Tender is Two.</td></tr>
<tr><td>13.</td><td>8.1</td><td>Address for clarification of Tendering Document is
Chief Executive Officer,
Northern Water Services Board
P.O Box 495 Garissa</td></tr>
<tr><td>14.</td><td>8.2</td><td>Period to Respond to request for clarification by the Procuring Entity 14 days

Period Prior to deadline for submission of Tenders for Tenderers to request clarification 7 days</td></tr>
</table>

<table>
<tr><th colspan="3">C. Preparation of Tenders</th></tr>
<tr><td>15.</td><td>11.1</td><td>Language of Tender and all correspondence shall be English</td></tr>
<tr><td>16.</td><td>13.3</td><td>Other information or materials required to be completed and submitted by Tenderers and of which will form the
EVALUATION CRITERIA
The following requirements must be met by the tenderer not withstanding other requirements in the tender documents-:, bidders must serialize all document sub mitted
Mandatory Requirements (MR)
<table>
<tr><th>No.</th><th>Requirement</th><th>Responsive orNon Responsive</th></tr>
<tr><td>MR 1</td><td>Must submit a copy of certificate of registration/Incorporation</td><td></td></tr>
<tr><td>MR 2</td><td>Must submit a copy of valid tax compliance certificate</td><td></td></tr>
<tr><td>MR 3</td><td>Must fill the bill of quantities in the format provided(partial filled Boq will be rejected)</td><td></td></tr>
<tr><td>MR 4</td><td>Must fill the form of tender in the format provided and signed by the authorized person</td><td></td></tr>
<tr><td>MR 5</td><td>Provide a tender security of Kshs 150,000.00 (bank guarantee) valid for 150 days</td><td></td></tr>
<tr><td>MR 6</td><td>Power of attorney proof authorizing the signatory of the tender to commit the tenderer (Must attach CR12)</td><td></td></tr>
<tr><td>MR 7</td><td>Must submit a copy of valid registration from NCA Water Works/Ministry of Water Class B – up 300 metres</td><td></td></tr>
</table>
At this stage, the tenderer’s submission will either be responsive in the entire mandatory requirement (MR) above or non – responsive. The non- responsive submission will be eliminated from the entire evaluation process and will not be considered further.</td></tr>
</table>

Technical Evaluation.

No.	PARAMETER			MAXIMUM SCORE
1	**Relevant Experience**			
	Experience as prime contractor in the construction of at least two project of a similar nature and complexity equivalent to the Works for the last 5 years			**30**
2	**Equipments**			
	Drilling Rig, Lorry, Water bowser,4XWD Pickup, Test pumping unit - proof of ownership and lease must be provided i.e logbooks		Owned(Max 25 marks)	**0 - 25**
			50% owned 50% leased (Mx 20 marks)	**0 - 20**
			100% leased(Max 15 marks)	**0 - 15**
3	**Key Personnel**			
	Hydrogeologist Max (8 marks)	Qualification – Hydrgeologist	Degree	**5**
			HND	**4**
			Diploma	**3**
		Relevant experience – (5 years)	3 – 5 years	**3**
			0-2	**2**
	Drilling supervisor	Qualification-plant mechanic	Certificate	**3**
	Operator	Qualification	Certificate	**2**
	Driver	Qualification	Driving Licence	**2**
4	**Financial Capacity**			
	Audited Accounts- financial capability of the firm based on information provided in the last 2 years audited account (2015 – 2017) Current Ratio = Current asset / Current Liabilities A ration of 1 and above (2 marks below 1 (1 marks for each year audited			**6**
	Line of credit of 10 million			**3**
	annual volume(turn over) of construction work for the successful Tenderer in any of the last 2 years shall be: **Ksh 10 million. others**			**6**
	Bank statements (last six months to date of tender)			**5**
	Proposed program (Work methodology and schedule)			**10**
	Total			**100%**

Only bidders who score 70% and above will be subject to financial

		evaluation. Those who score below 70% will be eliminated at this stage from the entire evaluation process and will not be considered further **If a bidder applies for more than one tender the aggregate capacity to undertake the works will be taken in to consideration during evaluation** **The authority will verify information submitted. Any form of forgery or misinformation will lead to cancellation of the bid** **If a bidder applies for more than one tender the aggregate capacity to undertake the works will be taken in to consideration during evaluation**
17.	**13.4**	In the case of joint venture each partner shall submit information required under Clause ITT Clause 13.4. In addition the Tenderer shall furnish the following , **a) The Power of the attorney……** **b) Audited books of account with a turnover of at least Ksh 20 Million for the last two years.**
18.	**16.4**	The price shall be ***fixed*** Information to be submitted with the Tender are: **i) The basic rates of materials and services**
19.	**17.1**	The currency in which the prices shall be quoted shall be**:** ***Kenyan Shilling***
20.	**17.2** **30.2**	The authority for establishing the rates of exchange shall **be** **N/A.** The applicable date for exchange rates for tendering and evaluation purposes N/A
21.	**18.1**	The Tender validity period shall be **120 days**.
22.	**19.1**	The amount of Tender Security shall **Kshs 150,000.00 One hundred and fifty thousand**
23.	**20.1**	In addition to the original of the Tender, the Tenderer **should submit** **2 copies of the Tender**
24.	**20.2**	Written confirmation of authorization are ***power of attorney*** ***power of attorney – copies of original documents to be provided as proof authorizing the signatory of the tender to commit the tenderer.*** ***The form of tender must be fully filled and signed by the authorized person***

D. Submission of Tenders		
25.	**21.2 a)**	Tenders shall be submitted to ***Northern Water Services Board*** **P.o Box 495 Garissa**……. Street Address …**Kisimayu Road…….** Building/Plot No. …**Maji House**…… Floor/Room No. ……**Fist Floor in the Boardroom**…….. City/Town ……**Garissa…**……
26.	**21.2 b)**	Project name…… **Drilling of Lagdima Primary School, Wajir High and Eldas Primary Boreholes** Tender number…**NWSB/T/042/2018-2019 – Lot 2** Time and date for submission…**16th April 2019 at 11.00 AM**
27.	**22.1**	The deadline for Tender submission is **a) Day** **b) Date…16th April 2019** **c) Time …11.00A.M……..**
28.	**22.3**	The extension of the deadline for submission of Tenders shall be made not later than **N/A.**
29	**24.4**	Expiry of Tender validity is **120 days**

E. Opening and Evaluation of Tenders		
29.	**25.1**	The Tender opening shall take place at: Street address …**Kisimayu Road**…… Building/Plot No. **Maji House Building**……. Floor/Room No. …**First Floor**…… City/Town ……**Garissa**…….. Country **Kenya** Date…**16th April, 2019.** Time **11.30AM**
30.	**32.3**	Additional Preference ***Not applicable***
31.	**34.1**	Post- qualification **will *be undertaken***
32.	**38.1**	Percentage for quantities increase or decrease is **15%**

F. Award of Contract		
33.	**41.1**	The amount of Performance Security shall be ***10% of the contract price***
34.	**42.1**	The Advance Payment shall be …**N/A**
35.	**43.1**	The proposed adjudicator for the project is: **The Institution of Engineers of Kenya…** *[insert name of the proposed adjudicator] whose hourly rate shall* ***be determined by the Institution***
G. Review of Procurement Decisions		
37.	**46.1**	The address for submitting appeals to Administrative Review Board : The Secretary, Public Procurement Administrative Review Board , The Public Procurement Oversight Authority, 10th Floor ,National Bank House, P.O. Box 58583-00200, NAIROBI, Kenya

SECTION IV: GENERAL CONDITIONS OF CONTRACT

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A. General

1. Definitions

1.1 Boldface type is used to identify defined terms.

The **Adjudicator** is the person appointed jointly by the Procuring Entity and the Contractor to resolve disputes in the first instance, as provided for in Clauses 27 and 28 hereunder.

Bill of Quantities means the priced and completed Bill of Quantities forming part of the Tender.

Compensation Events are those defined in Clause 47 hereunder.

The **Completion Date** is the date of completion of the Works as certified by the Project Manager, in accordance with Sub-Clause 58.1.

The **Contract** is the Contract between the Procuring Entity and the Contractor to execute, complete, and maintain the Works. It consists of the documents listed in Clause 2.3 below.

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

The **Contractor's Tender** is the completed Tendering document submitted by the Contractor to the Procuring Entity.

The **Contract Price** is the price stated in the Letter of Acceptance and thereafter as adjusted in accordance with the provisions of the Contract.

Days are calendar days; months are calendar months.

Dayworks are 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.

The **Defects Liability Certificate** is the certificate issued by the Project Manager upon correction of defects by the Contractor.

The **Defects Liability Period** is the period named in the **Contract Data Sheet** and calculated from the Completion Date.

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

The **Procuring Entity** is the party who employs the Contractor to carry out the Works.

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

The **Initial Contract Price** is the Contract Price listed in the Procuring Entity's Letter of Acceptance.

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

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

Plant is any integral part of the Works that shall have a mechanical, electrical, chemical, or biological function.

The **Project Manager** is the person named in the **Contract Data Sheet** (or any other competent person appointed by the Procuring Entity 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 and shall be an "Architect" or a "Quantity Surveyor" registered under the Architects and Quantity Surveyors Act Cap 525 or an "Engineer" registered under Engineers Registration Act Cap 530.

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

Site Investigation Reports are those that were included in the Tendering documents and are factual and interpretative reports about the surface and subsurface conditions at the Site.

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

The **Start Date** is given in the **Contract Data Sheet**. 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 the Project Manager that varies the Works.

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

"**Force Majeure**" means an event which is beyond the reasonable control of a Party and which makes a Party's performance of its obligations under the Contract impossible or so impractical as to be considered impossible under the circumstances.

2. Interpretation

2.1 In interpreting these Conditions of Contract, singular also

means plural, male also means female or neuter, and the other way round. Headings have no significance. Words have their normal meaning under the language of the Contract unless specifically defined. The Project Manager will provide instructions clarifying queries about these Conditions of Contract.

2.2 If sectional completion is specified in the **Contract Data Sheet**, references in the Conditions of Contract to the Works, the Completion Date, and the Intended Completion Date apply to any Section of the Works (other than references to the Completion Date and Intended Completion Date for the whole of the Works).

2.3 The documents forming the Contract shall be interpreted in the order of priority given in the **Contract Data Sheet**:

(1) Agreement;

(2) Letter of Acceptance;

(3) Contract Data Sheet;

(4) Conditions of Contract;

(5) Technical Specifications;

(6) Contractor's Tender;

(7) Drawings;

(8) Bill of Quantities; and

(9) Any other document listed in the **Contract Data Sheet** as forming part of the Contract.

3. Language, Law, Fraud and Corruption

3.1 The language of the Contract and the law governing the Contract are stated in the **Contract Data Sheet**.

3.2 The Government requires that Procuring Entities (including beneficiaries of Government funded projects) as well as Tenderers/Suppliers/Contractors under Government financed contracts, observe the highest standard of ethics during the procurement and execution of such contracts. It is the responsibility of the Procuring Entity to ensure that Tenderers, suppliers, and contractors and their subcontractors observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy:

For the purpose of this provision, the following definitions are provided:

(i). "**Corruption**" has the meaning assigned to it in the Anti Corruption and Economic Crime Act 2003 and includes the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement or disposal process or in contract execution;

(ii). "**Fraudulent Practice**" includes a misrepresentation

of fact in order to influence a procurement or disposal process or the execution of a contract to the detriment of the Procuring Entity and includes collusive practices amongst Tenderers prior to or after Tender submission designed to establish Tender prices at artificial non competitive levels and deprive the Procuring Entity of the benefits of free and open competition;

(iii). **"Collusive Practice"** means an arrangement between two or more suppliers, contractors and subcontractors designed to achieve an improper purpose, including to influence improperly the actions of the Procuring Entity prior to or after Tender submission , designed to establish Tender prices at artificial non competitive levels and to deprive the Procuring Entity of the benefit of free and open competition;

(iv). **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly a supplier, contractor or subcontractor or the property of any of them to influence improperly the actions of a Procuring Entity;

(v). **"Obstructive Practice"** means deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede an investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and /or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation.

A Procuring Entity has the right to require that Tenderers, suppliers, and contractors and their subcontractors permit persons duly appointed by KACC/PPOA/KNAO to inspect their accounts and records and other documents relating to the Tender submission and contract performance;

The Procuring Entity will reject a proposal for award if it determines that the Tenderer recommended for award has engaged in corrupt, fraudulent practices or others stated under Clause 44.1.a in competing for the contract;

In pursuit of the policy defined in sub-Clause 44.1 the Procuring Entity will cancel the portion of the funds allocated to a contract for goods, works, or services if it at any time determines that corrupt or fraudulent practices were engaged in by representatives of the Procuring Entity or Approving Authority or of a beneficiary of the funds during the procurement or the execution of that contract;

In the event that the Procuring Entity or Approving Authority does not take timely and appropriate action satisfactory to the Government of Kenya to remedy the situation, then the

Director-General may order an investigation of procurement proceedings for the purpose of determining whether there has been a breach of the Public Procurement and Disposal Act, 2005.

3.3 The Director-General may, on the advice of the Advisory Board, debar a person from participating in procurement proceedings on the ground that the person has committed an offence under the Public Procurement and Disposal Act, 2005. A debarment shall be for a period of time of not less than five years. Before a person is so debarred, he/she will be given an opportunity to make representations to the Director-General and may request the Review Board to review the debarment.

3.4 Any communication between the Tenderers and the Procuring Entity related to matters of alleged fraud or corruption must be made in writing.

4. Confidentiality

4.1 The Service Providers, their Subcontractors, and the Personnel of either of them shall not disclose any proprietary or confidential information relating to the Project, the Services, this Contract, or the Procuring Entity's business or operations without the prior written consent of the Procuring Entity.

5. Project Manager's Decisions

5.1 Except where otherwise specifically stated, the Project Manager will decide contractual matters between the Procuring Entity and the Contractor in the role representing the Procuring Entity.

6. Delegation

6.1 The Project Manager may delegate any of his duties and responsibilities to other people except to the Adjudicator, after notifying the Contractor, and may cancel any delegation after notifying the Contractor.

7. Communications

7.1 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.

8. Subcontracting

8.1 The Contractor may subcontract with the approval of the Project Manager, but may not assign the Contract without the approval of the Procuring Entity in writing. Subcontracting shall not alter the Contractor's obligations.

9. Other Contractors

9.1 The Contractor shall cooperate and share the Site with other contractors, public authorities, utilities, and the Procuring Entity between the dates given in the Schedule of Other Contractors, as referred to in the **Contract Data Sheet**. The Contractor shall also provide facilities and services for them as described in the Schedule. The Procuring Entity may modify the Schedule of Other Contractors, and shall notify the Contractor of any such modification

10. Personnel

10.1 The Contractor shall employ the key personnel named in the Schedule of Key Personnel, as referred to in the **Contract Data Sheet**, who shall be appropriately qualified and registered with the appropriate bodies to carry out the functions stated in the

Schedule or other personnel approved by the Project Manager. The Project Manager will 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.

10.2 If the Project Manager 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 seven days and has no further connection with the work in the Contract.

11. Procuring Entity's and Contractor's Risks

11.1 The Procuring Entity carries the risks which this Contract states are Procuring Entity's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.

12. Procuring Entity's Risks

12.1 From the Start Date until the Defects Correction Certificate has been issued, the following are Procuring Entity's risks:

a) The risk of personal injury, death, or loss of or damage to property (excluding the Works, Plant, Materials, and Equipment), which are due to:

(i) Use or occupation of the Site by the Works or for the purpose of the Works, which is the unavoidable result of the Works; or

(ii) Negligence, breach of statutory duty, or interference with any legal right by the Procuring Entity or by any person employed by or contracted to him except the Contractor.

b) The risk of damage to the Works, Plant, Materials, and Equipment to the extent that it is due to a fault of the Procuring Entity or in the Procuring Entity's design, or due to war or radioactive contamination directly affecting the country where the Works are to be executed.

12.2 From the Completion Date until the Defects Correction Certificate has been issued, the risk of loss of or damage to the Works, Plant, and Materials is an Procuring Entity's risk except loss or damage due to:

(a) A Defect which existed on the Completion Date;

(b) An event occurring before the Completion Date, which was not itself an Procuring Entity's risk; or

(c) The activities of the Contractor on the Site after the Completion Date.

13. Contractor's Risks

13.1 From the Starting Date until the Defects Correction Certificate has been issued, the risks of personal injury, death, and loss of or damage to property (including, without limitation, the Works, Plant, Materials, and Equipment) which are not Procuring Entity's risks are Contractor's risks.

14. Insurance

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

(a) Loss of or damage to the Works, Plant, and Materials;

(b) Loss of or damage to Equipment;

(c) Loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and

(d) Personal injury or death.

14.2 Policies and certificates for insurance shall be delivered by the Contractor to the Project Manager for the Project Manager's approval before the Start Date. All such insurance shall provide for compensation to be payable in the types and proportions of currencies required to rectify the loss or damage incurred.

14.3 If the Contractor does not provide any of the policies and certificates required, the Procuring Entity may effect the insurance which the Contractor should have provided and recover the premiums the Procuring Entity has paid from payments otherwise due to the Contractor or, if no payment is due, the payment of the premiums shall be a debt due.

14.4 Alterations to the terms of insurance shall not be made without the approval of the Project Manager.

14.5 Both parties shall comply with any conditions of the insurance policies.

15. Site Investigation Reports

15.1 The Contractor, in preparing the Tender, shall rely on any Site Investigation Reports referred to in the **Contract Data Sheet**, supplemented by any information available to the Tenderers.

16. Queries about the Contract Data Sheet

16.1 The Project Manager will clarify queries on the **Contract Data Sheet**.

17. Contractor to Construct the Works

17.1 The Contractor shall construct and install the Works in accordance with the Specifications and Drawings.

18. Commencement and Completion

18.1 The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the Programme submitted by the Contractor, as updated with the approval of the Project Manager, and complete them by the Intended Completion Date.

19. Approval by the Project Manager

19.1 The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Project Manager, who is to approve them if they comply with the Specifications and Drawings.

19.2 The Contractor shall be responsible for the design of Temporary Works.

19.3 The Project Manager's approval shall not alter the Contractor's responsibility for design of the Temporary Works.

19.4 The Contractor shall obtain approval of third parties to the design of the Temporary Works, where required.

19.5 All Drawings prepared by the Contractor for the execution of the temporary or permanent Works, are subject to prior approval by the Project Manager before their use.

20. Protection of the Environment

20.1 The Contractors shall take all reasonable steps to protect the environment and to limit damage and nuisance to people and property resulting from pollution, noise and other results of his operations.

20.2 The Contractors shall ensure that emissions, surface discharges and effluent from his activities shall not exceed prescribed values in the environmental laws.

21. Labour Laws

21.2 The Contractor shall comply with all the relevant labour laws applicable in the Country, including laws relating to workers employment, working hours, health, safety, welfare, and immigration, and shall allow them all their legal rights.

21.2 The Contractor shall require his employees to obey all applicable laws, including those concerning safety at work.

22. Health and Safety

22.1 The Contractor shall at all times take all reasonable precautions to maintain the health and safety of his personnel.

22.2 The Contractor shall ensure that first aid facilities are available at all times at the site and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics.

22.3 The Contractor shall notify the Procuring Entity details of any accident as soon as practicable after its occurrence. The Contractor shall maintain records and make reports concerning health, safety, and welfare of persons, and damage to the property, as the Procuring Entity may reasonably require.

22.4 The Contractor shall conduct an HIV-Aids awareness programme, and shall take other such measures as specified in the **Contract Data Sheet** to reduce the risk of transfer of HIV virus between and among Contractor personnel, the Procuring Entity's Staff and the surrounding community.

23. Discoveries

23.1 Anything of historical or other interest or of significant value unexpectedly discovered on the Site shall be the property of the Procuring Entity. The Contractor shall notify the Project Manager of such discoveries and carry out the Project Manager's instructions for dealing with them.

24. Possession of the Site

24.1 The Procuring Entity shall give possession of all parts of the Site to the Contractor. If possession of a part is not given by the date stated in the **Contract Data Sheet**, the Procuring Entity will be deemed to have delayed the start of the relevant activities, and this will be a Compensation Event.

25. Access to the Site

25.1 The Contractor shall allow the Project Manager and any person authorized by the Project Manager access to the Site and to any place where work in connection with the Contract is being carried out or is intended to be carried out.

26. Instructions, Inspections and Audits

26.1 The Contractor shall carry out all instructions of the Project Manager which comply with the applicable laws where the Site is located.

26.2 The Contractor shall permit the Kenya Government to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by the Kenya Government, if so required by the Kenya Government

27. Disputes

27. 1 If the Contractor believes that a decision taken by the Project Manager was either outside the authority given to the Project Manager by the Contract or that the decision was wrongly taken, the decision shall be referred to the Adjudicator within 14 days of the notification of the Project Manager's decision.

28. Procedure for Disputes

28.1 The Adjudicator shall give a decision in writing within 28 days of receipt of a notification of a dispute.

28.2 The Adjudicator shall be paid by the hour at the rate specified in the **Tender Data Sheet** and **Contract Data Sheet**, together with reimbursable expenses of the types specified in the **Contract Data Sheet**, and the cost shall be divided equally between the Procuring Entity and the Contractor, whatever decision is reached by the Adjudicator. Either party may refer a decision of the Adjudicator to an Arbitrator within 28 days of the Adjudicator's written decision. If neither party refers the dispute to arbitration within the above 28 days, the Adjudicator's decision will be final and binding.

28.3 The arbitration shall be conducted in accordance with the arbitration procedure published by the institution named and in the place shown in the **Contract Data Sheet**.

29. Replacement of Adjudicator

29.1 Should the Adjudicator resign or die, or should the Procuring Entity and the Contractor agree that the Adjudicator is not functioning in accordance with the provisions of the Contract, a new Adjudicator will be jointly appointed by the Procuring Entity and the Contractor. In case of disagreement between the Procuring Entity and the Contractor, within 30 days, the Adjudicator shall be designated by the Appointing Authority designated in the **Contract Data Sheet** at the request of either party, within 14 days of receipt of such request.

B. Time Control

30. Programme

30.1 Within the time stated in the **Contract Data Sheet**, the Contractor shall submit to the Project Manager for approval a Programme showing the general methods, arrangements, order, and timing for all the activities in the Works.

30.2 An update of the Programme shall be a programme showing the actual progress achieved on each activity and the effect of the progress achieved on the timing of the remaining work, including any changes to the sequence of the activities.

30.3 The Contractor shall submit to the Project Manager for approval an updated Programme at intervals no longer than the period stated in the **Contract Data Sheet**. If the Contractor does not submit an updated Programme within this period, the Project Manager may withhold the amount stated in the **Contract Data Sheet** from the next payment certificate and continue to withhold this amount until the next payment after the date on which the overdue Programme has been submitted.

30.4 The Project Manager's approval of the Programme shall not alter the Contractor's obligations. The Contractor may revise the Programme and submit it to the Project Manager again at any time. A revised Programme shall show the effect of Variations and Compensation Events

31. Extension of the Intended Completion Date

31.1 The Project Manager shall extend the Intended Completion Date if a Compensation Event occurs or a Variation is issued which makes it impossible for Completion to be achieved by the Intended Completion Date without the Contractor taking steps to accelerate the remaining work, which would cause the Contractor to incur additional cost.

31.2 The Project Manager shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Project Manager for a decision upon the effect of a Compensation Event or Variation and submitting full supporting information. If the Contractor has failed to give early warning of a delay or has failed to cooperate in dealing with a delay, the delay by this failure shall not be considered in assessing the new Intended Completion Date.

32. Acceleration

32.1 When the Procuring Entity wants the Contractor to finish before the Intended Completion Date, the Project Manager will obtain priced proposals for achieving the necessary acceleration from the Contractor. If the Procuring Entity accepts these proposals, the Intended Completion Date will be adjusted accordingly and confirmed by both the Procuring Entity and the Contractor.

32.2 If the Contractor's priced proposals for acceleration are accepted by the Procuring Entity, they shall be incorporated in the Contract Price and treated as a Variation.

33. Delays

33.1 The Project Manager may instruct the Contractor to delay the start

Ordered by the Project Manager

or progress of any activity within the Works.

34. Management Meetings

34.1 Either the Project Manager or the Contractor may require the other to attend a management meeting. The business of a management meeting shall be to review the plans for remaining work and to deal with matters raised in accordance with the early warning procedure.

34.2 The Project Manager shall record the business of management meetings and provide copies of the record to those attending the meeting and to the Procuring Entity. The responsibility of the parties for actions to be taken shall be decided by the Project Manager either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.

35. Early Warning

35.1 The Contractor shall warn the Project Manager 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 Project Manager 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.

35.2 The Contractor shall cooperate with the Project Manager 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.

C. Quality Control

36. Identifying Defects

36.1 The Project Manager shall check the Contractor's work and notify the Contractor of any Defects that are found. Such checking shall not affect the Contractor's responsibilities. The Project Manager may instruct the Contractor to search for a Defect and to uncover and test any work that the Project Manager considers may have a Defect.

37. Tests

37.1 If the Project Manager instructs the Contractor to carry out a test not specified in the Specification to check whether any work has a Defect and the test shows that it does, the Contractor shall pay for the test and any samples. If there is no Defect, the test shall be a Compensation Event.

38. Correction of Defects

38.1 The Project Manager 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 Sheet**. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.

38.2 Every time notice of a Defect is given, the Contractor shall correct the notified Defect within the length of time specified by

the Project Manager's notice.

38.3 If the Contractor has not corrected a defect within the time specified in the Procuring Entity's notice, a penalty for lack of performance will be paid by the Contractor. The amount to be paid will be calculated as a percentage of the cost of having the defect correct, assessed as described in Clause 39.

39. Uncorrected Defects

39.1 If the Contractor has not corrected a Defect within the time specified in the Project Manager's notice, the Project Manager will assess the cost of having the Defect corrected, and the Contractor will pay this amount.

D. Cost Control

40. Bill of Quantities

40.1 The Bill of Quantities shall contain items for the construction, installation, testing, and commissioning work to be done by the Contractor.

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

41. Changes in the Quantities

41.1 If the final quantity of the work done differs from the quantity in the Bill of Quantities for the particular item by more than 25 percent, provided the change exceeds 1 percent of the Initial Contract Price, the Project Manager shall adjust the rate to allow for the change.

41.2 The Project Manager shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 percent, except with the prior approval of the Procuring Entity.

41.3 If requested by the Project Manager, the Contractor shall provide the Project Manager with a detailed cost breakdown of any rate in the Bill of Quantities.

42. Variations

42.1 All Variations shall be included in the updated Programmes produced by the Contractor.

43. Payments for Variations

43.1 The Contractor shall provide the Project Manager with a quotation for carrying out the Variation when requested to do so by the Project Manager. The Project Manager shall assess the quotation, which shall be given within seven days of the request or within any longer period stated by the Project Manager and before the Variation is ordered.

43.2 If the work in the Variation corresponds with an item description in the Bill of Quantities and if, in the opinion of the Project Manager, the quantity of work is above the limit stated in Sub-Clause 41.1 or the timing of its execution do not cause the cost per unit of quantity to change, the rate in the Bill of Quantities shall be used to calculate the value of the Variation. If the cost per unit of quantity changes, or if the nature or timing of the work in the Variation does not correspond with items in

the Bill of Quantities, the quotation by the Contractor shall be in the form of new rates for the relevant items of work.

43.3 If the Contractor's quotation is unreasonable, the Project Manager may order the Variation and make a change to the Contract Price, which shall be based on the Project Manager's own forecast of the effects of the Variation on the Contractor's costs.

43.4 If the Project Manager decides that the urgency of varying the work would prevent a quotation being given and considered without delaying the work, no quotation shall be given and the Variation shall be treated as a Compensation Event.

43.5 The Contractor shall not be entitled to additional payment for costs that could have been avoided by giving early warning.

44. Cash Flow Forecasts

44.1 When the Programme is updated, the Contractor shall provide the Project Manager with an updated cash flow forecast. The cash flow forecast shall include different currencies, as defined in the Contract, converted as necessary using the Contract exchange rates.

45. Payment Certificates

45.1 The Contractor shall submit to the Project Manager monthly statements of the estimated value of the work executed less the cumulative amount certified previously.

45.2 The Project Manager shall check the Contractor's monthly statement and certify the amount to be paid to the Contractor within twenty eight 28 days of receipt of the certificate from the contractor.

45.3 The value of work executed shall be determined by the Project Manager.

45.4 The value of work executed shall comprise the value of the quantities of the items in the Bill of Quantities completed.

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

45.6 The Project Manager may exclude any item certified in a previous certificate or reduce the proportion of any item previously certified in any certificate in the light of later information.

45.7 The Project Manager shall not be bound to certify any payment, if the net amount, after all retentions and deductions would be less than minimum amount of Interim Payment Certificate stated in the **Contract Data Sheet.**

46. Payments

46.1 Payments shall be adjusted for deductions for advance payments and retention. The Procuring Entity shall pay the Contractor the amounts certified by the Project Manager within 28 days of the date of each certificate. If the Procuring Entity 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 prevailing rate of interest for commercial borrowing for each of the currencies in which payments are made as indicated in the **Contract Data Sheet.**.

46.2 If an amount certified is increased in a later certificate or as a result of an award by the Adjudicator or an Arbitrator, the Contractor shall be paid interest upon the delayed payment as set out in this clause. Interest shall be calculated from the date upon which the increased amount would have been certified in the absence of dispute.

46.3 Unless otherwise stated, all payments and deductions will be paid or charged in the proportions of currencies comprising the Contract Price.

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

47. Compensation Events

47.1 The following shall be Compensation Events:

(a) The Procuring Entity does not give access to a part of the Site by the Site Possession Date stated in the **Contract Data Sheet**.

(b) The Procuring Entity modifies the Schedule of Other Contractors in a way that affects the work of the Contractor under the Contract.

(c) The Project Manager orders a delay or does not issue Drawings, Specifications, or instructions required for execution of the Works on time.

(d) The Project Manager instructs the Contractor to uncover or to carry out additional tests upon work, which is then found to have no Defects.

(e) The Project Manager unreasonably does not approve a subcontract to be let.

(f) Ground conditions are substantially more adverse than could reasonably have been assumed before issuance of the Letter of Acceptance from the information issued to Tenderers (including the Site Investigation Reports), from information available publicly and from a visual inspection of the Site.

(g) The Project Manager gives an instruction for dealing with an unforeseen condition, caused by the Procuring Entity, or additional work required for safety or other reasons.

(h) Other contractors, public authorities, utilities, or the Procuring Entity does not work within the dates and other constraints stated in the Contract, and they cause delay or

extra cost to the Contractor.

(i) The advance payment is delayed.

(j) The effects on the Contractor of any of the Procuring Entity's Risks.

(k) The Project Manager unreasonably delays issuing a Certificate of Completion.

(l) Other Compensation Events described in the Contract or determined by the Project Manager shall apply.

47.2 If a Compensation Event would cause additional cost or would prevent the work being completed before the Intended Completion Date, the Contract Price shall be increased and/or the Intended Completion Date shall be extended. The Project Manager shall decide whether and by how much the Contract Price shall be increased and whether and by how much the Intended Completion Date shall be extended.

47.3 As soon as information demonstrating the effect of each Compensation Event upon the Contractor's forecast cost has been provided by the Contractor, it shall be assessed by the Project Manager, and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Project Manager shall adjust the Contract Price based on the Project Manager's own forecast. The Project Manager will assume that the Contractor will react competently and promptly to the event.

47.4 The Contractor shall not be entitled to compensation to the extent that the Procuring Entity's interests are adversely affected by the Contractor's not having given early warning or not having cooperated with the Project Manager.

48. Taxes

48.1 The Project Manager shall adjust the Contract Price if taxes, duties, and other levies are changed between the date 28 days before the submission of Tenders for the Contract and the date of the last Completion certificate. The adjustment shall be the change in the amount of tax payable by the Contractor, provided such changes are not already reflected in the Contract Price or are a result of Clause 50.

49. Currencies

49.1 Where payments are made in currencies other than the Kenya Shillings, the exchange rates used for calculating the amounts to be paid shall be the exchange rates stated in the Contractor's Tender.

50. Price Adjustment

50.1 The amounts payable to the Contractor, in various currencies pursuant to Sub-Clause 45.1, shall be adjusted in respect of the rise or fall in the cost of labour, Contractor's Equipment, Plant, materials, and other inputs to the Works, by applying to such amounts the formulae prescribed in this clause based on the prevailing consumer price index obtained from the Central Bureau of Statistics or the monthly inflation rate issued by the

Central Bank of Kenya.

50.2 To the extent that full compensation for any rise or fall in costs to the Contractor is not covered by the provisions of this or other clauses in the Contract, the unit rates and prices included in the Contract shall be deemed to include amounts to cover the contingency of such other rise or fall of costs.

50.3 The adjustment to be applied to amount payable to the Contractor as certified in Payment Certificates shall be determined formulae for each of the currencies in which the Contract Price is payable. No adjustment is to be applied to work valued on the basis of Cost or current prices. The formulae shall be as follows;

$$Pn = a + b\frac{Ln - Lo}{Lo} + c\frac{Mn - Mo}{Mo} + d\frac{En - Eo}{Eo} + etc.$$

where;

Pn is a price adjustment factor to be applied to the amount in each specific currency for the payment of the work carried out in the subject month, where such variations and daywork are not otherwise subject to adjustment;

a is a constant, specified in the **Appendix to Tender**, representing the nonadjustable portion in contractual payments;

b, c, d, etc., are weightings or coefficients representing the estimated proportion of each cost element (labour, materials, equipment usage, etc.) in the Works or sections thereof, net of Provisional Sums, as specified in the **Appendix to Tender**; the sum of a, b, c, d, etc., shall be one;

Ln, Mn, En, etc., are the current cost indices or reference prices of the cost elements in the specific currency of origin for month "**n,**" determined pursuant to Sub-Clause 50.5, applicable to each cost element; and

Lo, Mo, Eo, etc., are the base cost indices or reference prices corresponding to the above cost elements at the date specified in Sub-Clause 50.5

The value of net work done, certified by the Project Manager, in any monthly Interim or Final Certificate as payable by the Procuring Entity to the Contractor before deduction of any retention money shall be increased or decreased by an amount of **'F'.**

$$F = PnxPc$$

where;

The effective value **Pc** of work done which is to be subjected to increase or decrease shall be the difference between:

(i) the amount which, in the opinion of the Project Manager, is due to the Contractor under Clause 45 (before deduction of retention money and before deducting sums previously paid on account) less:

- any amount for payment or repayment of any advance payment;
- any amount for materials on site (if any);
- any amounts for nominated sub-contractors (if any)
- any amounts for any other items based on actual cost or current prices; or
- any sums for increase or decreases in the Contract Price paid under this Sub-Clause

and

(ii) the amount calculated in accordance with (i) above of this Sub-clause and included in the last preceding statement.

50.4 The sources of indices shall be those listed in the **Appendix to Tender**, as approved by the Engineer. Indices shall be appropriate for their purpose and shall relate to the Contractor's proposed source of supply of inputs on the basis of which his Contract Price and expected foreign currency requirements shall have been computed. As the proposed basis for price adjustment, the Contractor shall have submitted with his Tender the tabulation of Weightings and Source of Indices in the **Appendix to Tender**, which shall be subject to approval by the Engineer.

50.5 The base cost indices or prices shall be those prevailing on the day 28 days prior to the latest date for submission of Tenders. Current indices or prices shall be those prevailing on the day 28 days prior to the last day of the period to which a particular Interim Payment Certificate is related. If at any time the current indices are not available, provisional indices as determined by the Engineer will be used, subject to subsequent correction of the amounts paid to the Contractor when the current indices become available.

50.6 If the Contractor fails to complete the Works within the time for completion prescribed under Clause 58 adjustment of prices thereafter until the date of completion of the Works shall be made using either the indices or prices relating to the prescribed time for completion, or the current indices or prices, whichever is more favourable to the Procuring Entity, provided that if an extension of time is granted pursuant to Clause 28, the above provision shall apply only to adjustments made after the expiry of such extension of time.

50.7 The weightings for each of the factors of cost given in the **Appendix to Tender** shall be adjusted if, in the opinion of the Engineer, they have been rendered unreasonable, unbalanced, or inapplicable as a result of varied or additional work already executed or instructed under Clause 43 or for any other reason.

51. Retention

51.1 The Procuring Entity shall retain from each payment due to the

Contractor the proportion stated in the **Contract Data Sheet** until Completion of the whole of the Works.

51.2 On completion of the whole of the Works, half the total amount retained shall be repaid to the Contractor and the other half when the Defects Liability Period has passed and the Project Manager has certified that all Defects notified by the Project Manager to the Contractor before the end of this period have been corrected.

51.3 On completion of the whole Works, the Contractor may substitute retention money with an "on demand" Bank guarantee.

52. Liquidated Damages

52.1 The Contractor shall pay liquidated damages to the Procuring Entity at the rate per day stated in the **Contract Data Sheet** for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed the amount defined in the **Contract Data Sheet**. The Procuring Entity may deduct liquidated damages from payments due to the Contractor. Payment of liquidated damages shall not affect the Contractor's liabilities.

52.2 If the Intended Completion Date is extended after liquidated damages have been paid, the Project Manager shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate. The Contractor shall be paid interest on the overpayment, calculated from the date of payment to the date of repayment, at the rates specified in Sub-Clause 46.1.

52.3 If the Contractor has not corrected a defects within the time specified in the Procuring Entity's notice, the Procuring Entity will assess the cost of having the defect corrected, the Contractor will pay this amount, and a penalty for lack of performance calculated as described in Clause 38.

53. Bonus

53.1 The Contractor shall be paid a Bonus calculated at the rate per calendar day stated in the **Contract Data Sheet** for each day (less any days for which the Contractor is paid for acceleration) that the Completion is earlier than the Intended Completion Date. The Project Manager shall certify that the Works are complete, although they may not be due to be complete.

54. Advance Payment

54.1 The Procuring Entity shall make advance payment to the Contractor of the amounts stated in the **Contract Data Sheet** by the date stated in the **Contract Data Sheet**, against provision by the Contractor of an Unconditional Bank Guarantee in a form and by a bank acceptable to the Procuring Entity in amounts and currencies equal to the advance payment. The Guarantee shall remain effective until the advance payment has been repaid, but the amount of the Guarantee shall be progressively reduced by the amounts repaid by the Contractor. Interest will not be charged on the advance payment.

54.2 The Contractor is to use the advance payment only to pay for

Equipment, Plant, Materials, and mobilization expenses required specifically for execution of the Contract. The Contractor shall demonstrate that advance payment has been used in this way by supplying copies of invoices or other documents to the Project Manager.

54.3 The advance payment shall be repaid by deducting proportionate amounts from payments otherwise due to the Contractor, following the schedule of completed percentages of the Works on a payment basis. No account shall be taken of the advance payment or its repayment in assessing valuations of work done, Variations, price adjustments, Compensation Events, Bonuses, or Liquidated Damages.

55. Performance Securities

55.1 The Performance Security shall be provided to the Procuring Entity no later than the date specified in the Letter of Acceptance and shall be issued in an amount and form and by a bank or surety acceptable to the Procuring Entity, and denominated in the types and proportions of the currencies in which the Contract Price is payable. The Performance Security shall be valid until a date 28 days from the date of issue of the Certificate of Completion in the case of a Bank Guarantee, and until one year from the date of issue of the Completion Certificate in the case of a Performance Bond.

56. Dayworks

56.1 If applicable, the Dayworks rates in the Contractor's Tender shall be used for small additional amounts of work only when the Project Manager has given written instructions in advance for additional work to be paid for in that way.

56.2 All work to be paid for as Dayworks shall be recorded by the Contractor on forms approved by the Project Manager. Each completed form shall be verified and signed by the Project Manager within two days of the work being done.

56.3 The Contractor shall be paid for Dayworks subject to obtaining signed Dayworks forms.

57. Cost of Repairs

57.1 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.

E. Finishing the Contract

58. Completion Certificate

58.1 The Contractor shall request the Project Manager to issue a certificate of Completion of the Works, and the Project Manager will do so upon deciding that the work is completed.

59. Taking Over

59.1 The Procuring Entity shall take over the Site and the Works within seven days of the Project Manager's issuing a certificate of Completion.

60. Final Account

60.1 The Contractor shall supply the Project Manager 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 Project Manager shall issue a Defects Liability Certificate and certify any final payment that is due to the Contractor within 56 days of receiving the Contractor's account if it is correct and complete. If it is not, the Project Manager shall issue within 56 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 Project Manager shall decide on the amount payable to the Contractor and issue a payment certificate.

61. Operating and Maintenance Manuals

61.1 If "as built" Drawings and/or operating and maintenance manuals are required, the Contractor shall supply them by the dates stated in the **Contract Data Sheet**.

61.2 If the Contractor does not supply the Drawings and/or manuals by the dates stated in the **Contract Data Sheet**, or they do not receive the Project Manager's approval, the Project Manager shall withhold the amount stated in the **Contract Data Sheet** from payments due to the Contractor.

62. Termination

62.1 The Procuring Entity or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract.

62.2 Fundamental breaches of Contract shall include, but shall not be limited to, the following:

(a) The Contractor stops work for 28 days when no stoppage of work is shown on the current Programme and the stoppage has not been authorized by the Project Manager;

(b) The Project Manager instructs the Contractor to delay the progress of the Works, and the instruction is not withdrawn within 28 days;

(c) The Procuring Entity or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation;

(d) A payment certified by the Project Manager is not paid by the Procuring Entity to the Contractor within 84 days of the date of the Project Manager's certificate;

(e) The Project Manager gives Notice that failure to correct a particular Defect is a fundamental breach of Contract and the Contractor fails to correct it within a reasonable period of time determined by the Project Manager;

(f) The Contractor does not maintain a Security, which is required; and

(g) 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 Sheet**.

(h) If the Contractor, in the judgment of the Procuring Entity has engaged in corrupt or fraudulent practices in competing for or in executing the Contract.

For the purpose of this paragraph:

"corrupt practice" means the offering, giving, receiving or soliciting of anything of value to influence the action of a public official in the procurement process or in contract execution and includes inter alia, bribery and extortion or coercion which involves threats of injury to person ,property or reputation, and.

"fraudulent practice" means a misrepresentation of facts in order to influence a procurement process or the execution of a contract to the detriment of the Procuring Entity, and includes collusive practice among Tenderers (prior to or after Tender submission) designed to establish Tender prices at artificial non-competitive levels and to deprive the Procuring Entity of the benefits of free and open competition.

62.3 When either party to the Contract gives notice of a breach of Contract to the Project Manager for a cause other than those listed under Sub-Clause 62.2 above, the Project Manager shall decide whether the breach is fundamental or not.

62.4 Notwithstanding the above, the Procuring Entity may terminate the Contract for convenience.

62.5 If the Contract is terminated, the Contractor shall stop work immediately, make the Site safe and secure, and leave the Site as soon as reasonably possible.

63. Payment upon Termination

63.1 If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Project Manager shall issue a certificate for the value of the work done and Materials ordered less advance 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 Sheet**. Additional Liquidated Damages shall not apply. If the total amount due to the Procuring Entity exceeds any payment due to the Contractor, the difference shall be a debt payable to the Procuring Entity.

63.2 If the Contract is terminated for the Procuring Entity's convenience or because of a fundamental breach of Contract by the Procuring Entity, the Project Manager 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 advance payments received up to the date of the certificate.

64. Property

64.1 All Materials on the Site, Plant, Equipment, Temporary Works, and Works shall be deemed to be the property of the Procuring Entity if the Contract is terminated because of the Contractor's

default.

65. Release from Performance

65.1 If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Procuring Entity or the Contractor, the Project Manager 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 to which a commitment was made.

66. Suspension of Financing

66.1 In the event that the source of financing is suspended to the Procuring Entity, from which part of the payments to the Contractor are being made:

(a) The Procuring Entity is obligated to notify the Contractor of such suspension within 7 days of having received the financing agency's suspension notice.

(b) If the Contractor has not received sums due it within the 28 days for payment provided for in Sub-Clause 46.1, the Contractor may immediately issue a 14-day termination notice.

SECTION V: CONTRACT DATA SHEET (CDS)

Contract Data Sheet

Instructions for completing the Contract Data Sheet

CDS Clause	GCC Clause	Description
		A. General
1	**1.1**	**(Itemise Definitions to take the same numbering as per the General Conditions)** The Procuring Entity is ***The Northern Water Services Board*** The Adjudicator is ***The Institution of Engineers of Kenya (IEK)*** The Defects Liability Period is ***180*** **days.** The Project Manager is ***The Technical Services Manager Northern Water Services Board*** The name and identification number of the Contract is **Drilling Boreholes for Lagdima Primary School, Wajir High and Eldas Primary** **Tender No NWSB/T/042/2018-2019. Lot 2** The Works consist of , **drilling, casing and Capping** The objectives of the contract are *to* ***increase access to portable water*** **Lagdima Primary School, Wajir High and Eldas Primary** *which* are mandatory requirements that override any detail which may be provided below. The Start Date shall be ***Notified by the Project Manager***. The Intended Completion Date for the whole of the Works shall be ***End of 6Month from the start date*** The following documents also form part of the Contract: **1. The Bills of quantities** **2. The Specifications** **3.Hydrogeological Surveys** The Site is located *in* **Lagdima Primary School, Wajir High and Eldas Primary**
2.	**2.2**	Indicate whether there is sectional completion [*specified/not specified*]. ***Not applicable***
3.	**2.3(9)**	List other documents that form part of the contract if any: **a) Minutes of Negotiation**

4.	**3.1**	The language of the Contract documents is ***English***. The law that applies to the Contract is the Kenyan Law.
5.	**9.1**	Include the Schedule of Other Contractors, if any. ***Not Applicable***
6.	**10.1**	Include the Schedule of Key Personnel. ***1. Hydrogeologist*** ***2. Drilling Supervisor*** *3.* ***Drivers –*** *4.* ***operator***
7.	**14.1**	The minimum insurance covers shall be: (a) loss of or damage to the Works, Plant, and Materials ***Ksh 500,000*** *(b)* loss of or damage to Equipment ***Ksh 200,000*** (c) loss of or damage to property (except the Works, Plant, Materials, and Equipment) in connection with the Contract ***Ksh 200,000*** and *(d)* personal injury or death ***Ksh 100,000***
8.	**15.1**	Site Investigation Reports available to the Tenderers are: a) **Hydrogeological surveys**
9.	**22.4**	The other measures include: a. Minimising the number of migrant workers employed on the project and household in the site camp b. Providing access to voluntary counselling and testing (VCT) c. Providing psychological support and health care including prevention and treatment of opportunistic infections for workers infected and affected, as well as their families d. Providing condoms (male and female) to workers
10.	**24.1 & 47.1**	The Site Possession Date shall be **notified by the Project Manager**

11.	**28.2**	Hourly rate of Fees payable to the Adjudicator is: **Ksh 2000……** Types of reimbursable expenses to be paid to the Adjudicator include: a)…**Transport**…..

		b)…**Reports Production**…….. **c)…Accommodation**
12.	**28.3**	Arbitration will take place at *Northern Water Services Board offices* in accordance with rules and regulations published by The Kenya Government as contained in the Arbitration act
13.	**29.1**	Appointing Authority for the Adjudicator: ***The Institution of Engineers of Kenya***
B. Time Control		
14.	**30.1**	The Contractor shall Submit a Programme for the Works within **7 days of delivery of the Letter of Acceptance.**
15.	**30.3**	The period between Programme updates is ***monthly*.**
16.	**30.3**	The amount to be withheld by the Project Manager in the case the contractor does not submit an updated programme is: **N/A.**
C. Quality Control		
17.	**38.1**	The Defects Liability Period **is *180* days.**
D. Cost Control		
18.	**45.7**	Minimum Amount of Interim Payment Certificate will be **20%** ***percent of contract price***
19.	**46.1**	The interest rate shall be **2%** above prevailing interest rate for commercial borrowing from the contractors bank
20.	**47.1(a)**	The Site Possession Date shall be **notified by the Project manager**
21.	**50**	The contract ***is not*** subject to price adjustment in accordance with Clause 50 of the General Conditions of Contract.
22.	**51.1**	The amount of retention is **10%** of value of works of Interim Payment Certificate'.
		Limit of retention will be ***10%*** of contract price.
23.	**52.1**	The rate of liquidated damages is ***0.1 percent of contract price per day***
	52.1 62.2 (g)	The maximum amount of liquidated damages is **5% of Contract Price]**
24.	**53.1**	The bonus for early completion is …**Nil**…..
25.	**54.1**	The amount of **advance payment** shall be **20%** of the contract sum payable within
		Recovery of Advance Payment shall be **25%** of amount of Interim Payment Certificate.
26.	**55.1**	The Performance Security shall be **10% of the contract price**
		E. Finishing the Contract

27.	**61.1**	As built drawings shall be supplied by the contractor within **N/A** Operating manual shall be supplied by the contractor by **N/A**
28.	**61.2**	The amount to be withheld by the Project Manager in the case the contractor does not submit as built drawings is: **N/A.** The amount to be withheld by the Project Manager in the case the contractor does not submit operating manual is **N/A**
29.	**63.1**	The percentage to apply to the value of the work not completed, representing the Procuring Entity's additional cost for completing the Works, **is *10%***

SECTION VI: TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

1. BOREHOLE DRILLING

1.1 GENERAL

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 the Project Manager's prior review and written consent.

This contract comprises the drilling, construction, development; test pumping, water quality analysis and erection of a gantry. The drill sites are indicated in the zone allocation list.

1.2 REGULATIONS AND STANDARDS

The borehole shall be drilled at the site to be identified by the Project Manager. Each borehole shall be drilled to a depth specified in the hydrogeological survey report. It shall be drilled through all strata encountered.

The Employer will acquire the relevant permits and Government authorizations.

1.2 MOBILIZATION, DEMOBILIZATION AND RESTITUTION

1.**2.1** The Contractor shall mobilize to the site in accordance with the Agreed Programme. The sum for mobilization/demobilization shall include transportation of machinery, erection, dismantling and preparation of temporary camps as the Contractor deems necessary, provision of drilling and development fluids (bentonite, foam, water),water for camping, personnel sanitary facilities.

1.2.2 The Contractor shall minimize disturbance to neighbouring plots. This shall particularly include ensuring that bailed fines and pumped test water are discharged in a manner that does not create a nuisance either to the public or private property.

1.2.3 Site re-instatement under the conditions of contract shall include the removal of all hydrocarbons spilled, leaked or otherwise released and associated packaging and cotton waste. Site re-instatement is deemed an integral part of mobilization. This activity shall be costed taking into account the items above and expressed as a lump sum.

1.3. DRILLING

1.3.1 Unless otherwise approved by the Project Manager, drilling shall be by the Mud drilling method. Drilling shall continue through all strata encountered. Drilling fluids and additives used must be approved by the Project Manager prior to use. The Contractor shall provide the appropriate tools and equipment and maintain them in good condition capable of operating to the manufacturer's rating to ensure a smooth, a smooth, straight hole.

1.3.2 Drilling shall continue to the stipulated total depth at a minimum diameter of **12 inches** diameter to provide for a finished borehole of a cased internal diameter of **8 inches diameter** after allowing for **100mm thick gravel pack** and temporary casings as found necessary. The Project Manager reserves the right to stop drilling operation if he considers that further drilling is unlikely to be advantageous. In this event payment shall only be made for the amount of work actually executed.

1.3.3 All materials used in the borehole construction other than temporary works shall comply with the relevant standard specifications. A tolerance in dimensions will be permitted provided that the material quality is not inferior to specification and work is in no way impaired.

1.3.4 The boreholes shall be drilled straight and vertical.

1.4 SAMPLE COLLECTION, STORAGE AND RECORD KEEPING

1.4.1 Samples of the drill cuttings returned to the surface shall be collected at two (2) metre intervals, dried and bagged. Each bag shall be clearly marked with the sample depth interval and borehole number. The Contractor shall record the depth and any zone of lost circulation for which no sample was taken.

1.4.2 The Contractor shall maintain a log of the penetration rate on a metre by metre basis, in minutes per meter drilled. A stopwatch shall be used for this purpose so that only the net drilling time is recorded, excluding any time taken in drilling disruptions.

1.4.3 The depth of any voids, or of particular rapid penetration, or significant changes in rig noise shall also be noted.

1.4.4 Water level shall be measured and recorded at the start and end of every shift, after significant breaks in activity (such as meal breaks), and during periods of plant downtime (as appropriate). The water levels shall be measured using a sounding and/or lighting dipper approved for use by the Project Manager.

1.5 SUPPLY AND INSTALLATION OF CASINGS AND SCREENS

1.5.1 CASING AND SCREEN SPECIFICATIONS

a). Casings shall be new, **1500mm (6 inches)** internal diameter, black pipe class B, with a minimum wall thickness of 4.0mm in 6 meter lengths.

b). Mill slotted screens shall be constructed from new **200mm** internal diameter black pipe class B with a minimum wall thickness of 4.0mm. Slots shall not exceed 1.0 mm in width, and should constitute not less than 6.0% open space area. Gas slotted casing screens are not acceptable.

1.5.2 CASINGS AND SCREEN INSTALLATION

a). Before installation of the casings and screens, the Contractor shall ensure that the hole is clear to the total depth and shall flush out any backfilled materials present. The Project Manager shall provide the design of the casings and screens string prior to installation by the Contractor.

b). Casing jointing shall be by either flush square-section threading or tree pass electric arc welding. Screens may be welded to casing, or screw-jointed by means of flush square-section threads. Externally socket joints may be welded to the casing, or screw-jointed by means of flush square-section threads. Externally socketed joints will not be accepted. Where screwed joints are deemed by the Project Manager to be below standard, joint shoulders shall be spot welded at 900mm interval around the casing circumference at no extra cost. If screens and casing are to be welded, the appropriate welding electrode must be used.

c). During welding, casing and screen lengths must be held absolutely vertical in order to ensure a plumb installation. All joints to be welded must be evelled at the butt end; three continuous weld passes must be made to ensure a sound joint and the oxide coating be removed before the second and third passes.

d). Burn-through and subsequent deposition of metal on the inside of the casings and screens must be avoided. The base of the casing shall be sealed, unless otherwise directed by the Project Manager, with a circular plate of black pipe class B of thickness not less than 4.0mm (^{1}/4 inch) fixed with a continuous weld to the casing strip. The appropriate welding electrode shall be used. The weld passes will be made, with oxide coating removed prior to the second and third passes. The top of the casing straight shall terminate not less than 600mm above the highest recorded level of ground at the site.

e). The contractor shall be responsible for the provision of temporary casings as necessary, including the insertion and removal. Where the Project Manager deems it necessary to have temporary casings left in the borehole as a measure of securing the borehole, this will be indicated in the item for other works in the bill of quantity.

1.5.3 ADMISSIBLE RATES

a). Rates shall be expressed as supply and installation of casing or screen per Unit Linear Metre.

SUPPLY AND INSTALLATION OF GRAVEL PACK

1.6.1 SPECIFICATIONS

a). The Contractor shall supply and install filter pack/formation stabilizer. The material shall be 2-4 mm diameter, clean well rounded riverbed siliceous gravel with no more than 5.0% non-siliceous material. The pack must be approved by the Project Manager prior to installation. Granular calcium hypochlorite will be introduced into the annular space along the pack material at a concentration of 500 grammes per cubic metre of pack.

The gravel pack shall be placed in the production boreholes to a thickness of 50mm around the casing upto where all screen zones are covered with the gravel as per the Project Manager's satisfaction.

This will initiate the process of sterilizing the wellbore. The Contractor shall provide the Project Manager with the bulk density of the pack material (Kg/M^3).

b). Installation of the filter pack/formation stabiliser may be water wash down or reverse circulation methods. In the latter case a pump set or airlift string shall be installed in the bore so as to encourage material settlement. The filter pack shall terminate not less than 3.0 metres above the uppermost screen when stabilized, or as otherwise directed by the Project Manager. The Contractor shall provide a means by which this level shall be measured.

1.6.2 ADMISSIBLE RATES

Rates shall be expressed as supply and installation of gravel pack per Unit Cubic Metre.

1.7 INSTALLATION OF BACKFILL

1.7.1 SPECIFICATIONS

a). Backfill material shall comprise of fine clayey drill cuttings and shall be installed from the top of the filter pack to 3.0 metres below ground level unless otherwise directed by the Project Manager. The installation method must ensure that no bridging occurs within the annular space.

b). The Contractor shall measure the depth to the top of the backfill and provide the means by which this level may be measured.

1.7.2 ADMISSIBLE RATES

Rates shall be expressed as installation of backfill per Unit Linear Metre.

1.8 DEVELOPMENT

Development shall comprise both Physical and Chemical development, and shall include the following operations:-

1.8.1 BOREHOLE CLEANING

a). The Contractor shall clean the borehole to its "completed depth" using any of the methods listed below or as otherwise authorized by the Project Manager:-

- By bailer with percussion drilling rig
- By means of airlift, which may use a light or stable foam to assist in the removal of materials from the borehole.
- By means of educator airlift, with or without light or stable foam.

b). Bailers and other down hole plant shall adopt diameter limits of half a normal size or smaller (12.5mm or ½ inch) than the smallest casing or screen diameter.

c). Water levels shall be measured and recorded at the start and end of every shift, at significant breaks in activity (such as meal breaks), and during periods of plant downtime (as appropriate). Water levels be measured using a sounding and/or lighting dipper previously approved by the Project Manager.

d). The borehole shall be deemed clean when measured drilled depth has been reached and when insignificant or no materials is removed from the base of the borehole. Cleaning costs shall be expressed as a rate Per Hour.

1.8.2 CHEMICAL DEVELOPMENT

a).When the Project Manager has deemed the borehole clean; he may instruct the Contractor to commence with Chemical development. Chemical development shall comprise of an approved Polyphosphate as a desaggregate that shall break down the silty concentrations, any buildup clay or silts, or other fine materials within and adjacent to the borehole. The decision as whether chemical development shall be adopted and what dosage rates shall be made by the Project Manager.

b). Typical dosage shall comprise of powdered Sodium Hexametaphosphate dissolve in hot water. The polyphosphate shall be dosed at 10 to 15 Kg/m3 of water depending on the concentration of clays in the aquifer matrix. This shall be mixed with calcium hypochlorite at a dose of 200grammes per cubic metre to inhibit bacteria activity. The volume of polyphosphate dosed water shall be one and a half times the Volume of water within the screen section.

a) Both polyphosphate and added water shall be introduced by means of a pipe, the bottom end of that shall be located in the middle of the screen section of the borehole. The Contractor may get the liquids into the screened section using a jetting head if he wishes.

d). After dosing, the borehole shall be left overnight to allow disaggregation to occur. The borehole shall then be subject to physical development.

e). Chemical development costs shall be expressed as an Hour rate, and include all labour and materials (including clean water) required for the operation. Chemical development undertaken by a Contractor familiar with the technique shall take no longer than three (3) hours.

1.8.3 PHYSICAL DEVELOPMENT

a). Physical development may adopt any of the commonly used methods, including but not necessarily restricted to the following:-

- Surging
- Bailing
- High Velocity Water Jetting
- Airlift raw hiding
- Airlift raw hiding with educator pipe.

b). Development shall be considered complete when the water discharged is clear and contains no more than an estimated 5 parts per million of suspended solids and the borehole has been restored to the cleaned total depth or as otherwise directed by the Project Manager.

c) The Contractor shall describe the method he proposes to adopt and the plant required for physical development in his method statement. **Over pumping** shall not be considered a development method. The rate submitted by the Contractor for physical development is deemed to include installation and removal of necessary plant. The quantities given in the bills of quantities only apply to actual development time. Costs for physical development shall be expressed as an Hour Rate.

1.9 AQUIFER TESTING

Borehole testing will be conducted according to British Standard BS 6316 (1992) (Code of Practise for Test Pumping of Water Wells). The following elements are required.

- A pre-test
- A step drawdown test
- A constant discharge test
- A recovery test

1.9.1 INSTALLATION, PLANT AND METHODOLOGY

Pumping plant and dipping tube shall be installed in the borehole to be tested. The Contractor shall investigate and agree with the Project Manager the anticipated discharge and pump intake depth.

a) PUMPING PLANT

a) Pumps used for test pumping should be electrical submersible.

a) The pump used in tests must have a fully functioning **non-return valve** either in the pump itself or in the rising main immediately above the top of the pump.

a) The Contractor must have pumps covering the anticipated discharge range.

a) The water pumped from the borehole shall be discharged to waste at a distance and in such a manner that it does not pond or flow back towards the borehole.

a) The Contractor must provide a generator or other prime mover for powering the pump, as power is not necessarily available at the sites.

a) DISCHARGE MEASUREMENT AND CONTROL

Discharge measurements shall be by an approved accurate method, such as an Orifice Plate, calibrated flow meter or a V-notch weir. If volumetric methods are proposed, the Contractor will ensure the container to be used has been calibrated. When time to fill measurements is made, each discharge measurement shall be calculated from the average of three time measurements. Discharge shall vary by no more than 15%across each step of step drawdown test, and across the constant discharge test.

a) WATER LEVEL MEASUREMENT

Water level measurements shall be by electric sounding and/or lighting dipper, and shall be made in a dipper tube installed alongside the test pump rising main and tied securely to it. The Project Manager will check the dipper for stretch and any other inaccuracies prior to accepting its use. Accuracy measurements must not be less than 1.0 cm. Water level measurements using an air line will not be acceptable on the grounds of poor precision.

a) TIME MEASUREMENT

All times shall be measured by means of a stopwatch. The Contractor shall ensure that spare batteries etc for all equipment are available prior to commencing tests.

a) CONSTANT DISCHARGE TEST

Constant discharge test shall typically last not less than twenty four (24) hours,or as otherwise determined by the Project Manager. A water sample will be procured towards the end of the test for subsequent analysis by a competent laboratory.

a) RECOVERY TEST AND REMOVAL OF PLANT

Recovery tests shall not continue for more than twenty four (24) hours, or as otherwise directed by the Project Manager. Only after the completion of recovery data collection may pumping and ancillary plant be removed from the borehole, though above ground components may be dismantled during the recovering phase.

a) ADMISSIBLE RATES

Rates of pumping and recovery are deemed to include the cost of plant installation and removal. The rates are deemed inclusive of installation, removal, plant use, testing and data collection.

1.10 WATER SAMPLING AND ANALYSIS

- In the closing hour of the constant discharge test a water sample shall be collected for chemical and bacteriological analysis by a competent laboratory. The water samples shall be collected in containers supplied by the laboratory, in the manner conventionally used by the laboratory.

- The Contractor’s unit rate of sampling and analysis will include the cost of analysis and transportation to and from the laboratory for the sampling exercise.

1.11 BOREHOLE DISINFECTION

After removal of test equipment, the borehole shall be disinfected with Chlorine/water solution at a concentration of 50 milligrams per litre or greater of free chlorine. This will be sprayed into the borehole so as to ensure that all exposed borehole wall surfaces are coated. In preparing their Tenders, Contractors should allow for one (1) cubic metre of solution per borehole. This item shall be costed as a unit Lump Sum

1.12 BOREHOLE HEAD WORKS

a) SANITARY SEAL CASING

A sanitary seal shall be constructed at the wellhead. This shall comprise the following elements:

- A 3.2 metre length of internal diameter 205 mm (8 inch) plain black pipe class B sanitary steel casing installed around the permanent casing string.
- A grout seal between the 254mm sanitary seal casing and the 152 mm permanent casing string.
- A 1.0x1.0x1.0 metre reinforced concrete block (Y8/1:2:4) cast around the Sanitary seal casings.
- A lockable steel cap.

b). GROUT SEAL

A sanitary ground seal shall be installed between the 152 mm (6 inch) and 205 mm (8 inch) casings and grouted into place. Grout shall be a cement slurry, or cement and fine sand and shall have a density of at least 1175 Kg/lt.This shall be introduced into the annular space from the top of the inert backfill to the ground level, using a method that must be approved by the Project Manager.

a) CONCRETE PLINTH

The ground surface at the wellhead shall be excavated to a depth of one (1) metre, and be one metre square, to allow s Concrete Plinth to be cast. The 1.0x1.0x1.0 metre pit will be filled with concrete, to be finished flush with the ground surface. Concrete shall be 1:2:4 OPC: sand: half-inch ballast. This must be cast with two 0.8 metre lengths of 12 mm reinforcing steel bar welded to the 205 mm (8 inch) casing, 0.7 metre below ground level.

d). TEMPORARY CAP

The top of the borehole shall be sealed with a cap that shall comprise a round plate of mild steel, of thickness not less than 3.0mm. This will be continuously welded in single pass to the mild steel borehole casing or should be lockable.

1.13 RECORDS

After completion of all works at the borehole, the Contractor shall submit to the Project Manager within four (4) days a complete document with the following additions:-

- Drilling penetration Log
- Geological Log
- WAB 28 Borehole Completion Record (Three Complete Sets of Completion Reports shall be submitted.

1.14 TECHNICAL LITERATURE

a) A Tenderer **must** submit the following information together with the Tender documents to assist in fair evaluation:-

- Technical specifications on drilling rig and other ancillary equipment (make, model, rated capacity etc)

- Particulars and specifications of materials used in the construction of the borehole.

- Any other information the tenderer may deem is important in evaluation as well as BOOSTING his/her chances of winning the tender.

BOREHOLE GANTRY

The gantry shall be fabricated from double flanged GI class 'B' water pipes. The total length of the gantry shall be 8.7 metres wile the height above the ground shall be 7.5 metres. The top cross bar shall have a movable hook of capacity 4.0 tons. The gantry shall be held together using high tensile strength galvanized steel bolts and nuts. The access steps to the top cross bar shall be made from DN13 GI class 'B' water pipes firmly welded at 350mm interval along the entire length of the two vertical pipe columns starting from 600mm height above the ground level. The gantry shall be installed in square holes of size 1200x1200x1200mm depth using concrete of mix ration 1:2:4.

S E C T I O N 5

BILLS OF QUANTITIES

PREAMBLE TO BILLS OF QUANTITIES

1. The Bills of Quantities is an integral part of the Bidding documents and must be read in conjunction with the rest of the document contents.

2. The brief descriptions of works under the items in the Bill of Quantities are purely for the purpose of identification only, and shall in no way modify or supersede the descriptions given under the sections of the document.

3. The rates and prices inserted by the Bidder in the Bill of Quantities are to be full inclusive of the work described under the items and shall cover all overhead charges, incidentals, contingency expenses and profits.

4. The words ”TAKE CUSTODY’ shall be taken to mean delivery, unloading, stocking, getting from the store, transporting, unloading, getting into position for fixing all the materials concerned and all other contingency expenses.

5. Where dimensions are entered:-

   mm - means millimetres
   RM - means Running Metre
   L - means Length
   W - means Width
   LS - means Lump Sum.
   LM - means Linear Metre

6. Provisional sums (including Dayworks0 in the bill of Quantities shall be expended in whole or in part at the discretion of the engineer in accordance with Sub-clause 52.4 and clause 58 of the conditions of Contract.

SECTION IX: TENDER FORMS

A. Form of Tender

[date]

To:
THE CHIEF EXCUTIVE OFFICER
NORTHERN WATER SERVICES BOARD
P.O BOX 495-70100
GARISSA

We offer to execute the [*name and identification number of contract]* in accordance with the Conditions of Contract accompanying this Tender for the Contract Price of *[amount in numbers], [amount in words] [name of currency]*.

The Contract shall be paid in the following currencies:

Currency	**Percentage payable in currency**	**Rate of exchange: one foreign equals [*insert local]***	**Inputs for which foreign currency is required**
(a)			
(b)			

The advance payment required is:-

Amount	**Currency**
(a)	
(b)	

We accept the appointment of The Institution of Engineer's of Kenya as the adjudicator.
or
We do not accept the appointment The Institution of Engineer's of Kenya as the Adjudicator, and propose instead that [*name*] be appointed as Adjudicator, whose daily fees and biographical data are attached.

We are not participating, as Tenders, in more than one Tender in this Tendering process other than alternative Tenders in accordance with the Tendering documents.

Our firm, its affiliates or subsidiaries, including any subcontractors or suppliers for any part of the contract has not been declared ineligible by the Kenya Government under Kenya's laws or any other official regulations.

This Tender 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 Tender you receive.

We hereby confirm that this Tender complies with the Tender validity and Tender Security required by the Tendering documents and specified in the Tender Data Sheet.

Authorized Signature:_____

Name and Title of Signatory: _____

Name of Tenderer: _____

Address: _____

Appendix to Tender

Schedule of Adjustment Data

[In Tables A, B, and C, below, the Tenderer shall (a) indicate its amount of local currency payment, (b) indicate its proposed source and base values of indices for the different foreign currency elements of cost, (c) derive its proposed weightings for local and foreign currency payment, and (d) list the exchange rates used in the currency conversion. In the case of very large and/or complex works contracts, it may be necessary to specify several families of price adjustment formulae corresponding to the different works involved.]

Table A. Local Currency

Index code	Index description	Source of index	Base value and date	Tenderer's related currency amount	Range of weighting Proposed by the Procuring Entity	Tenderer's proposed weighting
	Nonadju-stable	—	—	—	**a: _____*** **b: ------ to -------- *** **c: ------- to ------- *** **d: ------- to ------- *** **e: ------- to ------- *** **etc.**	**a: _____*** **b: _____** **c: _____** **d: _____** **e: _____** **etc.**
				Total		**1.00**

Table B. Foreign Currency

State type: ..... [If the Tenderer wishes to quote in more than one foreign currency, this table should be repeated for each foreign currency.]

Index code	Index description	Source of index	Base value and date	Tenderer's related source currency in type/ Amount	Equivalent in Foreign Currency 1	Range of weighting Proposed by the Procuring Entity	Tenderer's proposed weighting
	Nonadju-stable	—	—	—		**a: _____***	**a: _____**
						b: ------ to ------*	**b: _____**
						c: ------- to ------*	**c: _____**
						d: ------- to ------*	**d: _____**
						e: ------- to ------*	**e: _____**
						etc.	**etc.**
						etc.	
Total							**1.00**

Table C. Summary of Payment Currencies

For ……..[insert name of Section of the Works]

[Separate tables may be required if the various sections of the Works (or of the Bill of Quantities) will have substantially different foreign and local currency requirements. The Procuring Entity should insert the names of each Section of the Works.]

Name of payment currency	**A Amount of currency**	**B Rate of exchange (local currency per unit of foreign)**	**C Local currency equivalent C = A x B**	**D Percentage of Net Tender Price (NBP) $\frac{100xC}{NBP}$**
Local currency _____		**1.00**		
Foreign currency #1 _____				
Foreign currency #2 _____				
Foreign currency # _____				
Net Tender Price				**100.00**
Provisional sums expressed in local currency	*	*	*	
TENDER PRICE				

Authorized Signature:_____

Name and Title of Signatory:_____

Name of Tenderer:_____

Address: _____

B. Tender-Securing Declaration

Date: *[insert **date** (as day, month and year)]*

Tender No.: *[insert **number of Tendering process**]*

Alternative No.: *[insert **identification No if this is a Tender for an alternative**]*

To:

Northern Water Services Board

We, the undersigned, declare that:

We understand that, according to your conditions, Tenders must be supported by a Tender-Securing Declaration.

We accept that we will automatically be suspended from being eligible for Tendering in any contract with the Procuring Entity for the period of time of *[insert **number of months or years**]* starting on *[insert **date**]*, if we are in breach of our obligation(s) under the Tender conditions, because we;

a) Have withdrawn our Tender during the period of Tender validity specified in the Form of Tender; or

b) Having been notified of the acceptance of our Tender by the Procuring Entity during the period of Tender validity,

   (i). Fail or refuse to execute the Contract, if required, or

   (ii). Fail or refuse to furnish the Performance Security, in accordance with the ITT.

We understand this Tender Securing Declaration shall expire if we are not the successful Tenderer, upon the earlier of;

1) Our receipt of your notification to us of the name of the successful Tenderer; or

2) Thirty days after the expiration of our Tender.

Signed: *[insert signature of person whose name and capacity are shown]* In the capacity of *[insert legal capacity of person signing the Tender Securing Declaration]*

Name: *[insert **complete name of person signing the Tender Securing Declaration**]*

Duly authorized to sign the Tender for and on behalf of: *[insert **complete name of Tenderer**]*

Dated on _____ day of _____, _____ *[insert **date of signing**]*

Corporate Seal (where appropriate)

C. Confidential Business Questionnaire

1 **Individual Tenderer or Individual Members of joint Ventures**

1.1 Constitution or legal status of Tenderer: [*attach copy*]

Place of registration: [*insert]*

Principal place of business: *[insert*]

Power of attorney of signatory of Tender: [*attach*]

Registration certificate [attach] current Business License [*attach]*

1.2 Total annual volume of construction work performed in two years, in Kenyan shillings as specified in the Tender Data Sheet; *[insert*]

1.3 Work performed as prime Contractor on works of a similar nature and volume over the last two years or as specified in the Tender Data Sheet in Kenyan Shillings. Also list details of work under way or committed, including expected completion dates.

Project name and country	**Name of client and contact person**	**Contractors Participation**	**Type of work performed and year of completion**	**Value of contract**
(a)				
(b)				

1.4 Major items of Contractor's Equipment proposed for carrying out the works. List all information requested below. Refer also to sub-Clause 12.3 of the Instructions to Tenderers.

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?)**
(a)			
(b)			
(c)			
(d)			

1.5 Qualifications and experience of key personnel proposed for administration and execution of the Contract. Attach biographical data. Refer also to sub-Clause 12.3 of the

Instructions to Tenderers and Sub- Clause 10.1 of the General Conditions of Contract.

Position	Name	Years of Experience (general)	Years of experience in proposed position
(a)			
(b)			

1.6 Proposed sub-contractor and firms involved. Refer to Clause 7 of General Conditions of Contract.

Sections of the Works	Value of subcontract	Subcontractor (name and address)	Experience in similar work
(a)			
(b)			

1.7 Financial reports for the number of years specified in the Tender Data Sheet.

1.8 Evidence of access to financial resources to meet the qualification requirements: cash in hand, lines of credit, etc. List below and attach copies of support documents.

1.9 Name, address, and telephone, e-mail address, and facsimile numbers of banks that may provide references if contracted by the Procuring Entity.

1.10 Information on current litigation in which the Tenderer is involved.

Other party(ies)	Cause of dispute	Amount involved
(a)		
(b)		

1.11 Statement of compliance with the requirements of sub-Clause 3.2 of the Instructions to Tenderers.

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

2. **Joint Ventures**

2.1 The information listed in 1.1 – 1.11 above shall be provided for each partner of the joint venture.

2.2 The information in 1.12 above shall be provided for the joint venture.

2.3 Attach the power of attorney of the signatory (ies) of the Tender authorizing signature of the Tender on behalf of the joint venture.

2.4 Attach the Agreement among all partners of the joint venture (and which is legally binding on all partners), which shows that:

(a) all partners shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms;

(b) one of the partners will be nominated as being in charge, authorized to incur liabilities, and receive instructions for and on behalf of any and all partners of the joint venture; and

(c) the execution of the entire Contract, including payment, shall be done exclusively with the partner in charge.

3. **Additional Requirements**

3.1 Tenderers should provide any additional information required in the **Tender Data Sheet** or to fulfil the requirements of sub-Clauses 12.1 of the Instructions to Tenderers, if applicable.

D. Integrity Declaration

UNDERTAKING BY TENDERER ON ANTI – BRIBERY POLICY / CODE OF CONDUCT AND COMPLIANCE PROGRAMME

1. Each Tenderer must submit a statement, as part of the Tender documents, in either of the two given formats which must be signed personally by the Chief Executive Officer or other appropriate senior corporate officer of the Tendering company and, where relevant, of its subsidiary in the Kenya. If a Tender is submitted by a subsidiary, a statement to this effect will also be required of the parent company, signed by its Chief Executive Officer or other appropriate senior corporate officer.

2. Tenderers will also be required to submit similar No-bribery commitments from their subcontractors and consortium partners; the Tenderer may cover the subcontractors and consortium partners in its own statement, provided the Tenderer assumes full responsibility.

3.
   a) Payment to agents and other third parties shall be limited to appropriate compensation for legitimate services.

   b) Each Tenderer will make full disclosure in the Tender documentation of the beneficiaries and amounts of all payments made, or intended to be made, to agents or other third parties (including political parties or electoral candidates) relating to the Tender and, if successful, the implementation of the contract.

   c) The successful Tenderer will also make full disclosure [quarterly or semi- annually] of all payments to agents and other third parties during the execution of the contract.

   d) Within six months of the completion of the performance of the contract, the successful Tenderer will formally certify that no bribes or other illicit commissions have been paid. The final accounting shall include brief details of the goods and services provided that they are sufficient to establish the legitimacy of the payments made.

   e) Statements required according to subparagraphs (b) and (d) of this paragraph will have to be certified by the company's Chief Executive Officer, or other appropriate senior corporate officer.

4. Tenders which do not conform to these requirements shall not be considered.

5. If the successful Tenderer fails to comply with its No-bribery commitment, significant sanctions will apply. The sanctions may include all or any of the following:

   a) Cancellation of the contract;

   b) Liability for damages to the public authority and/or the unsuccessful competitors in the Tendering possibly in the form of a lump sum representing a pre-set percentage of the contract value (liquidated).

6. Tenderers shall make available, as part of their Tender, copies of their anti-Bribery Policy/Code of Conduct, if any, and of their-general or project - specific - Compliance Program.

7. The Government of Kenya has made special arrangements for adequate oversight of the procurement process and the execution of the contract, and has invited civil society and other competent Government Departments to participate in the oversight. Those charged with the oversight responsibility will have full access to all documentation submitted by Tenderers for this contract, and to which in turn all Tenderers and other parties involved or affected by the project shall have full access (provided, however, that no proprietary information concerning a Tenderer may be disclosed to another Tenderer or to the public).

ANTI-CORRUPTION DECLARATION COMITMENT/ PLEDGE

(*Sections39, 40,41,42,43 & of the PPD Act, 2005)*

I/We/Messrs…….

of Street, Building, P O Box……

……..

Contact/Phone/E mail……..

declare that Public Procurement is based on a free and fair competitive Tendering process which should not be open to abuse.

I/We ..……..

declare that I/We will not offer or facilitate, directly or indirectly, any inducement or reward to any public officer, their relations or business associates, in connection with

Tender/Tender No ……..…….

for or in the subsequent performance of the contract if I/We am/are successful.

Authorized Signature**.....**

Name and Title of Signatory……

E. Letter of Acceptance

[Letter head paper of the Procuring Entity]

[*date*]

To: *[name and address of the Contractor]*

This is to notify you that your Tender dated [*date*] for execution of the [*name of the Contract and identification number, as given in the Contract Data Sheet*] for the Contract Price of the equivalent of [*amount in numbers and works*] [*name of currency*], as corrected and modified in accordance with the Instructions to Tenderers is hereby accepted by us.

We confirm that [*insert name proposed by the procuring entity]* to be the Adjudicator.

We accept that [*name proposed by Tenderer*] be appointed as Adjudicator.

Or

We do not accept that [*name proposed by Tenderer*] be appointed as adjudicator, and by sending a copy of this letter of acceptance to [*insert the name of the Appointing Authority*], we are hereby requesting [*name*], the Appointing Authority, to appoint the adjudicator in accordance with Clause 44.1 of the Instructions to Tenderers.

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

Please return the contract dully signed.

Authorized Signature: _____

Name and Title of Signatory: _____

Name of Agency: _____

Attachment: Form of Contract

F. Form of Contract Agreement

This Agreement, made the [*day*] day of [*month*], [*year*] between [*name and address of Procuring Entity*] (hereinafter called "the Procuring Entity") and [*name and address of Contractor*] (hereinafter called "the Contractor") of the other part.

Whereas the Procuring Entity is desirous that the Contractor execute [*name and identification number of contract*] (hereinafter called "the Works") with the objectives of *[insert functional objectives of the works]* and the Procuring Entity has accepted the Tender by the Contractor for the execution and completion of such works and the remedying of any defects therein in the sum of *[contract price in words and figures]* (hereinafter called "Contract Price").

NOW THIS AGREEMENT WITNESSES 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 pert of this Agreement;

2. In consideration of the payments to be made by the Procuring Entity to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Procuring Entity to execute and complete the Works and remedy any defects therein in conformity in all respects with the provisions of the Contract;

3. The Procuring Entity 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: _____

Tendering Signature of Procuring Entity_____

Binding Signature of Contractor _____

SECTION X: FORMS OF SECURITY

G. Tender Security (Bank Guarantee)

*[If required, the **Bank Tenderer** shall fill in this Guarantee form in accordance with the instructions indicated in brackets.]*

[insert bank's or insurance company's name, and address of issuing branch or office]

Beneficiary: *[insert name and address of Procuring Entity]*

Date: *[insert date]*

TENDER GUARANTEE No.: *[insert number]*

We have been informed that *[insert name of the Tenderer; if a joint venture, list complete legal names of partners]* (hereinafter called "the Tenderer") has submitted to you its Tender dated *[insert date]* (hereinafter called "the Tender") for the execution of *[insert name of Contract]* under Invitation for Tenders No. *[insert IFT number]* ("the IFT").

Furthermore, we understand that, according to your conditions, Tenders must be supported by a Tender Guarantee.

At the request of the Tenderer, we *[insert name of bank or insurance company]* hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of *[insert amount in figures expressed in the currency of the Purchaser's Country or the equivalent amount in an international freely convertible currency]* (*[insert amount in words]*) upon receipt by us of your first demand in writing accompanied by a written statement stating that the Tenderer is in breach of its obligation(s) under the Tender conditions, because the Tenderer;

a) Has withdrawn its Tender during the period of Tender validity specified by the Tenderer in the Form of Tender; or

b) Does not accept the correction of errors in accordance with the Instructions to Tenderers (hereinafter "the ITT") of the IFT; or

c) Having been notified of the acceptance of its Tender by the Procuring Entity during the period of Tender validity;

   (i). Fails or refuses to execute the Contract Form, if required, or

   (ii). Fails or refuses to furnish the Performance Security, in accordance with the ITT.

This Guarantee shall expire;

a) If the Tenderer is the successful Tenderer, upon our receipt of copies of the Contract signed by the Tenderer and of the Performance Security issued to you by the Tenderer; or

b) If the Tenderer is not the successful Tenderer, upon the earlier of;

   (i) Our receipt of a copy of your notification to the Tenderer that the Tenderer was unsuccessful, or

   (ii) Thirty days after the expiration of the Tenderer's Tender.

Consequently, any demand for payment under this Guarantee must be received by us at the office on or before that date.

_____

[signature(s) of authorized representative(s)]

H. Performance Bank

[The **Bank successful Tenderer** providing the Guarantee shall fill in this form in accordance with the instructions indicated in brackets, if the Procuring Entity requires this type of security.]

[insert bank's or insurance company's name, and address of issuing branch or office]

Beneficiary: *[insert name and address of Procuring Entity]*

Date: *[insert date]*

PERFORMANCE GUARANTEE No.: *[insert Performance Guarantee number]*

We have been informed that *[insert name of Contractor]* (hereinafter called "the Contractor") has entered into Contract No. *[insert reference number of the Contract]* dated with you, for the execution of *[insert name of Contract and brief description of Works]* (hereinafter called "the Contract").

Furthermore, we understand that, according to the conditions of the Contract, a Performance Guarantee is required.

At the request of the Contractor, we *[insert name of Bank or Insurance Company]* hereby irrevocably undertake to pay you any sum or sums not exceeding in total an amount of *[insert amount in figures]* (*[insert amount in words])*, such sum being payable in the types and proportions of currencies in which the Contract Price is payable, upon receipt by us of your first demand in writing accompanied by a written statement stating that the Contractor is in breach of its obligation(s) under the Contract, without your needing to prove or to show grounds for your demand or the sum specified therein.

We hereby waive the necessity of your demanding the said debt from the Contractor before presenting us with the demand.

We further agree that no change, addition or other modification of the terms of the Contract or of the Works to be performed there under or of any of the Contract documents which may be made between you and the Contractor shall in any way release us from any liability under this Guarantee, and we hereby waive notice of any change, addition, or modification.

This guarantee shall expire not later than thirty days from the date of issuance of the Taking-Over Certificate.

[signature(s) of an authorized representative(s) of the Bank

SECTION VIII: BILL OF QUANTITIES

BILLS OF QUANTITIES FOR DRILLING, DEVELOPMENT AND TEST PUMPING OF BOREHOLE AT LAGDIMA PRIMARY SCHOOL IN WAJIR WEST CONSTITUENCY - 250 METERS

No.	Item description	Unit	Qty	Rate (KES)	Amount (KES)
A1.1	Mobilization, transportation of machinery and personnel, erection of camps and sanitary facilities and demobilization within the same zone.	Ls	1		
A1.2	Erection and dismantling of drilling equipment and allied machinery at site including drilling of borehole of 205mm minimum diameter through all types of strata including disposal of excavated materials, taking any remedial measures to overcome caving-in, or over-drilling to accommodate sloughed material and keeping drilling records as specified between the ground level and **100 meters below the ground level.**	M	100		
A1.3	Ditto item A1.2 but between 100meters and 200meters below ground level.	M	100		
A1.4	Ditto item A1.2 but between 200meters and 300meters below ground level.	M	50		
A1.5	Supply and install 152 mm internal diameter plain steel casings in the borehole.	M	150		
A1.6	Supply and installation of 152mm internal diameter slotted steel borehole casings.	M	100		
A1.7	Allow for taking samples of borehole drill cuttings at 2 meter intervals.	LS	1		
A1.8	Supply and insert rounded 2-4mm diameter gravel pack.	Ton	15		
A1.9	Grout between the casing and the borehole for the top ten (10) meters.	LS	1		
A1.10	Allow for physical and chemical development of the borehole.	Hr	12		
A1.11	Undertake constant discharge borehole test pumping.	Hr	24		
A1.12	Undertake recovery water level observations.	Hr	8		
A1.13	Carry out sterilization	Ls	1		
A1.14	Install signboard, wellhead, well cap serial number, cement slab dimensions 1.0mx1.0x1.0m around the well.	Ls	1		
A1.15	Supply water and drilling fluids for drilling operations and field camp.	Ls	1		

A1.16	Allow for 15 liters water sample laboratory analysis (1No. sample for bacteriological and 1No. for chemical analysis-15 liters each)	Ls	1		
A1.17	Supply and install an approved gantry	No	1		
A1.18	Supply and install Standard Signboard	No	1		
A1.19	Allow for making good surface reinstatement at the borehole to the Project Manager's Satisfaction	LS	1		
A1.20	Supervision of civil works by a hydrogeologist	Ls	1	**100,000**	**100,000**
				SUBTOTAL -1	
				VA.T=16% OF SUBTOTAL-1	
				TOTAL BILL	

BILLS OF QUANTITIES FOR DRILLING, DEVELOPMENT AND TEST PUMPING OF BOREHOLE AT WAJIR HIGH SCHOOL IN WAJIR EAST CONSTITUENCY - 100 METERS

No.	Item description	Unit	Qty	Rate (KES)	Amount (KES)
A1.1	Mobilization, transportation of machinery and personnel, erection of camps and sanitary facilities and demobilization within the same zone.	Ls	1		
A1.2	Erection and dismantling of drilling equipment and allied machinery at site including drilling of borehole of 205mm minimum diameter through all types of strata including disposal of excavated materials, taking any remedial measures to overcome caving-in, or over-drilling to accommodate sloughed material and keeping drilling records as specified between the ground level and **100 meters below the ground level.**	M	100		
A1.3	Supply and install 152 mm internal diameter plain steel casings in the borehole.	M	60		
A1.4	Supply and installation of 152mm internal diameter slotted steel borehole casings.	M	40		
A1.5	Allow for taking samples of borehole drill cuttings at 2 meter intervals.	LS	1		
A1.6	Supply and insert rounded 2-4mm diameter gravel pack.	Ton	8		

A1.7	Grout between the casing and the borehole for the top ten (10) meters.	LS	1		
A1.8	Allow for physical and chemical development of the borehole.	Hr	12		
A1.9	Undertake constant discharge borehole test pumping.	Hr	24		
A1.10	Undertake recovery water level observations.	Hr	8		
A1.11	Carry out sterilization	Ls	1		
A1.12	Install signboard, wellhead, well cap serial number, cement slab dimensions 1.0mx1.0x1.0m around the well.	Ls	1		
A1.13	Supply water and drilling fluids for drilling operations and field camp.	Ls	1		
A1.14	Allow for 15 liters water sample laboratory analysis (1No. sample for bacteriological and 1No. for chemical analysis-15 liters each)	Ls	1		
A1.15	Supply and install an approved gantry	No	1		
A1.16	Supply and install Standard Signboard	No	1		
A1.17	Allow for making good surface reinstatement at the borehole to the Project Manager's Satisfaction	LS	1		
A1.18	Supervision of civil works by a hydrogeologist	Ls	1	**100,000**	**100,000**
				SUBTOTAL -1	
				VA.T=16% OF SUBTOTAL-1	
				TOTAL BILL	

BILLS OF QUANTITIES FOR DRILLING, DEVELOPMENT AND TEST PUMPING OF BOREHOLE AT ELDAS PRIMARY SCHOOL IN ELDAS CONSTITUENCY, WAJIR COUNTY - 60 METERS

No.	Item description	Unit	Qty	Rate (KES)	Amount (KES)
A1.1	Mobilization, transportation of machinery and personnel, erection of camps and sanitary facilities and demobilization within the same zone.	Ls	1		
A1.2	Erection and dismantling of drilling equipment and allied machinery at site including drilling of borehole of 205mm minimum diameter through all types of strata including disposal of excavated materials, taking any remedial measures to overcome caving-in, or over-drilling to accommodate sloughed material and keeping drilling records as specified between the ground	M	60		

	level and **100 meters below the ground level.**				
A1.3	Supply and install 152 mm internal diameter plain steel casings in the borehole.	M	40		
A1.4	Supply and installation of 152mm internal diameter slotted steel borehole casings.	M	30		
A1.5	Allow for taking samples of borehole drill cuttings at 2 meter intervals.	LS	1		
A1.6	Supply and insert rounded 2-4mm diameter gravel pack.	Ton	5		
A1.7	Grout between the casing and the borehole for the top ten (10) meters.	LS	1		
A1.8	Allow for physical and chemical development of the borehole.	Hr	12		
A1.9	Undertake constant discharge borehole test pumping.	Hr	24		
A1.10	Undertake recovery water level observations.	Hr	8		
A1.11	Carry out sterilization	Ls	1		
A1.12	Install signboard, wellhead, well cap serial number, cement slab dimensions 1.0mx1.0x1.0m around the well.	Ls	1		
A1.13	Supply water and drilling fluids for drilling operations and field camp.	Ls	1		
A1.14	Allow for 15 liters water sample laboratory analysis (1No. sample for bacteriological and 1No. for chemical analysis-15 liters each)	Ls	1		
A1.15	Supply and install an approved gantry	No	1		
A1.16	Supply and install Standard Signboard	No	1		
A1.17	Allow for making good surface reinstatement at the borehole to the Project Manager's Satisfaction	LS	1		
A1.18	Supervision of civil works by a hydrogeologist	Ls	1	**100,000**	**100,000**
				SUBTOTAL -1	
				VA.T=16% OF SUBTOTAL-1	
				TOTAL BILL	

GRAND SUMMARY

S/No.	ITEM DESCRIPTION	A M O U N T	
		KSHS	CTS
	TOTAL BOREHOLE 2; LAGDIMA		
	TOTAL BOREHOLE 3; WAJIR HIGH		
	TOTAL BOREHOLE 4; ELDAS PRIMARY		
	GRAND TOTAL		

HYDROGEOLOGICAL ASSESSMENT REPORT

FOR

NORTHERN WATER SERVICES BOARD
P.O. BOX 495-70100
GARISSA

CARRIED OUT AT LAGDIMA PRIMARY SCHOOL IN WAJIR WEST CONSTITUENCY
WAJIR COUNTY

Report No: 058/03/2019

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NGARA, NAIROBI

Summary of the Scope of works

*The **Government of Kenya** through **Northern Water Services Board** commissioned the present hydrogeologist to undertake a comprehensive hydrogeological study to establish whether there are good chances of drilling high yielding borehole at **Lagdima Primary School** which is located in Wajir West constituency, Wajir County. The water is to be used for various purposes within the school compound.*

The area falls under the arid and semi arid land (ASAL) of Kenya. The area experiences high temperatures and low unreliable rainfall. Rainfall is generally low and unreliable in the area but when it comes, it falls in sudden heavy storms often causing unpredictable flash foods.

The area is geologically underlain by thick sedimentary rocks of several thousand metres in thickness. Most of these rocks are highly decomposed into clay and clayey sediments. Water is expected in sediments and in limestone where the clay element is low.

Several sites were identified by means of Horizontal Electrical profiling and Resistivity Methods within the school compound the details are discussed at the end of this report. The selected site is based on groundwater potential.

*Our observation from the fieldwork is that the area has **excellent groundwater potential** of reasonable quality and quantity that can be exploited for the intended purposes.*

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ABBREVIATIONS AND GLOSSARY OF TERMS

ABBREVIATIONS

asl	*above sea level*
VES	*Vertical Electrical Sounding*
HEP	*Horizontal Electrical Profiling*
TDS	*Total Dissolved Solids*
DTH	*Down the Hummer, (rotary drilling method)*
m bgl	*metres below ground level*
PWL	*pumped water level*
Q	*discharge (m^3/hr)*
SWL	*Static Water Level*
T	*transmissivity (m^2/day)*
WSL	*Water Struck Level*
WRMA	*Water Resources and Management Authority*
Kenya-RAPID	*Kenya Resilient Arid Lands Partnership for Integrated Development*

GLOSSARY OF TERMS

Aquifer *A geological formation or structure that stores and transmits water and which is able to supply water to wells, boreholes or springs.*

Breccias *A coarse-grained rock composed of angular fragments.*

Conductivity *Transmissivity per unit length (m/day)*

Confined aquifer *Confined aquifers are those in which the piezometric level is higher than the elevation at which the aquifer was encountered. Static water levels are at a higher level than the top of the formation.*

Drawdown *The distance between the static water level and the pumped water level The term* ***residual drawdown*** *is used for the same distance during recovery of the well.*

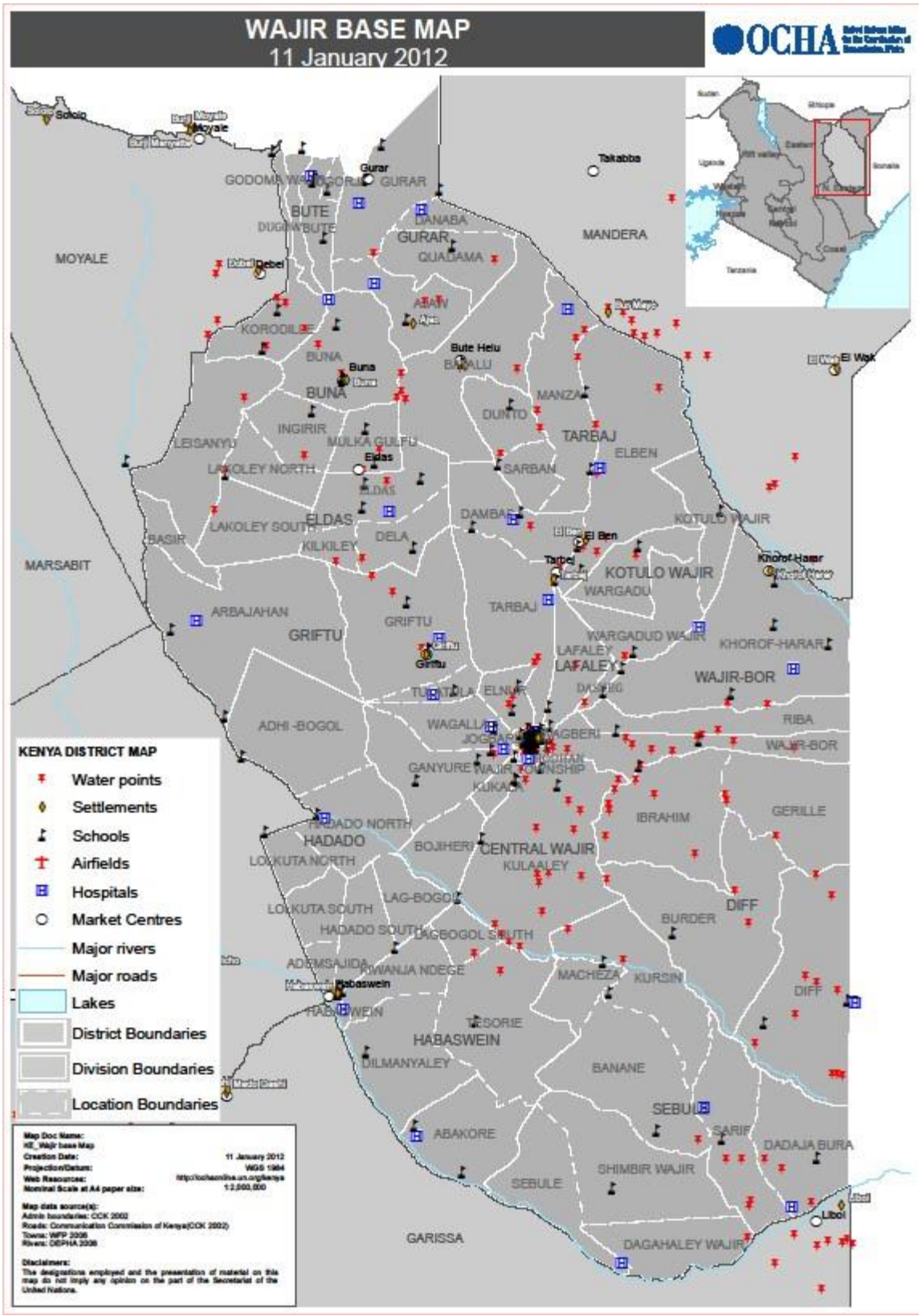
Development *In borehole engineering, this is the general term for procedures applied to repair the damage done to the formation during drilling. Often the borehole walls are partially clogged by an impermeable "wall cake", consisting of fine debris crushed during drilling, and clays from the penetrated formations. Well development removes these clayey cakes, and increases the porosity and permeability of the materials around the intake portion of the well. As a result, a higher sustainable yield can be achieved.*

Fault *A larger fracture surface along which appreciable displacement has taken place.*

Gradient *The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head*

Hydraulic head *Energy contained in a water mass, produced by elevation, pressure or velocity (also referred to as:* ***Head****).*

Hydro geological	*Those factors that deal with subsurface waters and related geological aspects of surface waters.*
Perched aquifer	*Accumulation of groundwater on top of a layer of low conductivity, underlain by unsaturated sediments or rocks*
Pumping test	*A test that is conducted to determine aquifer and/or well characteristics.*
Recharge	*General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, and lateral groundwater flow) to the aquifer zones.*
Recovery	*Return to static water level following abstraction of water.*
Specific Capacity	*Ratio of pumping rate and drawdown (m^3/hr/m); a measure for the well performance*
Static Water Level	*A measure for the capacity of an aquifer to conduct water through its saturated thickness (m^2/day)*
Well development	*The act of repairing damage to the formation caused by the drilling process or gradual well deterioration. Increases the porosity and permeability of the materials around the intake portion of a well*
Yield	*Volume of water discharged from a well**.***


WAJIR BASE MAP
11 January 2012
OCHA
KENYA DISTRICT MAP
Water points
Settlements
Schools
Airfields
Hospitals
Market Centres
Major rivers
Major roads
Lakes
District Boundaries
Division Boundaries
Location Boundaries
MOYALE
MANDERA
MARSABIT
GARISSA
BUTE
GURAR
BUNA
TARBAJ
ELDAS
KOTULO WAJIR
GRIFTU
HADADO
CENTRAL WAJIR
HABASWEIN
WAJIR-BOR
DIFF
SEBUL
Takabba
Bute Helu
El Wak
Khorof Harar
Libol

1.0 PREABLE.

This detailed report is presented as a technical site investigations report for the groundwater Survey program carried out for ***Northern Water service Board****, specific as a water supply facility for Lagdima Primary School, which is located in Wajir West Constituency, Wajir County.*

The program entailed a thorough and detailed hydro geological and geophysical borehole site investigations conforming to the WRA requirements and standards. The sole objective of this survey was geared towards developing sustainable water supply facility for various purposes in the Institution which include cleaning, drinking, washing and cooking.

For one to develop a highly efficient water supply model for the school, it appears imperative to analyze the records of the existing boreholes and the typical accompanying data that characterize the aquifer system replenishing the area.

This preliminary report is based on detailed aquifer mapping that goes to the extent of deploying state of the art geophysical data interpretations to un-ravel the geo-technical elements that can support high borehole yields.

The geologist's experience in basement and sedimentary terrains is that for a successful drilling program, there is need to characterize both the structural and geological aspects that control groundwater recharge/discharge- Vis-à-vis the groundwater flow patterns.

Apparently, there is need to address the water quality requirements for the facility. The water supply from the proposed borehole needs to conform to high quality standards; thus entailing the hydrogeologist to define aquifer characteristics that would meet the particular standards.

The government plans to drill productive boreholes to supply water to primary and secondary schools which face water scarcity. The aim of this survey was therefore to identify the most suitable drill site for the proposed borehole.

The climate of Wajir County is hot and dry with thorn bushes and acacia trees. Most of the vegetation is concentrated along drainage channels of which most of them are seasonal.

Nomadic pastoralism is the major economic activity in this County with camels, goats, sheep and cows being the main type of livestock reared here. The regions vast pasture lands have allowed this activity to be viable though much more could be done to ensure the county plays its role in the country's beef and milk production.

In recent time the community is also embracing sedentary settlements in order to take advantage of social – economic infrastructures in urban centers hence, putting pressure on existing water sources. It is due to the above that the client found it appropriate to develop a water supply facility since the already existing water sources have been overstretched by increased demand.

The main water source in the region is from boreholes and a few major earth pans. The region has small scale agricultural activities with small scale horticultural producers supplying mangoes, paw paws, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize.

The local Community in the area relies on seasonal earth pans, and boreholes fitted with submersible pumps and genset. The school has no water source hence compromising on the learning and hygiene of the students.

A detailed hydrogeological survey was then necessary within the proposed area in order to locate the most suitable site for sinking the proposed borehole. At least five boreholes have been drilled recently within 15Km radius in the project area, whereby all of them encountered good quality water averaging 10M^3/hr.

2.0 GEOGRAPHICAL LOCATION/PHYSIOGRAPHY.

Wajir County borders Ethiopia to the North, Somalia Republic to the East, Marsabit County to the north west, Isiolo County to the west, Garissa County to the south and Mandera County to the north and north east. The proposed site is located approximately 100Km south of Wajir Town along Wajir-Habaswein-Modogashe Road and is 10Km from Habaswein town within the Ewaso Ng'iro-Lorian swamp plains.

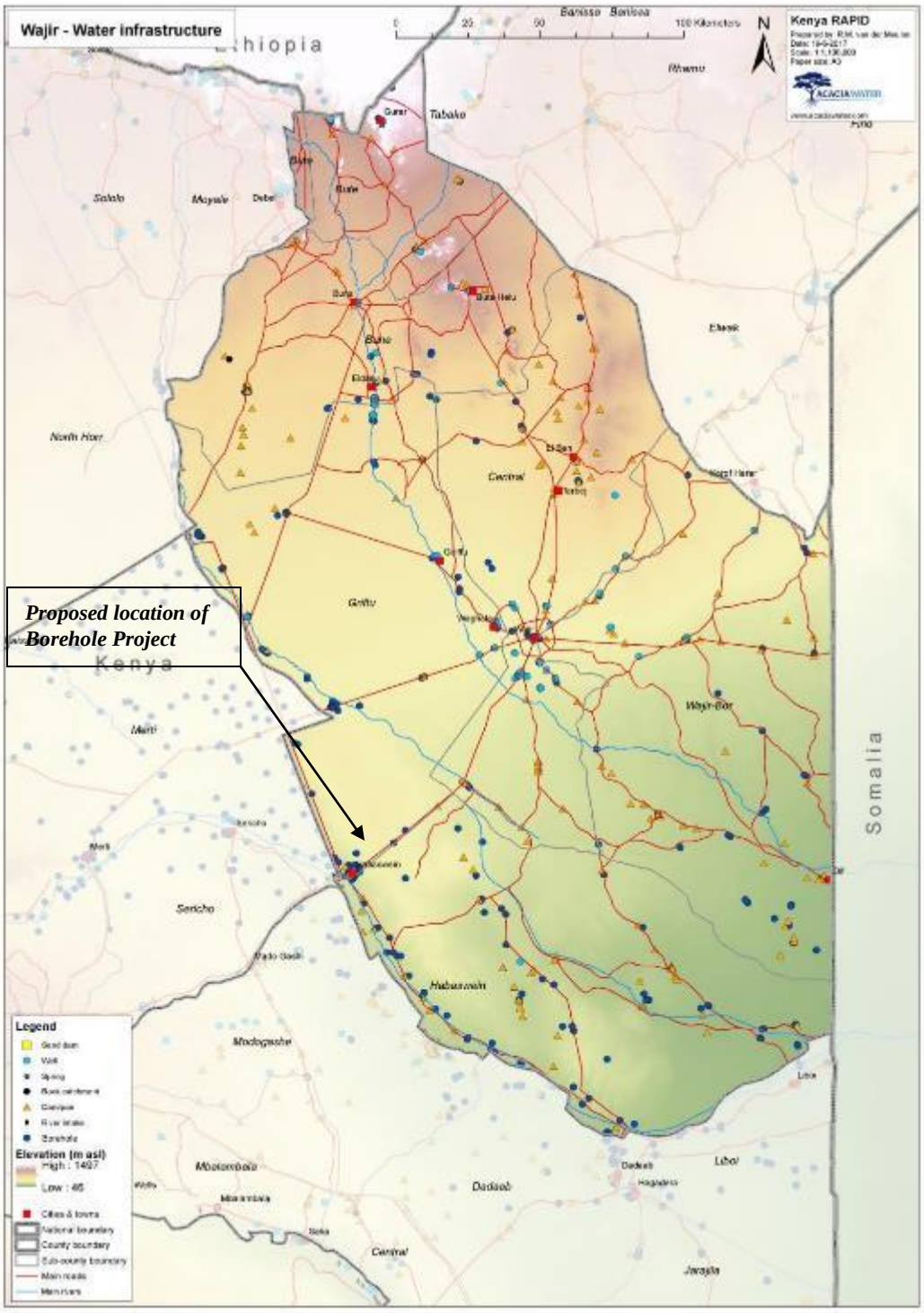

Wajir - Water infrastructure
Ethiopia
Kenya
Somalia
Proposed location of Borehole Project
Legend
Elevation (m asl)
Kenya RAPID

Fig 1.0: Map of Wajir County showing the location of the proposed borehole project and the existing water infrastructure (Courtesy of Kenya-RAPID and Acacia Water, 2017)

2.2 Rainfall and Climate.

The project area lies within the Sahelian Climatic region, characterized by dry spells and short rainy seasons and is classified as 100% Arid and Semi Arid Land (ASAL). The area experiences high temperatures and low unreliable rainfall throughout the year. The hottest season falls between November and April with temperatures soaring up to 38°C. Cooler months of July and August have mean temperatures of between 25 – 30°C. Rainfall is generally low and unreliable in the area but when it rains, it falls in sudden heavy storms often causing unpredictable sheet wash and flash floods.

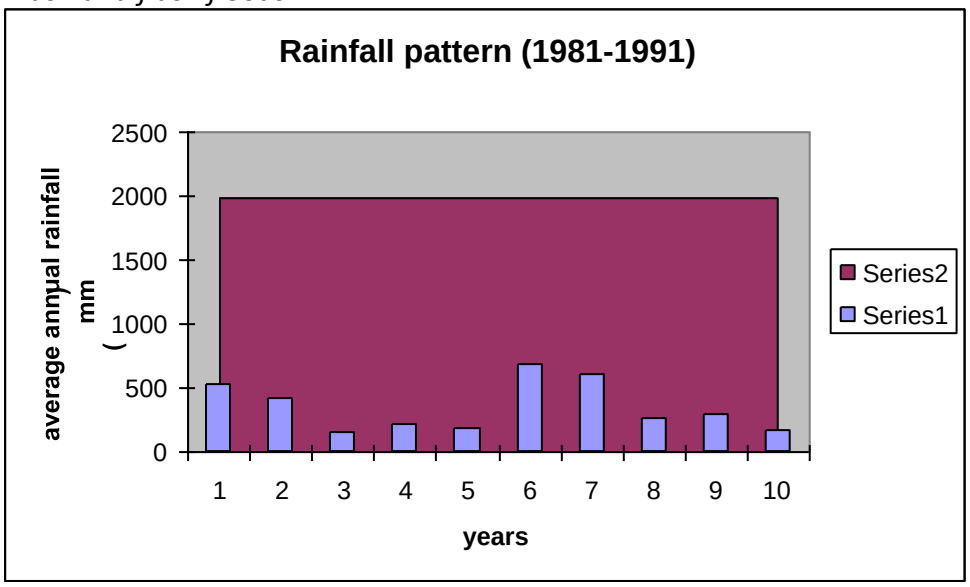


Figure 2.0: A photograph of the Lagdima primary school showing infrastructure, terrain and vegetation.

2.3 Current Land use

The major economic activity is nomadic pastoralism which is mainly practiced by the indigenous Somali Community. The communities rear goats, sheep, donkeys, camels and cattle. The growth of the towns has enabled various businesses to thrive such as Horticultural Farming, Catering and accommodation, construction, shops, etc.

In addition, the region has small scale agricultural production with small scale horticultural producers supplying mangoes, paw paws, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize.

2.4 Approximate Demand.

Approximately 50M^3/Day of water will be required for various purposes for this project. The school has a population of more than 200pupils. The proposed boreholes will be equipped with either a solar pump or electric submersible pumps hence the extraction of water will be fairly high but of course based on the proposed borehole yield of 10m^3/hr.

3.0 GEOLOGY.

3.1 Geology of the area.

The Geology of the area is generally viewed to be of the sedimentary rock sediments of Quaternary Geological Age associated with the Coastal plains of the Country. There was no solid rock exposures encountered within the exploration area during this fieldwork survey. The few poor exposures encountered during the field survey consisted of poorly unconsolidated marine kunkar limestone covered by thick sandy and red soils. See the geological map below.

The soils are mainly sandy calc-alluvium deposits along the Ewaso Ng'iro-Lorian swamp plains. The large part of the project area is covered by light grey sandy-loams along the vast Lorian Swamp valley but which grades to light grey-sandy clays along watercourses locally known as 'laggas'. The loam soils are as a result of deposition of eroded soil and humus transported all the way from Mt Kenya, Aberdare Ranges and Meru areas by Ewaso-Ng'iro River.

3.2 Geological setting of Wajir County.

The geology of Wajir and its immediate surroundings have been mapped by Joubert (1963). Earlier information was gathered and concepts developed by various investigators (e.g. Bestow, 1953). The geological map of the area bordering north (Thompson and Dodson, 1960) and a review by Swarzenski and Mundorff (1977) make the regional context more clear and provide supplementary clues for interpretation.

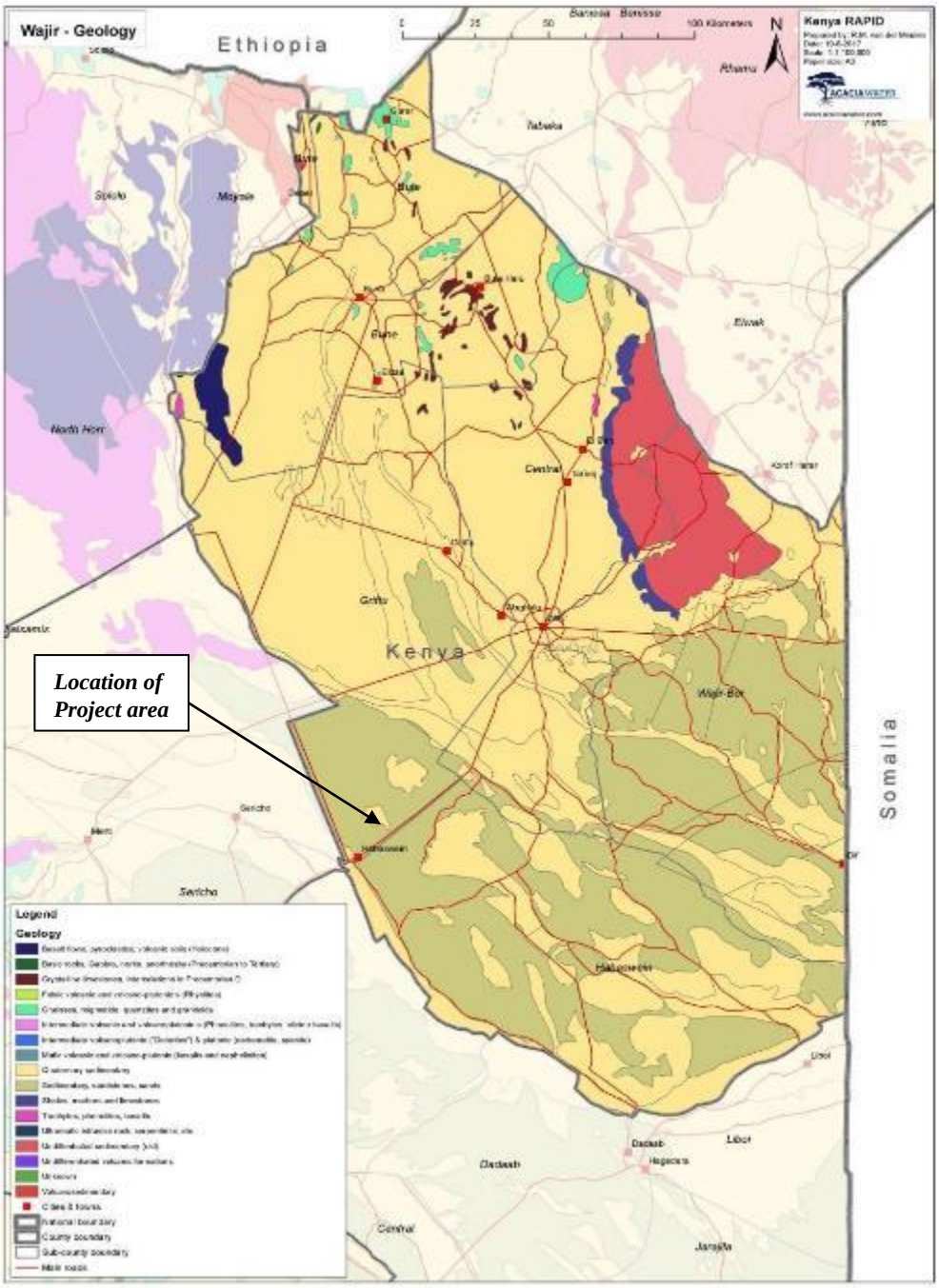


Fig 3.0: Map showing the Geology of Wajir County (Courtesy of Kenya-RAPID and Acacia Water, 2017)

Table 1. Stratigraphical table (after Joubert, 1963)

Relevant information on the regional geological units is summarized (stratigraphical table).

Period	***Formation***	***Lithology***
Recent		*Sandy soils*
Pleistocene	*Wajir Beds*	*Gritty soils, Laminated limestones limestones/Sandstones*
Jurassic	*Merti Beds*	*Sandstones* *Clays and sandy clays*
Triassic	*Bur Mayo Formation*	*Grey and brown limestones*
Precambrian	*Mansa Guda Formation.*	*Conglomerates* *& Sandstones*

As far as is known, Paleozoic rocks are absent in the area, which cause Basement rocks to be overlain directly by Mesozoic or even younger rocks. Down warping of the coastal area at the end of the Paleozoic resulted in a transgression of the sea, in which the Triassic Mansa Guda Formation was deposited as a delta. Recurrence of down warping in the Lower Jurassic caused another transgression and the deposition of the Jurassic Limestone Series.

After regression from Middle Jurassic times, the Cretaceous continental Marehan Series was deposited. During the Tertiary, erosion of Mesozoic and Precambrian rocks took place and Miocene sediments were deposited, but probably largely removed again as a result of Pliocene uplift.

The Pliocene Merti Beds were laid down in at least some parts of the Northeastern Province. Alternating pluvial and interpluvial periods during the Pleistocene and this explains the variation in lithology observed in the Wajir Beds and younger formations (Joubert, 1963; Swarzenski and Mundorff, 1977).

The occurrence and extent of the different geological units is rather well known at the surface, but uncertainties exist in many zones regarding the geological units at some depth. Bestow (1953)

and Joubert (1963) suggest, for example, that under Wajir Town, Basement rocks are directly overlain by (Tertiary and?) Quaternary rocks, whereas more recent reports (Swarzenski and Mundorff, 1977) and recent boreholes make plausible that the Mansa Guda Formation extends more southwestwards than previously thought and might occur under Wajir at a depth of 120 metres.

Furthermore, equivalent of the Merti Beds, found in a wide belt from NW of Habasweni to Liboi at the Somalian border (and beyond), are not mentioned by Joubert (1963), but Swarzenski and Mundorff (1977) suggest that they are present in the Wajir area as clays, sands and grits underlying a 20-25 m thick succession of Wajir Beds.

Finally, the sequence of Quaternary deposits varies considerably over short distances, which makes it difficult to recognize and correlate the different stratigraphic units in wells and boreholes. This fact has given rise to inconsistencies in this respect between various reports (Bestow, 1953; Joubert, 1963; Balasha Jalon, 1976; Swarzenski and Mundorff, 1977; Alexander Gibb & Partners, 1979).

3.3 Aquifer Zones

The following are parameters that define the aquifer characteristics of the Wajir similar to other areas in Northeastern Kenya.

3.3.1 Lithology and geometry

The widely exploited deep aquifer in the Wajir Area consists of gravelly sandy sediment and weathered sandstone. It is commonly found at depths of around 90-180M metres below ground level and is assumed to be approximately 40 metres thick. The occurrence of deep boreholes in the area (200-250M) suggests that there exist other aquifers deep below or it may be continuous.

Within its lateral limits the aquifer is assumed to be continuous.

3.3.2 Well yield

Pumping tests suggest that the sustained yield of boreholes drilled in the Habaswein area may exceed some 10 m^3/hr in roughly 70% and 7 m^3/hr in 30% of the cases, provided that well depth exceeds 180M. Commonly, the beds of water bearing sand and gravel in the merti aquifer are 10 to 15m thick and apparently are of limited lateral extent

3.3.3 Hydraulic aquifer properties

Specific capacities of boreholes tapping into the merti Aquifer range from about 2 to 90(L/Min/) M (liters per minute per metre of drawdown).

Transmissivities of the aquifer can be estimated from specific capacity data of boreholes. They range from about 6 to 120M^2/day. Hydraulic conductivities similarly estimated are in agreement with the very fine to medium grain sizes of much of the aquifer material and range from 0.25 to 4.0 m/day (metres per day).

3.3.4 Groundwater levels, groundwater flow and recharge

The extensive fresh-water zone of the Merti Aquifer that has water containing less than 1,000 mg/l of total dissolved solids follows approximately the alignment of Ewaso Ng'iro and Lak Dera channel ways. Its width ranges from 20-90Km and it is widest at the Kenya Somalia Border near Liboi.

In the area of merti aquifer, groundwater is found at rather uniform depths of about 90M in the low lying areas, and at depths as great as 140M in areas of higher altitude. Successful boreholes tap the more permeable zones of the Merti beds, commonly between depths of 105 to 150M below the land surface. The groundwater is generally confined, and potentiometric heads may be several metres higher than the top of the saturated sand beds

Groundwater level hydrographs measured shows that direct recharge of groundwater by local rainfall occurs. Tested yields of all deeper boreholes are good at very small drawdown (2-4M). This has been attributed to good aquifer characteristics and proper well construction.

4.0 WATER RESOURCES.

4.1 Surface Water Resources.

The project area has no perennial rivers except for numerous seasonal streams. Ewaso Ng'iro River that covers a large area drains the project area. Most of our fieldwork was concentrated in the midst of this valley. These seasonal rivers have water only during rainy seasons and few months after, otherwise they are dry most part of the year, hence no adequate supply of surface water. Residents in the area rely on water supply from boreholes, scooping water from dry riverbeds, earth pans and shallow wells.

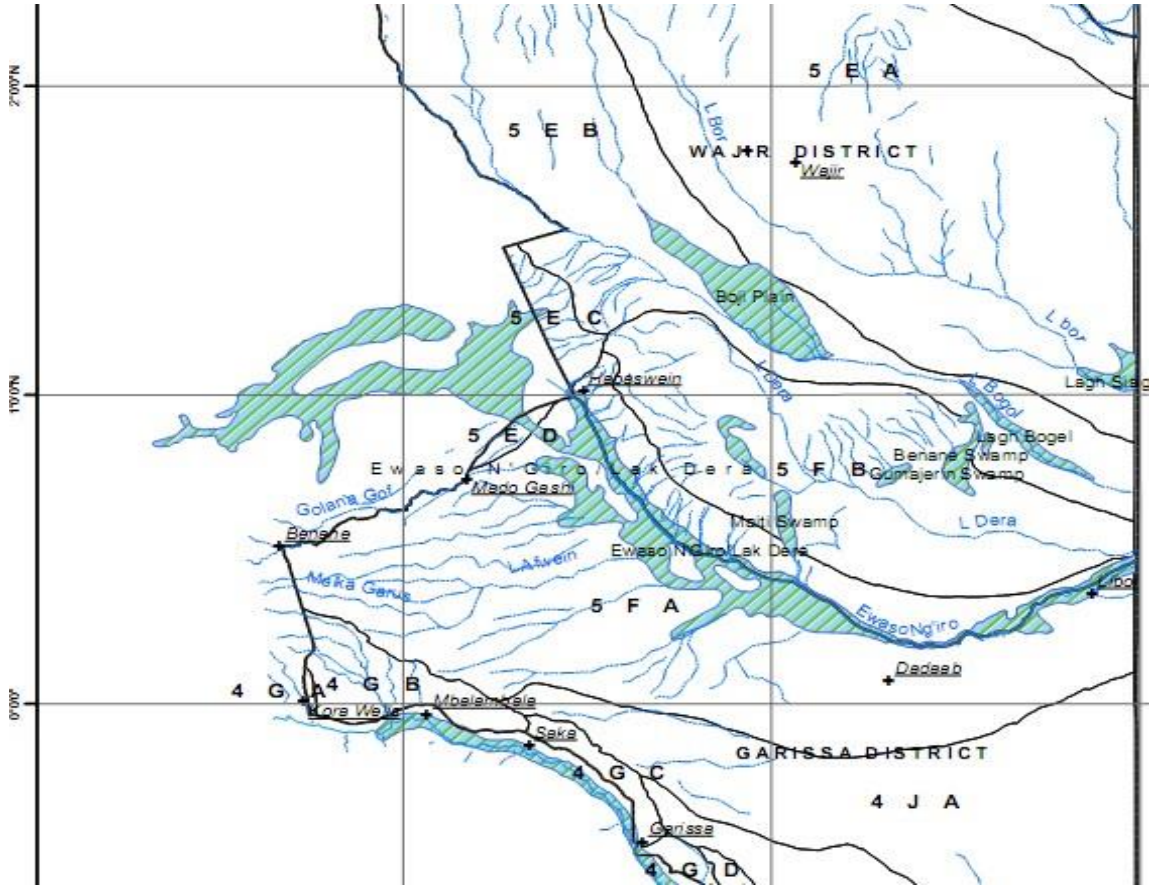


Fig.4.0: Hydrological Map of Wajir County and its neighbourhood showing drainage system of the area

4.2 Groundwater Resources.

The geology of the project area comprises rocks of the sedimentary System that overlie the Basement rocks at great depth. It is estimated that sedimentary rocks have a thickness of more than 3000 meters in some areas (?). The sedimentary rocks comprises of sandy soil, gritty soils, laminated limestone/ mudstone, clays and sand clays, grey and brown limestone conglomerates and sandstones.

There are several faults and weak structural zones within the project area that control groundwater movements. Some of these weak zones act as the main groundwater subsurface flow and drain zones. Boreholes drilled within these structures can have very good discharge. During our fieldwork our aim was locate these structural weak zones by horizontal electrical profiling. The selected borehole drill site is on these weak zones.

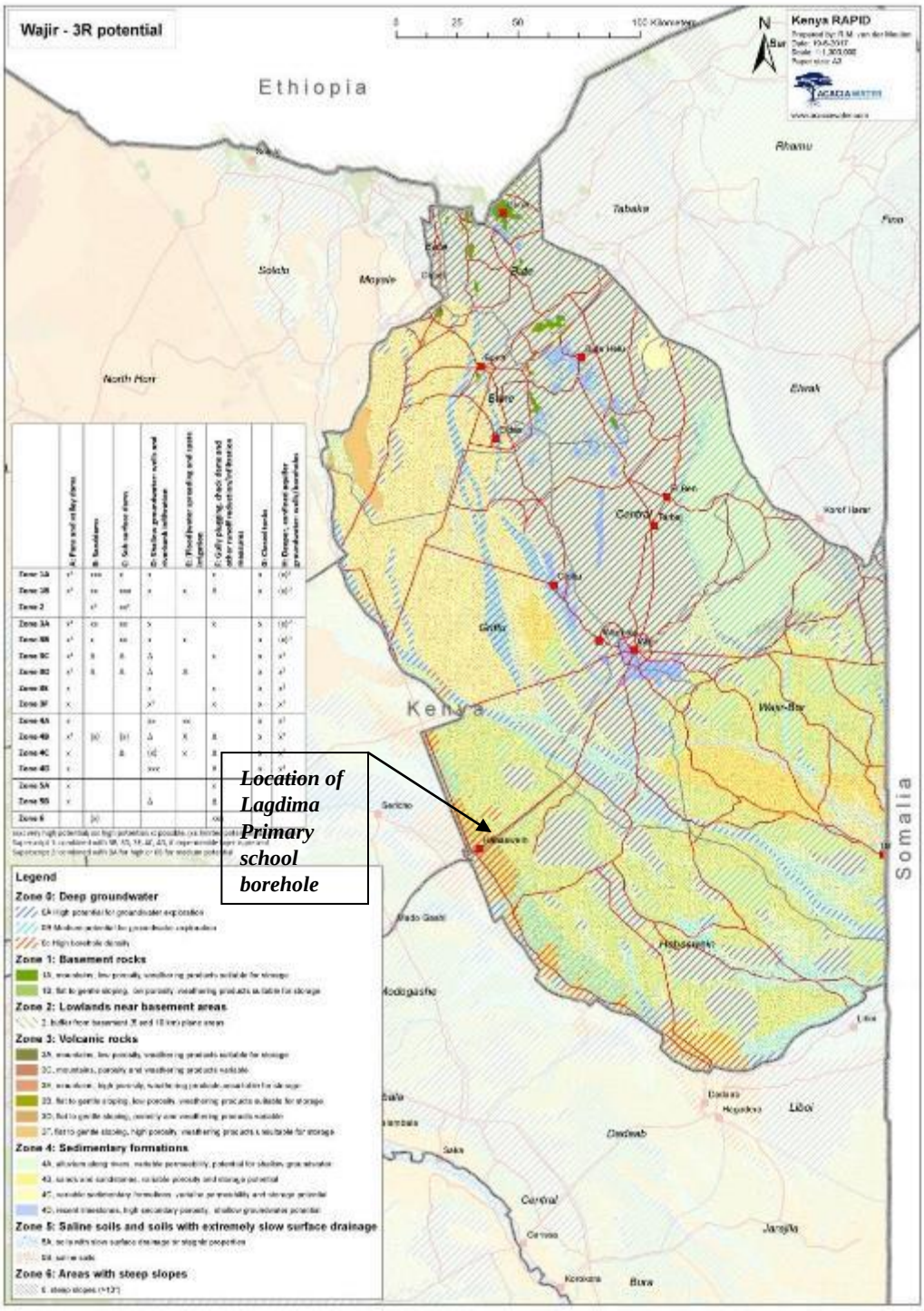


Fig. 5.0: Groundwater potential map for Wajir County (Courtesy of Kenya-RAPID and Acacia Water, 2017)

5.0 GROUNDWATER OCCURRENCE.

Groundwater occurrence, as discussed in this Chapter is dependent upon geology, rainfall, weathering and recharge. The best aquifers are found when a conjunction occurs of optimum recharge (rainfall, soil permeability), storage (porous rocks), and transmissivity (the ease with which water can travel, both vertically and horizontally, within an aquifer).
The merti Aquifer, in the northern part of Garissa and the southern part of Wajir counties occurs in the semi consolidated merti beds of Pliocene age and constitutes the most important source of groundwater in the area. In an area of about 100,000 square kilometers, approximately paralleling the drainage ways of the Ewaso Ng'iro Lak Dera (lagh Dera) from Habaswein to the Somalia border near Liboi, Groundwater of excellent quality can be obtained from the merti aquifer in boreholes drilled to depths of 120 to 150 metres. Moreover adjacent areas, probably exceeding 20,000 square kilometers contain groundwater of good to marginal quality that is suitable for use by livestock. Although Transmissivities in the aquifer are generally low, there are local areas where properly screened boreholes yield 180 liters per minute or more with drawdown of 2 to 4 meters.

5.1 Rainfall, Percolation and Recharge.

Given that suitable storage media exist below ground, the mechanisms by which water must reach it also affect aquifer potential.

Obviously, if no rainfall or river flow is able to percolate to a sandy weathered Sedimentary and Basement aquifer due to the presence of an aquitard (impermeable layer) probably clay, the actual potential is very low.

Both Basement and Sedimentary systems suffer the same limitations so far as recharge is concerned: if rainfall is high the volume of water which may eventually percolate to a suitable aquifer is likely to be relatively high, and possibly slightly mineralised due to high evaporation rate.

Percolation is dependent on soil structure, vegetation coverage and the erosion state of the parent rock.

Rocks that weather to clayey soils will naturally inhibit percolation (such as `black cotton' soils); conversely, the sandy soils resulting from the erosion of some Sedimentary and Basement rocks are eminently suited to deep, swift percolation.

Recharge is the term applied to the whole mechanism, and includes all the aspects of parent geology, effective rainfall and percolation. Some aquifer systems are recharged by water falling a substantial distance away - this is for instance the case where recharge apparently occurs laterally from the high grounds. For, instance, in the project area, Ewaso Ng'iro and Lagh Dera

river that originates from Laikipia through Isiolo, Habaswein, through Dadaab to Somalia the main source of recharge in this area.

5.2 Groundwater Quality.

Generally, sedimentary complex waters are sometimes hard, with low Total Dissolved solids (TDS) and fluoride content seldom exceeding World Health Organization limits. However, at local level significant peak concentrations of chloride, sulphate, fluoride, sodium, calcium and potassium ions can occur, especially where groundwater is shallow, groundwater flow is low or absent and the evapo-transpiration rate is high.

The factors which determine the degree of salinity in groundwater are as follows:-

Evaporation and Transpiration

Direct evaporation by the heat of the sun and preferential uptake of certain mineral ions by plants can, in certain environments, lead to salinisation.

Dissolution of Evaporites

The process of evapotranspiration may, in arid conditions, lead to the precipitation of salts in the unsaturated zone (soil). These salts may then be carried down to the groundwater store during periods of rain, thus leading to high ion concentrations in space and time. This process is exacerbated in an intensely seasonal climatic regime, such as in the study area.

Dissolution of Host Rock

Given relatively long residence times and fairly high ambient temperatures in groundwater systems, progressive salinity of groundwater can be expected via the host rock.

This will vary according to local geology, local structures (which may speed the passage of water through an aquifer by means of faults, etc, and so limit retention time), and local climate and so on.

Water quality Analysis

Several boreholes which were tested within the project site indicated the level of total dissolved solids; sulfate, total hardness and calcium are within the recommended guideline values for portable water. The water quality is good which we attribute to proper recharge by River Ewaso Ng'iro.

In the project area we expect similar god water quality as the neighbouring boreholes namely

Kiwanja Ndege (10M^3/hr) Kanjara (7 M^3/hr), Lagdima-1 borehole (24 M^3/hr), Admasajida(10 M^3/hr), Ogle Girls Secondary School (12 M^3/hr), Dilmanyare 1&2(10 M^3/hr) , Bulla Abak, Dulgub and Abakore.

Table 2: Ionic Concentration: WHO &Various Authorities

World Health Organization:		*European Community:*			
		1983	*1971 Int.*	*EC Directive 1980 relating to the quality*	
		Guidelines	*Standard*	*of water intended for human consumption*	
Substance or Characteristic		*Guidelines Value (GV)*	*Upper limit (HL), tentative*	*Guide level (GL)*	*Max. Admissible Conc. (MAC)*
Inorganic Constituents of health significance:					
Antimony Sb				*0.01*	
Arsenic	*As*	*0.05*	*0.05*		*0.05*
Cadmium Cd		*0.005*	*0.01*		
Chromium	*Cr*	*0.05*	*0.05*		
Cyanide	*CN*	*0.10*	*0.05*		*0.05*
Fluoride	*F*	*1.5*	*1.7*		*1.5*
Lead	*Pb*	*0.05*	*0.10*		*0.05*
Mercury	*Hg*	*0.001*	*0.001*		*0.001*
Nickel	*Ni*				*0.05*
Nitrates		*10(as N)*	*45 (as NO)*	*25(as (No)*	*50 (as NO)*
Selenium Se		*0.01*		*0.01*	

Other Substances		*GV: Desirable Level*	*Highest Permissible Level:*	*Max.*	*GV*	*MAC*	
Aluminum	*Al*	*0.20*				*0.05*	*0.20*
Ammonium	*NH*					*0.05*	*0.50*
Barium	*Ba*					*0.10*	
Boron	*B*					*1.0*	
Calcium	*Ca*		*75*	*50*		*100*	
Chloride Cl		*250*	*200*	*600*	*25*		
Copper	*CU*		*0.05*			*0.10*	
Hydrogen Sulphide	*H_2S.*	*ND*					*ND*
Iron	*Fe*	*0.30*	*0.10*	*1.0*		*0.05*	*0.20*
Magnesium	*Mg*	*0.10*	*30*	*150*		*30*	*50*
Manganese	*Mn*	*0.10*	*0.05*	*0.50*		*0.02*	*0.05*
Nitrite	*No*						*0.10*
Potassium	*K*					*10*	*12*

Silver	*Ag*					*0.01*
Sodium	*Ng*	*200*			*20*	*175*
Sulphate	*Soq*	*400*	*200*	*400*	*25*	*250*
Zinc	*Zn*		*5.0*	*15*	*0.10*	
Total Dissolved solids		*1000*	*500*	*1500*		*1500*
Total Hardness as $CaCo_3$		*500*	*100*	*500*		
Colour	*Hazen*	*15*	*5*	*50*	*1*	*20*
Odour		*Inoffensive*	*Unobjectionable*			*2 or 3 Ton*
Taste		*Inoffensive*	*Unobjectionable*			*2 or 3 Ton*
Turbidity (JTU)		*5*	*5*	*25*	*0.4*	*4*
PH		*6.5-8.5*	*7.0-8.5*	*6.5-9.2*	*6.5-8.5*	*9.5 (max)*
Temperature	*0C*				*12*	*25*
EC	*us/cm*				*400*	

Notes *ND-Not Detectable* *IO-Inoffensive*

GL-Guide Level *UO-Unobjectionable*

6.0 BOREHOLES DATA'S

Several boreholes have been drilled and constructed in our project area. The average depth of the boreholes is 200m though some are 250 deep. There are also water pans and earth dams that had been constructed in various parts of this region by the Government and other organizations over the years to supplement the supply from boreholes.

The information obtained from these data indicates that most of the borehole water is of good quality water. This is because the boreholes are located in the middle section of merti aquifer and which has favorable geological setup. The other factor is the depth of the borehole and the recharge that also affects the quantity and the quality of groundwater. If the recharge potential is low the water is expected to be highly mineralized and the discharge low otherwise if the recharge is good the quality and the quantity of water is expected to be good.

In the geological set up within Habaswein area, drilled boreholes will have a definite trend as to water struck levels, drilled depths and yields, since they are at the same zone.

7.0 GEOPHYSICS.

A great variety of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity method (also known as the geoelectrical method) and the Horizontal Electrical Profiling (HEP) methods has been used. The latter was used to detect any anomalous conductive zones in the subsurface, which might be associated with faulted or fractured zones.

Vertical Electrical Soundings (VES) were carried out to probe the conditions at such anomalous zones within the sub-surface and to confirm the existence of groundwater. The VES probes the resistivity layering below the site of measurement. The techniques are described below.

7.1 Basic Principles of the Resistivity Method.

The electrical properties of the upper parts of the earth's crust are dependent upon the lithology, porosity, degree of pore space saturation and the salinity of the pore water. Saturated rocks have lower resistivities than unsaturated and dry rocks. The higher the porosity of the saturated rock the lower the resistivity and the higher the salinity of the saturating fluids, the lower the resistivity. The presence of clays and conductive minerals also reduces the resistivity of the rock.

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 = Rs *L/A (in Ohm) (1)

Where Rs is known as the specific resistivity, characteristic of the material and independent of its shape or size

With Ohm's Law
R = dV/I (Ohm) (2)

Where dV is the potential difference across the resistor and I is the electric current through the resistor; the specific resistivity may be determined by:

Rs = (A/L) *(dV/I) (in Ohm.m) (3)

7.2 General.

The field investigations carried out in the project area to evaluate the groundwater potential of this area included the following:

- *Geomorphological interpretation and hydrogeological reconnaissance to establish overview impression of the area;*

- *Execution of geo-electrical measurements comprising the following:*

- ✓ *Horizontal Electrical Profiling using ABEM Terrameter SAS 1000;*
- ✓ *Vertical Electrical sounding using the ABEM Terrameter SAS 1000;*

7.3 Methods.

7.3.1 Horizontal Electrical Profiling (HEP)

These were carried out at each site to determine changes in electrical properties laterally with a constant electrode spacing and interpreted as a continuous profile. The electrode spacing controls both the profiling depth and the resolution of the survey.

The probe depth on all the profiles was maintained at a depth of 50 metres with a constant interval of 10 metres from one station to the other.

The observed resistivity values are plotted on logarithmic paper and the curve obtained depicts lateral resistivity variation at constant depth. Geological structures such as faults, fractures, buried stream channels that may conduct groundwater, can be inferred.

7.3.2 Vertical Electrical Soundings (VES)

Vertical Electrical Soundings were carried out to probe the electrical properties and depth to subsurface layered formations below the site of measurement at the most significant anomalous zones.

When carrying out a resistivity sounding, electric current is led into the ground by means of two electrodes and the potential field generated by the current is measured. The separation between the electrodes is step-wise increased (in what is known as a Schlumberger Array), thus causing the flow of current to penetrate greater depths. The observed resistivity values are plotted on log-log paper and the curve obtained depicts resistivity variation against depth.

This curve can be interpreted with the aid of a computer, and the actual resistivity layering of the subsoil is obtained. The depths and resistivity values provide the hydrogeologist with information on the geological layering and thus the occurrence of groundwater.

7.4 Fieldwork.

Field reconnaissance survey and fieldwork was carried out from 6th to 7th March 2019.

The field data and the location map are presented in the appendixes.

7.5 The Results and Interpretations.

The site that was surveyed is as indicated in Table-4 below. The results of the geophysical site investigations for the site are illustrated with resistivity curves and table-3 shown below.

VES-1: LAGDIMA PRIMARY SCHOOL

The surveyed site is located approximately five 100 kilometers along Wajir-Habaswein-Road. Vertical electrical sounding was executed E-W across the project site to a maximum electrode separation of 250M. The results of VES were plotted on the resistivity curve shown below and interpretations done as indicated on Table 3.

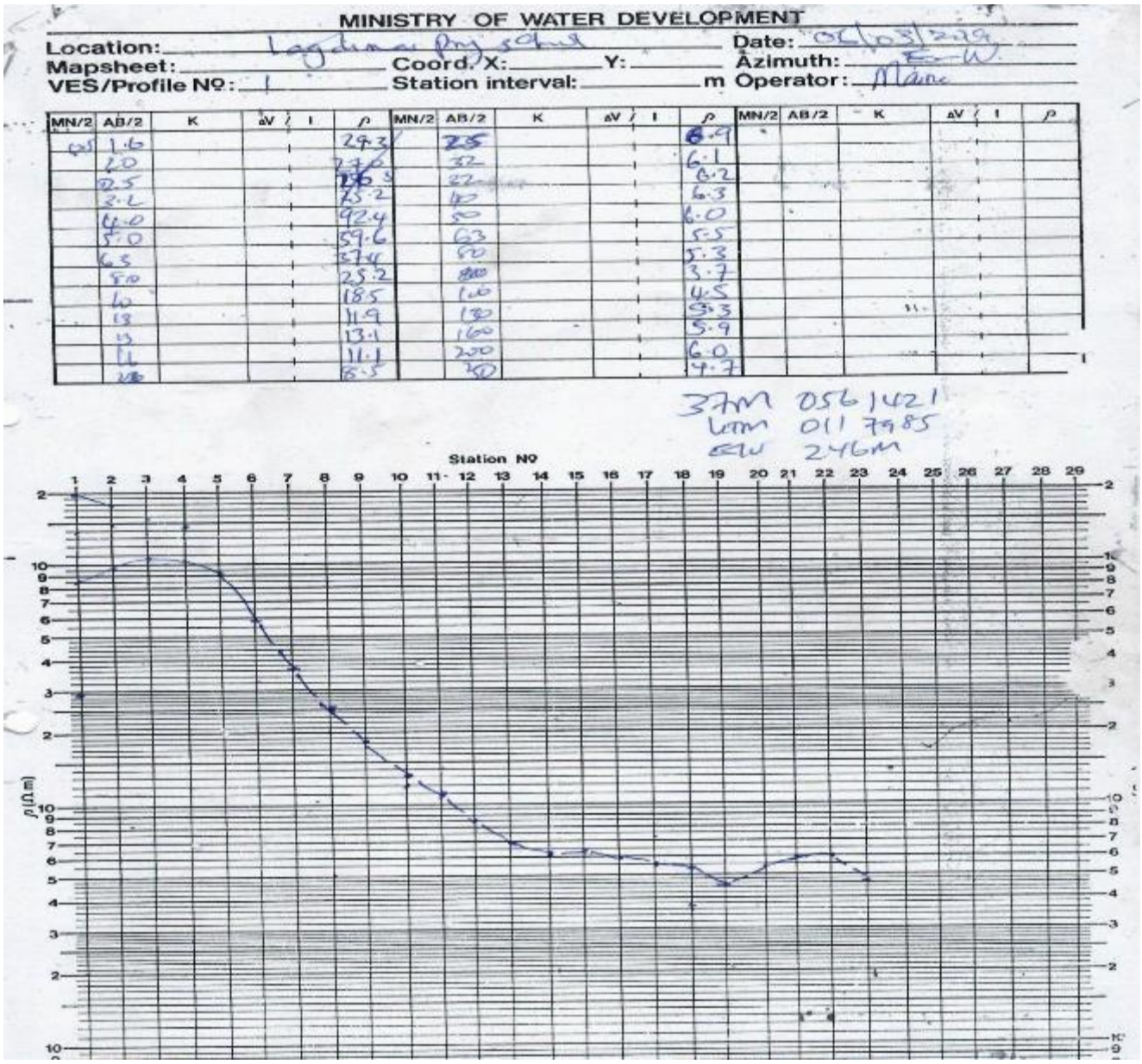


Fig. 6.0: Resistivity curve for VES-1.

Table 3: Results and interpretations.

FORMATION DEPTH (M)	APPARENT RESISTIVITY (OHM-M)	EXPECTED FORMATION	REMARKS

0 – 2.2	*17.0*	*Top Sandy loams.*	*Dry*
2.2– 4.5	*9.0*	*Silty sandy deposits.*	*Dry*
4.5 – 22.0	*8.0*	*Gravelly sandy deposits.*	*Dry.*
22.0 – 38.0	*7.0*	*Sand stone.*	*Dry.*
38.0 – 63.0	*8.0*	*Sandstone.*	*Moist.*
63.0 – 90.0	*10.0*	*Slightly weathered sandstone.*	*Wet.*
90.0 – 130.0	*11.0*	*Silty weathered sandstone.*	*Wet.*
130.0 – 250.0	*12.0*	*Gravelly weathered sand stone.*	*Wet.*
>250.0	*16.0*	*Clayey sandstone.*	*Top-Wet Base-Dry*

The interpreted model results of this VES shows progressively weathered unconsolidated sedimentary set up of different textures up to a depth of 250 meters and beyond. The site has excellent groundwater potential and is thus recommended that the borehole be drilled to a maximum depth of ***250M.***
The proposed drilling site has been marked on the ground and is conversant with one of the school teachers ***(Phone 0719778050)****.*

TABLE NO. 4. Site number, coordinates, site name and recommended depths.

VES No.	***Coordinates***	***Groundwater Prospects***	***Remarks***	***Recommended Depth (metres)***
1.	***Lagdima Primary school*** *37N 561421* *UTM 117985* *Elevation 246M*	*Excellent*	*Mud drilling*	*250*

8.0 CONCLUSION AND RECOMMENDATIONS.

- *Our project area lies within an average altitude of 230-250m above sea level.*

- *The area lies in the 100% arid and semiarid area of northeastern Kenya where the transevaporation is very high and hence most of ground water is mineralized leading to salinity and hardness.*

- *The area is within the Merti aquifer, which is a continental aquifer covering parts of Wajir and Garissa counties, consequently any borehole drilled in this area to a of depth more than 180 metres below ground level will have water.*

- *Due to low rainfall and long residence time of groundwater in the rocks and the mild topography may be contributing high mineralization of groundwater.*

- *From hydro-geological data collected the formations in this area manifests low apparent resistivities is due to presence of clay and silt in the formations that deter transmissivity and hence give water a longer residence time in the aquifers that lead to mineralization from the host rocks.*

- *From the borehole data it can be observed that properly sited boreholes and drilled to a good depth (220m and deeper) are high yielding and give fairly good quality water. A good sited borehole is that which is sited on a wide structural weak zone with a good gradient.*

- *This area is characterised by seasonal rivers which only flows during rain seasons, the structures which control the flow are fractures and a borehole located along these structures would be high yielding. These seasonal streams in most cases recharge the groundwater in this area. Boreholes drilling near these seasonal drainage channels in most cases have good quantity and quality water.*

Conclusion

From the observations it can be concluded that;

- *The proposed sites has good groundwater potential*
- *Properly sited and drilled boreholes will be high yielding and will give portable water.*
- *Drilling should be done by Registered Drilling company properly acquainted to mud drilling because the geological formations though stable may be prone to collapsing.*

Recommendation

(a) It is therefore recommended that boreholes of 8" diameter be drilled at the proposed selected sites to the depths indicated on the above table. The sites were benchmarked on the ground and also shown to various village elders.

(b) The proposed boreholes should be lined with casings and screens of 152 mm minimum diameter and should be gravel packed.

(c) Undertake the environmental Impact Assessment for the project and obtain necessary permits.

(d) Finally drilling work SHOULD NOT commence until groundwater permits are obtained from Water Resources Authority (Daua Sub-Region Office Mandera) of Ministry of Environment, Water and Natural Resources.

(e) We further recommend that the services of a qualified, independent hydrogeologist be employed during drilling for supervision and technical advice.

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APPENDIX - Drilling

Drilling should be carried out at a diameter of not less than 8", using either a rotary type machine. The drilling rig should be able to drill to the recommended depth, at the specified diameter of 8". The rig and the drilling method adopted must be suitable for drilling through both unconsolidated material, and hard, compact rocks. The rotary drilling technique offers very high penetration rates in all types of materials, rig mobilisation and demobilisation are rapid, minimal casings are required during drilling exercise and reliable yield estimates can easily be made during drilling.

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 method will however considerably prolong the required time for drilling, which may be undesirable if water is required at short notice. Another main disadvantage is that no reliable yield estimates can be made during drilling. As a result, a reliable judgement whether to stop or continue drilling at a certain depth can not be made. In addition, borehole development techniques will be less efficient than with a rotary plant compressor. This may reduce the capacity of the borehole, and may fail to stop the intake of fine sediments during pumping. In case of friable materials and/or loose sediments, bentonite is used to stabilise the materials when drilling using percussion technique. The sticky clay-based mud seals the aquifer pores reducing the aquifer transmissivity and hence borehole yields. In rotary drilling, the biodegradable polymers or foam is used to stabilise collapsing formations. This biodegradable mud can easily be removed during borehole development.

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On the other hand, the percussion method is considerably cheaper than the modern rotary technique, partly because of the lower drilling rates, but also due to the often much lower sum charged for mobilisation. However, it must be noted that the initial savings may be offset against the continuing costs of labour, fuel, etc., the prolonged absence of a water source, and the time input of the Client and his representatives. Regarding the long time required when applying the percussion drilling technique.

Geological rock samples should be collected at 2 metre intervals. Water struck and rest 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 (rotary) or bailed (percussion) 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, in order to avoid collapsing and sediment intake. Considering the moderate depth of the borehole, it is recommended to use Mild steel casings and screens of 6" diameter. They should be machine cut not gas-slotted. Screen slots should be a maximum of 1.5 mm in size. The minimum open area of the screens should be 5%.

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. An 8" diameter borehole screened at 6" will leave an annular space of approximately 1", 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 round to well round. 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, involves the insertion with a tremie pipe.

Well Construction

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 plug at the surface, to prevent contamination 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, gravel pack, seals and backfill have been installed, the well should be developed. Development is the term used to describe the procedures designed to maximise well yield. Although an expensive element in the completion of a well, the additional costs are usually justified by longer well life, greater efficiencies, lower operational and maintenance costs and a more constant yield.

Development has two broad objectives, which can be divided into borehole and aquifer stimulation:

- *To repair the damage done to the aquifer material during drilling and restore the natural hydraulic properties.*

In both cable tool (i.e. percussion) and air hammer drilling, the bit action chips and crushes the rock, and mixes it with water and other fine material into thick mud slurry. The pounding of the bit forces this slurry into the openings in the wall of the borehole, thus blocking the pores and impeding the flow of water from the aquifer. A thick "wallcake" may form, especially when clay additives (such as bentonite) are used during drilling or where natural clays occur in the penetrated formations. This cake, if not removed, may virtually plug the borehole, and significantly reduce the discharge. It should be noted that the maximum yield of a formation can only be realised if all the fractures and crevices are unblocked and able to supply water to the well. Borehole development techniques are applied to break down and remove the impermeable layer

of clayey material from the borehole wall. Swabbing, wall-scratching, airlift rawhiding and polyphosphate dosing are all borehole development techniques.

- *To alter the characteristics of the aquifer volume in the vicinity of the borehole, by improving hydraulic contact between the aquifer and the hole. This is essentially aquifer development, and is also known as aquifer stimulation.*
  Polyphosphate dosing, hydrofracturing and acidification are examples of aquifer stimulation techniques.

The development methods to be applied depend on the available equipment, and differ significantly between percussion and rotary drilling (the latter being superior, when it comes to efficiency):

Development with a percussion rig: if a cable tool rig has been deployed the available development techniques are relatively simple, but less effective than the methods used in modern rotary drilling. The following measures are recommended:

- *Backwashing and bailing: using a surge block with rubber flaps slightly smaller than the internal diameter of the hole, start near the top of the water bearing zones and surge downwards (surging upwards may lead to the surge block sand-locking, which can jeopardise the hole). Bail the borehole clean periodically. Repeat this cycle until no more material is brought up, bailed water is clear and electrical conductivity is stable.*
- *Polyphosphate dosing: percussion equipment does not include mud pumps and drill pipe, so jetting is impossible. Polyphosphate dosing comprises no more than simply pouring water with dissolved sodium hexametaphosphate and calcium hypochlorite into a pipe, the base of which is located near the bottom of the hole.□□ The polyphosphate is allowed to act for 12 hours or overnight. Repeat the backwashing and bailing cycle until the water is clear and electrical conductivity stable.*

If a rotary rig equipped with a strong air compressor is available, more effective development techniques can be applied:

- *Airlift rawhiding, into and through the aquifer zones. This should continue until the water lifted is clean and clear, with electrical conductivity stable. Rawhiding comprises cyclic airlifting: once the airlift has been established, air supply is cut off and water allowed to cascade down the hole. This creates overpressures across the borehole wall, which agitates the formation and enhances cleaning. The airlift is then started again and the cycle repeated.*
- *Water jetting with an on-wall velocity of 30 m/s: at least 0.3 m^3 of fluid should be jetted per linear metre of screen. The water used for jetting must be absolutely clean, and it is dissolved as in the polyphosphate dosing described under Section 4.2. The jetting tool should be so constructed that the jet openings are not more than 1" (25 mm) from the borehole wall.*
  Jetting should start from the top of the water bearing formation rotating downwards. After

□□ 3

Recommended concentrations are 3.8 kg/m of sodium hexametaphosphate (a locally available, common food additive and clay disaggregant known under the trade names “Calgon” or “SHMP”), and 1.5 kg/m^3 of calcium hypochlorite.

the entire saturated zone has been jetted, the hole should be left for at least 12 hours or overnight, to allow the hexametaphosphate to work on the “wallcake” and any clayey material in the aquifer material.

- *Airlift rawhiding again, from the bottom of the hole, until airlifted water is absolutely clean and electrical conductivity stable.*

During development, an estimate of the bailed or air-blown yield should be made. This usually gives a fair indication of the final range of abstraction that can be expected from the borehole. The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable.

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-bystep, 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 and Irrigation and Water Act 2002, that all boreholes in Kenya be equipped with a master/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.

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 should also be equipped in the borehole to monitor water rest level.

Pumping Plant

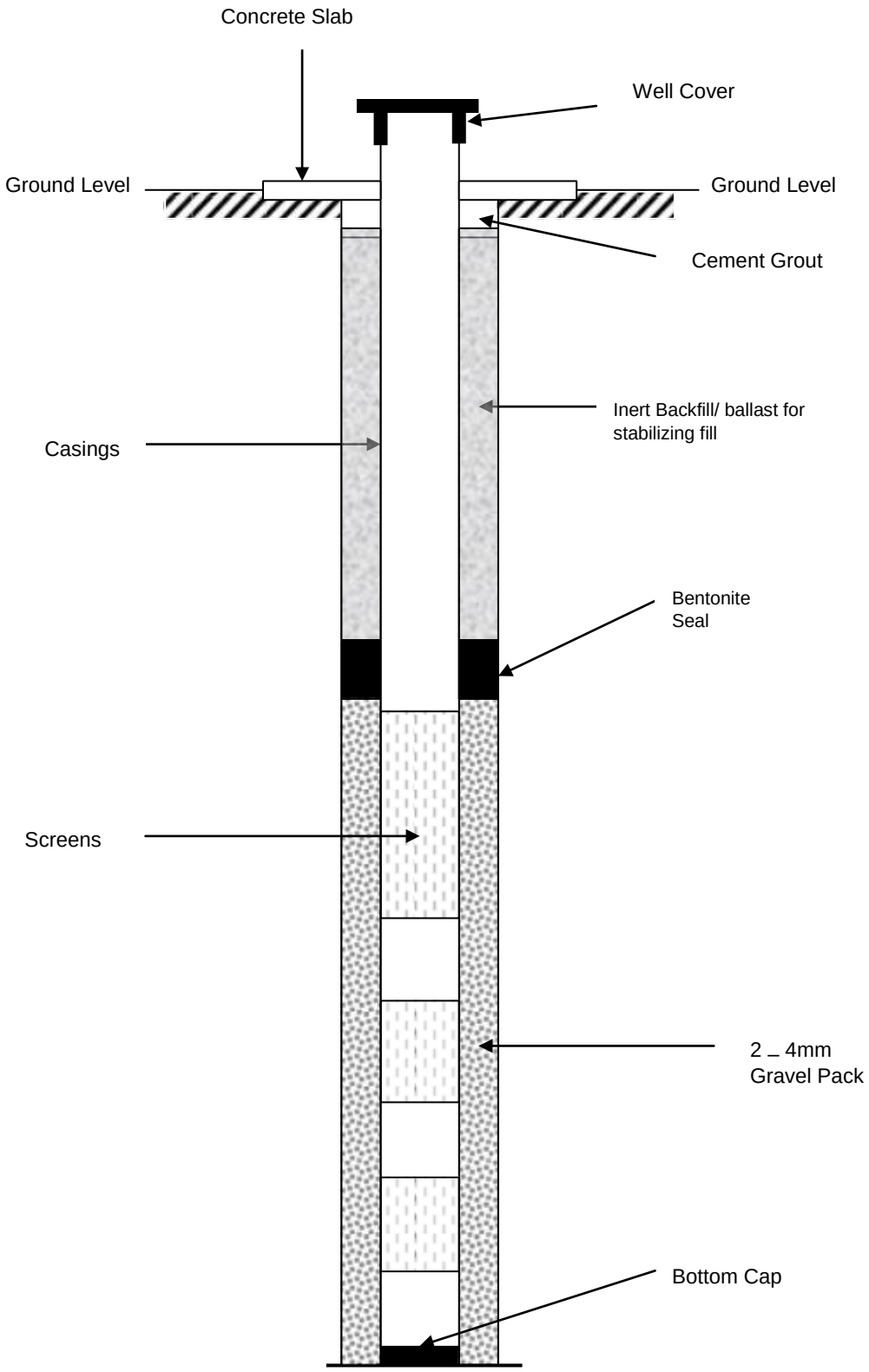
Several options are open to the Client:

a) *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.*

b) *Electrical solar submersible pumps: These are not widely used mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers.*

c) *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 wind pumps, reciprocating pumps. They 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.*


Concrete Slab
Well Cover
Ground Level
Ground Level
Cement Grout
Inert Backfill/ ballast for stabilizing fill
Casings
Bentonite Seal
Screens
2 _ 4mm Gravel Pack
Bottom Cap

Map of Project area.

Picture showing the existing Lagdima community borehole (depth270M, Yield 24M^3/hr)

HYDROGEOLOGICAL ASSESSMENT REPORT

FOR

NORTHERN WATER SERVICES BOARD
P.O. BOX 495-70100
GARISSA

CARRIED OUT AT WAJIR HIGH SCHOOL IN WAJIR EAST CONSTITUENCY
WAJIR COUNTY

Report No: 059/03/2019

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Summary of the Scope of works

*The **Government of Kenya** through **Northern Water Services Board** commissioned the present hydrogeologist to undertake a comprehensive hydrogeological study to establish whether there are good chances of drilling high yielding borehole at **Wajir High School** which is located in Wajir East constituency, Wajir County. The water is to be used for various purposes within the school compound.*

The area falls under the arid and semi arid land (ASAL) of Kenya. The area experiences high temperatures and low unreliable rainfall. Rainfall is generally low and unreliable in the area but when it comes, it falls in sudden heavy storms often causing unpredictable flash foods.

The area is geologically underlain by thick sedimentary rocks of several thousand metres in thickness. Most of these rocks are highly decomposed into clay and clayey sediments. Water is expected in sediments and in limestone where the clay element is low.

Several sites were identified by means of Horizontal Electrical profiling and Resistivity Methods within the school compound the details are discussed at the end of this report. The selected site is based on groundwater potential.

*Our observation from the fieldwork is that the area has **excellent groundwater potential** of reasonable quality and quantity that can be exploited for the intended purposes.*

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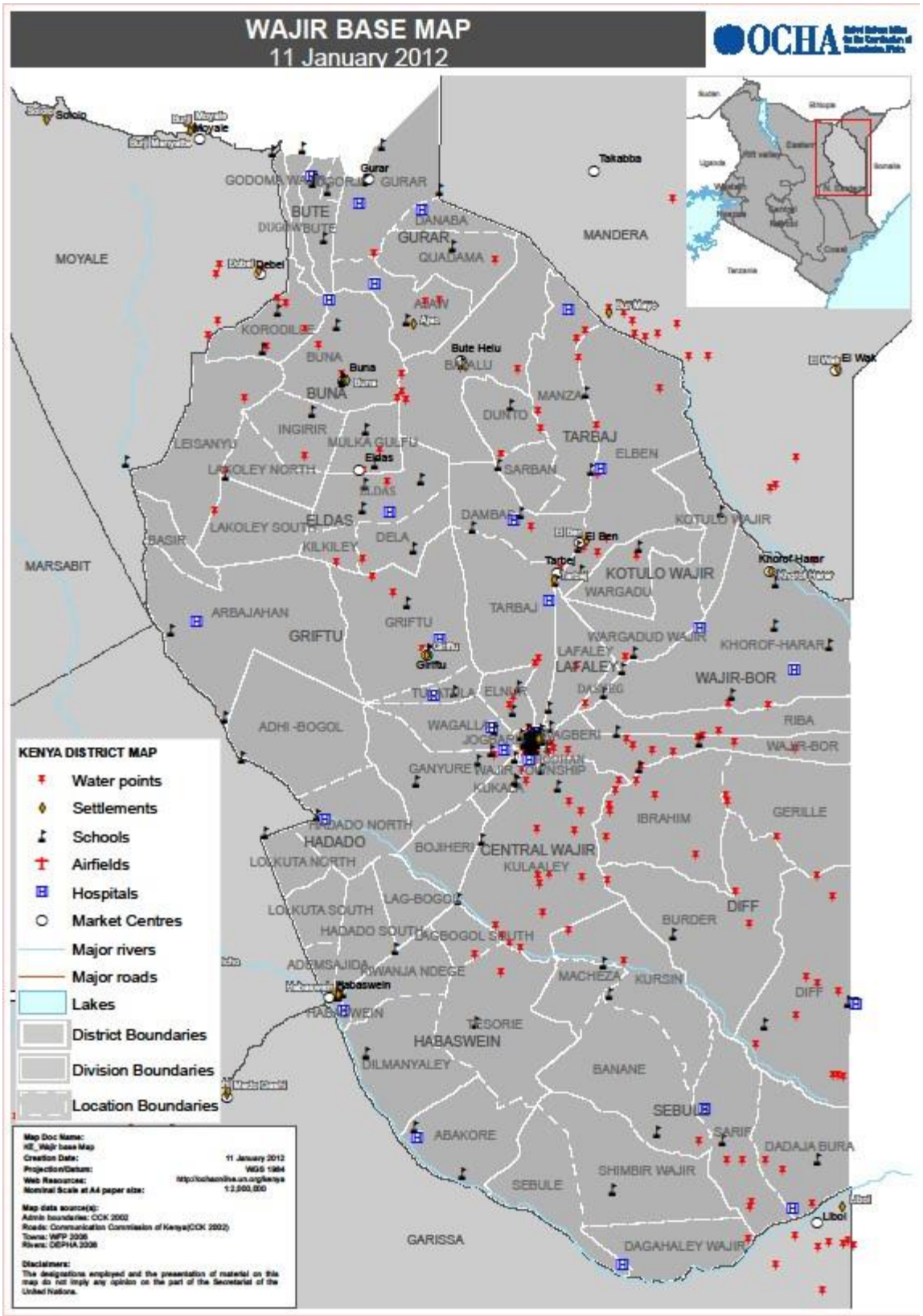
ABBREVIATIONS AND GLOSSARY OF TERMS

ABBREVIATIONS

asl	*above sea level*
VES	*Vertical Electrical Sounding*
HEP	*Horizontal Electrical Profiling*
TDS	*Total Dissolved Solids*
DTH	*Down the Hummer, (rotary drilling method)*
m bgl	*metres below ground level*
PWL	*pumped water level*
Q	*discharge (m^3/hr)*
SWL	*Static Water Level*
T	*transmissivity (m^2/day)*
WSL	*Water Struck Level*
WRMA	*Water Resources and Management Authority*
Kenya-RAPID	*Kenya Resilient Arid Lands Partnership for Integrated Development*

GLOSSARY OF TERMS

Aquifer	*A geological formation or structure that stores and transmits water and which is able to supply water to wells, boreholes or springs.*
Breccias	*A coarse-grained rock composed of angular fragments.*
Conductivity	*Transmissivity per unit length (m/day)*
Confined aquifer	*Confined aquifers are those in which the piezometric level is higher than the elevation at which the aquifer was encountered. Static water levels are at a higher level than the top of the formation.*
Drawdown	*The distance between the static water level and the pumped water level The term **residual drawdown** is used for the same distance during recovery of the well.*
Development	*In borehole engineering, this is the general term for procedures applied to repair the damage done to the formation during drilling. Often the borehole walls are partially clogged by an impermeable "wall cake", consisting of fine debris crushed during drilling, and clays from the penetrated formations. Well development removes these clayey cakes, and increases the porosity and permeability of the materials around the intake portion of the well. As a result, a higher sustainable yield can be achieved.*
Fault	*A larger fracture surface along which appreciable displacement has taken place.*
Gradient	*The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head*
Hydraulic head	*Energy contained in a water mass, produced by elevation, pressure or velocity (also referred to as: **Head**).*
Hydro geological	*Those factors that deal with subsurface waters and related geological aspects of surface waters.*
Perched aquifer	*Accumulation of groundwater on top of a layer of low conductivity, underlain by unsaturated sediments or rocks*
Pumping test	*A test that is conducted to determine aquifer and/or well characteristics.*
Recharge	*General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, and lateral groundwater flow) to the aquifer zones.*
Recovery	*Return to static water level following abstraction of water.*
Specific Capacity	*Ratio of pumping rate and drawdown (m^3/hr/m); a measure for the well performance*
Static Water Level	*A measure for the capacity of an aquifer to conduct water through its saturated thickness (m^2/day)*
Well development	*The act of repairing damage to the formation caused by the drilling process or gradual well deterioration. Increases the porosity and permeability of the materials around the intake portion of a well*
Yield	*Volume of water discharged from a well**.***


WAJIR BASE MAP
11 January 2012
OCHA
KENYA DISTRICT MAP
Water points
Settlements
Schools
Airfields
Hospitals
Market Centres
Major rivers
Major roads
Lakes
District Boundaries
Division Boundaries
Location Boundaries
MOYALE
MANDERA
MARSABIT
GARISSA
BUTE
GURAR
BUNA
TARBAJ
ELDAS
KOTULO WAJIR
GRIFTU
HADADO
CENTRAL WAJIR
HABASWEIN
SEBULE
WAJIR-BOR
DIFF
DAGAHALEY WAJIR
SHIMBIR WAJIR
DADAJA BURA
Takabba
El Wak
Khorof Harar
Libol

1.0 PREABLE.

This detailed report is presented as a technical site investigations report for the groundwater Survey program carried out for ***Northern Water service Board****, specific as a water supply facility for Wajir High School, which is located in Wajir East Constituency, Wajir County.*

The program entailed a thorough and detailed hydro geological and geophysical borehole site investigations conforming to the WRA requirements and standards. The sole objective of this survey was geared towards developing sustainable water supply facility for various purposes in the Institution which include cleaning, drinking, washing and cooking.

For one to develop a highly efficient water supply model for the school, it appears imperative to analyze the records of the existing boreholes and the typical accompanying data that characterize the aquifer system replenishing the area.

This preliminary report is based on detailed aquifer mapping that goes to the extent of deploying state of the art geophysical data interpretations to un-ravel the geo-technical elements that can support high borehole yields.

The geologist's experience in basement and sedimentary terrains is that for a successful drilling program, there is need to characterize both the structural and geological aspects that control groundwater recharge/discharge- Vis-à-vis the groundwater flow patterns.

Apparently, there is need to address the water quality requirements for the facility. The water supply from the proposed borehole needs to conform to high quality standards; thus entailing the hydrogeologist to define aquifer characteristics that would meet the particular standards.

The government plans to drill productive boreholes to supply water to primary and secondary schools which face water scarcity. The aim of this survey was therefore to identify the most suitable drill site for the proposed borehole.

The climate of Wajir County is hot and dry with thorn bushes and acacia trees. Most of the vegetation is concentrated along drainage channels of which most of them are seasonal.

Nomadic pastoralism is the major economic activity in this County with camels, goats, sheep and cows being the main type of livestock reared here. The regions vast pasture lands have allowed this activity to be viable though much more could be done to ensure the county plays its role in the country's beef and milk production.

In recent time the community is also embracing sedentary settlements in order to take advantage of social – economic infrastructures in urban centers hence, putting pressure on existing water sources. It is due to the above that the client found it appropriate to develop a water supply facility since the already existing water sources have been overstretched by increased demand.

The main water source in the region is from boreholes, shallow wells and a few major earth pans. The region has small scale agricultural activities with small scale horticultural producers supplying mangoes, paw paws, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize.

The local Community in the area relies on Shallow wells, seasonal rivers, seasonal earth pans, and boreholes fitted with submersible pumps and genset. The school has few shallow wells which supply water though is insufficient hence compromising on the learning and hygiene of the students.

A detailed hydrogeological survey was then necessary within the proposed area in order to locate the most suitable site for sinking the proposed borehole. At least five boreholes have been drilled recently within 15Km radius in the project area, whereby all of them encountered good quality water averaging 4M^3/hr.

2.0 GEOGRAPHICAL LOCATION/PHYSIOGRAPHY.

Wajir County borders Ethiopia to the North, Somalia Republic to the East, Marsabit County to the north west, Isiolo County to the west, Garissa County to the south and Mandera County to the north and north east. The proposed site is located approximately 1.5Km from Wajir CBD off Airport Road.

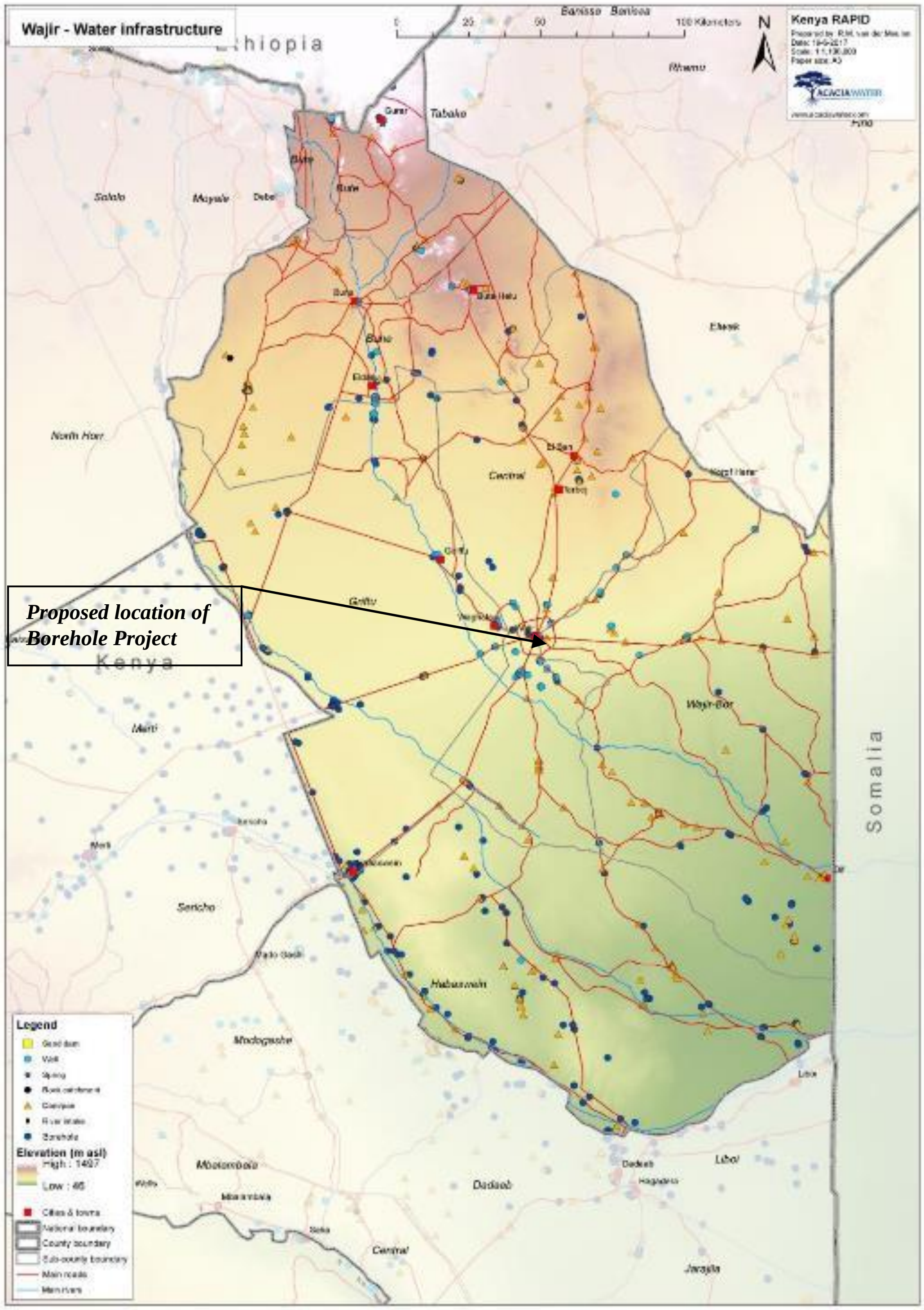

Wajir - Water infrastructure
thiopia
Kenya RAPID
N
Proposed location of
Borehole Project
Kenya
Somalia
Legend
Elevation (m asl)
Central
Wajir-Bor
Habaswein
North Horr
Moyale
Tabaka
Sericho
Modogashe
Dadaab
Jarajila

Fig 1.0: Map of Wajir County showing the location of the proposed borehole project and the existing water infrastructure (Courtesy of Kenya-RAPID and Acacia Water, 2017)

2.2 Rainfall and Climate.

The project area lies within the Sahelian Climatic region, characterized by dry spells and short rainy seasons and is classified as 100% Arid and Semi Arid Land (ASAL). The area experiences high temperatures and low unreliable rainfall throughout the year. The hottest season falls between November and April with temperatures soaring up to 38°C. Cooler months of July and August have mean temperatures of between 25 – 30°C. Rainfall is generally low and unreliable in the area but when it rains, it falls in sudden heavy storms often causing unpredictable sheet wash and flash floods.

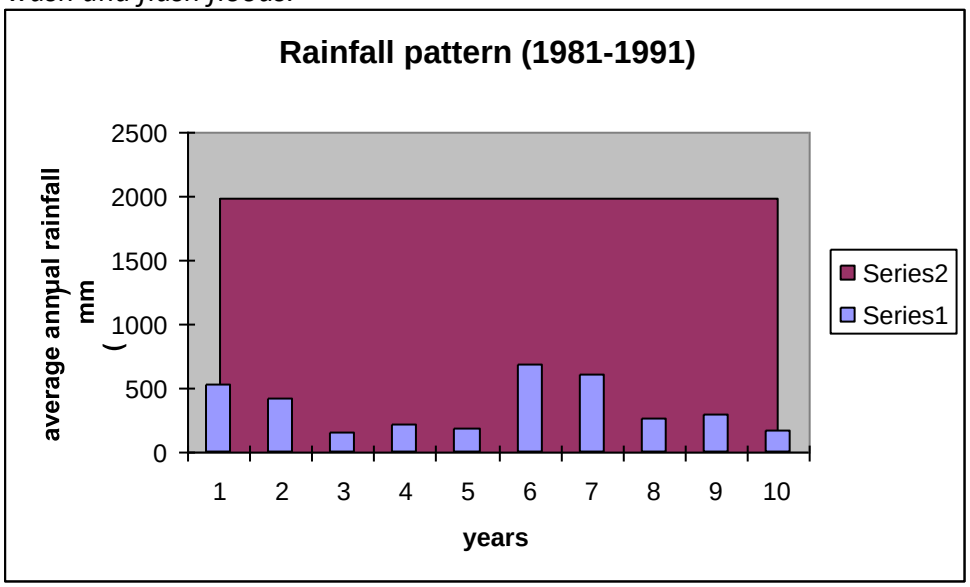


Figure 2.0: A photograph of the area showing infrastructure, terrain and vegetation.

2.3 Current Land use

The major economic activity is nomadic pastoralism which is mainly practiced by the indigenous Somali Community. The communities rear goats, sheep, donkeys, camels and cattle. The growth of the towns has enabled various businesses to thrive such as Horticultural Farming, Catering and accommodation, construction, shops, etc.

There are numerous schools and colleges in the project area to cater for the educational need of the people of Wajir County.

In addition, the region has small scale agricultural production with small scale horticultural producers supplying mangoes, paw paws, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize.

2.4 Approximate Demand.

Approximately 100M^3/Day of water will be required for various purposes for this project. The school has a population of more than 3000 students and over 15 teachers residing within the school compound. The proposed boreholes will be equipped with either a solar pump or electric submersible pumps hence the extraction of water will be fairly high but of course based on the proposed borehole yield of 8m^3/hr.

3.0 GEOLOGY.

3.1 Geology of the area.

The Geology of the area is generally viewed to be of the sedimentary rock sediments of Quaternary Geological Age associated with the Coastal plains of the Country. There was solid rock exposures encountered within the exploration area during this fieldwork survey. The exposures encountered during the field survey consisted of poorly unconsolidated marine kunkar limestone covered by thin sandy and red soils. See the geological map below.
The large part of the project area is comprised of white kunkar limestone covered by thin layer of reddish coarse sandy soils.

3.2 Geological setting of Wajir County.

The geology of Wajir and its immediate surroundings have been mapped by Joubert (1963). Earlier information was gathered and concepts developed by various investigators (e.g. Bestow, 1953). The geological map of the area bordering north (Thompson and Dodson, 1960) and a review by Swarzenski and Mundorff (1977) make the regional context more clear and provide supplementary clues for interpretation.

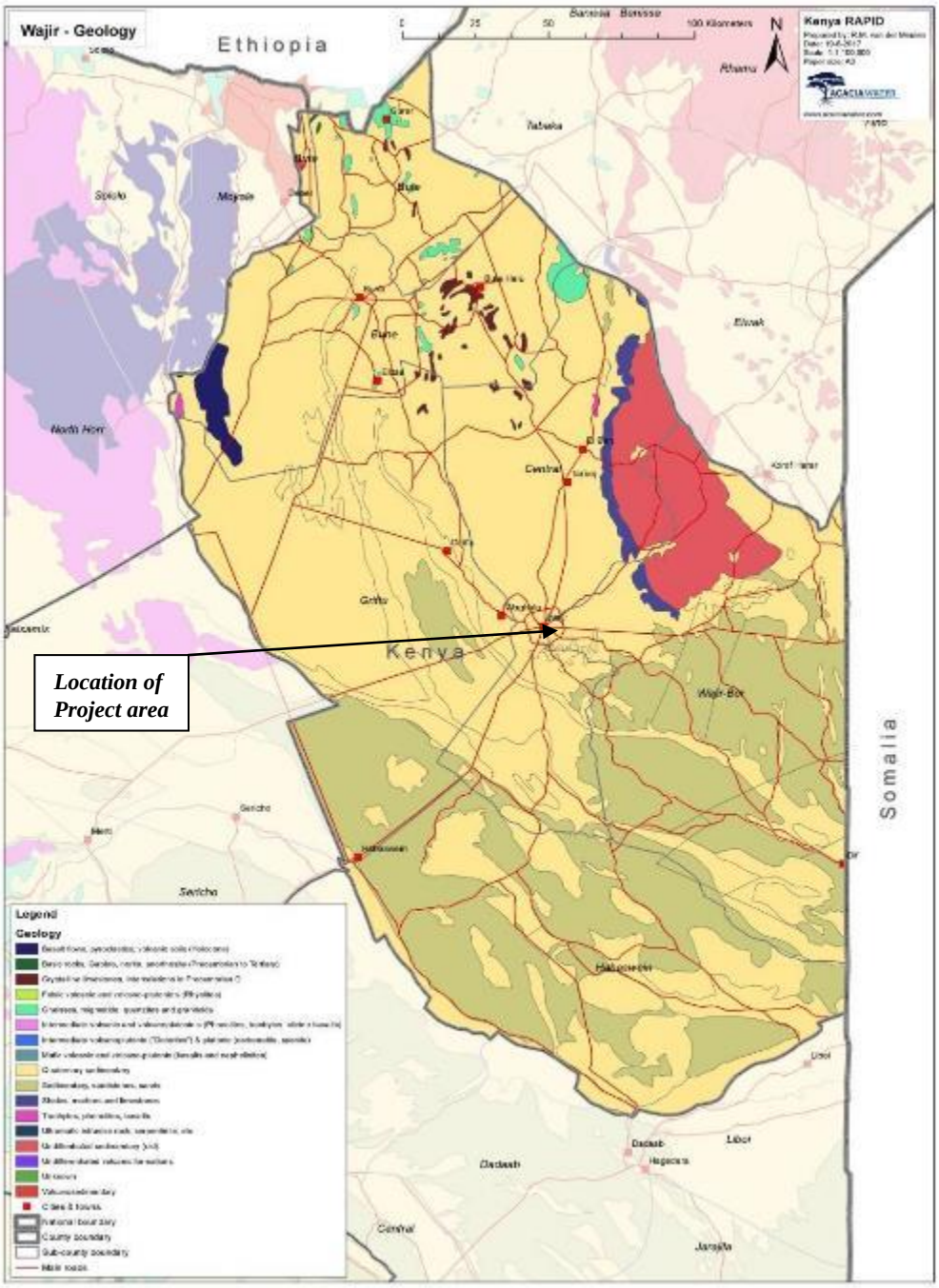


Fig 3.0: Map showing the Geology of Wajir County (Courtesy of Kenya-RAPID and Acacia Water, 2017)

Table 1. Stratigraphical table (after Joubert, 1963)

Relevant information on the regional geological units is summarized (stratigraphical table).

Period	***Formation***	***Lithology***
Recent		*Sandy soils*
Pleistocene	*Wajir Beds*	*Gritty soils, Laminated limestones limestones/Sandstones*
Jurassic	*Merti Beds*	*Sandstones* *Clays and sandy clays*
Triassic	*Bur Mayo Formation*	*Grey and brown limestones*
Precambrian	*Mansa Guda Formation.*	*Conglomerates* *& Sandstones*

As far as is known, Paleozoic rocks are absent in the area, which cause Basement rocks to be overlain directly by Mesozoic or even younger rocks. Down warping of the coastal area at the end of the Paleozoic resulted in a transgression of the sea, in which the Triassic Mansa Guda Formation was deposited as a delta. Recurrence of down warping in the Lower Jurassic caused another transgression and the deposition of the Jurassic Limestone Series.

After regression from Middle Jurassic times, the Cretaceous continental Marehan Series was deposited. During the Tertiary, erosion of Mesozoic and Precambrian rocks took place and Miocene sediments were deposited, but probably largely removed again as a result of Pliocene uplift.

The Pliocene Merti Beds were laid down in at least some parts of the Northeastern Province. Alternating pluvial and interpluvial periods during the Pleistocene and this explains the variation in lithology observed in the Wajir Beds and younger formations (Joubert, 1963; Swarzenski and Mundorff, 1977).

The occurrence and extent of the different geological units is rather well known at the surface, but uncertainties exist in many zones regarding the geological units at some depth. Bestow (1953)

and Joubert (1963) suggest, for example, that under Wajir Town, Basement rocks are directly overlain by (Tertiary and?) Quaternary rocks, whereas more recent reports (Swarzenski and Mundorff, 1977) and recent boreholes make plausible that the Mansa Guda Formation extends more southwestwards than previously thought and might occur under Wajir at a depth of 120 metres.

Furthermore, equivalent of the Merti Beds, found in a wide belt from NW of Habasweni to Liboi at the Somalia border (and beyond), are not mentioned by Joubert (1963), but Swarzenski and Mundorff (1977) suggest that they are present in the Wajir area as clays, sands and grits underlying a 20-25 m thick succession of Wajir Beds.

Finally, the sequence of Quaternary deposits varies considerably over short distances, which makes it difficult to recognize and correlate the different stratigraphic units in wells and boreholes. This fact has given rise to inconsistencies in this respect between various reports (Bestow, 1953; Joubert, 1963; Balasha Jalon, 1976; Swarzenski and Mundorff, 1977; Alexander Gibb & Partners, 1979).

The following are parameters that define the aquifer characteristics of the Wajir similar to other areas in Northeastern Kenya.

3.3.1 Lithology and geometry

The widely exploited shallow aquifer in the Wajir Town Area consists of more or less permeable horizons in the Wajir Beds. It is commonly found at depths of around 6 metres below ground level and is assumed to be 2 -15 metres thick (Bestow, 1953; Joubert, 1963; Swarzenski and Mundorff, 1977). It is thought to consist of the arenaceous lower part of the "impure limestone" and the sands or silts immediately underneath. The shallow aquifer is underlain by clay layers several tens of metres thick, with intercalated silty or sandy lenses.

Tentatively, a northern limit of the aquifer could be assumed at approximately 7 to 8 km north of Wajir Town. The absence of shallow wells west of Waghalla suggests that also a lateral limit at some 20 km west of Wajir might exist. In eastern and southern direction, the shallow aquifer probably extends over a larger (but still unknown) distance.

Within its lateral limits the aquifer is assumed to be continuous. The preferential occurrence of livestock well fields in topographic depressions may be associated rather with history and convenience of well digging than with variations in the aquifer properties.

3.3.2 Well yield

Pumping tests suggest that the sustained yield of shallow dug wells in the Wajir Town area may exceed some 5 m^3/hr in roughly 40% and 2 m^3/hr in 60% of the cases, provided that well depth and pump allow for 2 metres of drawdown. About one-third of the tested wells have specific capacities higher than 1 l/s per metres of drawdown (after 24 hrs of pumping). Local variation is pronounced, which means that highly productive wells can be found close to almost unproductive ones.

3.3.3 Hydraulic aquifer properties

Pumping tests results show local "apparent' Transmissivities from less than 80 to 300 m^2/day, or more. The effect of the relatively impervious saturated limestones on top of the sandy beds of the aquifer cannot easily be assessed quantitatively. It will, more or less, act as a confining layer during transient flow stages (during intermittent abstraction and recovery). On the other hand, it is assumed to be sufficiently pervious to allow direct recharge to take place.

3.3.4 Groundwater levels, groundwater flow and recharge

Groundwater levels are shallow: roughly between 1 and 11 metres below surface in the wells. The water table follows closely the topographic surface and is sloping with the same dip of approximately 1.6 m per km from NNW to SSE.

The Piezometric map and the estimated average transmissivity indicate that a net flux of some 75,000 m^3 of groundwater annually moves SSE through each 1 km wide section perpendicular to the flow direction. The hypothesis is put forward that groundwater in this shallow aquifer does not follow one regional flow system, but circulates partly in small local flow systems, fed by local recharge and drained by wells and by deeply rooted trees and shrubs. Supporting evidence for this hypothesis is provided by: the demonstrated occurrence of local recharge from rainfall; the assumed heterogeneity of the shallow limestone beds permeability; the presence of numerous 'cones of depression' around wells; and the, more or less, randomly scattered pattern of water quality variations, e.g., EC and NO_3^- content.

Groundwater level hydrographs measured shows that direct recharge of groundwater by local rainfall occurs. On the other hand, tested yields of all deeper boreholes are disappointing at very large drawdown. It is questionable, however, whether this was always due to poor aquifer characteristics or to poor well construction.

4.0 WATER RESOURCES.

4.1 Surface Water Resources.

There are no perennial rivers draining the project area. Residents in the area rely on water supply from boreholes, scooping water from dry riverbeds, earth pans and shallow wells.

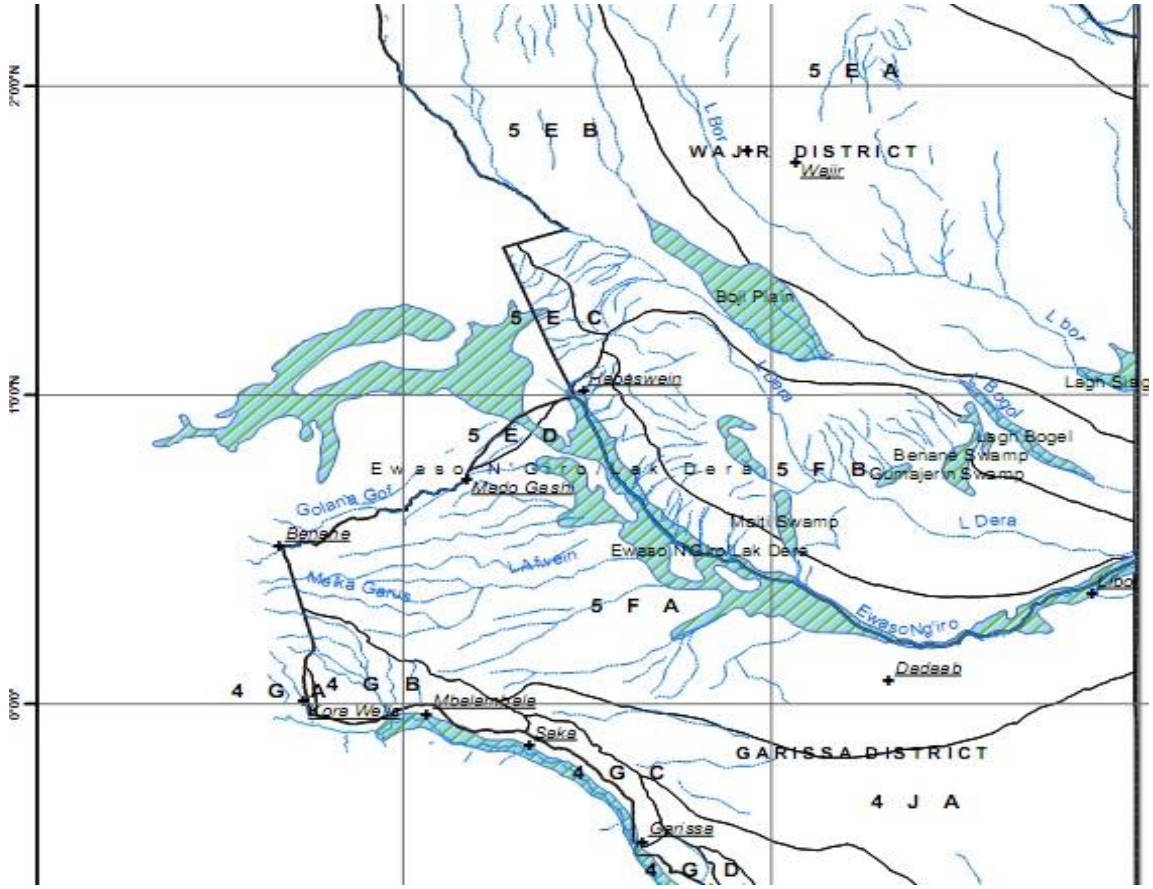


Fig.4.0: Hydrological Map of Wajir County and its neighbourhood showing drainage system of the area

4.2 Groundwater Resources.

The geology of the project area comprises rocks of the sedimentary System that overlie the Basement rocks at great depth. It is estimated that sedimentary rocks have a thickness of more than 3000 meters in some areas (?). The sedimentary rocks comprises of sandy soil, gritty soils, laminated limestone/ mudstone, clays and sand clays, grey and brown limestone conglomerates and sandstones.

There are several faults and weak structural zones within the project area that control groundwater movements. Some of these weak zones act as the main groundwater subsurface flow and drain zones. Boreholes drilled within these structures can have very good discharge.
During our fieldwork our aim was locate these structural weak zones by horizontal electrical profiling. The selected borehole drilling site is on these weak zones.

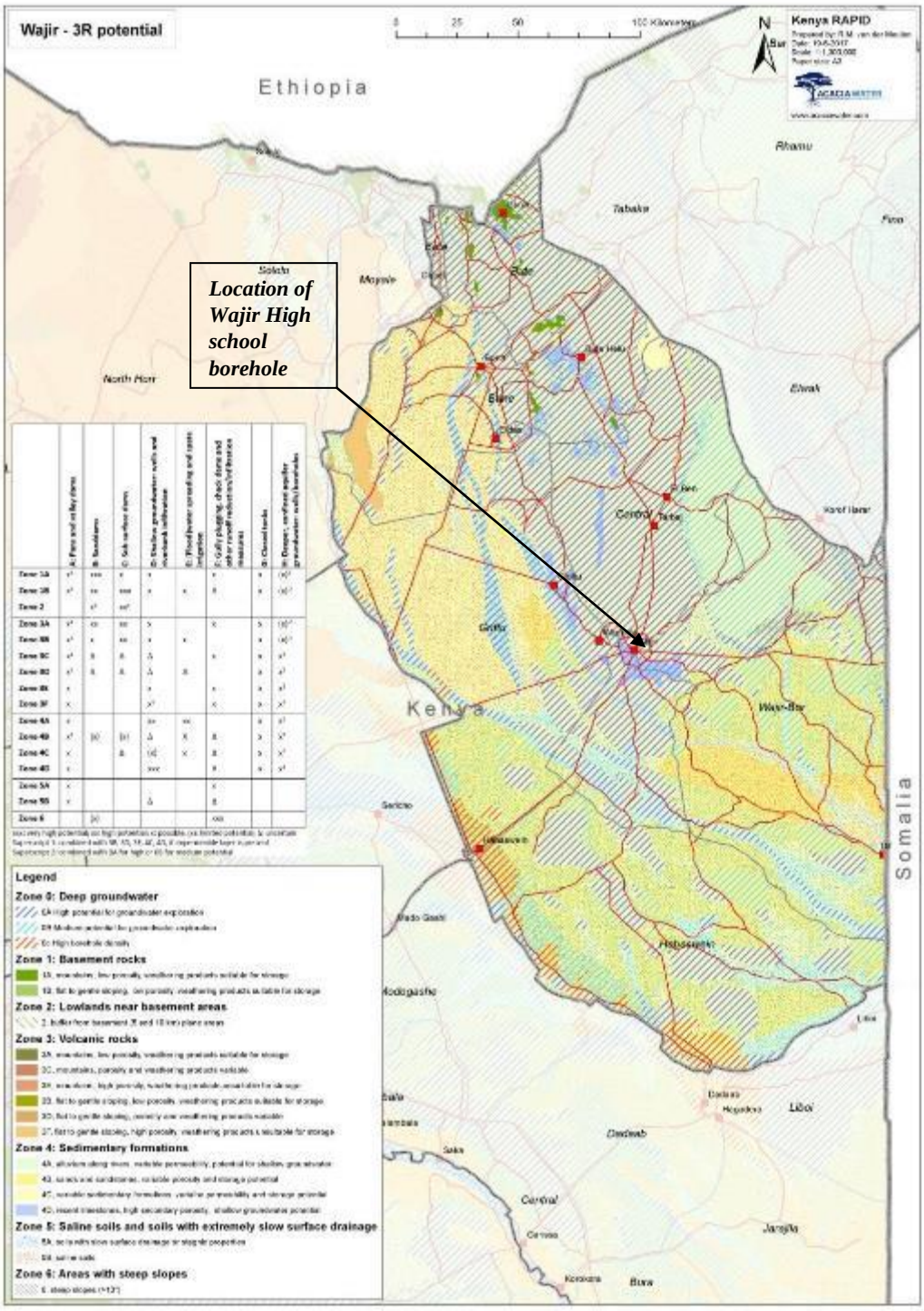


Fig. 5.0: Groundwater potential map for Wajir County (Courtesy of Kenya-RAPID and Acacia Water, 2017)

5.0 GROUNDWATER OCCURRENCE.

Groundwater occurrence, as discussed in this Chapter is dependent upon geology, rainfall, weathering and recharge. The best aquifers are found when a conjunction occurs of optimum recharge (rainfall, soil permeability), storage (porous rocks), and transmissivity (the ease with which water can travel, both vertically and horizontally, within an aquifer).

5.1 Rainfall, Percolation and Recharge.

Given that suitable storage media exist below ground, the mechanisms by which water must reach it also affect aquifer potential.

Obviously, if no rainfall or river flow is able to percolate to a sandy weathered Sedimentary and Basement aquifer due to the presence of an aquitard (impermeable layer) probably clay, the actual potential is very low.

Both Basement and Sedimentary systems suffer the same limitations so far as recharge is concerned: if rainfall is high the volume of water which may eventually percolate to a suitable aquifer is likely to be relatively high, and possibly slightly mineralised due to high evaporation rate.

Percolation is dependent on soil structure, vegetation coverage and the erosion state of the parent rock.

Rocks that weather to clayey soils will naturally inhibit percolation (such as `black cotton' soils); conversely, the sandy soils resulting from the erosion of some Sedimentary and Basement rocks are eminently suited to deep, swift percolation.

Recharge is the term applied to the whole mechanism, and includes all the aspects of parent geology, effective rainfall and percolation. Some aquifer systems are recharged by water falling a substantial distance away - this is for instance the case where recharge apparently occurs laterally from the high grounds. For, instance, in the project area, the water in the Wajir aquifer originates from Ethiopia to the North, is the main recharge in this area.

5.2 Groundwater Quality.

Generally, sedimentary complex waters are sometimes hard, with low Total Dissolved solids (TDS) and fluoride content seldom exceeding World Health Organization limits. However, at local level significant peak concentrations of chloride, sulphate, fluoride, sodium, calcium and potassium ions can occur, especially where groundwater is shallow, groundwater flow is low or absent and the evaporate-transpiration rate is high. For example the case of Wajir Town there is considerable variations in quality of water ranging from very saline to almost fresh water.

The factors which determine the degree of salinity in groundwater are as follows:-

Evaporation and Transpiration

Direct evaporation by the heat of the sun and preferential uptake of certain mineral ions by plants can, in certain environments, lead to salinisation.

Dissolution of Evaporites

The process of evapotranspiration may, in arid conditions, lead to the precipitation of salts in the unsaturated zone (soil). These salts may then be carried down to the groundwater store during periods of rain, thus leading to high ion concentrations in space and time. This process is exacerbated in an intensely seasonal climatic regime, such as in the study area.

Dissolution of Host Rock

Given relatively long residence times and fairly high ambient temperatures in groundwater systems, progressive salinity of groundwater can be expected via the host rock.

This will vary according to local geology, local structures (which may speed the passage of water through an aquifer by means of faults, etc, and so limit retention time), and local climate and so on.

Water quality Analysis

Several boreholes which were tested within the project site indicated the level of total dissolved solids, sulfate, total hardness and calcium exceeded the recommended guideline values for portable water, while those at Habaswein have better water quality which we attribute it to being near River Ewaso Nyiro.

In the project area we expect similar water quality as the neighboring boreholes.

Table 2: Ionic Concentration: WHO &Various Authorities

World Health Organization:	*European Community:*		
	1983	*1971 Int.*	*EC Directive 1980 relating to the quality*
	Guidelines	*Standard*	*of water intended for human consumption*

Substance or Characteristic	*Guidelines Value (GV)*	*Upper limit (HL), tentative*	*Guide level (GL)*	*Max. Admissible Conc. (MAC)*
Inorganic Constituents of health significance:				
Antimony Sb			*0.01*	
Arsenic As	*0.05*	*0.05*		*0.05*
Cadmium Cd	*0.005*	*0.01*		
Chromium Cr	*0.05*	*0.05*		

Cyanide	*CN*	*0.10*	*0.05*		*0.05*
Fluoride	*F*	*1.5*	*1.7*		*1.5*
Lead	*Pb*	*0.05*	*0.10*		*0.05*
Mercury	*Hg*	*0.001*	*0.001*		*0.001*
Nickel	*Ni*				*0.05*
Nitrates		*10(as N)*	*45 (as NO)*	*25(as (No)*	*50 (as NO)*
Selenium Se		*0.01*		*0.01*	

Other Substances		*GV: Desirable*	*Highest Permissible Level*	*Max. Level:*	*GV*	*MAC*	
Aluminum	*Al*		*0.20*			*0.05*	*0.20*
Ammonium	*NH*					*0.05*	*0.50*
Barium	*Ba*					*0.10*	
Boron	*B*					*1.0*	
Calcium	*Ca*			*75*	*50*	*100*	
Chloride Cl		*250*	*200*	*600*	*25*		
Copper	*CU*			*0.05*		*0.10*	
Hydrogen Sulphide	*H_2S.*		*ND*				*ND*
Iron	*Fe*		*0.30*	*0.10*	*1.0*	*0.05*	*0.20*
Magnesium	*Mg*		*0.10*	*30*	*150*	*30*	*50*
Manganese	*Mn*		*0.10*	*0.05*	*0.50*	*0.02*	*0.05*
Nitrite	*No*						*0.10*
Potassium	*K*					*10*	*12*
Silver	*Ag*						*0.01*
Sodium	*Ng*		*200*			*20*	*175*
Sulphate	*Soq*		*400*	*200*	*400*	*25*	*250*
Zinc	*Zn*			*5.0*	*15*	*0.10*	
Total Dissolved solids			*1000*	*500*	*1500*		*1500*
Total Hardness as $CaCo_3$			*500*	*100*	*500*		
Colour	*Hazen*		*15*	*5*	*50*	*1*	*20*
Odour			*Inoffensive*	*Unobjectionable*			*2 or 3 Ton*
Taste			*Inoffensive*	*Unobjectionable*			*2 or 3 Ton*
Turbidity (JTU)			*5*	*5*	*25*	*0.4*	*4*
PH			*6.5-8.5*	*7.0-8.5*	*6.5-9.2*	*6.5-8.5*	*9.5 (max)*

Temperature	*0C*	*12*	*25*
EC	*us/cm*	*400*	
Notes	*ND-Not Detectable*	*IO-Inoffensive*	
	GL-Guide Level	*UO-Unobjectionable*	

6.0 BOREHOLES DATA'S

Several boreholes and shallow wells have been drilled and constructed in our project area. There are also water pans and earth dams that had been constructed in various parts of this region by the Government and other organizations over the years.

The information obtained from these data indicates that some of the borehole water is saline while other has good quality water. This is dependent on the actual location of the well and the geological setup of the same. The other factor is the depth of the borehole and the recharge that also affects the quantity and the quality of groundwater. If the recharge potential is low the water is expected to be highly mineralized and the discharge low otherwise if the recharge is good the quality and the quantity of water is expected to be good.

In this geological set up, drilled boreholes will have no definite trend as to water struck levels, drilled depths and yields, unless of course they are at the same zone. This is attributed to the fracturing and weathering depths of the underlying formations.

7.0 GEOPHYSICS.

A great variety of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity method (also known as the geoelectrical method) and the Horizontal Electrical Profiling (HEP) methods has been used. The latter was used to detect any anomalous conductive zones in the subsurface, which might be associated with faulted or fractured zones.

Vertical Electrical Soundings (VES) were carried out to probe the conditions at such anomalous zones within the sub-surface and to confirm the existence of groundwater. The VES probes the resistivity layering below the site of measurement. The techniques are described below.

7.1 Basic Principles of the Resistivity Method.

The electrical properties of the upper parts of the earth's crust are dependent upon the lithology, porosity, degree of pore space saturation and the salinity of the pore water. Saturated rocks have lower resistivities than unsaturated and dry rocks. The higher the porosity of the saturated rock the lower the resistivity and the higher the salinity of the saturating fluids, the lower the resistivity. The presence of clays and conductive minerals also reduces the resistivity of the rock.

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 = Rs *L/A (in Ohm) (1)

Where Rs is known as the specific resistivity, characteristic of the material and independent of its shape or size

With Ohm's Law
R = dV/I (Ohm) (2)

Where dV is the potential difference across the resistor and I is the electric current through the resistor; the specific resistivity may be determined by:

Rs = (A/L) *(dV/I) (in Ohm.m) (3)

7.2 General.

The field investigations carried out in the project area to evaluate the groundwater potential of this area included the following:

- *Geomorphological interpretation and hydrogeological reconnaissance to establish overview impression of the area;*
- *Execution of geo-electrical measurements comprising the following:*
  - ✓ *Horizontal Electrical Profiling using ABEM Terrameter SAS 1000;*
  - ✓ *Vertical Electrical sounding using the ABEM Terrameter SAS 1000;*

7.3 Methods.

7.3.1 Horizontal Electrical Profiling (HEP)

These were carried out at each site to determine changes in electrical properties laterally with a constant electrode spacing and interpreted as a continuous profile. The electrode spacing controls both the profiling depth and the resolution of the survey.

The probe depth on all the profiles was maintained at a depth of 50 metres with a constant interval of 10 metres from one station to the other.

The observed resistivity values are plotted on logarithmic paper and the curve obtained depicts lateral resistivity variation at constant depth. Geological structures such as faults, fractures, buried stream channels that may conduct groundwater, can be inferred.

7.3.2 Vertical Electrical Soundings (VES)

Vertical Electrical Soundings were carried out to probe the electrical properties and depth to subsurface layered formations below the site of measurement at the most significant anomalous zones.

When carrying out a resistivity sounding, electric current is led into the ground by means of two electrodes and the potential field generated by the current is measured. The separation between the electrodes is step-wise increased (in what is known as a Schlumberger Array), thus causing the flow of current to penetrate greater depths. The observed resistivity values are plotted on log-log paper and the curve obtained depicts resistivity variation against depth.

This curve can be interpreted with the aid of a computer, and the actual resistivity layering of the subsoil is obtained. The depths and resistivity values provide the hydrogeologist with information on the geological layering and thus the occurrence of groundwater.

7.4 Fieldwork.

Field reconnaissance survey and fieldwork was carried out from 6th to 14th March 2019.

The field data and the location map are presented in the appendixes.

7.5 The Results and Interpretations.

The site that was surveyed is as indicated in Table-4 below. The results of the geophysical site investigations for the site are illustrated with resistivity curves and table-3 shown below.

VES-1: WAJIR HIGH SCHOOL

The surveyed site is located approximately 1.5 kilometers from Wajir CBD off Wajir-Airport Road. Vertical electrical sounding was executed E-W across the project site to a maximum electrode separation of 100M. The results of VES were plotted on the resistivity curve shown below and interpretations done as indicated on Table 3.

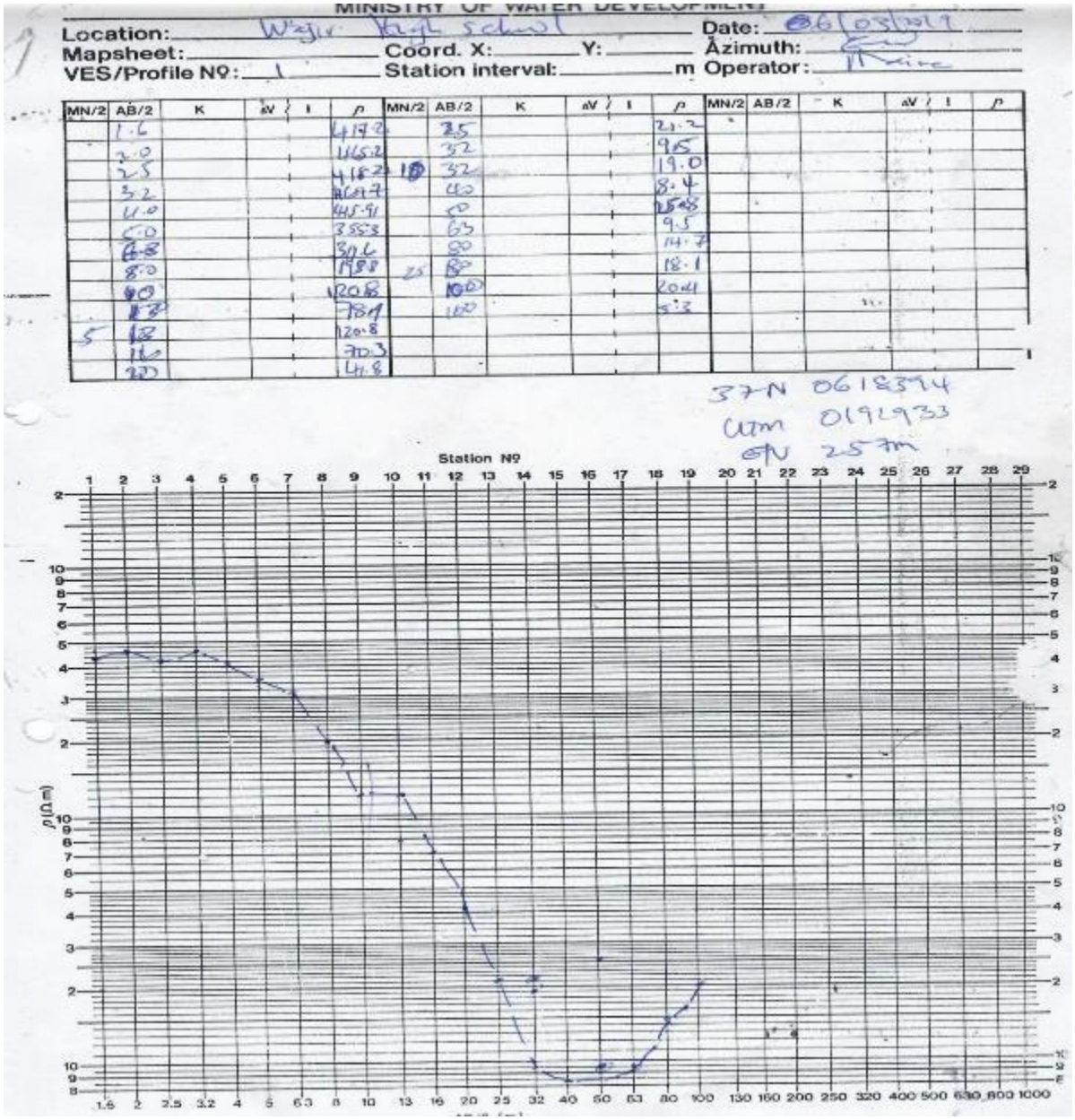


Fig. 6.0: Resistivity curve for VES-1.

Table 3: Results and interpretations.

FORMATION DEPTH (M)	APPARENT RESISTIVITY (OHM-M)	EXPECTED FORMATION	REMARKS
0 – 0.002	450.0	Top Sandy Soils.	Dry
0.002– 10.0	400.0	Limestone deposits.	Dry
10.0 – 13.0	100.0	Weathered limestone deposits.	Wet.
22.0 – 38.0	80.0	Clay stone.	Dry.
38.0 – 63.0	22.0	Weathered sandstone.	Moist.
63.0 – 90.0	10.0	Gravelly weathered sandstone	Wet.
90.0 – 100.0	11.0	Clayey sandstone	Wet
>100.0	18.0	Sandstone	Top-Wet Base-Dry

The interpreted model results of this VES shows progressively weathered unconsolidated sedimentary set up of different textures up to a depth of 100 meters and beyond. The site has excellent groundwater potential and is thus recommended that the borehole be drilled to a maximum depth of ***100M.***

The proposed drilling site has been marked on the ground and is conversant with the Deputy Principal and the School Watchman.

TABLE NO. 4. Site number, coordinates, site name and recommended depths.

VES No.	***Coordinates***	***Groundwater Prospects***	***Remarks***	***Recommended Depth (metres)***
1.	***Wajir High school*** *37N 618394* *UTM 191933* *Elevation 257M*	*Excellent*	*Mud drilling*	*100*

8.0 CONCLUSION AND RECOMMENDATIONS.

- *Our project area lies within an average altitude of 240-260m above sea level.*

- *The area lies in the 100% arid and semiarid area of northeastern Kenya where the transevaporation is very high and hence most of ground water is mineralized leading to salinity and hardness.*

- *The area is within the Merti aquifer, which is a continental aquifer covering parts of Wajir and Garissa counties, consequently any borehole drilled in this area to a of depth more than 180 metres below ground level will have water.*

- *Due to low rainfall and long residence time of groundwater in the rocks and the mild topography may be contributing high mineralization of groundwater.*

- *From hydro-geological data collected the formations in this area manifests low apparent resistivities is due to presence of clay and silt in the formations that deter transmissivity and hence give water a longer residence time in the aquifers that lead to mineralization from the host rocks.*

- *From the borehole data it can be observed that properly sited boreholes and drilled to a good depth (220m and deeper) are high yielding and give fairly good quality water. A good sited borehole is that which is sited on a wide structural weak zone with a good gradient.*

- *This area is characterised by seasonal rivers which only flows during rain seasons, the structures which control the flow are fractures and a borehole located along these structures would be high yielding. These seasonal streams in most cases recharge the groundwater in this area. Boreholes drilling near these seasonal drainage channels in most cases have good quantity and quality water.*

Conclusion

From the observations it can be concluded that;

- *The proposed sites has good groundwater potential*
- *Properly sited and drilled boreholes will be high yielding and will give portable water.*
- *Drilling should be done by Registered Drilling company properly acquainted to mud drilling because the geological formations though stable may be prone to collapsing.*

Recommendation

(a) It is therefore recommended that boreholes of 8" diameter be drilled at the proposed selected sites to the depths indicated on the above table. The sites were benchmarked on the ground and also shown to various village elders.

(b) The proposed boreholes should be lined with casings and screens of 152 mm minimum diameter and should be gravel packed.

(c) Undertake the environmental Impact Assessment for the project and obtain necessary permits.

(d) Finally drilling work SHOULD NOT commence until groundwater permits are obtained from Water Resources Authority (Daua Sub-Region Office Mandera) of Ministry of Environment, Water and Natural Resources.

(e) We further recommend that the services of a qualified, independent hydrogeologist be employed during drilling for supervision and technical advice.

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APPENDIX - Drilling

Drilling should be carried out at a diameter of not less than 8", using either a rotary type machine. The drilling rig should be able to drill to the recommended depth, at the specified diameter of 8". The rig and the drilling method adopted must be suitable for drilling through both unconsolidated material, and hard, compact rocks. The rotary drilling technique offers very high penetration rates in all types of materials, rig mobilisation and demobilisation are rapid, minimal casings are required during drilling exercise and reliable yield estimates can easily be made during drilling.

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 method will however considerably prolong the required time for drilling, which may be undesirable if water is required at short notice. Another main disadvantage is that no reliable yield estimates can be made during drilling. As a result, a reliable judgement whether to stop or continue drilling at a certain depth can not be made. In addition, borehole development techniques will be less efficient than with a rotary plant compressor. This may reduce the capacity of the borehole, and may fail to stop the intake of fine sediments during pumping. In case of friable materials and/or loose sediments, bentonite is used to stabilise the materials when drilling using percussion technique. The sticky clay-based mud seals the aquifer pores reducing the aquifer transmissivity and hence borehole yields. In rotary drilling, the biodegradable polymers or foam is used to stabilise collapsing formations. This biodegradable mud can easily be removed during borehole development.

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On the other hand, the percussion method is considerably cheaper than the modern rotary technique, partly because of the lower drilling rates, but also due to the often much lower sum charged for mobilisation. However, it must be noted that the initial savings may be offset against the continuing costs of labour, fuel, etc., the prolonged absence of a water source, and the time input of the Client and his representatives. Regarding the long time required when applying the percussion drilling technique.

Geological rock samples should be collected at 2 metre intervals. Water struck and rest 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 (rotary) or bailed (percussion) 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, in order to avoid collapsing and sediment intake. Considering the moderate depth of the borehole, it is recommended to use Mild steel casings and screens of 6" diameter. They should be machine cut not gas-slotted. Screen slots should be a maximum of 1.5 mm in size. The minimum open area of the screens should be 5%.

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. An 8" diameter borehole screened at 6" will leave an annular space of approximately 1", 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 round to well round. 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, involves the insertion with a tremie pipe.

Well Construction

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 plug at the surface, to prevent contamination 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, gravel pack, seals and backfill have been installed, the well should be developed.
Development is the term used to describe the procedures designed to maximise well yield. Although an expensive element in the completion of a well, the additional costs are usually justified by longer well life, greater efficiencies, lower operational and maintenance costs and a more constant yield.

Development has two broad objectives, which can be divided into borehole and aquifer stimulation:

- *To repair the damage done to the aquifer material during drilling and restore the natural hydraulic properties.*

In both cable tool (i.e. percussion) and air hammer drilling, the bit action chips and crushes the rock, and mixes it with water and other fine material into thick mud slurry. The pounding of the bit forces this slurry into the openings in the wall of the borehole, thus blocking the pores and impeding the flow of water from the aquifer. A thick "wallcake" may form, especially when clay additives (such as bentonite) are used during drilling or where natural clays occur in the penetrated formations. This cake, if not removed, may virtually plug the borehole, and significantly
reduce the discharge. It should be noted that the maximum yield of a formation can only be realised if all the fractures and crevices are unblocked and able to supply water to the well. Borehole development techniques are applied to break down and remove the impermeable layer

of clayey material from the borehole wall. Swabbing, wall-scratching, airlift rawhiding and polyphosphate dosing are all borehole development techniques.

- *To alter the characteristics of the aquifer volume in the vicinity of the borehole, by improving hydraulic contact between the aquifer and the hole. This is essentially aquifer development, and is also known as aquifer stimulation.*
  Polyphosphate dosing, hydrofracturing and acidification are examples of aquifer stimulation techniques.

The development methods to be applied depend on the available equipment, and differ significantly between percussion and rotary drilling (the latter being superior, when it comes to efficiency):

Development with a percussion rig: if a cable tool rig has been deployed the available development techniques are relatively simple, but less effective than the methods used in modern rotary drilling. The following measures are recommended:

- *Backwashing and bailing: using a surge block with rubber flaps slightly smaller than the internal diameter of the hole, start near the top of the water bearing zones and surge downwards (surging upwards may lead to the surge block sand-locking, which can jeopardise the hole). Bail the borehole clean periodically. Repeat this cycle until no more material is brought up, bailed water is clear and electrical conductivity is stable.*
- *Polyphosphate dosing: percussion equipment does not include mud pumps and drill pipe, so jetting is impossible. Polyphosphate dosing comprises no more than simply pouring water with dissolved sodium hexametaphosphate and calcium hypochlorite into a pipe, the base of which is located near the bottom of the hole.* [3] *The polyphosphate is allowed to act for 12 hours or overnight. Repeat the backwashing and bailing cycle until the water is clear and electrical conductivity stable.*

If a rotary rig equipped with a strong air compressor is available, more effective development techniques can be applied:

- *Airlift rawhiding, into and through the aquifer zones. This should continue until the water lifted is clean and clear, with electrical conductivity stable. Rawhiding comprises cyclic airlifting: once the airlift has been established, air supply is cut off and water allowed to cascade down the hole. This creates overpressures across the borehole wall, which agitates the formation and enhances cleaning. The airlift is then started again and the cycle repeated.*
- *Water jetting with an on-wall velocity of 30 m/s: at least 0.3 m^3 of fluid should be jetted per linear metre of screen. The water used for jetting must be absolutely clean, and it is dissolved as in the polyphosphate dosing described under Section 4.2. The jetting tool should be so constructed that the jet openings are not more than 1" (25 mm) from the borehole wall.*
  Jetting should start from the top of the water bearing formation rotating downwards. After

[3] Recommended concentrations are 3.8 kg/m of sodium hexametaphosphate (a locally available, common food additive and clay disaggregant known under the trade names “Calgon” or “SHMP”), and 1.5 kg/m^3 of calcium hypochlorite.

the entire saturated zone has been jetted, the hole should be left for at least 12 hours or overnight, to allow the hexametaphosphate to work on the "wallcake" and any clayey material in the aquifer material.

- *Airlift rawhiding again, from the bottom of the hole, until airlifted water is absolutely clean and electrical conductivity stable.*

During development, an estimate of the bailed or air-blown yield should be made. This usually gives a fair indication of the final range of abstraction that can be expected from the borehole. The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable.

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-bystep, 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 and Irrigation and Water Act 2002, that all boreholes in Kenya be equipped with a master/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.

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 should also be equipped in the borehole to monitor water rest level.

Pumping Plant

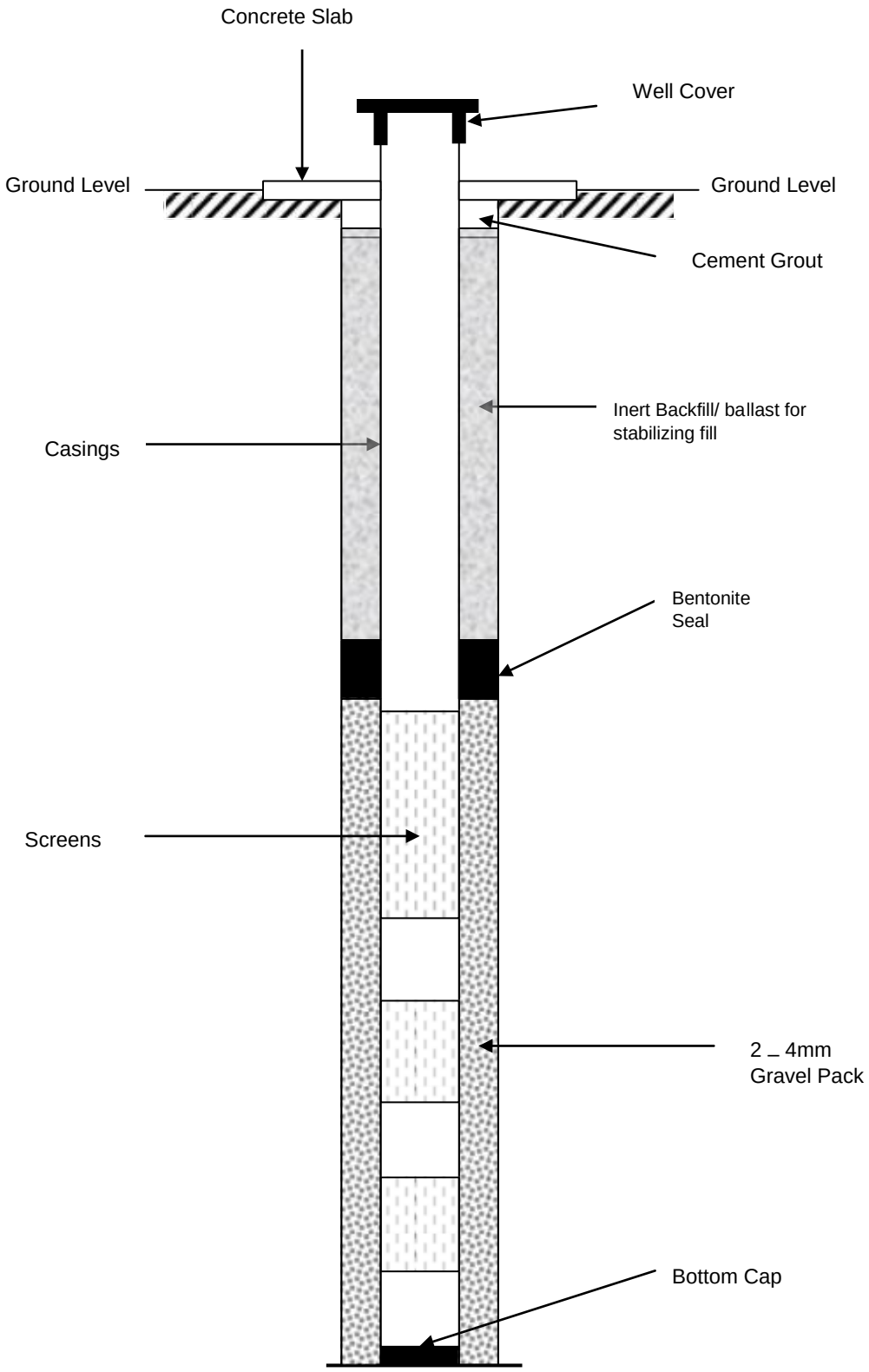
Several options are open to the Client:

a) *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.*

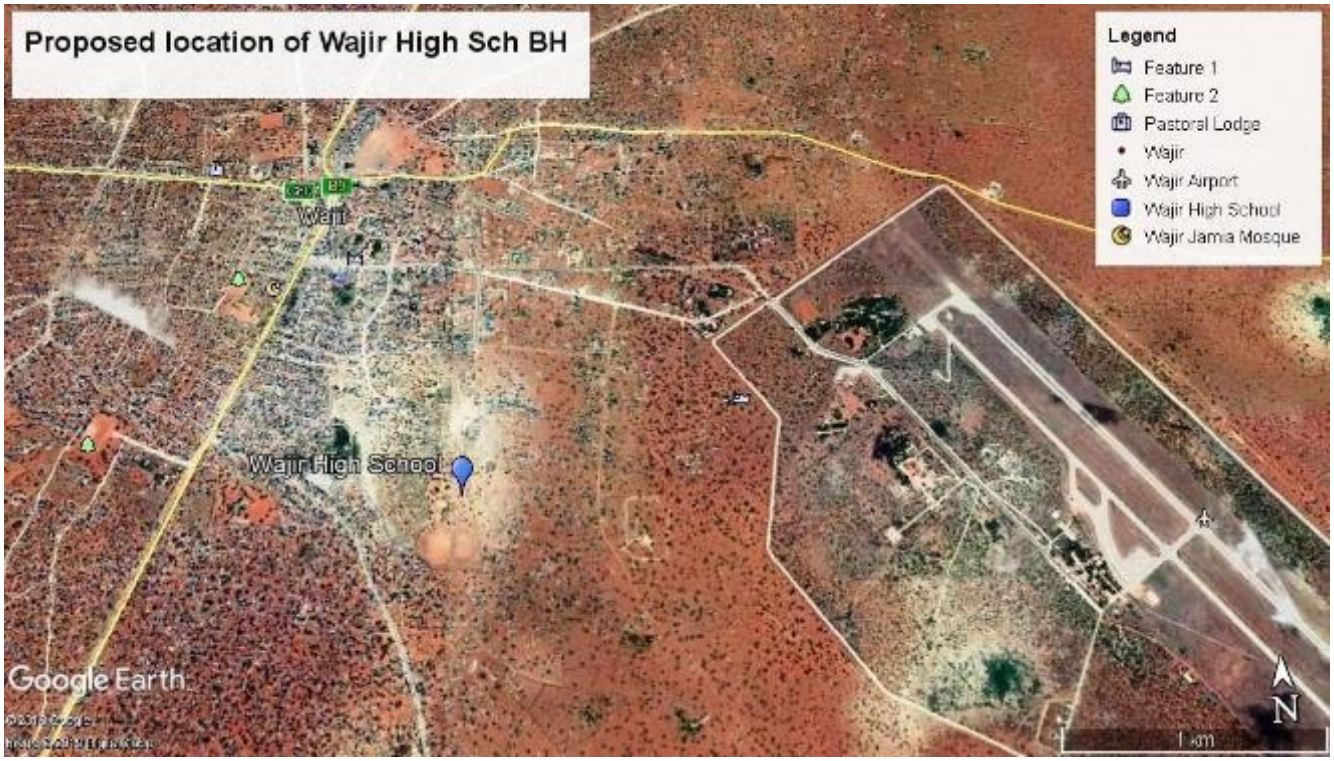
b) *Electrical solar submersible pumps: These are not widely used mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers.*

c) *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 wind pumps, reciprocating pumps. They 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.*


Concrete Slab
Well Cover
Ground Level
Ground Level
Cement Grout
Inert Backfill/ ballast for stabilizing fill
Casings
Bentonite Seal
Screens
2 _ 4mm Gravel Pack
Bottom Cap

Map of Project area.



Picture showing the existing Lagdima community borehole (depth270M, Yield 24M^3/hr)

HYDROGEOLOGICAL ASSESSMENT REPORT

FOR

NORTHERN WATER SERVICES BOARD

P.O. BOX 495-70100

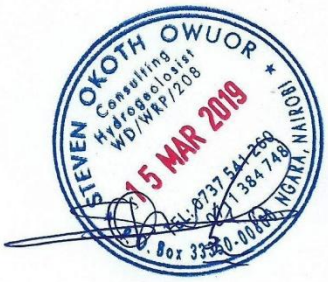
GARISSA

CARRIED OUT AT ELDAS PRIMARY SCHOOL IN

ELDAS CONSTITUENCY

WAJIR COUNTY

Report No: 060/03/2019



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Summary of the Scope of works

*The **Government of Kenya** through **Northern Water Services Board** commissioned the present hydrogeologist to undertake a comprehensive hydrogeological study to establish whether there are good chances of drilling high yielding borehole at **Eldas Primary School** which is located in Eldas constituency, Wajir County. The water is to be used for various purposes within the school compound.*

The area falls under the arid and semi arid land (ASAL) of Kenya. The area experiences high temperatures and low unreliable rainfall. Rainfall is generally low and unreliable in the area but when it comes, it falls in sudden heavy storms often causing unpredictable flash foods.

The area is geologically underlain by thick sedimentary rocks of several thousand metres in thickness. Most of these rocks are highly decomposed into clay and clayey sediments. Water is expected in sediments and in limestone where the clay element is low.

Several sites were identified by means of Horizontal Electrical profiling and Resistivity Methods within the school compound the details are discussed at the end of this report. The selected site is based on groundwater potential.

*Our observation from the fieldwork is that the area has **excellent groundwater potential** of reasonable quality and quantity that can be exploited for the intended purposes.*

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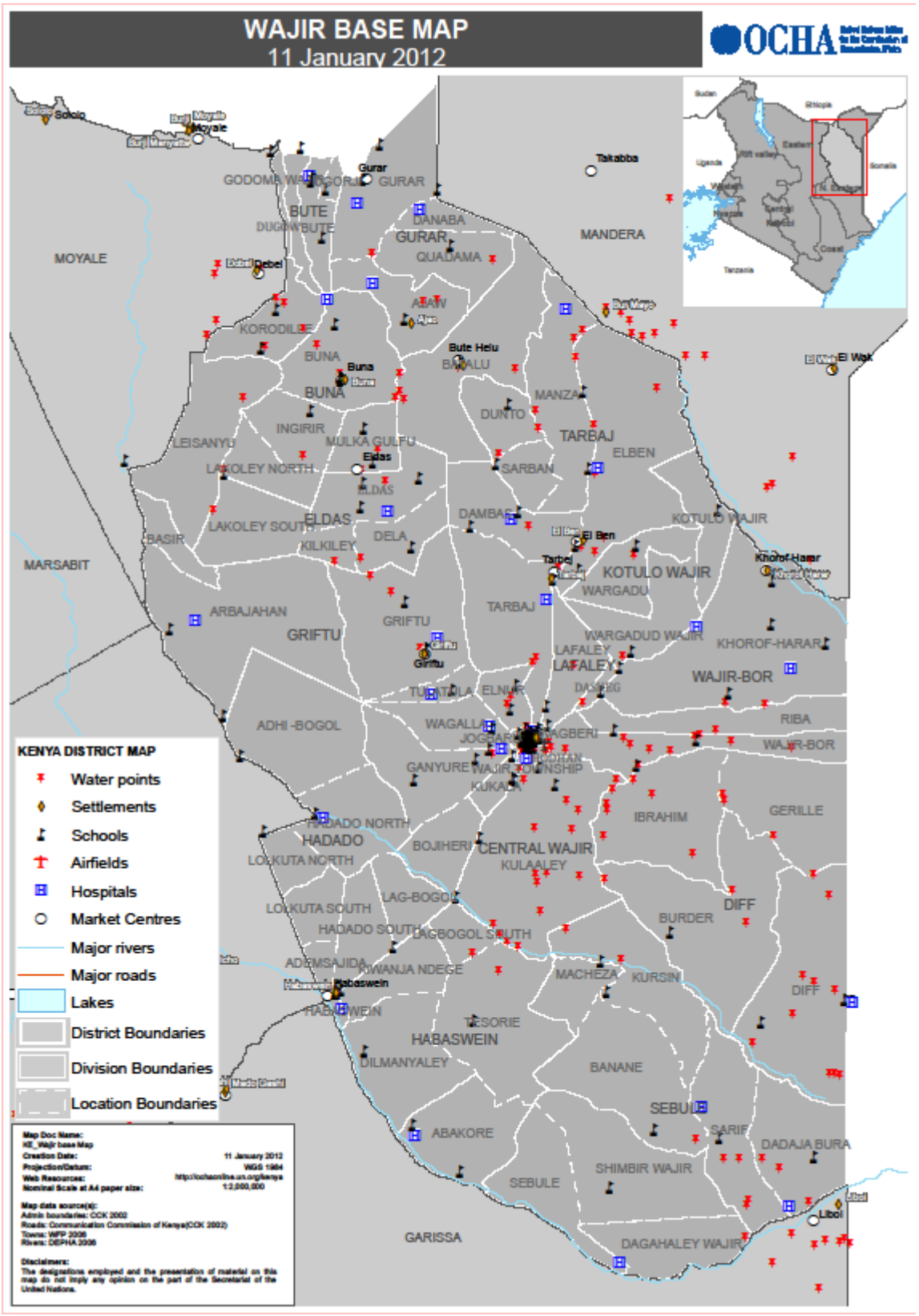
ABBREVIATIONS AND GLOSSARY OF TERMS

ABBREVIATIONS

asl	*above sea level*
VES	*Vertical Electrical Sounding*
HEP	*Horizontal Electrical Profiling*
TDS	*Total Dissolved Solids*
DTH	*Down the Hummer, (rotary drilling method)*
m bgl	*metres below ground level*
PWL	*pumped water level*
Q	*discharge (m^3/hr)*
SWL	*Static Water Level*
T	*transmissivity (m^2/day)*
WSL	*Water Struck Level*
WRMA	*Water Resources and Management Authority*

GLOSSARY OF TERMS

Aquifer	*A geological formation or structure that stores and transmits water and which is able to supply water to wells, boreholes or springs.*
Breccias	*A coarse-grained rock composed of angular fragments.*
Conductivity	*Transmissivity per unit length (m/day)*
Confined aquifer	*Confined aquifers are those in which the piezometric level is higher than the elevation at which the aquifer was encountered. Static water levels are at a higher level than the top of the formation.*
Drawdown	*The distance between the static water level and the pumped water level .The term **residual drawdown** is used for the same distance during recovery of the well.*
Development	*In borehole engineering, this is the general term for procedures applied to repair the damage done to the formation during drilling. Often the borehole walls are partially clogged by an impermeable "wall cake", consisting of fine debris crushed during drilling, and clays from the penetrated formations. Well development removes these clayey cakes, and increases the porosity and permeability of the materials around the intake portion of the well. As a result, a higher sustainable yield can be achieved.*
Fault	*A larger fracture surface along which appreciable displacement has taken place.*
Gradient	*The rate of change in total head per unit of distance, which causes flow in the direction of the lowest >head*
Hydraulic head	*Energy contained in a water mass, produced by elevation, pressure or velocity (also referred to as: **Head**).*
Hydro geological	*Those factors that deal with subsurface waters and related geological aspects of surface waters.*
Perched aquifer	*Accumulation of groundwater on top of a layer of low conductivity, underlain by unsaturated sediments or rocks*
Pumping test	*A test that is conducted to determine aquifer and/or well characteristics.*
Recharge	*General term applied to the passage of water from surface or subsurface sources (e.g. rivers, rainfall, and lateral groundwater flow) to the aquifer zones.*
Recovery	*Return to static water level following abstraction of water.*
Specific Capacity	*Ratio of pumping rate and drawdown (m^3/hr/m); a measure for the well performance*
Static Water Level	*A measure for the capacity of an aquifer to conduct water through its saturated thickness (m^2/day)*
Well development	*The act of repairing damage to the formation caused by the drilling process or gradual well deterioration. Increases the porosity and permeability of the materials around the intake portion of a well*
Yield	*Volume of water discharged from a well.*


WAJIR BASE MAP
11 January 2012
OCHA
KENYA DISTRICT MAP
Water points
Settlements
Schools
Airfields
Hospitals
Market Centres
Major rivers
Major roads
Lakes
District Boundaries
Division Boundaries
Location Boundaries
MOYALE
BUTE
GURAR
MANDERA
BUNA
TARBAJ
ELDAS
KOTULO WAJIR
WAJIR-BOR
HADADO
CENTRAL WAJIR
HABASWEIN
GRIFTU
GARISSA
Takabba
Bute Helu
El Wak
Eldas
El Ben
Khorof-Harar
Libol
Map Doc Name: KE_Wajir base Map
Creation Date: 11 January 2012
Projection/Datum: WGS 1984
Web Resources: http://ochaonline.un.org/kenya
Nominal Scale at A4 paper size: 1:2,000,000
Map data source(s):
Admin boundaries: CCK 2002
Roads: Communication Commission of Kenya(CCK 2002)
Towns: WFP 2006
Rivers: DEPHA 2006
Disclaimers:
The designations employed and the presentation of material on this map do not imply any opinion on the part of the Secretariat of the United Nations.

1.0 INTRODUCTION.

*This detailed report is presented as a technical site investigations report for the groundwater Survey program carried out for **Northern Water service Board**, specific as a water supply facility for Eldas Primary School, which is located in Eldas Constituency, Wajir County.*

The program entailed a thorough and detailed hydro geological and geophysical borehole site investigations conforming to the WRA requirements and standards. The sole objective of this survey was geared towards developing sustainable water supply facility for various purposes in the Institution which include cleaning, drinking, washing and cooking.

For one to develop a highly efficient water supply model for the school, it appears imperative to analyze the records of the existing boreholes and the typical accompanying data that characterize the aquifer system replenishing the area.

This preliminary report is based on detailed aquifer mapping that goes to the extent of deploying state of the art geophysical data interpretations to un-ravel the geo-technical elements that can support high borehole yields.

The geologist's experience in basement and sedimentary terrains is that for a successful drilling program, there is need to characterize both the structural and geological aspects that control groundwater recharge/discharge- Vis-à-vis the groundwater flow patterns.

Apparently, there is need to address the water quality requirements for the facility. The water supply from the proposed borehole needs to conform to high quality standards; thus entailing the hydrogeologist to define aquifer characteristics that would meet the particular standards.

The government plans to drill productive boreholes to supply water to primary and secondary schools which face water scarcity. The aim of this survey was therefore to identify the most suitable drill site for the proposed borehole.
The climate of Wajir County is hot and dry with thorn bushes and acacia trees. Most of the vegetation is concentrated along drainage channels of which most of them are seasonal.
Nomadic pastoralism is the major economic activity in this County with camels, goats, sheep and cows being the main type of livestock reared here. The regions vast pasture lands have allowed this activity to be viable though much more could be done to ensure the county plays its role in the country's beef and milk production.
In recent time the community is also embracing sedentary settlements in order to take advantage of social – economic infrastructures in urban centers hence, putting pressure on existing water sources. It is due to the above that the client found it appropriate to develop a water supply facility since the already existing water sources have been overstretched by increased demand.

The main water source in the region is from boreholes, shallow wells and a few major earth pans.

The region has small scale agricultural activities with small scale horticultural producers supplying mangoes, paw paws, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize.
The local Community in the area relies on Shallow wells, seasonal rivers, seasonal earth pans, and boreholes fitted with submersible pumps and genset. The school has 1No. shallow borehole (30M deep) which supply water though is insufficient hence compromising on the learning and hygiene of the students.
A detailed hydrogeological survey was then necessary within the proposed area in order to locate the most suitable site for sinking the proposed borehole. At least five boreholes have been drilled recently within 3 Km radius in the project area, whereby all of them encountered good quality water averaging $5M^3$/hr.

2.0 GEOGRAPHICAL LOCATION/PHYSIOGRAPHY.

Wajir County borders Ethiopia to the North, Somalia Republic to the East, Marsabit County to the north west, Isiolo County to the west, Garissa County to the south and Mandera County to the north and north east.
Eldas Center is located 110KM NE of Wajir along Wajir Moyale Road. The school is within the town centre and has a population of about 400 students and 12 teachers.

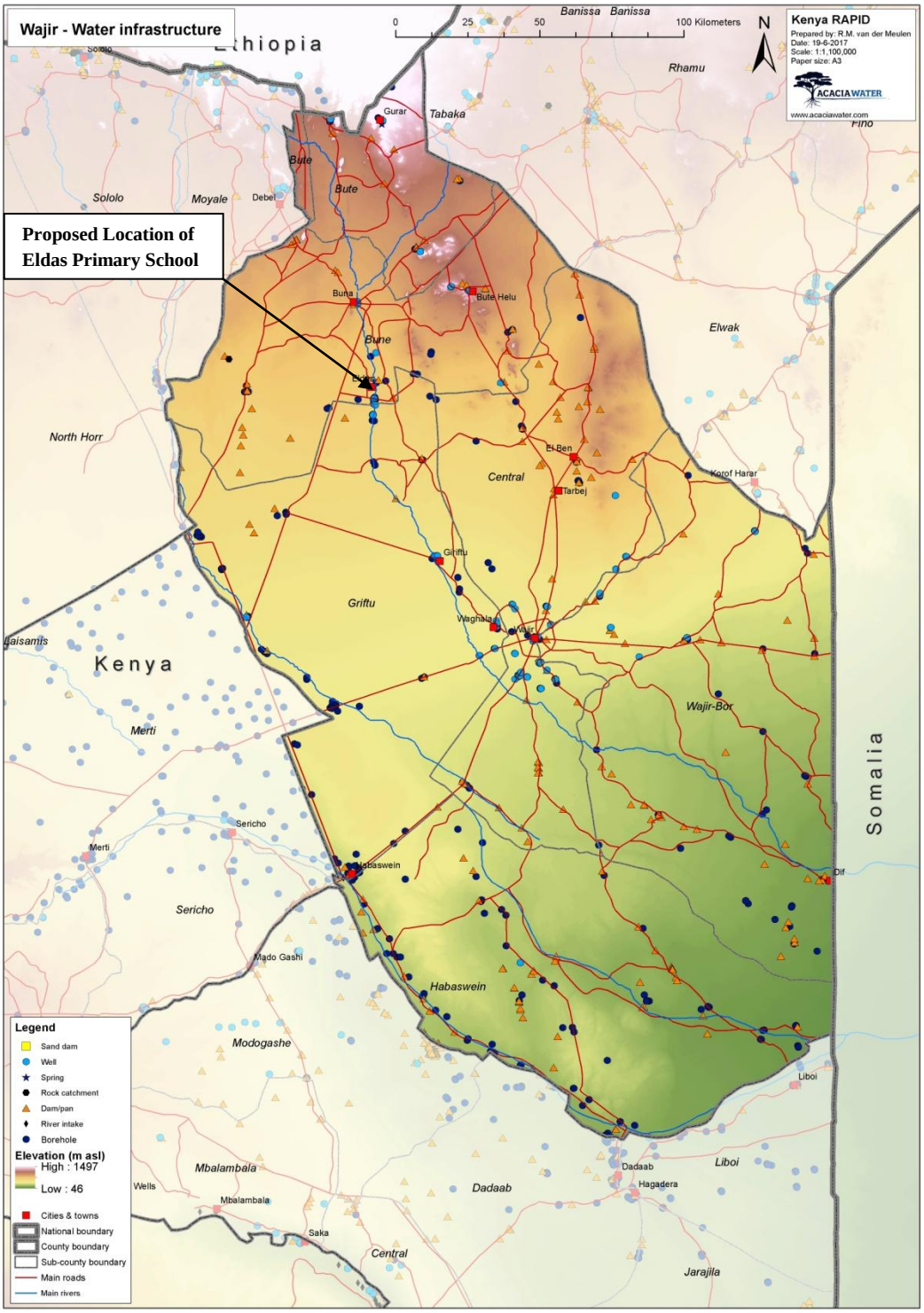


Fig. 1.0: GIS map showing the location of existing water infrastructure, major drainage channels and topography of Wajir County (Kenya Rapid, 2017).

2.2 Rainfall and Climate and Vegetation

The project area lies within the Sahelian Climatic region, characterized by dry spells and short rainy seasons and is classified as 100% Arid and Semi Arid Land (ASAL). The area experiences high temperatures and low unreliable rainfall throughout the year. The hottest season falls between November and April with temperatures soaring up to 38°C. Cooler months of July and August have mean temperatures of between 25 – 30°C. Rainfall is generally low and unreliable in the area but when it rains, it falls in sudden heavy storms often causing unpredictable sheet wash and flash floods. Over most of the county, rainfall is scanty and ranges from 200 to300mm per year, while potential evapotranspiration ranges from 2,200 to more 2600 mm per year. In spite of the great excess of potential evapotranspiration over rainfall (8-10 to 1) there are good stands for grass, moderate to dense bush, considerable internal runoff and occasional small amounts of groundwater recharge. The fact that excess moisture is available to satisfy these needs is due to the concentration and intensity of storms during some of the rainy seasons.

Typically, most of the area is covered by open or more or less dense bush, alternating with grassy plains. Large trees, for the most part Acacia species, are found only along drainageways. All vegetation is adapted to survive on a small amount of residual soil moisture or on water obtained from condensation. The vegetation becomes verdant within a week following the rains.

*The low to medium bush consists of predominantly of species of **Acacia** and **Cammiphora,** with varying amounts of grass as undergrowth, where grazing has been heavy the grasses are chiefly annuals and where grazing has particularly intense, the undergrowth is chiefly weeds and unpalatable shrubs. Areas remote from permanent water often have a good cover of perennial grasses.*

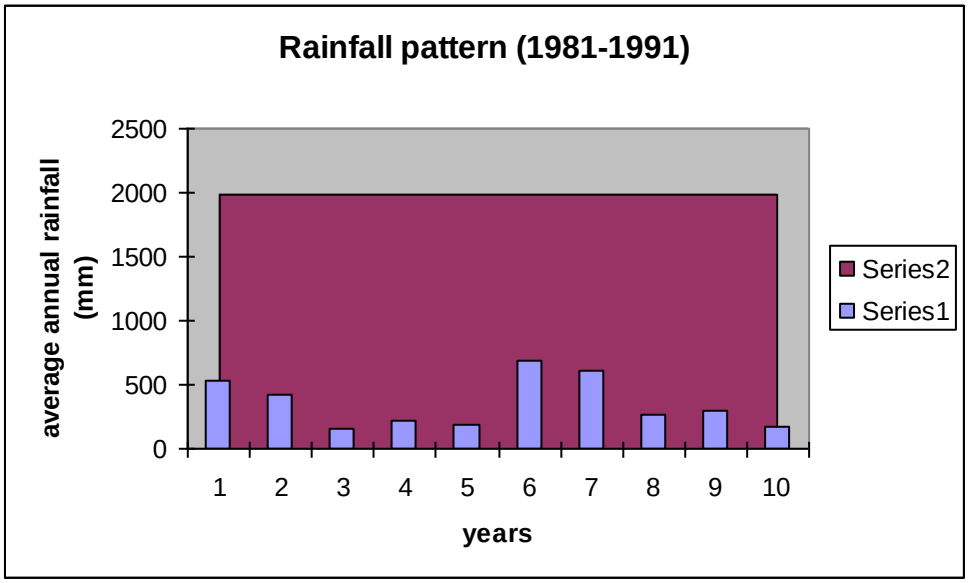


Figure 2.0: A photograph of the project area showing the terrain and vegetation.

2.3 Current Land use

The region has small scale agricultural production with small scale horticultural producers supplying mangoes, paw paws, watermelons, onions, kales and bananas to the local markets. Other crops that can be found are cowpeas and maize. The communities in most of the area rear goats, sheep, donkeys, camels and cattle.

There are numerous government institutions constructed in the area including schools by the government. The Water demand for the institutions is relatively high thus putting pressure on the available supply.

2.4 Approximate Demand.

Approximately 50M^3/Day of water will be required for various purposes for this project. The school has a population of more than 300 students and over 12 teachers some residing within the school compound. The proposed boreholes will be equipped with either a solar pump or electric submersible pumps hence the extraction of water will be fairly high but of course based on the proposed borehole yield of 7m^3/hr.

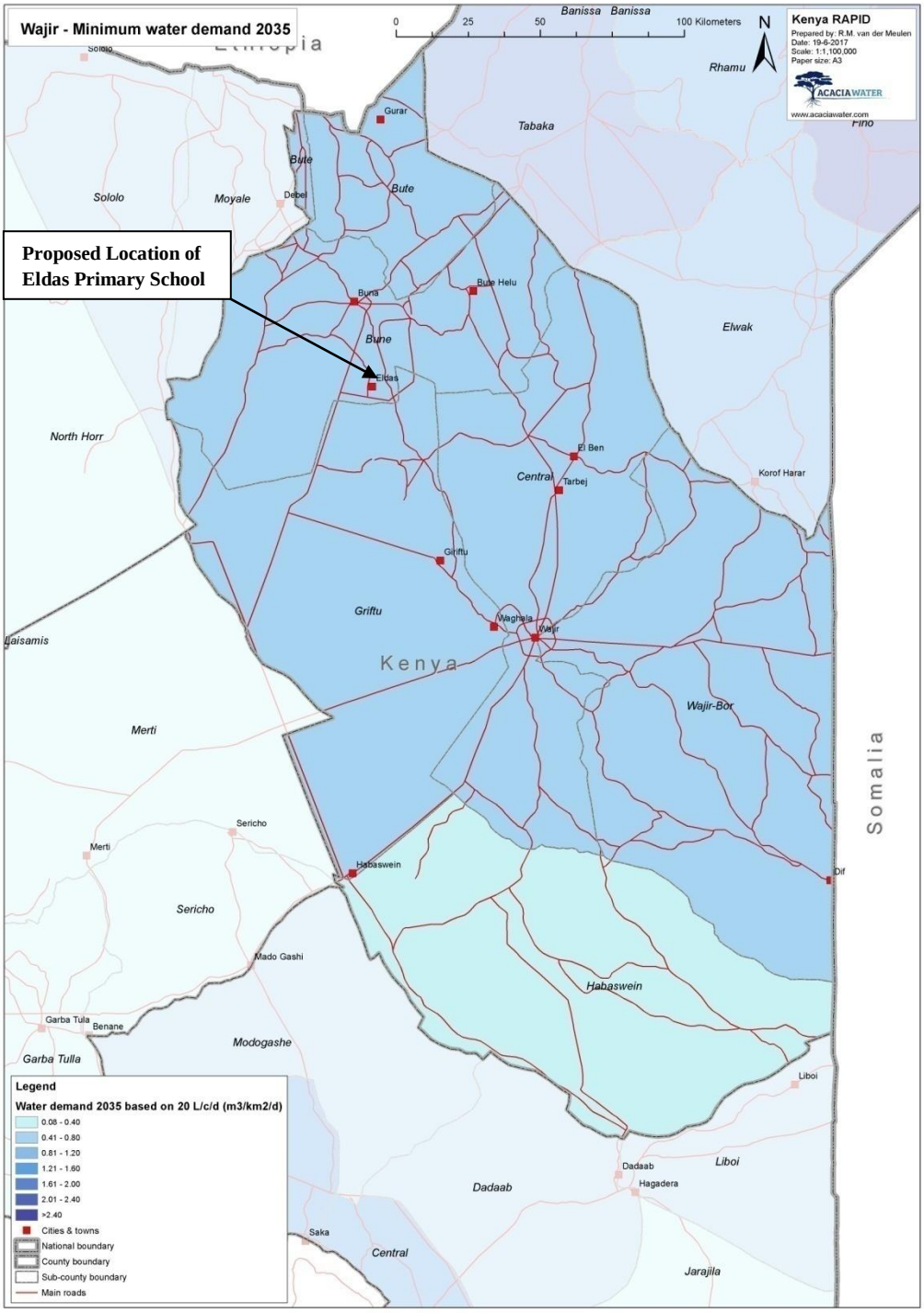


Fig. 3.0: Map of Wajir County showing the projected minimum water demand by 2035(Kenya Rapid, 2017)

3.0 GEOLOGY.

3.1 General Geology of the Region

The Geology of the area is generally viewed to be of the sedimentary rock sediments of Quaternary Geological Age associated with the Coastal plains of the Country. The Merti beds of late Pliocene age extend beneath the plains of southern Wajir County and Most of Garissa County and constitute a major stratigraphic unit in North Eastern Province, the Merti Beds Have been described in outcrop and mapped in comparatively small area North and South of Garba-Tula By Matheson (1971).

The oldest rocks consist of metamorphosed sedimentary and igneous rocks of Precambrian age. They include gneiss, schist, quartzite, amphibolite and granulites. Together with granite, gabbro, and other salic rocks, they form a basement complex that lies beneath the veneer in rounded inselbergs or elongated hills and ranges. Although most geologic reports indicate Precambrian or a Precambrian (?) age for the intrusive rocks, some of these show no evidence of metamorphism, as for Example the Granite at Takabba, and may have been intruded in the Paleozoic Era. The northern part of Wajir County including areas like Bute has a very rough terrain due to the erosion of the basement system.

The Triassic, Jurassic and Cretaceous sediments were deposited successfully in a subsiding basin lying in northeastern corner of Kenya, the southeastern corner of Ethiopia, and in western Somalia. The centre of the basin of Mesozoic rocks lies near El-Wak. The strata dip generally at an angle of 1^0 to 3^0 towards the centre and subsequent erosion has beveled the tilted beds, exposing successfully older strata at progressively greater distances from the centre. Locally, folding and faulting have basically modified the simple pattern of the structural basin. Rocks of Triassic age are represented in the region by Mansa Guda Formation, which crops out in a narrow band trending north from Tarbaj Village to Burmayo Village. The Surface Exposures of the formation consist of unfossiferous sandstone and conglomerate. Drilling at several sites however indicates that thick beds of shale and mudstone are an important part of the formation. The Mansa Guda formation directly overlies rocks of the basement Complex and extends southwards at least as far as Wajir, while it is overlain by 120M of tertiary and younger deposits. The Triassic rocks range in thickness from a feather edge to more than 240M near Tarbaj village.

In the Northeastern part of the Province, strata of Jurassic age overlie the Mansa Guda Formation. At least two series, the Mandera Series and Underlying Daua Limestone Series, and about 10 formations have been described (Jourbert, 1960, Ayers, 1952).

The Jurassic rocks include limestone, mudstone, shale and sandstone, lithologies indicative of deposition in a marine or lagoonal environment. Their Aggregate thickness is estimated by Ayers (1952) to range from a feather edge to about 2400m. The series of Jurassic sedimentary rocks covers the largest are and the thickest of the three sequences of Mesozoic rocks in the North Eastern province. The outcrops area extends 275 Km, from east of Wajir northward into Mandera County.

The tertiary system is represented only by the deposits of Pliocene age. Strata of Miocene age, which are not exposed, have been reported, however, from deep test drilling in Garissa County. Pliocene deposits correlated with the merti beds crop out in the Benane area and in a strip bordering the Tana River. Elsewhere, Pliocene strata are overlain by a relatively thin veneer of soils or Quaternary alluvium. The Merti beds extend southward from Griftu and Tarbaj Village through southern Wajir County and apparently through Most of Garissa County. The .The strata mainly consist of interbedded clay, sand and weathered gravel in a clayey matrix, largely derived from erosion of the basement rocks to the west.

Tertiary or Quartenary volcanic consisting of two lava flows of olivine basalt crop out extensively in the eastern part of Eastern Province from about 25Km South of Moyale south to the Latitude of Wajir County. Because the older flow seems to rest on the late Tertiary erosional surface of the region, it has been referred to Pleistocene by Walsh (1972), who considers the younger flow to be of Pleistocene or Holocene age. Two similar lava flows capping the Merti Beds at Merti, in Eastern province, are considered to be of late Pliocene age by Matheson (1971). It seems likely, however, that the lava flows in both localities are of the same age. The lava flows capping the Merti Beds are probably related to volcanism of Nyambeni Range, northeast of Mt.Kenya, during the Pleistocene.

The Quarternary system is represented by deposits of both Pleistocene and Holocene age. Pleistocene deposits are widespread in the whole of northern, eastern and northwest of Garissa County. In Garissa they include subsurface deposits of arenaceous limestone, calcareous sandstone, marl and gypsum. These limestone beds were deposited in an arid to semi arid environment by shallow streams or in playas and lakes, and they reflect climatic variations during the Pleistocene, including periods of rainfall greater than at present.

Terraces along the Tana River and the Daua and some of the calcretes overlying the merti beds may also be of Pleistocene age.

Alluvial sand, silt and clay, probably ranging in age from late Pleistocene to Holocene, occur along many of the present drainageways. The Most important of these are the Ewaso ng'iro, Tana River, Galana Gof, Lagh Kotulo and Lak Bor. Probably 90 to 95 % of north eastern province has soil cover of a few centimeters to several metres , ranging from red sandy soils to black or grey clayey soils. Some of the soils have developed by weathering of the older rocks, but most have developed on Pliocene or younger deposits.

Because of the extensive soil cover it is not possible to map the Merti Beds separately from the younger Quaternary and Tertiary deposits.

3.2 Geological setting of Wajir County.

Groundwater studies in the North eastern region, related chiefly to the improvement of existing sources or to the development of new water supplies, are contained in the files and administrative reports of the water department. They include a hydrographical survey of Kenya's Northern Frontier District by Dixey (1944), a report on the Geology and Hydrology of Wajir District by Bestow (1953), a report on the Lorian Swamp by Arnold (1952). A comprehensive report on the water resources of the Ewaso Ng'iro Basin, largely outside the province, has been published by the Hydraulic Branch, Kenya Ministry of Works (Bestow and others, 1963). Moreover geological reports by Saggerson and Miller (1957); Thompson and Dodson (1958; Jourbert (1960); and Walsh (1972) on areas in the northern part of the province, published by the Geological Survey of Kenya, contain Borehole logs and references to the availability of ground water.

Table 1. Stratigraphical table (after Joubert, 1963)

Relevant information on the regional geological units is summarized (stratigraphical table).

Period	***Formation***	***Lithology***
Recent		*Sandy soils*
Pleistocene	*Wajir Beds*	*Gritty soils, Laminated limestones* *limestones/Sandstones*
Jurassic	*Merti Beds*	*Sandstones* *Clays and sandy clays*
Triassic	*Bur Mayo Formation*	*Grey and brown limestones*
Precambrian	*Mansa Guda Formation.*	*Conglomerates* *& Sandstones*

As far as is known, Paleozoic rocks are absent in the area, which cause Basement rocks to be overlain directly by Mesozoic or even younger rocks. Down warping of the coastal area at the end of the Paleozoic resulted in a transgression of the sea, in which the Triassic Mansa Guda Formation was deposited as a delta. Recurrence of down warping in the Lower Jurassic caused another transgression and the deposition of the Jurassic Limestone Series.

After regression from Middle Jurassic times, the Cretaceous continental Marehan Series was deposited. During the Tertiary, erosion of Mesozoic and Precambrian rocks took place and Miocene sediments were deposited, but probably largely removed again as a result of Pliocene uplift. The Pliocene Merti Beds were laid down in at least some parts of the Northeastern Province.

Furthermore, equivalent of the Merti Beds, found in a wide belt from NW of Habasweni to Liboi at the Somalia border (and beyond), are not mentioned by Joubert (1963), but Swarzenski and Mundorff (1977) suggest that they are present in the Wajir area as clays, sands and grits underlying a 20-25 m thick succession of Wajir Beds.

Finally, the sequence of Quaternary deposits varies considerably over short distances, which makes it difficult to recognize and correlate the different stratigraphic units in wells and bore-holes. This fact has given rise to inconsistencies in this respect between various reports (Bestow, 1953; Joubert, 1963; Balasha Jalon, 1976; Swarzenski and Mundorff, 1977; Alexander Gibb & Partners, 1979).

3.3 Aquifer Zones

The following are parameters that define the aquifer characteristics of the Wajir similar to other areas in Northeastern Kenya.

3.3.1 Lithology and geometry

The widely exploited Merti aquifer in the Wajir Area consists of gravelly sandy sediment and weathered sandstone. It is commonly found at depths of around 90-180M metres below ground level and is assumed to be approximately 5 to 40 metres thick. The occurrence of deep boreholes in the area (200-250M) suggests that there exist other aquifers deep below or it may be continuous.

Within its lateral limits the aquifer is assumed to be continuous.

3.3.2 Well yield

Pumping tests suggest that the sustained yield of boreholes drilled in the Merti area may exceed some 10 m^3/hr in roughly 70% and 7 m^3/hr in 30% of the cases, provided that well depth exceeds 180M. Commonly, the beds of water bearing sand and gravel in the merti aquifer are 10 to 15m thick and apparently are of limited lateral extent.

3.3.3 Hydraulic aquifer properties

Specific capacities of boreholes tapping into the merti Aquifer range from about 2 to 90(L/Min/) M (liters per minute per metre of drawdown).

Transmissivities of the aquifer can be estimated from specific capacity data of boreholes. They range from about 6 to 120M^2/day. Hydraulic conductivities similarly estimated are in agreement with the very fine to medium grain sizes of much of the aquifer material and range from 0.25 to 4.0 m/day (metres per day).

3.3.4 Groundwater levels, groundwater flow and recharge

The extensive fresh-water zone of the Merti Aquifer that has water containing less than 1,000 mg/l of total dissolved solids follows approximately the alignment of Ewaso Ng'iro and Lak Dera channel ways. Its width ranges from 20-90Km and it is widest at the Kenya Somalia Border near Liboi.

Groundwater from boreholes tapping Precambrian crystalline rocks or consolidated sedimentary rocks of Mesozoic age commonly contains 2,000 to 4,000 mg/l of dissolved solids, which is marginally suitable for human consumption. There is, however, isolated areas e.g Ogorare where the dissolved solids is as much as 15,000 mg/l. The groundwater of the area is generally

of sodium chloride type. The water also contains relatively large amounts of calcium and magnesium and is moderately to very hard. Locally excessive nitrate concentrations, as high as 440mg/l, have been reported from widely separated areas.

In the area of merti aquifer, groundwater is found at rather uniform depths of about 90M in the low lying areas, and at depths as great as 140M in areas of higher altitude. Successful boreholes tap the more permeable zones of the Merti beds, commonly between depths of 105 to 150M below the land surface. The groundwater is generally confined, and potentiometric heads may be several metres higher than the top of the saturated sand beds.

Groundwater level hydrographs measured shows that direct recharge of groundwater by local rainfall occurs. Tested yields of all deeper boreholes are good at very small drawdown (2-4M). This has been attributed to good aquifer characteristics and proper well construction.

4.0 WATER RESOURCES.

4.1 Surface Water Resources.

Several types of surface water storage are utilized in the region. There are hundreds of natural depressions or widely distributed in areas of flat terrain. These are usually formed in areas of clayey and silty soils by wind action (deflation), erosion by water aided by trampling of animals. Generally the, the natural pans are broad and shallow and contain water for no more than a few weeks after rainfall ceases. The county government has been deepening these waterpans to help improve storage capacity. Artificial storage reservoirs, commonly known as tanks are excavated by hand or machines, generally in natural depressions and drainageways. Dams are constructed across relatively deep and narrow channels, where soil and foundation conditions are favorable. Suitable sites are found in small areas of Wajir North. Rock catchments are also utilized in northern areas, where weirs and dams have been constructed across shallow drainageways along the foot slopes of bedrock hills or ranges.

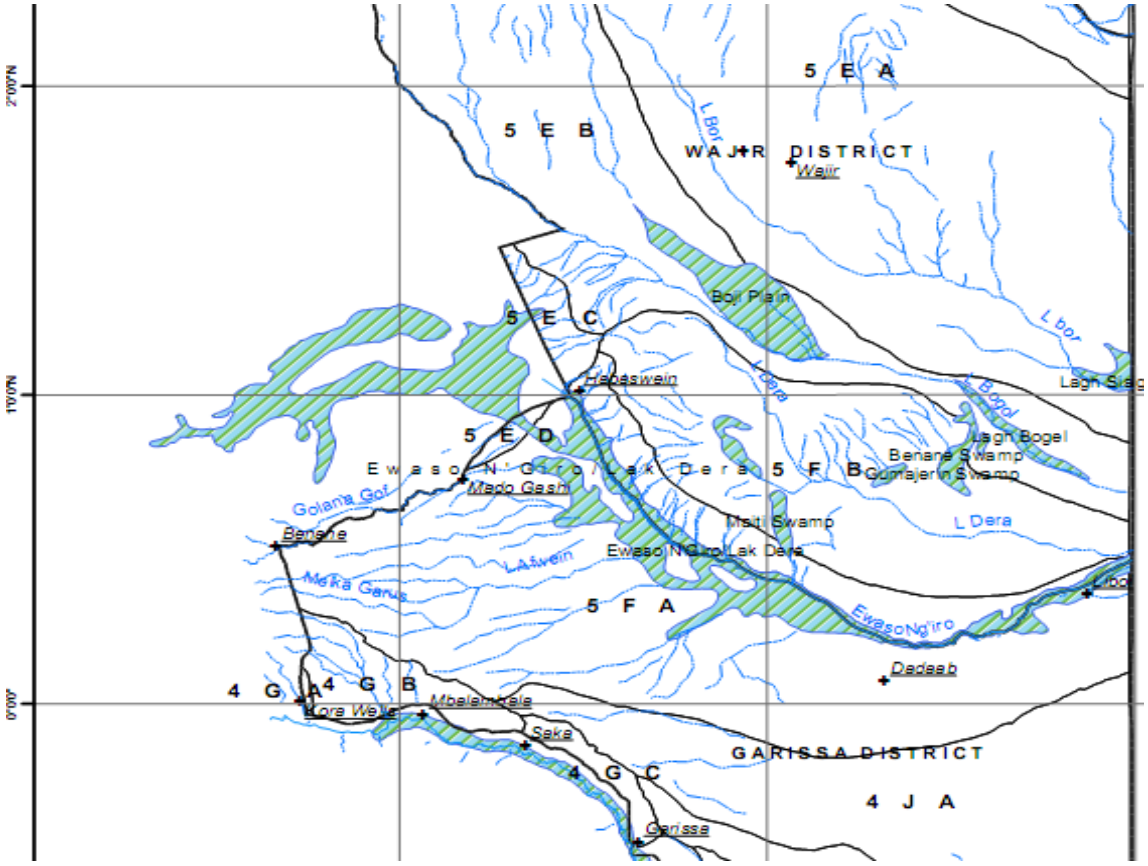


Fig. 4.0: Hydrological Map of Wajir County and its neighbourhood showing drainage system of the area

4.2 Groundwater Resources.

The geology of the project area comprises rocks of the sedimentary System that overlie the Basement rocks at great depth. It is estimated that sedimentary rocks have a thickness of more than 3000 meters in some areas (?). The sedimentary rocks comprises of sandy soil, gritty soils, laminated limestone/ mudstone, clays and sand clays, grey and brown limestone conglomerates and sandstones.

There are several faults and weak structural zones within the project area that control groundwater movements. Some of these weak zones act as the main groundwater subsurface flow and drain zones. Boreholes drilled within these structures can have very good discharge.
During our fieldwork our aim was to try and locate these structural weak zones by both water dowsing method and horizontal electrical profiling. The selected boreholes drill sites are on these weak zones.

5.0 GROUNDWATER OCCURRENCE.

Groundwater occurrence, as discussed in this Chapter is dependent upon geology, rainfall, weathering and recharge. The best aquifers are found when a conjunction occurs of optimum recharge (rainfall, soil permeability), storage (porous rocks), and transmissivity (the ease with which water can travel, both vertically and horizontally, within an aquifer).
The merti Aquifer, in the northern part of Garissa and the southern part of Wajir counties occurs in the semi consolidated merti beds of Pliocene age and constitutes the most important source of groundwater in the area. In an area of about 100,000 square kilometers, approximately paralleling the drainage ways of the Ewaso Ng'iro Lak Dera (lagh Dera) from Habaswein to the Somalia border near Liboi, Groundwater of excellent quality can be obtained from the merti aquifer in boreholes drilled to depths of 120 to 150 metres. Moreover adjacent areas, probably exceeding 20,000 square kilometers contain groundwater of good to marginal quality that is suitable for use by livestock. Although Transmissivities in the aquifer are generally low, there are local areas where properly screened boreholes yield 180 liters per minute or more with drawdown of 2 to 4 meters.

In the North West part of Wajir County, the results of drilling for water supplies in Precambrian metamorphic or igneous rocks of the basement complex have thus far been disappointing (e.g At Lesayu, Harade). They are predominantly granite, granite gneiss and biotite gneiss with minor occurrence of igneous or metamorphic rocks. Small quantities of ground water are obtained at favorable sites from joints and fractures in granitic rocks or from the cleavage planes in metamorphic rocks. Successful boreholes yielding 25 to more than 100 l/min (liters per minute) generally tap zones of weathered rock that may be as much as 50 to 100m thick. Favorable sites are upgradient from faults o buried ridges or in areas where the potential for recharge from runoff down adjacent hill slopes is high.
Although there are isolated, pockets of salty water, most of the boreholes drilled in the crystalline rocks yield water that is satisfactory for stock and domestic use.

5.1 Rainfall, Percolation and Recharge.

Given that suitable storage media exist below ground, the mechanisms by which water must reach it also affect aquifer potential.

Obviously, if no rainfall or river flow is able to percolate to a sandy weathered Sedimentary and Basement aquifer due to the presence of an aquitard (impermeable layer) probably clay, the actual potential is very low.

Both Basement and Sedimentary systems suffer the same limitations so far as recharge is concerned: if rainfall is high the volume of water which may eventually percolate to a suitable aquifer is likely to be relatively high, and possibly slightly mineralised due to high evaporation rate.

Percolation is dependent on soil structure, vegetation coverage and the erosion state of the parent rock.

Rocks that weather to clayey soils will naturally inhibit percolation (such as `black cotton' soils); conversely, the sandy soils resulting from the erosion of some Sedimentary and Basement rocks are eminently suited to deep, swift percolation.

Recharge is the term applied to the whole mechanism, and includes all the aspects of parent geology, effective rainfall and percolation. Some aquifer systems are recharged by water falling a substantial distance away - this is for instance the case where recharge apparently occurs laterally from the high grounds. For, instance, in the project area, Lagh Bor and other small tributaries that originates from Moyale, Wajir North and Ethiopia are the main source of recharge in this area.

5.2 Groundwater Quality.

Generally, sedimentary complex waters are sometimes hard, with low Total Dissolved solids (TDS) and fluoride content seldom exceeding World Health Organization limits. However, at local level significant peak concentrations of chloride, sulphate, fluoride, sodium, calcium and potassium ions can occur, especially where groundwater is shallow, groundwater flow is low or absent and the evapo-transpiration rate is high.

The factors which determine the degree of salinity in groundwater are as follows:-

Evaporation and Transpiration

Direct evaporation by the heat of the sun and preferential uptake of certain mineral ions by plants can, in certain environments, lead to salinisation.

Dissolution of Evaporites

The process of evapotranspiration may, in arid conditions, lead to the precipitation of salts in the unsaturated zone (soil). These salts may then be carried down to the groundwater store during periods of rain, thus leading to high ion concentrations in space and time. This process is exacerbated in an intensely seasonal climatic regime, such as is present in the study area.

Dissolution of Host Rock

Given relatively long residence times and fairly high ambient temperatures in groundwater systems, progressive salinity of groundwater can be expected via the host rock.

This will vary according to local geology, local structures (which may speed the passage of water through an aquifer by means of faults, etc, and so limit retention time), and local climate and so on.

Water quality Analysis

Several boreholes which were tested within the project site indicated that the level of total dissolved solids, sulfate, total hardness and calcium do not exceed the recommended guideline values for portable water which we attribute it to being located within the less mineralized Lagh Bor Drainage Channel.

In the project area we expect good water quality similar to that in the neighbouring boreholes.

Table 2: Ionic Concentration: WHO &Various Authorities

World Health Organization:		*European Community:*			
		1983 Guidelines	*1971 Int. Standard*	*EC Directive 1980 relating to the quality of water intended for human consumption*	
Substance or Characteristic		*Guidelines Value (GV)*	*Upper limit (HL), tentative*	*Guide level (GL)*	*Max. Admissible Conc. (MAC)*
Inorganic Constituents of health significance:					
Antimony	*Sb*			*0.01*	
Arsenic	*As*	*0.05*	*0.05*		*0.05*
Cadmium	*Cd*	*0.005*	*0.01*		
Chromium	*Cr*	*0.05*	*0.05*		
Cyanide	*CN*	*0.10*	*0.05*		*0.05*
Fluoride	*F*	*1.5*	*1.7*		*1.5*
Lead	*Pb*	*0.05*	*0.10*		*0.05*
Mercury	*Hg*	*0.001*	*0.001*		*0.001*
Nickel	*Ni*				*0.05*
Nitrates		*10(as N)*	*45 (as NO)*	*25(as (No)*	*50 (as NO)*
Selenium	*Se*	*0.01*		*0.01*	

Other Substances		*GV:*	*Highest Desirable Level*	*Permissible Level:*	*Max.*	*GV*	*MAC*	
Aluminum	*Al*		*0.20*				*0.05*	*0.20*
Ammonium	*NH*						*0.05*	*0.50*
Barium	*Ba*						*0.10*	
Boron	*B*						*1.0*	
Calcium	*Ca*			*75*		*50*	*100*	
Chloride	*Cl*	*250*	*200*		*600*	*25*		
Copper	*CU*			*0.05*			*0.10*	
Hydrogen Sulphide	*H_2S.*		*ND*					*ND*
Iron	*Fe*		*0.30*	*0.10*		*1.0*	*0.05*	*0.20*
Magnesium	*Mg*		*0.10*	*30*		*150*	*30*	*50*
Manganese	*Mn*		*0.10*	*0.05*		*0.50*	*0.02*	*0.05*
Nitrite	*No*							*0.10*
Potassium	*K*						*10*	*12*
Silver	*Ag*							*0.01*
Sodium	*Ng*		*200*				*20*	*175*
Sulphate	*Soq*		*400*	*200*		*400*	*25*	*250*
Zinc	*Zn*			*5.0*		*15*	*0.10*	
Total Dissolved solids			*1000*	*500*		*1500*		*1500*
Total Hardness as $CaCo_3$			*500*	*100*		*500*		
Colour	*Hazen*		*15*	*5*		*50*	*1*	*20*
Odour			*Inoffensive*	*Unobjectionable*				*2 or 3 Ton*
Taste			*Inoffensive*	*Unobjectionable*				*2 or 3 Ton*
Turbidity (JTU)			*5*	*5*		*25*	*0.4*	*4*
PH			*6.5-8.5*	*7.0-8.5*		*6.5-9.2*	*6.5-8.5*	*9.5 (max)*
Temperature	*0C*						*12*	*25*
EC	*us/cm*						*400*	

Notes *ND-Not Detectable* *GL-Guide Level* *IO-Inoffensive* *UO-Unobjectionable*

6.0 BOREHOLES DATA'S

Several boreholes and shallow wells have been drilled and constructed in our project area as shown in fig 1.0. There are also water pans and earth dams that had been constructed in various parts of this region by the Government and other organizations over the years.

The information obtained from these data indicates that some of the borehole water is saline while other has good quality water. This is dependent on the actual location of the well and the geological setup of the same. The other factor is the depth of the borehole and the recharge that also affects the quantity and the quality of groundwater. If the recharge potential is low the water is expected to be highly mineralized and the discharge low otherwise if the recharge is good the quality and the quantity of water is expected to be good.

In this geological set up, drilled boreholes will have a definite trend as to water struck levels, drilled depths and yields, since they are at the same zone.

7.0 GEOPHYSICS.

A great variety of geophysical methods are available to assist in the assessment of geological subsurface conditions. In the present survey, the resistivity method (also known as the geo-electrical method) and the Horizontal Electrical Profiling (HEP) methods has been used. The latter was used to detect any anomalous conductive zones in the subsurface, which might be associated with faulted or fractured zones.

Vertical Electrical Soundings (VES) were carried out to probe the conditions at such anomalous zones within the sub-surface and to confirm the existence of groundwater. The VES probes the resistivity layering below the site of measurement. The techniques are described below.

7.1 Basic Principles of the Resistivity Method.

The electrical properties of the upper parts of the earth's crust are dependent upon the lithology, porosity, and the degree of pore space saturation and the salinity of the pore water. Saturated rocks have lower resistivities than unsaturated and dry rocks. The higher the porosity of the saturated rock, the lower its resistivity, and the higher the salinity of the saturating fluids, the lower the resistivity; the presence of clays and conductive minerals also reduces the resistivity of the rock.

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 = Rs *L/A (in Ohm) ***(1)***

Where Rs is known as the specific resistivity, characteristic of the material and independent of its shape or size

With Ohm's Law
R = dV/I (Ohm) ***(2)***

Where dV is the potential difference across the resistor and I is the electric current through the resistor; the specific resistivity may be determined by:

Rs = (A/L) *(dV/I) (in Ohm.m) ***(3)***

7.2 General.

The field investigations carried out in the project area to evaluate the groundwater potential of this area included the following:

- *Geomorphological interpretation and hydrogeological reconnaissance to establish overview impression of the area;*

- *Execution of geo-electrical measurements comprising the following:*

  - ✓ *Horizontal Electrical Profiling using ABEM Terrameter SAS 1000;*

  - ✓ *Vertical Electrical Sounding using the ABEM Terrameter SAS 1000.*

7.3 Methods.

7.3.1 Horizontal Electrical Profiling (HEP)

These were carried out at each site to determine changes in electrical properties laterally with a constant electrode spacing and interpreted as a continuous profile. The electrode spacing controls both the profiling depth and the resolution of the survey.

The probe depth on all the profiles was maintained at a depth of 50 metres with a constant interval of 10 metres from one station to the other.

The observed resistivity values are plotted on logarithmic paper and the graph obtained depicts lateral resistivity variation at constant depth. Geological structures such as faults, fractures, buried stream channels that may conduct groundwater, can be inferred.

7.3.2 Vertical Electrical Soundings (VES)

Vertical Electrical Soundings were carried out to probe the electrical properties and depth to sub-surface layered formations below the site of measurement at the most significant anomalous zones.

When carrying out a resistivity sounding, electric current is led into the ground by means of two electrodes and the potential field generated by the current is measured. The separation between the electrodes is step-wise increased (in what is known as a Schlumberger Array), thus causing the flow of current to penetrate greater depths. The observed resistivity values are plotted on log-log paper and the graph obtained depicts resistivity variation against depth.

This graph can be interpreted with the aid of a computer, and the actual resistivity layering of the subsoil is obtained. The depths and resistivity values provide the hydrogeologist with information on the geological layering and thus the occurrence of groundwater.

7.4 Fieldwork.

Field reconnaissance survey and fieldwork was carried out from 15th February to 27th February 2018.

The field data and the graphs of the VES's are presented in the appendixes.

7.5 The Results and Interpretations.

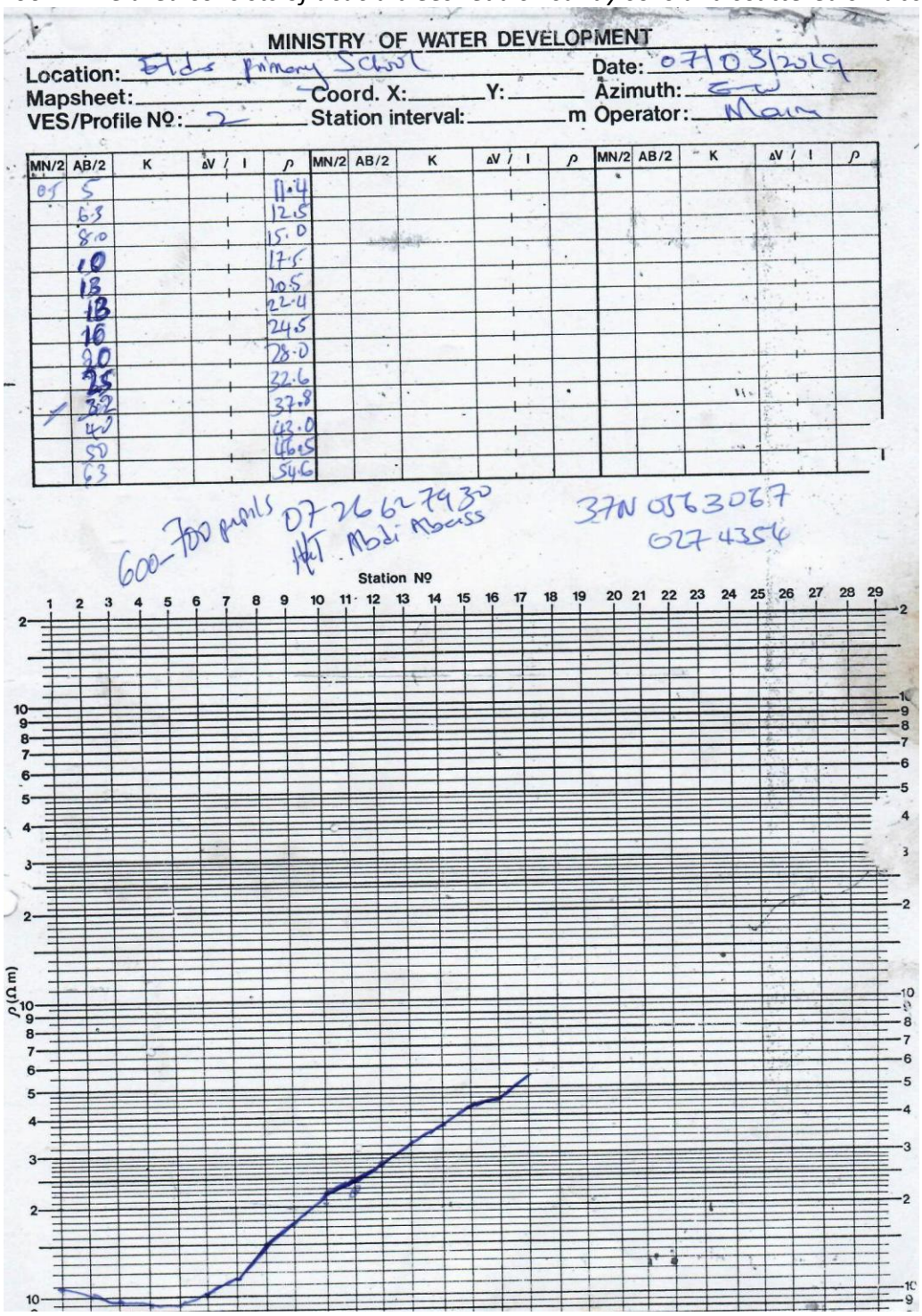
The site that was surveyed is as indicated in Table-3 below. The results of the geophysical site investigations for the proposed site are presented in the appendix of this report. The results for the site are illustrated with the model Vertical Electrical Soundings (VES's) curves shown below.

Additional description of each site has been given in the adjacent tables.

1. HOROTE

Done on 07-03-2019; Azimuth E-W.

The VES executed at the southern edge of the school to a maximum electrode separation of 200M. The area consists of acacia trees reddish sandy soils and scattered shrubs.



MINISTRY OF WATER DEVELOPMENT

Location: Eldas primary School Date: 07/03/2019

Mapsheet: Coord. X: Y: Azimuth: E-W

VES/Profile Nº: 2 Station interval: m Operator: Mary

MN/2	AB/2	K	ΔV / I	ρ	MN/2	AB/2	K	ΔV / I	ρ	MN/2	AB/2	K	ΔV / I	ρ
0.5	5			11.4										
	6.3			12.5										
	8.0			15.0										
	10			17.5										
	13			20.5										
	16			22.4										
	20			24.5										
	25			28.0										
	32			32.6										
	40			37.8										
	50			43.0										
	63			46.5										
				54.6										

600-700 pupils 0726627430 Hkt Abdi Abdiss

37N 0563067 0274354

Station Nº

ρ (Ω m)

Fig 5.0 Resistivity curve for Eldas Primary VES-2

Table 3: Interpreted Model for Horote site

FORMATION DEPTH (M)	***APPARENT RESISTIVITY (OHM-M)***	***EXPECTED FORMATION***	***REMARKS***
0 – 0.3	*6.0*	*Top sandy, silty soils.*	*Dry*
0.3– 13.0	*11.0*	*Weathered Schists.*	*Dry*
13.0 – 32.0	*22.0*	*Decomposed Schists*	*Wet*
40.0 – 60.0 *>60.0*	*45.0* *50.0*	*Fractured Schist* *Weathered Schist*	*Wet* *Top wet* *Base-Dry*

The interpreted model results of this VES shows progressively weathered consolidated metamorphic set up of different textures up to a depth of 63 meters. Water is expected within the decomposed zones at a depth between 25-50M and in fracture zones.

It is therefore recommended that a borehole be drilled to a Maximum depth of 60M at the point marked VES 1 and which is conversant with the school headmaster.

Table 11: Site number, coordinates, site name, estimated yield and recommended depths.

VES No.	***Coordinates***	***Groundwater Prospects***	***Estimated Yield*** *(M^3/hr)*	***Remarks***	***Recommended Depth (metres)***
1.	*Eldas Primary* *37M 563067* *UTM 0274354* *Elevation 399M*	*Good*	*5*	*Air drilling*	*60*

8.0 CONCLUSION AND RECOMMENDATIONS.

- *Our project area lies within an average altitude of 390-500m above sea level.*

- *The area lies in the 100% arid and semiarid area of northeastern Kenya where the trans-evaporation is very high and hence most of ground water is mineralized leading to salinity and hardness.*

- *The area is within the Lagh Bor Shallow Aquifer, which is a local aquifer covering parts of Wajir county, consequently any borehole drilled in this area to a of depth more than 40 metres below ground level will have water and provided that it is within a weak zone.*

- *Due to low rainfall and long residence time of groundwater in the rocks and the mild topography may be contributing high mineralization of groundwater in some borehole. The level of salinity also depends on the exact location of the borehole; if it is located within an aquifer that has good recharge the water quality drastically improves.*

- *From hydro-geological data collected the formations in this area manifests low apparent resistivities is due to presence of clay and silt in the formations that deter transmissivity and hence give water a longer residence time in the aquifers that lead to mineralization from the host rocks.*

- *From the borehole data it can be observed that properly sited boreholes and drilled to a good depth (40m and Beyond) are high yielding and give fairly good quality water. A good sited borehole is that which is sited on a wide structural weak zone with a good gradient.*

- *This area is characterised by seasonal rivers which only flows during rain seasons, the structures which control the flow are fractures and a borehole located along these structures would be high yielding. These seasonal streams in most cases recharge the groundwater in this area. Boreholes drilling near these seasonal drainage channels in most cases have good quantity and quality water.*

Conclusion

From the observations it can be concluded that;

- *The proposed sites has good groundwater potential*
- *Properly sited and drilled boreholes will be high yielding and will give portable water.*
- *Drilling should be done by Drilling company properly acquainted to mud drilling because the geological formations though stable may be prone to collapsing.*

Recommendation

(a) It is therefore recommended that boreholes of 8" diameter be drilled at the proposed selected sites to the depths indicated on the above table. The sites were benchmarked on the ground and also shown to various village elders.

(b) The proposed boreholes should be lined with casings and screens of 152 mm minimum diameter and should be gravel packed.

(c) Undertake the environmental Impact Assessment for the project and obtain necessary permits.

(d) Finally drilling work SHOULD NOT commence until groundwater permits are obtained from Water Resources Authority (Daua Sub-Region Office Mandera) of Ministry of Environment, Water and Natural Resources.

(e) We further recommend that the services of a qualified, independent hydrogeologist be employed during drilling for supervision and technical advice.

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APPENDIX - Drilling

Drilling should be carried out at a diameter of not less than 8", using either a rotary type machine. The drilling rig should be able to drill to the recommended depth, at the specified diameter of 8"-12". The rig and the drilling method adopted must be suitable for drilling through both unconsolidated material, and hard, compact rocks. ***Surface casing*** *should be availed for use when necessary. The rotary drilling technique offers very high penetration rates in all types of materials, rig mobilisation and demobilisation are rapid, minimal casings are required during drilling exercise and reliable yield estimates can easily be made during drilling.*

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 method will however considerably prolong the required time for drilling, which may be undesirable if water is required at short notice. Another main disadvantage is that no reliable yield estimates can be made during drilling. As a result, a reliable judgement whether to stop or continue drilling at a certain depth cannot be made. In addition, borehole development techniques will be less efficient than with a rotary plant compressor. This may reduce the capacity of the borehole, and may fail to stop the intake of fine sediments during pumping. In case of friable materials and/or loose sediments, bentonite is used to stabilise the materials when drilling using percussion technique. The sticky clay-based mud seals the aquifer pores reducing the aquifer transmissivity and hence borehole yields. In rotary drilling, the biodegradable polymers or foam is used to stabilise collapsing formations. This biodegradable mud can easily be removed during borehole development.

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On the other hand, the percussion method is considerably cheaper than the modern rotary technique, partly because of the lower drilling rates, but also due to the often much lower sum charged for mobilisation. However, it must be noted that the initial savings may be offset against the continuing costs of labour, fuel, etc., the prolonged absence of a water source, and the time input of the Client and his representatives. Regarding the long time required when applying the percussion drilling technique.

Geological rock samples should be collected at 2 metre intervals. Water struck and rest 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 (rotary) or bailed (percussion) 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, in order to avoid collapsing and sediment intake. Considering the moderate depth of the borehole, it is recommended to use Mild steel casings and screens of 6"-10" diameter. They should be machine cut not gas-slotted. Screen slots should be a maximum of 1.5 mm in size. The minimum open area of the screens should be 5%.

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. An 8" diameter borehole screened at 6" will leave an annular space of approximately 1", 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 5 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, involves the insertion with a tremie pipe.

Well Construction

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 plug at the surface, to prevent contamination 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, gravel pack, seals and backfill have been installed, the well should be developed. Development is the term used to describe the ***procedures designed to maximise well yield****. Although an expensive element in the completion of a well, the additional costs are usually justified by longer well life, greater efficiencies, lower operational and maintenance costs and a more constant yield.*

Development has two broad objectives, which can be divided into borehole and aquifer stimulation:

- *To repair the damage done to the aquifer material during drilling and restore the natural hydraulic properties.*

In both cable tool (i.e. percussion) and air hammer drilling, the bit action chips and crushes the rock, and mixes it with water and other fine material into thick mud slurry. The pounding of the bit forces this slurry into the openings in the wall of the borehole, thus blocking the pores and impeding the flow of water from the aquifer. A thick "wallcake" may form, especially when clay additives (such as bentonite) are used during drilling or where natural clays occur in the penetrated formations. This cake, if not removed, may virtually plug the borehole, and significantly reduce the discharge. It should be noted that the maximum yield of a formation can only be realised if all the fractures and crevices are unblocked and able to supply water to the well.
Borehole development techniques are applied to break down and remove the impermeable layer of clayey material from the borehole wall. Swabbing, wall-scratching, airlift rawhiding and polyphosphate dosing are all borehole development techniques.

- *To alter the characteristics of the aquifer volume in the vicinity of the borehole, by improving hydraulic contact between the aquifer and the hole. This is essentially aquifer development, and is also known as aquifer stimulation.*
  Polyphosphate dosing, hydrofracturing and acidification are examples of aquifer stimulation techniques.

The development methods to be applied depend on the available equipment, and differ significantly between percussion and rotary drilling (the latter being superior, when it comes to efficiency):

Development with a percussion rig: if a cable tool rig has been deployed the available development techniques are relatively simple, but less effective than the methods used in modern rotary drilling. The following measures are recommended:

- *Backwashing and bailing: using a surge block with rubber flaps slightly smaller than the internal diameter of the hole, start near the top of the water bearing zones and surge downwards (surging upwards may lead to the surge block sand-locking, which can jeopardise the hole). Bail the borehole clean periodically. Repeat this cycle until no more material is brought up, bailed water is clear and electrical conductivity is stable.*
- *Polyphosphate dosing: percussion equipment does not include mud pumps and drill pipe, so jetting is impossible. Polyphosphate dosing comprises no more than simply pouring water with dissolved sodium hexametaphosphate and calcium hypochlorite into a pipe, the base of which is located near the bottom of the hole.*[•f] *The polyphosphate is allowed to act for 12 hours or overnight. Repeat the backwashing and bailing cycle until the water is clear and electrical conductivity stable.*

If a rotary rig equipped with a strong air compressor is available, more effective development techniques can be applied:

[•f] Recommended concentrations are 3.8 kg/m^3 of sodium hexametaphosphate (a locally available, common food additive and clay disaggregant known under the trade names “Calgon” or “SHMP”), and 1.5 kg/m^3 of calcium hypochlorite.

- *Airlift rawhiding, into and through the aquifer zones. This should continue until the water lifted is clean and clear, with electrical conductivity stable. Rawhiding comprises cyclic airlifting: once the airlift has been established, air supply is cut off and water allowed to cascade down the hole. This creates overpressures across the borehole wall, which agitates the formation and enhances cleaning. The airlift is then started again and the cycle repeated.*
- *Water jetting with an on-wall velocity of 30 m/s: at least 0.3 m^3 of fluid should be jetted per linear metre of screen. The water used for jetting must be absolutely clean, and it is dissolved as in the polyphosphate dosing described under Section 4.2. The jetting tool should be so constructed that the jet openings are not more than 1" (25 mm) from the borehole wall. Jetting should start from the top of the water bearing formation rotating downwards. After the entire saturated zone has been jetted, the hole should be left for at least 12 hours or overnight, to allow the hexametaphosphate to work on the "wallcake" and any clayey material in the aquifer material.*
- *Airlift rawhiding again, from the bottom of the hole, until airlifted water is absolutely clean and electrical conductivity stable.*

During development, an estimate of the bailed or air-blown yield should be made. This usually gives a fair indication of the final range of abstraction that can be expected from the borehole.
The use of overpumping as a means of development is not advocated, since it only increases permeability in zones, which are already permeable.

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 and Irrigation and Water Act 2002, which requires all boreholes in Kenya to be equipped with a master/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.

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 should also be equipped in the borehole to monitor water rest level.

Pumping Plant

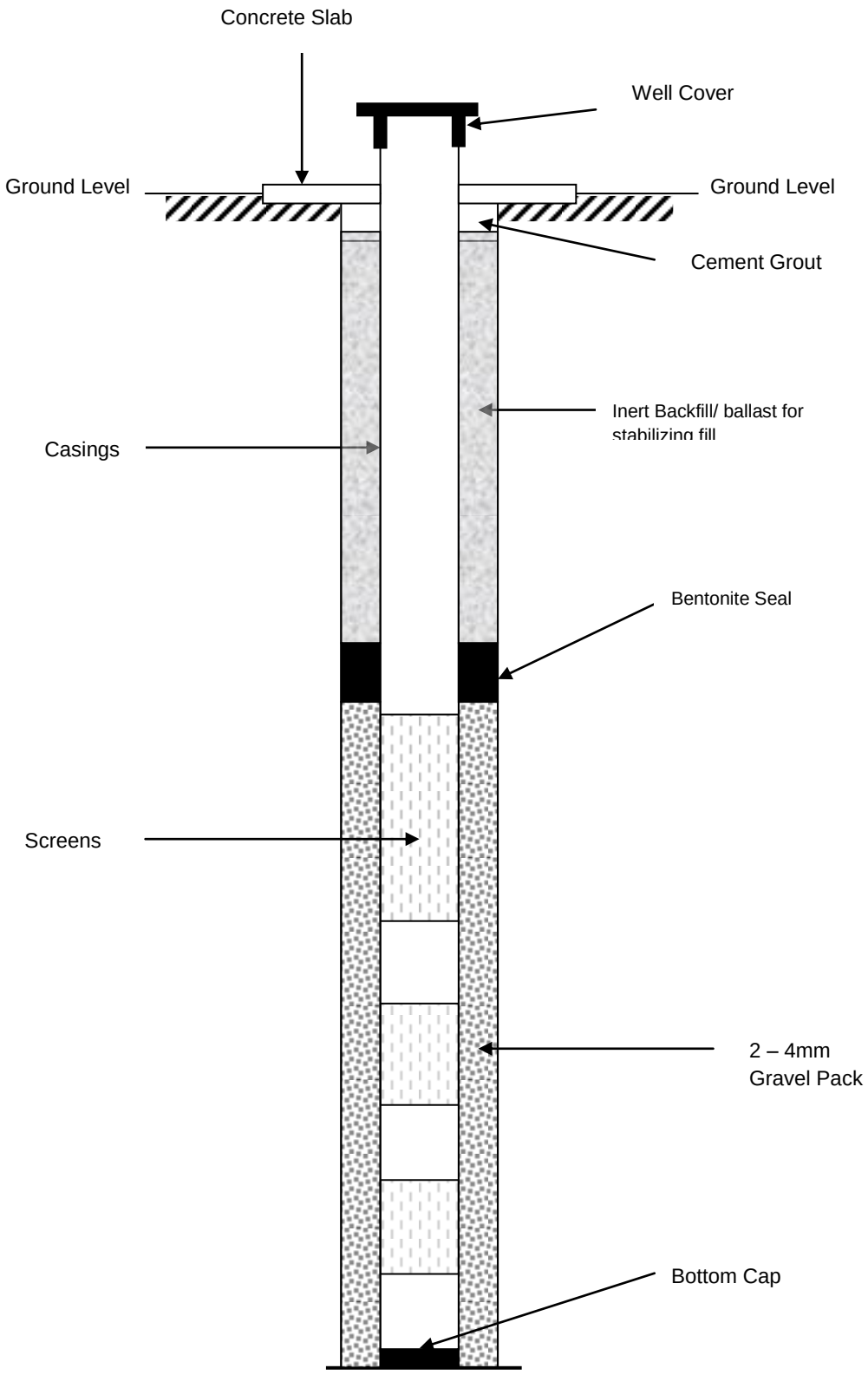
Several options are open to the Client:

a) *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.*

b) ***Electrical solar submersible pumps**: These are not widely used mainly because the plant is comparatively expensive. Generally, solar pumps are not routinely stocked by the main pump suppliers. However they are the most energy efficient.*

c) *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 wind pumps, reciprocating pumps. They 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.*


Concrete Slab
Well Cover
Ground Level
Ground Level
Cement Grout
Inert Backfill/ ballast for
Casings
Bentonite Seal
Screens
2 – 4mm
Gravel Pack
Bottom Cap

Location Maps (Google Map Images for the surveyed site, Digital Globe/Google, 2018)