Item No.	Description	Unit	Qty.	Price in US$	
				Unit	Total
1	**Lot 1: Mobilisation, Demobilisation**				
1.1	Mobilization of all necessary plant, materials, and maintenance of Camp.	LS	1		
1.2	Demobilization at completion of Contract.	LS	1		
1.3	Providing Security (base camp, site camp, transport between base camp and site camp)	LS	1		
1.4	Transport and set up at well sites	pcs	42		
1.5	Transport and set up for Surface installations	pcs	42		
1.6	***Providing facilities for WSTF***				
1.6.1	4x4 vehicle (Toyota, Nissan, Mitsubishi)	pcs	1		
1.7	***Providing facilities for Consultant Engineer***				
1.7.1	4x4 vehicle (Toyota, Nissan, Mitsubishi)	pcs	2		
1.7.2	Furniture office for the consultant engineer at the base camp this will include office in the base camp fully furniture with all necessary equipment and tools. Beside accommodation and transportation of technicians at the base camp and site.	u	1		
1.8	Domestic flight tickets	pcs	72		
1.9	Arrangements for Saudi Fund Follow up Missions	u	1		
1.10	Ten minutes promotional video of the project and the SFD. The content of the narrative is to be agreed with the SFD and will be done in Arabic, English and Swahili	u	1		
	Total Lot 1				
2	**Lot 2: Well Drilling & Construction**				
2.1	Hydrogeological and geophysical pre-investigations.	LS	1		
2.2	Drilling at a diameter 12"	m	252		
2.3	Supply and installation of mild steel 12" temporary casing	m	252		
2.4	Drilling				
2.4a	Drilling with a final diam. of 10” to a depth of 100m	m	4 200		
2.4b	As above between 100 and 200 metres	m	3 500		
2.4c	AS above between 200 and 300 metres	m	200		
2.5	Supply and installation of mild steel 8" casing	m	6 198		
2.6	Supply and installation of slotted mild steel screens	m	1 702		
2.7	Sampling and storing of drilling samples at 2 m interval	No.	3 950		
2.8	Supply and installation of gravel pack.	m3	126		
2.9	Supply and installation of grout material	m3	21		
2.10	Supply and installation of inert back fill material	m3	42		
2.11	Development of Drilled Well.	Hours	504		
2.12	Test pumping				
2.12a	Test pumping of Drilled Well (calibration, step drawdown and constant discharge test (assume 29 hours))	Hours	1 218		
2.12b	Recovery measurements (assume 12 hours)	Hours	504		
2.13	Camera review and reporting	No.	42		
2.14	Water Quality Analysis				
2.14a	Chemical analysis of water sample	No.	42		
2.14b	Bacteriological analysis of water sample	No.	42		
2.15	Disinfection of Drilled Well	pcs	42		
2.16	Temporary wellhead capping and lock	No.	42		
	Total Lot 2				

Item No.	Description	Unit	Qty.	Price in US$	
				Unit	Total
3	**Lot 3: Surface Installations**				
3.1.	Supply of Project Symbol	pcs	42		
3.2	Supply of brass ident. plate.	pcs	42		
3.3	Water Tank				
3.3a	Design & construction of elevated steel water tanks of 100 m3 capacity including geotechnical survey, supply of materiel, excavation of foundation and columns, painting etc.	pcs	42		
3.3b	Design & construction of elevated steel water tanks of 100 m3 capacity including geotechnical survey, supply of materiel, excavation of foundation and columns, painting etc.	pcs	Rate only		
3.5	Preparation of a platform and site clearance for the installation of the solar panels, water tanks etc.	pcs	42		
3.6	Construction of a complete Kiosk with two taps and water meter each including concrete slab, soak pit, drainage pipe and all necessary works, furnishing of all necessary parts, masonry walls and corrogated sheet as a roof.	pcs	84		
3.7	Construction of a complete watering trough for livestock	pcs	42		
3.8	Supply and construction of a wire mesh fence	ml	4 200		
3.9	Supply and installation of water pipeline and fittings from well to the elevated tank. Pipes class C 50mm and fitting (water meter, valves etc.) as per figure 2 of the tender annexes	m	630		
3.10	Supply and installation of HDPE pipes (NOD 90 PN10)	m	21 000		
3.11	Supply and installation of HDPE pipes (NOD 50 PN10)	m	10 500		
3.12	Supply and installation of HDPE pipes (NOD 25 PN10)	m	840		
3.13	Valve for HDPE90	pcs	84		
3.14	Valve for HDPE50	pcs	168		
Total Lot 3					
4	**Lot 4: Submersible pumps and PV generation**				
4.1	Supply and delivery of SP14-15 or equivalent				
4.1a	Supply submersible pumps Grundfos **SP 14-15** or similar: HMT 60m, 4Kw, 3 x380v, Qmin 15m3/h)	pcs	Rate only		
4.1b	Delivery, transport, insurance and installation of submersible pumps (SP14-15).	pcs	Rate only		
4.2	Supply and delivery of SP17-12 or equivalent				
4.2a	Supply submersible pumps Grundfos **SP 17-12** or similar: HMT 100m, 7.5Kw, 3 x380v, Qmin 15m3/h)	pcs	7		
4.2b	Delivery, transport, insurance and installation of submersible pumps (SP17-12).	pcs	7		
4.3	Supply and delivery of SP17-18 or equivalent				
4.3a	Supply submersible pumps Grundfos **SP17-18** or similar: HMT 150m, 11Kw, 3 x380v, Qmin 15m3/h)	pcs	31		
4.3b	Delivery, transport, insurance and installation of submersible pumps (SP17-18).	pcs	31		
4.4	Supply and delivery of SP17-23 or equivalent				
4.4a	Supply submersible pumps Grundfos **SP17-23** or similar: HMT 200m, 13Kw, 3 x380v, Qmin 15m3/h)	pcs	4		
4.4b	Delivery, transport, insurance and installation of submersible pumps (SP17-23).	pcs	4		
4.5	Pump fittings				

Item No.	Description	Unit	Qty.	Price in US$	
				Unit	Total
4.5a	Supply and installation of 50mm diameter galvanised steel pipes, heavy duty class C as rising main (including fittings).	m	7 144		
4.5b	Supply and installation of 25 mm diameter uPVC airline.	m	7 144		
4.6	Supply and installation of the submersible cables				
4.6a	Supply and installation of mm diameter submersible for SP14-25 or equivalent	m	Rate only		
4.6b	Supply and installation of the 8mm diameter cable for SP 17-12	m	602		
4.6c	Supply and installation of the 12mm diameter cable for SP 17-18	m	5 890		
4.6d	Supply and installation of 16 mm diameter submersible cable for SP17-23	m	960		
4.7	Supply grundfos CU3 control unit for pump protection	Pcs	42		
4.8	PV power System				
4.8a	Supply and install ation of a complete solar power system to drive **4 kw** motor (**SP14-15**). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **20%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminium frame including control pannel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	Rate only		
4.8b	Supply and install. of solar power system to drive **7.5 kw** motor (**SP17-12**). The minimum annual number of hours of sunshine is **1469**. The tilt is 8°, The overpower is **22%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminium frame including control pannel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	7		
4.8c	Supply and install. of solar power system to drive **11kw** motor (**SP17-18**). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **37%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminium frame including control pannel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	31		

Item No.	Description	Unit	Qty.	Price in US$	
				Unit	Total
4.8d	Supply and install. Of solar power system to drive **13 kw** motor (SP17-23). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **40%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminium frame including control pannel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	4		
Total Lot 4					
5	**Lot 5: Training of Service Personnel and Maintenance**				
5.1	Supply Tutorial material for drilled wells and PV operation and maintenance	LS	1		
5.2	O&M Training for Water Supply Systems and PV system	Pcs	42		
5.3	Supply of tool boxes suitable for maintenance of Water Supply Systems.	Pcs	42		
Total Lot 5					
6	**Lot 6: Animation and sensitization**				
6.1	Animation and sensitization services for Wells and Water Supply Systems.	Pcs	42		
6.3	Reporting : Borehole report, Monthly, Quarterly, final Reports	LS	1		
Total Lot 6					
Total without VAT					
VAT 16%					
Total VAT included					

Project Name	The Saudi Program for Drilling of Wells and Rural Development in Africa, (Phase5).
Project No.	P5/2019/Kenya

Pre-Bid Clarification No: 1

N°	REFERENCE	BIDDER'S QUERIES	RESPONSE
1	Request for extension of submission due date	We kindly request you to extend the submission deadline for at least 30 days from the submission due date (14-10-2021) to give us enable time for study the tender and submit our best technical and commercial offer.	The bidder are granted an **extension of time** till the **14/11/2021 at 14:30 KSA time** to submit their proposals.
2	Site Visit	Would you please wave the site visit	Please be advised that the site visit is **no longer compulsory**. Indeed, we leave the site visit **to the discretion of the bidders**. However If the bidder still would like to visit the sites in order to obtain complementary information for preparing the bid, it is recommended to liaise with the WSTF Project Coordinator, Mr. Hassan Kassim, (email: Hassan.Kassim@waterfund.go.ke)
3	Instruction to Bidders (Clause 3.1): **SOURCE OF MATERIALS** –	The documents state that the materials required should be sourced from the Kingdom of Saudi Arabia. The principal materials are borehole casings and Steel tanks. Please let us know if we can source the materials locally as they are all available in Kenya.	The Contractor **is free** to buy the supplies and materials from anywhere he likes.
4	Conditions of Contract (Clause 4.1):	**TAX EXEMPTION** – Please confirm that if we are to import any materials we can cost on tax free basis, also I am not sure if this tax exemption will also apply to local suppliers of materials.	As per the MoU signed between the Government of Kenya and the SFD, all the materials, equipment, spare parts **are exempt** from port and import charges, customs tariffs and taxes in Kenya. The taxes will be mentioned in the Tender to enable having an idea about the amount of tax exception the project is seeking. The BOQ in attachment has been revised accordingly.
5	Submittal Folder	Please confirm to us that Bid Bond submit with Technical Folder or commercial folder.	The bid bond shall be submitted within the Financial offer.
6	Technical Submittal	Please confirm to me that in Technical submittal required **Technical data sheet of Materials** or not	Technical data sheet of material shall be enclosed **in the technical file**.
7	Pre-bid clarifications	Please kindly share with us Copied of the Employer's response and addendums which sent earlier to all bidders.	The Employers' responses and addendums will be posted in the **SFD website** in due time.

Project Name	The Saudi Program for Drilling of Wells and Rural Development in Africa, (Phase5).
Project No.	P5/2019/Kenya

Pre-Bid Clarification No: 1

N°	REFERENCE	BIDDER'S QUERIES	RESPONSE
8	Conditions of Contract (Clause 14.1a): BASE CAMP	The project covers a very large area in Northern Kenya and realistically we will be required to prepare at least 2-3 Base camps in the lift of the project. It will not be sensible to serve the project from a single Base camp. We would have to cost for the multiple base camps setup/teardown and movement, Please advice.	It is **up to the Contractor** to decide how he would organize the works that should be detailed in his technical proposal.
9	Conditions of Contract	There is a condition that only boreholes with greater than 3m3/hr. capacity and suitable water quality will be considered for payment. My knowledge of the project area suggests that this may be difficult in some areas. The quantity is not a serious issue, however, the quality may be a problem. We will have to consider failed drilling in our unit rates based on probability of success. Please advice.	As stated in article 4 - Well Drilling and Construction of the Technical specifications (page 94) as well as in the the appraisal report, **only the yield criteria will be applied to pay for successful boreholes (greater than 3m3/hr).**
10	Scope of Work	we would like to seek clarification on the type of casing to be used The bill of quantities casing is indicated to be mild steel casing ➢ Under contract data sheet its indicated as PVC ➢ Under technical specification its indicated mild steel casing Please kindly advice.	The **casings and screens** shall comprise of **mild steel** as per technical specifications and the bill of quantities.

PROJECT DATA SHEET

Project Name:
The Saudi Program for Drilling of Wells and Rural Development in Africa, (Phase5).

Name of the Client:
Water Sector Trust Fund (WSTF) –Republic of Kenya

Financer:
Saudi Fund for Development

The Consultant
SCET-TUNISIE

Duration
24 months

Objectives and components of the project:
The Project include The Construction of about 42 Drilled Wells Equipped with Solar and / or diesel pumping generator and pipelines connections to supply several Villages in Marsabit, Isiolo, Samburu, Mandera, Garissa and Wajir Counties in the Republic of Kenya. The Project components fall within borehole drilling, procurement, installation of solar/diesel driven pumps with reticulation systems and RC water tanks as well as animation, sensitization, and training. The primary objective of the project is to increase access to safe drinking water to about 130 555 persons in the Republic of Kenya.

The work at each site comprises of:

1. Conducting Environmental and Social Impact Assessment
2. Drilling of wells
3. Supply and installation of Pumps and ancillaries
4. Supply and installation of solar system and / or diesel generators
5. Supply and installation 42 steel water tanks
6. Supply and installation of 42 pipe distribution systems
7. Training of maintenance team and providing spare parts

Submission of Offers:

All Saudi contractors who are interested in participating to implement the project should submit their offer by submitting the envelopes including the technical and financial offers (hard and soft copies) before 14/10/2021 to the following: -

The Saudi Fund for Development (SFD)
P.O. Box 50483
Riyadh, 11523
Kingdom of Saudi Arabia

1) Eng. Azzam Albarrak,
   Operation Sector, Africa Dep.
   Saudi Fund for Development
   Phone: +966 11 2794022
2) Eng. Amar Albelaihees,
   Operation Sector, Africa Dep.
   Saudi Fund for Development
   Phone: +966 11 2794276

Eligibility:

Only Saudi Bidders.

A Grant from the Government of the Kingdom of Saudi Arabia

to

The Republic of Kenya

The Saudi Program for Drilling of Wells and Rural Development in Africa – Phase V

The Republic of Kenya

Project No.: **P5/2019/Kenya**

Tender No.: **P5/2019/Kenya/Contractor**

Invitation to Tender

For

The Construction of 42 Drilled Wells Equipped with Solar pumping generator and pipelines connections to supply several villages in Marsabit, Isiolo, Samburu, Mandera, Wajir and Garissa Counties

Ref. : A20-27
Date: July 2021

SCET TUNISIE

2, Rue Sahab Ibn Abbad, Cité Jardins
1002 Tunis Bélvédère TUNISIA
Phone : +216 71 800 033 - Fax. +216 71 785 066
E-mail : deha@scet-tunisie.com.tn

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SECTION 1

INVITATION TO BIDDERS

Date: 18 August 2021

The Saudi Program for Drilling of Wells and Rural Development in Africa – Phase V
Tender Documents for Construction – Republic of Kenya

Project No. P5/2019/Kenya Tender No.: P5/2019/Kenya/Contractor

Dear Sir,

We are pleased to herewith forward to you the Tender Documents for the Construction of about 42 Drilled Wells equipped with Solar and/or diesel pumping generator, water tanks and pipelines connections to supply several villages in Marsabit, Isiolo, Samburu, Mandera, Wajir and Garissa Counties of the Saudi Program for Drilling of Wells and Rural Development in Africa, Phase V in the Republic of Kenya.

The offers must be submitted no later than 18 October 2021 at 14:30 KSA time.

Please be aware that the evaluation of your offer will follow the selection criteria laid out in Section 6, each tenderer must submit a separate offer.

For further details on the actual situation in the different project regions such as access, location and hydrogeological situation of the well sites as well as for the standard design of wells and water supply systems; you have to visit the project area and contact the Water Sector Trust Fund in Kenya as indicated in the tender document sub clause 7.1 in the instruction to bidders.

We are looking forward to receiving your Tender.

Yours sincerely,

SECTION 2

GENERAL INFORMATION ON THE REPUBLIC OF KENYA

General Information about the Republic of Kenya

National Flag

Introduction

Kenya, officially the **Republic of Kenya (**Swahili: *Jamhuri ya Kenya*), is a country in Eastern Africa and a founding member of the East African Community (EAC). The Country's capital and largest city is Nairobi while its oldest city and first capital is the coastal city of Mombasa. Kisumu City is the third largest city and also an inland port on Lake Victoria. Other important urban centres include Nakuru and Eldoret. Kenya's territory lies on the equator and overlies the East African Rift covering a diverse and expansive terrain that extends roughly from Lake Victoria to Lake Turkana (formerly called Lake Rudolf) and further south-east to the Indian Ocean. It is bordered by Tanzania to the south and southwest, Uganda to the west, South Sudan to the north-west, and Ethiopia to the north and Somalia to the north-east. Kenya covers 580,367 sq. km (224,081 sq mi), and had a population of approximately 47,6 million people as at August 2019 making her the 29th most populous country.

Kenya has a warm and humid tropical climate on its Indian Ocean coastline. The climate is cooler in the savannah grasslands around the capital city, Nairobi, and especially closer to Mount Kenya, which has snow permanently on its peaks. Further inland are highlands in Central and Rift Valley regions where tea and coffee are grown as cash crops which are major foreign revenue earners. In the West are Nyanza and Western regions, there is an equatorial, hot and dry climate which becomes humid around Lake Victoria, the largest tropical fresh-water lake in the world. This gives way to temperate and forested hilly areas in the neighboring western region. The north-eastern regions along the border with Somalia and Ethiopia are arid and semi-arid areas with near-desert landscapes. Kenya is known for its world class athletes in track and field and rugby. Thanks to its diverse climate and geography, expansive wildlife reserves and national parks such as the East and West Tsavo National Park, Amboseli National Park, Maasai Mara, Lake Nakuru National Park, Aberdares National Park and white sand beaches at the Coastal region, Kenya is home to the modern safari and has several world heritage sites such as Lamu and a number of beaches, including in Watamu, Diani, Bamburi and Kilifi.

The African Great Lakes region, which Kenya is a part of, has been inhabited by humans since the Lower Paleolithic period. By the first millennium AD, the Bantu expansion had reached the area from West-Central Africa. The borders of the modern state consequently comprise the crossroads of the Niger-Congo, Nilo-Saharan and Afro-asiatic areas of the continent, representing most major ethno linguistic groups found in Africa. Bantu and Nilotic populations together constitute around 97% of the nation's residents. European and Arab presence in coastal Mombasa dates to the Early Modern period; European exploration of the interior began in the 19th century. The British Empire established the East Africa Protectorate in 1895, which starting in 1920 gave way to the Kenya Colony. Kenya obtained independence in December 1963. Following a referendum in August 2010

and adoption of a new constitution, Kenya is now divided into 47 semi-autonomous counties, governed by elected governors.

Geography

The geography of Kenya is diverse, varying amongst Kenya's 47 Counties. Kenya has a coastline on the Indian Ocean, which contains swamps of East African mangroves. Inland are broad plains and numerous hills. Kenya borders South Sudan to the northwest, Uganda to the west, the Jubaland province of Somalia to the east, Tanzania to the south, and Ethiopia to the north.

Central and Western Kenya is characterised by the Kenyan Rift Valley and central province home to the highest mountain, Mount Kenya and Mount Elgon on the border between Kenya and Uganda. The Kakamega Forest in western Kenya is a relic of an East African rainforest. Much bigger is Mau Forest, the largest forest complex in East Africa.

Climate

Kenya’s climate varies by location; from mostly cool every day, to always warm/hot. The climate along the coast is tropical. This means rainfall and temperatures are higher throughout the year. At the coastal cities, Mombasa, Lamu and Malindi, the air changes from cool to hot, almost every day. The further inside Kenya, the more arid the climate becomes. An arid climate is nearly devoid of rainfall, and temperature swings widely according to the general time of the day/night. For many areas of Kenya, the daytime temperature rises about 12 °C almost every day. Elevation is the major factor in temperature levels, with the higher areas, on average, as 11 °C cooler, day or night. The many cities over a kilometre in elevation have temperature swings from roughly 10–26 °C. Nairobi, at 1,798 m (5,899 ft), ranges from 9–27 °C, and Kitale, at 1,825 m (5,988 ft), ranges from 11–28 °C. At night, heavy clothes or blankets are needed, in the highlands, when the temperature drops to about 10–12 °C every night.

At lower altitudes, the increased temperature is like day and night, literally: like starting the morning at the highland daytime high, and then adding the heat of the day, again. Hence, the overnight low temperatures near sea level are nearly the same as the high temperatures of the elevated Kenyan highlands. However, locations along the Indian Ocean have more moderate temperatures, as a few degrees cooler in the daytime, such as at Mombasa.

There are slight seasonal variations in temperature, of 4 °C cooler in the winter months. Although Kenya is centred at the equator, it shares the seasons of the southern hemisphere: with the warmest summer months in December–March and the coolest winter months in June–August, again with differences in temperature varying by location within the country. On the high mountains, such as Mount Kenya, Mount Elgon and Kilimanjaro, the weather can become bitterly cold for most of the year. Some snowfall occurs on the highest mountains.

The "long rains" season occurs from March/April to May/June. The "short rains" season occurs from October to November/December. The rainfall is sometimes heavy and often falls in the afternoons and evenings. The temperature remains high throughout these months of tropical rain. The hottest period is February and March, leading into the season of the long rains, and the coldest is in July, until mid-August.

Geology

Much of the western two-thirds of the country consist of the Pliocene–Pleistocene volcanics deposited on Precambrian basement rocks. The southeast corner of the country is underlain by sediments of the Karoo System of Permian to Late Triassic age and a strip of Jurassic age sediments along the coast in the Mombasa area. The Anza trough is a NW–SE trending Jurassic rift extending from the Indian Ocean coast to the Sudan northwest of Lake Turkana. The Anza Rift resulted from the break–up of Gondwana.

Economy

Kenya's Economy is a market-based economy with a liberalised external trade system and a few state enterprises. Major industries include agriculture, forestry, fishing, mining, manufacturing, energy, tourism and financial services. As of 2020, Kenya had the third largest economy in Sub-Saharan Africa, coming behind Nigeria and South Africa. The government of Kenya is generally investment-friendly and has enacted several regulatory reforms to simplify both foreign and local investment, including the creation of an export processing zone. An increasingly significant portion of Kenya's foreign financial inflows are remittances by non-resident Kenyans who work in the US, Middle East, Europe and Asia.

In 2020, Kenya ranked 56th in the World Bank ease of doing business rating, up from 61st in 2019 (out of 190 countries). Compared to its neighbours, Kenya has a well-developed social and physical infrastructure.

Industry and Manufacturing

Manufacturing is one of the country's key economic sectors, contributing 10.7% to the GDP in 2019 with industrial activity concentrated around the three largest urban centres of Nairobi, Mombasa, and Kisumu, and is dominated by food-processing industries such as grain milling, beer production, sugarcane crushing, and the fabrication of consumer goods, e.g., vehicles from kits.

Kenya also has a cement production industry. In addition, a substantial and expanding informal sector commonly referred to as jua kali engages in small-scale manufacturing of household goods, auto parts, and farm implements. Kenya's inclusion among the beneficiaries of the US Government's African Growth and Opportunity Act (AGOA) gave a boost to manufacturing in recent years. Since AGOA took effect in 2000, Kenya's clothing sales to the United States increased from US$44 million to US$270 million (2006). Other initiatives to strengthen

manufacturing have been the new government's favourable tax measures, including the removal of duty on capital equipment and other raw materials.

Transport

Kenya has an extensive network of paved and unpaved roads. Kenya's standard gauge railway system links the Mombasa to Nairobi City. Kenya has 18 airports and airstrips under direct management of Kenya Airports Authority (KAA).

Energy

Energy is a critical enabler and component of a country's economy, with a country's level of economic growth and development being closely linked to its level and intensity of energy use. Kenya is energy poor both in terms of its overall energy consumption levels and access to modern energy services. The largest share of Kenya's electricity supply comes from geothermal energy, followed by hydroelectric stations at dams along the upper Tana River, as well as the Turkwel Gorge Dam in the west. A petroleum-fired plant on the coast, geothermal facilities at Olkaria, and electricity imported from Uganda make up the rest of the supply.

Kenya's installed capacity increased from 1,142 megawatts between 2001 and 2003 to 2,341 in 2016. The state-owned Kenya Electricity Generating Company (KenGen), established in 1997 under the name of Kenya Power Company, handles the generation of electricity, while Kenya Power handles the electricity transmission and distribution system in the country. Shortfalls of electricity occur periodically, when drought reduces water flow. To become energy sufficient, Kenya has installed wind power and solar power (over 300 MW each), and aims to build a nuclear power plant by 2027.

Kenya has proven deposits of oil in Turkana. Tullow Oil estimates the country's oil reserves to be around one billion barrels. Exploration is still continuing to determine if there are more reserves.

Demographics

The demography of Kenya is monitored by the Kenyan National Bureau of Statistics. Kenya is a multi-ethnic state in the Great Lakes region of East Africa. It is inhabited primarily by Bantu and Nilotic populations, with some Cushitic-speaking ethnic minorities in the north. Its total population was at 47,564,296 as of the 2019 census.

Kenya's population was reported as 47.6 million during the 2019 census compared to 38.6 million inhabitants 2009, 28.7 million in 1999, 21.4 million in 1989, and 15.3 million in 1979. This was an increase of a factor of 2.5 over 30 years, or an average growth rate of more than 3 percent per year. The population growth rate has been reported as reduced during the 2000s, and was estimated at 2.7 percent (as of 2010), resulting in an estimate of 46.5 million in 2016.

Languages

Kenya is a multilingual country. Kiswahili and English are the recognized official languages. According to *Ethnologue*, there are a total of 69 languages spoken in Kenya. This variety is a reflection of the country's diverse population that includes most major ethnoracial and linguistic groups found in Africa. Most languages spoken locally belong to two broad language families: Niger-Congo (Bantu branch) and Nilo-Saharan (Nilotic branch), spoken by the country's Bantu and Nilotic populations, respectively. The Cushitic and Arab ethnic minorities speak languages belonging to the separate Afro-asiatic family, with the Hindustani and European residents speaking languages from the Indo-European family.

Kenya's various ethnic groups typically speak their mother tongues within their own communities. The two official languages, English and Kiswahili, are used in varying degrees of fluency for communication with other populations. English is widely spoken in commerce, schooling and government. Peri-urban and rural dwellers are less multilingual, with many in rural areas speaking only their native languages. British English is primarily used in Kenya. Additionally, a distinct local dialect, Kenyan English, is used by some communities and individuals in the country and contains features unique to it that were derived from local Bantu languages, such as Kiswahili and Kikuyu. It has been developing since colonization and contains certain elements of American English. Sheng is a Kiswahili-based and is spoken in some urban areas. Primarily consisting of a mixture of Kiswahili and English, it is an example of linguistic code-switching.

Government and Politics

The politics of Kenya take place in a framework of a presidential representative democratic republic, whereby the President of Kenya is both head of state and head of government, and of a multi-party system in accordance with a new constitution passed in 2010. The executive power is exercised by the executive branch of government, headed by the President, who chairs the cabinet that is composed of people chosen from outside parliament. Legislative power is vested exclusively in a bicameral Parliament (The National Assembly and the Senate). The judiciary is independent of the executive and the legislature. The Economist Intelligence Unit rated Kenya a "hybrid regime" in 2019.

The president is elected for a five-year term by the people. As of the 2013 March general election, the Constitution of Kenya had two requirements for any candidate to be declared winner:

- to win at least 25% of the vote in a majority of Kenya's forty seven counties
- to garner 50% + 1 vote of the total valid votes.

If none of the candidates fulfils these requirements there is to be a runoff between the two leading contenders. The Deputy President is the running mate of the candidate that wins the presidential election whilst other cabinet members will be appointed, with the approval from the National Assembly, from outside Parliament.

Between 2008 and 2013 Kenya was governed by a Grand coalition, established by a power sharing agreement, signed by then President Mwai Kibaki and Prime Minister Raila Odinga of the Orange Democratic Movement. That government was semi-presidential in form, with the executive headed by a President and a Prime Minister, and ministers were appointed to reflect political parties' relative strength in Kenya's 10th Parliament in which Raila Odinga's party, the Orange Democratic Movement was the largest party. Under the power-sharing agreement, each of the two major parties also nominated a deputy prime minister. The post of the Prime Minister was abolished after 2013, returning Kenya to a presidential system of government.

The Bicameral Parliament consists of a National Assembly and Senate. The National Assembly, or *Bunge*, has 349 members, 290 members elected for a five-year term in single-seat constituencies, 47 women elected from each county, 12 members nominated by political parties in proportion to their share of seats won in the single-member constituencies, and an ex officio member: the speaker. There is also a senate with 67 members. 47 elected from counties acting as single member constituencies, 16 women nominated by political parties, a man and a woman representing youths and a man and woman representing people with disabilities. The speaker is an ex-officio member.

The judiciary is divided into Superior Courts and Subordinate Courts. Superior Courts consist of: a chief justice, deputy chief justice (who are members of the Supreme Court), Supreme Court judges, High Court judges, and judges of Kenya's Court of Appeal (no associate judges) appointed by an independent Judicial Service Commission. The Chief Justice and his or her deputy are nominated by the President from names selected by the Judicial Service Commission and voted by the National Assembly. Subordinates Courts are Magistrates Courts, Kadhi Courts and Courts Martial.

Under the 2010 Constitution, Kenya is divided into 47 counties (including the Cities of Nairobi and Mombasa), each comprising a whole number of Parliamentary constituencies. Each county has an elected Assembly, whose members are elected from single-member wards. There are provisions for additional Assembly members to be appointed to improve the gender balance and to represent special groups such as persons with disabilities and youth. Each county is administered by an elected County Governor and Deputy Governor, backed by a County Executive Committee appointed by the Governor with approval from the County Assembly.

SECTION 3

INSTRUCTIONS TO BIDDERS

Section 3: Instructions to Bidders

A. General		
1. Scope of Bid	1.1	Employer as defined in the Contract Data, invites bids for the construction of Works, as described in the Contract Data. The name and identification number of the Contract is provided in the Bidding Data and Contract Data.
	1.2	The successful Bidder will be expected to complete the Works by the Intended Completion Date in the Contract Data.
2. Source of Funds	2.1	The Beneficiary, as defined in the Bidding and the Contract Data, intends to apply the funds of the Employer financing, as defined in the Bidding Data, towards the cost of the Project, as defined in the Bidding Data, to cover eligible payments under the Contract for the Works. Payments by the Employer will be made only at the request of the Consulting Engineer as defined in the Bidding Data and Contract Data and upon approval by the Employer in accordance with the Financing Agreement, and will be subject in all respects to the terms and conditions of that Agreement. Except as the Employer may specifically otherwise agree, no party other than the Beneficiary shall derive any rights from Financing agreement or have any rights to the financing proceeds.
	2.2	The Financing Agreement prohibits a withdrawal from the funds of the Employer financing for the purpose of any payment to persons or entities, or for any import of goods, if such payment or import, to the knowledge of the Employer, is prohibited by an Employer's eligibility rules.
3. Eligible Bidders	3.1	This Invitation for Bids is open exclusively for Saudi Companies. A Saudi Company may choose to enter into a joint venture (JV) with any international company, which has relevant experience in water well drilling in Sub Saharan Africa. However, the lead firm shall be the Saudi Company. Besides, the key personnel shall be from the lead Company. It is preferable that the Company or the JV has relevance experience in undertaking SFD supported programs for water wells drilling in rural Africa and specifically to the region (please refer to the evaluation criteria). Any materials to be used in the performance of the Contract shall be of the Kingdom of Saudi Arabian origin unless it is unavailable then it shall be from any other eligible source country.
	3.2	All bidders shall provide their bid in the form in section 6.

	3.3	Bidders shall not be under a declaration of ineligibility for corruption and fraudulent practices issued by the SFD in accordance with sub-clause 35.1.
4. Qualification of the Bidder	4.1	All bidders shall provide as in Section 6, Qualification Information, a preliminary description of the proposed work method and schedule, including drawings and charts, as necessary as stipulated in form in Section 6.
	4.2	In the event that prequalification of potential bidders has been undertaken, only bids from prequalified bidders will be considered for award of contract. These qualified bidders should submit with their bids any information updating their originally submitted prequalification information remains essentially correct as of the date of bid submission.
	4.3	If the Employer has not undertaken prequalification of potential bidders, all bidders shall include the following information and documents with their bids in Section 6, unless otherwise stated in the Bidding Data: (a) Copies of original documents defining the constitution or legal status, place of registration, and principal place of business, written power of attorney of the signatory of the Bid to commit the Bidder; (b) Total monetary value of construction work performed for each of the last five years; (c) Experience in works of a similar nature and size for each of the last five years, and details of work underway or contractually committed and clients who may be contacted for further information on those contracts; (d) Major items of construction equipment proposed to carry out the Contract; (e) Qualifications and experience of key site management technical personnel proposed for the Contract; (f) Reports on the financial standing of the Bidder, such as profit and loss statements and auditor's reports for the past five years;

		(g) Evidence of adequacy of working capital for this Contract (access to line (s) of credit and availability of other financial resources); (h) Authority to seek references from the Bidder's bankers; (i) Information regarding any litigation, current or during the last five years, in which the Bidder is involved, the parties concerned, and disputed amount; (j) Proposals for subcontracting components of the Works amounting to more than 10 percent of the Contract Price.
	4.4	Bids submitted by a joint venture of two or more firms as partners shall comply with the following requirements, unless otherwise stated in the Contract Data: (a) the Bid shall include all the information listed in Sub-Clause 4.3 above for each joint venture partner; (b) the Bid shall be signed so as to be legally binding on all partners. (c) all partners shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms. (d) 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 (e) the execution of the entire Contract, including payment, shall be done exclusively with the partner in charge.
	4.5	To qualify for award of the Contract, bidders shall meet the following minimum qualifying criteria: (a) annual volume of construction work of at least $2,000,000 (b) experience as prime Contractor in the construction of at least two works of a nature and complexity equivalent to the Works over the last 10 years (to comply with this requirement, works cited should be at least 70 percent complete);

		(c) proposals for the timely acquisition (own, lease, hire, etc.) of the essential equipment listed in Bidding Data; (d) a Project Manager with five years' experience in works of an equivalent nature and volume, including no less than three years as Manager;
	4.6	A consistent history of litigation or arbitration awards against the Applicant or any partner of a Joint Venture may result in disqualification. The figures for each of the partners of a joint venture shall be added together to determine the Bidder's compliance with the minimum qualifying criteria of Sub-Clause 4.5 (a); however, for a Joint venture to qualify, each of its partners must meet at least 25 percent of minimum criteria set forth in Sub-Clause 4.5 (a) and (b) for an individual Bidder, and the partner in charge at least 40 percent of those minimum criteria. Failure to comply with this requirement will result in rejection of the joint venture's Bid. Subcontractors' experience and resources will not be taken into account in determining the Bidder's compliance with qualifying criteria.
5. One Bid per Bidder	5.1	Each Bidder shall submit only one Bid, either individually or a partner in a joint venture. A Bidder who submits or participates in more than one Bid (other than as a subcontractor or in cases of alternatives that have been permitted or requested) will cause all the proposals with the Bidder's participation to be disqualified.
6. Cost of Bidding	6.1	The Bidder shall bear al costs associated with the preparation and submission of his Bid, and the Employer will in no case be responsible or liable for those costs.
7. Site Visit	7.1	The Bidder, at the Bidder's own responsibility and risk, is expected to visit and examine the Site of Works and its Surroundings in at least three counties and obtain all information that may be necessary for preparing the Bid and entering into a contract for construction of the Works. The site visits will require that the contractor liaise with the coordinator Mr. Hassan Kassim, WSTF Project Coordinator on email: Hassan.Kassim@waterfund.go.ke. Mr. Hassan Kassim will coordinate with the WSTF Resident Engineers in Mandera, Wajir, Garissa, Samburu and Marasabit & Isiolo. The costs of visiting the Site shall be at the Bidder's own expense. Proof of the site visits must be provided in the tender document.

B. Bidding Document		
8. Content of Bidding Documents	8.1	The set of bidding documents comprises the documents listed in the table below and addenda issued in accordance with Clause 10: Section 3 Instructions to Bidders Section 4 Conditions of Contract Section 5 Contract Data Section 6 Forms of Bid and Contract Section 7 Specifications Section 8 Bill of Quantities Appendix – A List of boreholes, Villages and coordinates Appendix – B Drawings Appraisal report Google map
	8.2	Three copies of sections 4, 6, 7 and 8 are supplied to the prospective Bidder. 3 copies to be completed as appropriate and signed by the bidder and returned with the Bid.
	8.3	The Appraisal report and Google map containing the details of the sites form part of the RFP tender document provided to the bidders. Bidders may request these documents if not provided through the email: azzam.b@sfd.gov.sa Aalbelaihees@sfd.gov.sa
9. Clarification of Bidding Documents	9.1	A prospective Bidder requiring any clarification of the bidding documents may notify the Employer by Email to the followings Email addresses: scet-eastafrica@scet-tunisie.com.tn; Aalbelaihees@sfd.gov.sa; azzam.b@sfd.gov.sa The Employer will respond to any request for clarification received earlier than 15 days prior to the deadline for submission of bids. Copied of the Employer's response will be forwarded to all bidders including a description of the inquiry, but without identifying its source.
10. Amendment of Bidding documents	10.1	Before the deadline for submission of bids, the Employer may modify the bidding documents by issuing addenda.
	10.2	

	10.3	Any addendum thus issued shall be part of the bidding documents and shall be communicated in writing or by cable to all bidders. Prospective bidders shall acknowledge receipt of each addendum by cable to the Employer. To give prospective bidders reasonable time in which to take an addendum into account in preparing their bids, the Employer shall extend, as necessary, the deadline for submission of bids, in accordance with Sub-Clause 20.2 below.

C. Preparation of Bids		
11. Language of Bid	11.1	All documents relating to the bid shall be in the English language
12. Documents Comprising the Bid	12.1	The Bid submitted by the Bidder shall comprise the following: (a) The Bid (in the form in Section 6) (b) Bid Security in the forms in Section 6 (c) Priced Bill of Quantities (Appendix C) (d) Qualification Information Form and Documents (form in Section 6) (e) Alternative offers if any
13. Bid Prices	13.1	The Bidders shall apply for the whole Works as described in the Sub - Clause 1.1, based on the priced Bill of Quantities submitted by the Bidder.
	13.2	The Bidder shall fill in the rates and prices for all items of the works described in the bill of Quantities. Items for which no rate or price entered by the Bidder will not be paid for by the Employer when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities.
14. Currencies of Bid and Payment	14.1	The unit rates and prices shall be quoted by the Bidder entirely in the American dollars. Payment will be in American dollars.
15. Bid Validity	15.1	Bids shall remain valid for a period of **120 days** after the deadline for the bid submission specified in the tender document.
	15.2	In exceptional circumstances, the Employer may request that the bidders extend the period of validity for a specified additional period. The request and the bidders' responses shall be made in writing or by cable. A Bidder agreeing to the request will not be required or permitted to otherwise modify the Bid, but will be required to extend the validity of Bid Security for the period of the extension, and in compliance with Clause 16 in all aspects.
16. Bid Security	16.1	The Bidder shall furnish, as part of the Bid, a Bid Security in American dollars equivalent to **2%** of the contract price.
	16.2	The Bid Security shall, at the Bidders' option, be in the form of a certified check, letter of credit, bank guarantee from a banking institution, or a bond issued by insurance or bonding institution from a reputable institution selected by the Bidder and located in

		any eligible country. Bid security shall be valid for **28 days** beyond the validity of the Bid.
	16.3	Any bid not accompanied by an acceptable Bid Security shall be rejected by the Employer. The Bid Security of a joint venture must define as "bidder" all joint venture partners and list them in the following manner: a joint venture consisting of "----------" And "----------"
	16.4	The Bid Security of unsuccessful bidders will be returned within **28 days** of the end of the Bid validity period specified in Sub – Clause 15.1.
	16.5	The Bid Security of the successful Bidder will be discharged when the Bidder has signed the Agreement and furnished the required Performance Security.
	16.6	The Bid Security may be forfeited: (a) if the Bidder withdraws the Bid after Bid opening during the period of Bid validity. (b) if the Bidder does not accept the correction of Bid price, pursuant to Clause 27: or (c) in case of a successful Bidder, if the Bidder fails within the specified time limit to: (i). sign the Agreement or (ii). Furnish the required Performance Security.
17. Alternative Proposals by the Bidders	17.1	Bidders shall submit offers that comply with the requirements of the bidding documents, including the basic technical design as indicated in the drawings and specifications. Alternatives will not be considered.
18. Format and Signing of Bid	18.1	The Bidders shall prepare one original of the documents comprising the Bid as described in Clause 12 of these Instructions to Bidders, bound with the volume containing the Form of Bid and clearly marked "**ORIGINAL**" in addition, the Bidder shall submit **2** copies of the Bid and clearly marked as "**COPIES**" In the event of discrepancy between them, the original shall prevail. The Bidder shall also provide a soft copy of the bidding document in a pdf format in a USB.

	18.2	The original and all copies of the Bid shall be typed or written in indelible ink and shall be signed by a person or persons duly authorized to sign on behalf of the Bidder, pursuant to Sub-Clauses 4.3(a) or 4.4(b), as the case may be. All pages of the Bid where entries or amendments have been made shall be initiated by the person or persons signing the Bid.
	18.3	The Bid shall contain no alterations or additions, except those to comply with instructions issued by the Employer, or as necessary to correct errors made by the Bidder, in which case corrections shall be initiated by the person or persons signing the Bid.

D. Submission of Bids		
19. Sealing and marking of Bids	19.1	The Bidder shall seal the original and all copies of the Bid in two inner envelopes and one outer envelope, duly marking the inner envelopes as "**ORIGINAL**" and "**COPIES**".
	19.2	The inner and outer envelopes shall: (a) be addressed to the Employer at the address provided in the Bidding Data. (b) Bear the same name and identification number of the Contract as defined in the Bidding and Contract Data; and (c) Provide a warning not to open the specified time and date for Bid opening as defined in the Bidding Data.
	19.3	In addition to the identification required in Sub-Clause 19.2, the inner envelopes shall indicate the name and address of the Bidder to enable the Bid to be returned unopened in case it is declared late, pursuant to Clause 21.
	19.4	If the outer envelope is not sealed and marked as above, the Employer will assume no responsibility for the misplacement or premature opening of the Bid.
20. Deadline for submission of Bids	20.1	Bids shall be delivered to the Employer at the address specified in the Bidding Data not later than the time and date specified in the Bidding Data.
	20.2	The Employer may extend the deadline for submission of bids by issuing an amendment in accordance with Clause 10, in which case all rights and obligations of the Employer and the bidders previously subject to the original deadline will then be subject to the new deadline.
21. Late Bids	21.1	Any Bid received by the Employer after the deadline prescribed in Clause 20 will be returned unopened to the Bidder.
22. Modification and withdrawal of Bids	22.1	Bidders may modify or withdraw their bids by giving notice in writing before the deadline prescribed in Clause 20.
	22.2	Each Bidder's modification or withdrawal notice shall be prepared, sealed, marked, and delivered in accordance with Clauses 18 and 19,

		with the outer and inner envelopes additionally marked "**MODIFICATION**" or "**WITHDRWAL**" as appropriate.
	22.3	No Bid may be modified after the deadline for submission of Bids.
	22.4	Withdrawal of a Bid between the deadline for submission of bids and the expiration of the period of Bid validity specified in the Bidding Data or as extended pursuant to Sub-Clause 15.2 may result in the forfeiture of the Bid Security pursuant to Clause 16.
	22.5	Bidders may only offer discounts to, or otherwise modify the prices of their bids by submitting Bid modifications in accordance with this clause, or included in the original Bid submission.

E. Bid Opening and Evaluation		
23. Bid Opening	23.1	The Employer will open the bids, including modifications made pursuant to Clause 22, in the presence of the bidders' representatives who choose to attend at the time and in the place specified in the Bidding Data.
	23.2	Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause 22 shall not be opened.
	23.3	The bidders' names, the Bid prices, the total amount of each Bid and of any alternative Bid (if alternatives have been requested or permitted), any discounts, Bid modifications and withdrawals, the presence or absence of Bid Security, and such other details as the Employer may consider appropriate, will be announced by the Employer at the opening.
	23.4	The Employer will prepare minutes of the Bid opening, including the information disclosed to those present in accordance with Sub-Clause 23.3.
24. Process to be Confidential	24.1	Information relating to the examination, clarification, evaluation, and comparison of bids and recommendations for the persons not officially concerned with such process until the award to the successful Bidder has been announced. Any effort by a Bidder to influence the Employer's processing of bids or award decisions may result in the rejection of his Bid.
25. Clarification of Bids and Contacting the Employer	25.1	From the time of the bid opening to the time of contract award, if any bidder wishes to contact the Employer on any matter related to the bid, it should do so in writing.
	25.2	To assist in the examination, evaluation, and comparison of bids, the Employer may, at the Employer's discretion, ask any Bidder for clarification of the Bidder's Bid, including breakdowns of unit rates. The request for clarification and the response shall be in writing or by cable but no change in the price or substance of the Bid shall be sought, offered, or permitted except as required to confirm the correction of arithmetic errors discovered by the Employer in the evaluation of the bids in accordance with Clause 27.
	25.3	Any effort by the Bidder to influence the Employer in the Employer's bid evaluation, bid comparison or contract award decisions may result in the rejection of the Bidder's bid.

26. Examination of Bids and Determination of Responsiveness	26.1	Prior to the detailed evaluation of bids, the Employer will determine whether each Bid (a) meets the eligibility criteria defined in Clause 3; (b) has been properly signed; (c) is accompanied by the required securities; and (d) is substantively responsive to the requirements of the bidding documents.
	26.2	A substantially responsive Bid is one which conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with bidding documents, the Employer's rights or the Bidder's obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.
	26.3	All bids will be subject to a technical evaluation according to technical evaluation sheet in form in section 6. Only bids attaining $\geq 70\%$ will be accepted to enter the competition and will be considered to be responsive.
	26.4	If a Bid is not substantially responsive, it will be rejected by the Employer, and may not subsequently be responsive by correction or withdrawal of the non-conforming deviation or reservation.
27. Correction of Errors	27.1	Bids determined to be substantially responsive will be checked by the Employer for any arithmetic errors. Errors will be corrected by the Employer as follows: (a) Where there is a discrepancy between the amounts in figures and in words, the amount in words will govern; and (b) Where there is a discrepancy between the unit rate and the line-item total resulting from multiplying the unit rate by the quantity, the unit rate as quoted will govern, unless in the opinion of the Employer there is an obviously gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern, and the unit rate will be corrected.
	27.2	The amount stated in the Bid will be adjusted by the Employer in accordance with the above procedure for the correction of errors and,

		with the concurrence of the Bidder, shall be considered as binding upon the Bidder. If the Bidder does not accept the corrected amount, the Bid will be rejected, and the Bid Security may be forfeited in accordance with Sub-Clause 16.6(b).
28. Currency for Bid Evaluation	28.1	Currency for Bid Evaluation as specified in Clause 14.1
29. Evaluation and Comparison of Bids	29.1	The Employer will evaluate and compare only the bids determined to be substantially responsive in accordance with Clause 26.
	29.2	In evaluating the bids, the Employer will determine for each Bid, the evaluated Bid price by adjusting the Bid price as follows: (a) Making any correction for errors pursuant to Clause 27; (b) Excluding provisional sums and the provision, if any, for contingencies in the Bill of Quantities, but including Day work, where priced competitively; (c) Making an appropriate adjustment for any other acceptable variations, deviations, or alternative offers submitted in accordance with Clause 17; and (d) Making appropriate adjustments to reflect discounts or other price modifications offered in accordance with Sub-Clause 22.5.
	29.3	The Employer reserves the right to accept or reject any variation, deviation, or alternative offer. Variations, deviations, and alternative offers and other factors which are in excess of the requirements of the bidding documents or otherwise result in unsolicited benefits for the Employer will not be taken into account in Bid evaluation.
	29.4	The estimated effect of any price adjustment conditions under Clause 47 of the Conditions of Contract, during the period of implementation of the Contract, will not be taken into account in Bid evaluation.

F. Award of Contract		
30. Award Criteria	30.1	Subject to Clause 31, the Employer will award the Contract to the Bidder whose Bid has been determined to be substantially responsive to the bidding documents and who has offered the lowest evaluated Bid price, provided that such Bidder has been determined to be: (a) Eligible in accordance with provisions of Clause 3, and (b) Qualified in accordance with the provisions of Clause 4.
31. Employer's Right to Accept any Bid and to Reject any or all Bids	31.1	Notwithstanding Clause 30, the Employer reserves the right to accept or reject any Bid, and to cancel the bidding process and reject all bids, at any time prior to the award of Contract, without thereby incurring any liability to the affected Bidder or bidders or any obligation to inform the affected Bidder or bidders of the grounds for the Employer's action.
32. Notification of Award and Signing of Agreement	32.1	The Bidder whose Bid has been accepted will be notified of the award by the Employer prior to expiration of the Bid validity period by cable confirmed by registered letter. This letter (hereinafter and in the Conditions of Contract called the "Letter of Acceptance") form shown in Section 6 will state the sum that the Employer will pay the Contractor in consideration of the execution, completion, and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter and in the Contract called the "Contract Price").
	32.2	The notification of award will constitute the formation of the Contract, subject to the Bidder furnishing the Performance Security in accordance with Clause 33 and signing the Agreement in accordance with Sub-Clause 32.3.
	32.3	The Agreement as shown in form in Section 6 will incorporate all agreements between the Employer and the successful Bidder. It will be signed by the Beneficiary and approved by the Employer and sent to the successful Bidder, within 28 days following the notification of award along with the Letter of Acceptance. Within 21 days of receipt, the successful Bidder will sign the Agreement and deliver it to the Employer.
	32.4	Upon the furnishing by the successful Bidder of the Performance Security, the Employer will promptly notify the other bidders that their bids have been unsuccessful.

33. Performance Security	33.1	Within 21 days after receipt of the Letter of Acceptance, the successful Bidder shall deliver to the Employer a Performance Security in the amount stipulated in the Contract Data and in the form (Bank Guarantee and/or Bond) stipulated in the Bidding Data, denominated in the type and proportions of currencies in the Letter of Acceptance and in Accordance with the Conditions of Contract.
	33.2	If the Performance Security is provided by the successful Bidder in the form of a Bank Guarantee, it shall be issued either (a) at the Bidder's option, by a bank located in the country of the Employer or a foreign bank through a correspondent bank located in the country of the Employer. Or (b) with the agreement of the Employer directly by a foreign bank acceptable to the Employer.
	33.3	If the Performance Security is to be provided by the successful Bidder in the form of a Bond, it shall be issued by a surety which the Bidder has determined to be acceptable to the Employer.
	33.4	Failure of the successful Bidder to comply with the requirements of Sub-Clause 33.1 shall constitute sufficient grounds for cancellation of the award and forfeiture of the Bid Security.
34.Advance Payment	34.1	The Employer will provide an Advance Payment on the Contract Price as stipulated in the Conditions of Contract, subject to a maximum amount of 20% of the contract price against a valid Advance Payment Guarantee.
35. Corrupt or Fraudulent Practices	35.1	The Employer requires that Beneficiaries as well as Bidders/ Suppliers/Contractors observe the highest standard of ethics during the procurement and execution of such contracts. In pursuance of this policy, the Employer. (a) Defines, for the purposes of this provision, the terms set forth below as follows: (i) "**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 (ii) "**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 Beneficiary, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Beneficiary of the benefits of free and open competition; (b) Will reject a proposal for award if it determines that the Bidder recommended for award has engaged in corrupt or fraudulent practices in competing for the contract in question.

G. Bidding Data The Construction of 42 Drilled Wells Equipped with Solar or diesel pumping generator and pipelines connections to supply several Villages in Marsabit, Isiolo, Samburu, Mandera, Garissa and Wajir Counties. For Phase V in the Republic of Kenya	
Instructions to Bidders Clause	Reference
2.1	- The Project Name is **The Saudi Program for Drilling of Wells and Rural Development in Africa, Phase V – Republic of Kenya** - The Project Identification Number is **P5/2019/Kenya** - The Employer is **The Saudi Fund For Development SFD** **P.O. Box 50483, Riyadh, 11523, Kingdom of Saudi Arabia.** - The Beneficiary is **Water Sector Trust Fund (WSTF) –Republic of Kenya** - The financing refers to the type of financing which Employer, as of the date of issue of the bidding documents has approved. - The Project is The Construction of about 42 Drilled Wells Equipped with Solar and / or diesel pumping generator and pipelines connections to supply several Villages in Marsabit, Isiolo, Samburu, Mandera, Garissa and Wajir Counties in the Republic of Kenya. The Project components fall within borehole drilling, procurement, installation of solar/diesel driven pumps with reticulation systems and RC water tanks as well as animation, sensitization, and training. The primary objective of the project is to increase access to safe drinking water to about **130 555** persons in the Republic of Kenya. - The Consulting Engineer is **SCET-Tunisie**. The Engineer is the sole supervisor of the works and is responsible to the Employer.

(4.5c)	The essential equipment and personnel to be made available for the Contract by the successful Bidder shall be as shown below.

Minimum required equipment

No.	Equipment Type and Characteristics	Minimum Number Required
01	Drilling Rig	02
02	3 phase generator	02
03	Submersible pump – 3 phase	02
04	Dip meter	03
05	Stop watch	03
06	Welding machine	01
07	4 – wheel drive pick-ups	05 (are included 2 x 4WD for the consultant and 1 x 4WD for the WSTF)
08	Water tanker	02
09	7 ton crane truck	02
10	Height – pressure Compressor	02
11	7 ton crane truck	01
12	Concrete-mixer	02
13	Survey Equipment	01

Minimum required personnelNo.	The Essential Personnel is	Total Work Experience (Years)	Experience in Similar Works (Years)
01	Project Manager	15	05
02	Civil Engineer	10	05
03	Geophysical Engineer	10	05
04	Geologist	10	05
05	Surveyor Engineer	10	05
06	Survey team (at least 3 persons)	05	-
07	Auto CAD operator	05	03
08	2 Drillers	10	05
09	2 Assistant drillers	05	05
10	Solar system expert	10	05
11	5 Skilled labourers (masons, electricians and mechanics)	10	05
12	10 Unskilled labourers	10	-
13	5 car drivers	02	-
14	1 crane driver	10	05
15	Animation Expert	05	02

(16.1)	The format of the Bid security shall be in accordance with the forms included in the bidding documents and shall be issued by a reputable bank or financial selected by the bidder.
(19.2)	The Employer's address for the purpose of Bid submission is: **The Saudi Fund for Development (SFD)** **P.O. Box 50483** **Riyadh, 11523** **Kingdom of Saudi Arabia**
(20.1)	The deadline for submission of bids shall be on 18th October 2021 at: 14:30 KSA time.
(23.1)	The bids will be opened in SFD office in Riyadh, Kingdom of Saudi Arabia
(34.1)	The Standard Form of Performance Security acceptable to the Employer shall be Bank Guarantee. The format of the performance security shall be in accordance with the form included in the bidding documents and shall be issued by a reputable bank or financial institution selected by the bidder.

SECTION 4

CONDITIONS OF CONTRACT

Conditions of Contract
A. General

1. Definitions	1.1	Boldface type is used to identify terms. **Bill of Quantities** means the priced and completed Bill of Quantities forming part of the Bid. **Compensation Events** are those defined in Clause 40 hereunder. The **Completion Date**is the date of completion of the Works as certified by the Consulting Engineer (CE), in accordance with Sub-Clause 48.1. The **Contract** is the Contract between the Employer and the Contractor to execute, complete, and maintain the Works. It consists of the documents listed in Clause 2.2 below. The **Contractor** is a person or corporate body whose Bid to carry out the Works has been accepted by the Employer. The **Contractor's Bid** is the completed bidding document submitted by the Contractor to the Employer. 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. **Day works** 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 Consulting Engineer (CE) upon correction of defects by the Contractor.

		The **Defects Liability Period** is the period named in the Contract Data and calculated from the Completion Date. **Drawings** include calculations and other information provided or approved by the Consulting Engineer (CE) for the execution of the Contract. The **Employer** 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 Employer'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. The Intended Completion Date maybe revised only by the Consulting Engineer (CE) 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 **Consulting Engineer (CE)** is the person named in the Contract Data who is responsible for supervising the execution of the Works and administering the Contract. The **Site** is the area defined as such in the Contract Data. **Specification** means the Specification of the Works included in the Contract and any modification or addition made by the Consulting Engineer and approved by the Employer. The **Start Date** is given in the Contract Data. It is the latest date when the Contractor shall commence execution of the

		Works. It does not necessarily coincide with any of the Site Possession Dates. A **subcontractor** is a person or corporate body who has a Contract with the Contractor to carry out a part of the work in the Contract which includes work on the Site. **Temporary Works** are works designed, constructed, installed, and removed by the Contractor that are needed for construction or installation of the Works. No payment for temporary work. A **Variation** is an instruction given by the Consulting Engineer (CE) which varies the Works. The **Works** are what the Contract requires the Contractor to construct, install, and turn over to the Employer, as defined in the Contract Data.
2. Interpretation	2.1 2.2	In interpreting these Conditions of Contract, singular also means plural, male also means female and the other way around. Headings have no significance. Words have their normal meaning under the language of the contract unless specifically defined. The Consulting Engineer (CE) will provide instructions clarifying queries about these Conditions of Contract. The documents forming the Contract shall be interpreted in the following order of priority: (1) Agreement (2) Letter of Acceptance, (3) Contractor's Bid (4) Contract Data, (5) Conditions of Contract, (6) Specifications, (7) Drawings, (8) Bill of Quantities and (9) Any other document listed in the Contract Data as forming part of the Contract.
3. Language and law	3.1	The language of the Contract and the law governing the Contract are stated in the Contract Data.

4. Consulting Engineer's Decisions	4.1	Except where otherwise specifically stated, the Consulting Engineer (CE) will decide contractual matters between the Employer and the Contractor in the role representing the Employer.
5. Delegation	5.1	The Consulting Engineer (CE) may delegate any of his duties and responsibilities to other people after notifying the Contractor, and may cancel any delegation after notifying the Contractor.
6. Communications	6.1	Communication 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.
7. Subcontracting	7.1	The Contractor may subcontract with the approval of the Consulting Engineer (EC), but may not assign the Contract without the approval of the Employer in writing. Subcontracting shall not alter the Contractors' obligations.
8. Personnel	8.1 8.2	The Contractor shall employ the key personnel named in the Schedule of Key Personnel to carry out the functions stated in the Schedule or other personnel approved by the Consulting Engineer (CE). The Consulting Engineer (CE) 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. If the Consulting Engineer (CE) 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
9. Employer's and Contractor's Risks	9.1	The Employer carries the risks which Contract states are Employer's risks, and the Contractor carries the risks which this Contract states are Contractor's risks.
10. Employer's Risks	10.1	By this contract the Employer does not carry any risk. The Contractor shall notify the Consultant Engineer (CE) and/or the Employer to any probable risk to be agreed on the consequence.
11. Contractor's Risks	11.1	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) shall be borne by the Contractor.

12. Insurance	12.1	The Contractor shall provide, in the joint names of the Employer 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 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 property (except the Works, Plant, Materials, and Equipment) in connection with the Contract; and (c) Personal injury or death.
	12.2	Policies and certificate for insurance shall be delivered by the Contractor to the Employer for the Employer'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.
	12.3	If the Contractor does not provide any of the policies and certificates required, the Employer may effect the insurance which the Contractor should have provided and recover the premiums the Employer 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.
	12.4	Alterations to the terms of insurance shall not be made without the approval of the Employer.
	12.5	Both parties shall comply with any conditions of the insurance policies.
13. Queries about the Contract Data	13.1	The Consulting Engineer (CE) will clarify queries on the Contract Data.

14. Contractor to Construct the Works	14.1	The Contractor shall construct and install the Works in accordance with the Specifications and Drawings, beside he shall: (a) Provide an office at his base camp for the Consultant Engineer (EC) with all facilities; furniture, laptops, printing, facsimile, digital cameras, refrigerator, etc… (b) Two four wheel drive vehicles for the sole use of the Supervisor and the Animation Expert (c) One four wheel drive vehicle to the RE of the WSTF All the operation costs of the Consultant premises as well as the three 4WD (including driver cost) are to be provided by the Contractor.
15. The Works to Be Completed by the Intended Completion Date	15.1	The Contractor may commence execution of the Works on the Start Date and shall carry out the Works in accordance with the Program submitted by the Contractor, as updated with the approval of the Consulting Engineer (CE), and complete then by the Intended Completion Date.
16. Approval by the Consulting Engineer (CE)	16.1	The Contractor shall submit Specifications and Drawings showing the proposed Temporary Works to the Consulting Engineer (CE), who is to approve them if they comply with the Specifications and Drawings.
	16.2	The Contractor shall be responsible for design of Temporary Works.
	16.3	The Consulting Engineer (CE) approval shall not alter the Contractor's responsibility for design of the Temporary works.
	16.4	All Drawings prepared by the Contractor for the execution of the temporary or permanent works, are subject to prior approval by the Consulting Engineer (CE) before this use.

14. Safety	17.1	The Contractor shall be responsible for the safety of all activities.
18. Discoveries	18.1	Anything of historical or other interest or of significant value unexpectedly discovered on the Site shall be the property of the Employer. The Contractor shall notify the Consulting Engineer (CE) of such discoveries and carry out the Consulting Engineer's (CE) instructions for dealing with them.
19. Possession of the Site	19.1	The Employer 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, the Employer will be deemed to have delayed the start of the relevant activities, and this will be a Compensation Event.
20. Access to the Site	20.1	The Contractor shall allow the Consulting Engineer (CE) and any person authorized by the Consulting Engineer (CE) 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.
21. Instructions, Inspections and Audits	21.2	The Contractor shall permit the Employer to inspect the Contractor's accounts and records relating to the performance of the Contractor and to have them audited by auditors appointed by him, if so required.
22. Disputes	22.1	If the Contractor believes that a decision taken by the Consulting Engineer (CE) was either outside the authority given to the Consulting Engineer (CE) by the Contract or that the decision was wrongly taken, the decision shall be referred to the Employer within 14 days of the notification of the Consulting Engineer's (CE) decision.
	22.2	Dispute arising out or in connection to this Contract shall first be resolved by: (a) Amicable means: Each party shall assign an authorized representative of its executive level personnel. The representatives shall hold meeting in any place agreed upon by the two parties. The representatives shall in good faith negotiate the dispute and reach a solution.

		Should the two parties fail to reach a resolution acceptable to both parties within a period not exceeding 30 days, then the parties shall seek a resolution. (b) Mediation: The two parties shall assign a mutually agreed upon mediator well known for experience and integrity. The mediator shall carry out the mediation process guided by nationally recognized mediation codes and practice. Should the mediator not reach a resolution acceptable by both parties within a period not exceeding 30 days then the parties or anyone of them proceed for arbitration in accordance of the arbitration rules of the Saudi Fund for Development. The arbitration award shall be final and binding on both parties. All costs of disputes shall be divided between the Employer and the Contractor.
B. Time Control		
23. Program	23.1	Within the time stated in the Contract Data, the Contractor shall submit to the Consulting Engineer (CE) for approval a Program showing the general methods, arrangements, order, and timing for all the activities in the works.
	23.2	An update of the Program shall be a program 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.
	23.3	The Contractor shall submit to the Consulting Engineer (CE) for approval an updated program at intervals no longer than the period stated in the Contract Data. If the Contractor does not submit an updated Program within this period, the Consulting Engineer (CE) may withhold the amount stated in the Contract Data from the next payment certificate and continue to withhold

		this amount until the next payment after the date on which the overdue program has been submitted.
	23.4	The Consulting Engineer's (CE) approval of the Program shall not alter the Contractor's obligations. The Contractor may revise the Program and submit it to the Consulting Engineer (CE) again at any time. A revised program shall show the effect of variations and Compensation Events.
24. Extension of the Intended Completion Date	24.1	The Consulting Engineer (CE) shall extend with the approval of the employer 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.
	24.2	The Consulting Engineer (CE) shall decide whether and by how much to extend the Intended Completion Date within 21 days of the Contractor asking the Consulting Engineer (CE) 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.
25. Acceleration	25.1	When the Employer wants the Contractor to finish before the Intended Completion Date, the Consulting Engineer (CE) will obtain priced proposals for achieving the necessary acceleration from the Contractor. If the Employer accepts these proposals, the Intended Completion Date will be adjusted accordingly and confirmed by both the Employer and the Contractor.

	25.2	If the Contractor's priced proposals for acceleration are accepted by the Employer, they are incorporated in the Contract Price and treated as a variation.
26. Delays Ordered by the Consulting Engineer	26.1	The Consulting Engineer (CE) may instruct the Contractor to delay the start or progress of any activity within the Works.
27. Management Meetings	27.1	Either the Consulting Engineer (CE) 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.
	27.2	The Consulting Engineer (CE) shall record the business of management meetings and provide copies of the record to those attending the meeting and to the Employer. The responsibility of the parties for actions to be taken shall be decided by the Consulting Engineer (CE) either at the management meeting or after the management meeting and stated in writing to all who attended the meeting.
28. Early warning	28.1	The Contractor shall warn the Consulting Engineer (CE) 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 Consulting Engineer (CE) 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.
	28.2	The Contractor shall cooperate with the Consulting Engineer (CE) 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 Consulting Engineer (CE).

C. Quality Control		
29. Identifying Defects	29.1	The Consulting Engineer (CE) 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 Consulting Engineer (CE) may instruct the Contractor to search for a Defect and to uncover and test any work that the Consulting Engineer (CE) considers may have a Defect.
30. Tests	30.1	If the Consulting Engineer (CE) 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.
31. Correction of Defects	31.1	The Consulting Engineer (CE) shall give notice to the Contractor of any Defects before the end of the Defects Liability Period, which begins at Completion, and is defined in the contract Data. The Defects Liability Period shall be extended for as long as Defects remain to be corrected.
	31.2	Every time of Defect is given, the Contractor shall correct the notified Defect within the length of time specified by the Consulting Engineer's (EC) notice.
32. Uncorrected Defects	32.1	If the Contractor has not corrected a Defect within the time specified in the Consulting Engineer's (EC) notice, the Consulting Engineer will assess the cost of having the Defect corrected, and the Contractor will pay this amount.
D. Cost Control		
33. Bill of Quantities	33.1	The Bill of Quantities shall contain items for the construction, installation, testing, and commissioning work to be done by the Contractor.
	33.2	The Bill of Quantities is used to calculate the Contract Price. The Contractor is paid for the quantity of the work done at the rate in the Bill of Quantities for each item

34. Changes in the Quantities	34.1	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 per cent, provided the change exceeds 1 per cent of the Initial Contract Price, the Consulting Engineer (CE) shall adjust the rate to allow for the change.
	34.2	The Consulting Engineer (CE) shall not adjust rates from changes in quantities if thereby the Initial Contract Price is exceeded by more than 15 per cent, except with the prior approval of the Employer.
	34.3	If requested by the Consulting Engineer (CE), the Contractor shall provide the Consulting Engineer (CE) with a detailed cost breakdown of any rate in the Bill of Quantities.
35. Variations	35.1	All Variations shall be included in updated Programs produced by the Contractor.
36. Payments	36.1	The Contractor shall provide the Consulting Engineer (CE) with a quotation for carrying out the Variation when requested to do so by the Consulting Engineer (CE). The Consulting Engineer (CE) shall assess the quotation, which shall be given within seven days of the request or within any longer period stated by the Consulting Engineer (CE) and before the Variation is ordered.
	36.2	If the work in the Variation corresponds with an item description in the Bill of Quantities and if, in the opinion of the Consulting Engineer (CE), the quantity of work above the limit stated in Sub-Clause 34.1 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.

	36.3	If the Contractor's quotation is unreasonable, the Consulting Engineer (CE) may order the Variation and make a change to the Contract Price, which shall be based on the Consulting Engineer's (CE) own forecast of the effects of the Variation on the Contractor's costs.
	36.4	If the Consulting Engineer (CE) 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.
	36.5	The Contractor shall not be entitled to additional payment for cost that could have been avoided by giving early warning.
37. Cash Flow Forecasts	37.1	When the Program is updated, the Contractor shall provide Consulting Engineer (CE) with an updated cash flow forecast.
38. Payment Certificates	38.1	The Contractor shall submit to the Consulting Engineer (CE) 3 months statements of the estimated value of the work executed less than the cumulative amount certified previously.
	38.2	The Consulting Engineer (CE) shall check the Contractor's statement and certify the amount to be paid to the Contractor
	38.3	The value of work executed shall be determined by the Consulting Engineer (CE)
	38.4	The value of work executed shall comprise the value of the quantities of the items in the Bill of quantities completed.
	38.5	The value of work executed shall include the valuation of Variations and Compensation Events.

	38.6	The Consulting Engineer (EC) may exclude any item certified in a previous certificate or reduce the proportion of the item previously certified in any certificate in the light of later information.
39. Payments	39.1	Payments shall be adjusted for deductions for advance payments and retention. The Employer shall pay the Contractor the amount certified by the Consulting Engineer (CE) within 45 days of the date of each certificate.
	39.2	Unless otherwise stated, all payments and deductions will be paid or charged in the proportions of currencies comprising the Contract Price.
	39.3	Items of the Works for which no rate or price has been entered in will not be paid for by the Employer and shall be deemed covered by other rates and prices in the Contract.
40. Compensation Events	40.1	The following shall be Compensation Events: (a) The Employer does not give access to a part of the Site by the Site Possession Date stated in the Contract Data (b) The Employer modifies the Schedule of Other Contractors in a way that affects the work of the Contractor under the Contract (c) The Consulting Engineer (CE) orders a delay or does not issue Drawings, Specifications, or instructions required or execution of the Works on time. (d) The Consulting Engineer (CE) instructs the Contractor to uncover or to carry out additional tests upon work, which is then found to have no defects. (e) The Consulting Engineer (CE) 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

		bidders (including the Site Investigation Reports), from information available publicly and from a visual inspection of the Site. (g) The Consulting Engineer (CE) gives an instruction for dealing with an unforeseen condition, caused by the Employer, or additional work required for safety or other reasons. (h) Other Contractors, public authorities, Utilities, or the Employer 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 Employer's Risks. (k) The Consulting Engineer (CE) unreasonably delays issuing a Certificate of Completion. (l) Other Compensation Events described in the Contract or determined by the Consulting Engineer (CE) shall apply.
	40.2	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 Consulting Engineer (CE) 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.
	40.3	As soon as information demonstrating the effect of each Compensation Event upon the Contractor, it shall be assessed by the Consulting Engineer (CE), and the Contract Price shall be adjusted accordingly. If the Contractor's forecast is deemed unreasonable, the Consulting Engineer (CE) shall adjust the Contract Price based on the Consulting Engineer (CE) own forecast. The Consulting Engineer (CE) will assume

		that the Contractor will react competently and promptly to the event.
	40.4	The Contractor shall not be entitled to compensation to the extent that the Employer's interests are adversely affected by the Contractor's not having given early warning or not having cooperated with the Consulting Engineer (CE).
41. Tax	41.1	The project is taxes, duties and other levies exempted and this is all equipment, tools and personnel of the Contractor.
42. Retention	42.1	The Employer shall retain from each payment due to the Contractor the proportion stated in the Contract Data until Completion of the whole of the Works.
	42.2	On completion of the whole of the Works, half of the total amount retained shall be repaid to the Contractor and half when the Defects Liability Period has passed and the Consulting Engineer (CE) has certified that all Defects notified by the Consulting Engineer (CE) to the Contractor before the end of this period have been corrected.
	42.3	On completion of the whole Works, the Contractor may substitute retention money with an "on demand" Bank guarantee.
43.Liquidated Damages	43.1	The Contractor shall pay liquidated damages to the Employer at the rate per day stated in the Contract Data for each day that the Completion Date is later than the Intended Completion Date. The total amount of liquidated damages shall not exceed that amount defined in the Contract Data. The Employer may deduct liquidated damages shall not affect the Contractor's liabilities.
	43.2	If the Contractor fails to comply with the Time for Completion in accordance with Clause 48 for the whole of the Works or, if applicable, any Section within the relevant time prescribed by Clause 43.1,

		then the Contractor shall pay to the Employer all extra Consultant fees due because of that failure and a penalty as subsequently mentioned for the time which shall elapse between the relevant Time for Completion and the date stated in the Taking-Over Certificate of the whole of the Works or the relevant Section. ▪ For each of the first four of such weeks of delay the sum of 0.25% per week of the Contract Price. ▪ For each of the second four such weeks of delay the sum of 0.75% per week of the Contract Price. ▪ For each subsequent week of delay thereafter the sum of 1% per week of the Contract Price
	43.3	The Employer may, without prejudice to any other method of recovery, deduct the amount of such penalty from any monies due to or to become due to the Contractor, the Payment or deduction of such penalty shall not relieve the Contractor from his obligations to complete the works, or from any other of his obligations and liabilities under this Contract, namely for damages caused by delay. If the Intended Completion Date is extended after liquidated damages have been paid, the Consulting Engineer shall correct any overpayment of liquidated damages by the Contractor by adjusting the next payment certificate.
44. Advance Payment	44.1	The Employer shall make advance payment to the Contractor of the amounts stated in the Contract Data by the date stated in the Contract Data, against provision by the Contractor of an Unconditional Bank Guarantee in a form and by a bank acceptable to the Employer 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

	44.2	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 Consulting Engineer (CE).
	44.3	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, or Liquidated Damages.
45. Securities	45.1	The Performance Security as specified in the Contract Data shall be provided to the Employer 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 Employer, 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.
46. Day Works	46.1	If applicable, the Day works rates in the Contractor's Bid shall be used for small additional amounts of work only when the Consulting Engineer (CE) has given written instructions in advance for additional work to be paid for in that way.
	46.2	All work to be paid for as Day works shall be recorded by the Contractor on forms approved by the Consulting Engineer (CE). Each completed form shall be verified

		and signed by the Consulting Engineer (CE) within two days of the work being done.
	46.3	The Contractor shall be paid for Day works subject to obtaining signed Day works forms.
47. Cost of Repair	47.1	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 commissions.
E. Finishing the Contract		
48. Completion	48.1	The Contractor shall request the Consulting Engineer (CE) to issue a certificate of Completion of the Works, and the Consulting Engineer (CE) will do so upon deciding that the work is completed.
49. Taking Over	49.1	The Employer shall take over the Site and the Works with in seven days of the Consulting Engineers (CE) issuing a certificate of Completion.
50. Final Account	50.1	The Contractor shall supply the Consulting Engineer (CE) 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 Consulting Engineer's (CE) 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 not, the Consulting Engineer (CE) 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 Consulting Engineer's (CE) shall decide on the amount payable to the Contractor and issue a payment certificate.
51. Operating and Maintenance Manuals	51.1	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.

	51.2	If the Contractor does not supply the Drawings and/or manuals by the dates stated in the Contract Data, or they do not receive the Consulting Engineer's (CE) approval, the Consulting Engineer (CE) shall withhold the amount stated in the Contract Data from payments due to the Contractor.
52. Termination	52.1	The Employer or the Contractor may terminate the Contract if the other party causes a fundamental breach of the Contract. Either party must write a notice of termination to the other party before termination. A warning letter will be sent to the contractor for the first breach of the contract. Only if the breach is not corrected within a stipulated period indicated in the warning letter or the breach is repeated again shall the Employer notify the contractor of the contract termination.
	52.2	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 Program and the stoppage has not been authorized by the Consulting Engineer (CE). b) The Consulting Engineer (CE) instructs the Contractor to delay the progress of the Works, and the instruction is not withdrawn within 28 days. c) The Employer or the Contractor is made bankrupt or goes into liquidation other than for a reconstruction or amalgamation; d) A payment certified by the Consulting Engineer (CE) is not paid by the Employer to the Contractor within 84 days of the date of the Consulting Engineer's (CE) certificate;

		e) The Consulting Engineer (CE) 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 Consulting Engineer (CE); 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 which the maximum amount of liquidated damages can be aid, as defined in the Contract Data. h) The Contractor, in the judgment of the Employer has engaged in corrupt of 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. "**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 Beneficiary, and includes collusive practice among Bidders (prior to or after bid submission) designed to establish bid prices at artificial non-competitive levels and to deprive the Beneficiary of the benefits of free and open competition.
	52.3	When either party of the Contract gives notice of a breach of Contract to the Consulting Engineer (CE) for

		a cause other than those listed under Sub-Clause 52.2 above, the Consulting Engineer (CE) shall decide whether the breach is fundamental or not.
	52.4	Notwithstanding the above, the Employer may terminate the Contract for convenience.
	52.5	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.
53. Payment Upon Termination	53.1	If the Contract is terminated because of a fundamental breach of Contract by the Contractor, the Consulting Engineer 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. Additional Liquidated Damages shall not apply. If the total amount due to the Employer exceeds any payment due to the Contractor, the difference shall be a debt payable to the Employer.
	53.2	If the Contract is terminated for the Employer's convenience or because of a fundamental breach of Contract by the Employer, the Consulting Engineer shall issue a certificate for the value of the work done, Materials ordered, the reasonable cost of removal of Equipment, repatriation of the Contractor's personnel employed solely on the Works, and the Contractor's costs of protecting and securing the Works, and less advance payments received up to the date of the certificate.
54. Property	54.1	All Materials on the Site, Plant, Equipment, Temporary Works', and Works shall be deemed to be the property of the Employer if the Contract is terminated because of the Contractor's fault.
55. Release from Performance	55.1	If the Contract is frustrated by the outbreak of war or by any other event entirely outside the control of either the Employer or the Contractor, the Consulting

		Engineer shall certify that the Contract has been frustrated. The Contractor shall make the Site safe and stop work as quickly as possible after receiving this certificate and shall be paid for all work carried out before receiving it and for any work carried out afterwards to which a commitment was made.
56. Suspension of Project Financing	56.1	In the event that the financing of the Project is stopped. (a) The Employer is obligated to notify the Contractor of such suspension within 7 days of having received the suspension notice. (b) If the Contractor has not received sums due within 84 days for payment provided for in Sub-Clause 52.2, the Contractor may immediately issue a 14-day termination notice.
57. FIDIC	57.1 57.2	FIDIC conditions of Contract for work of Civil Engineering Construction also apply beside the above conditions. If a condition stipulated here is different of the FIDIC Condition, this contract conditions prevail.

SECTION 5

CONTRACT DATA

CONTRACT DATA

Section in Condition of Contract	
1.1	▪ Project Name: **The Saudi Program for Drilling of Wells and Rural Development in Africa, Phase V – Republic of Kenya**
1.1	▪ Project Identification Number: **P5/2019/Kenya**
1.1	▪ The Employer is: **The Saudi Fund for Development SFD** **P.O. Box 50483** **Riyadh, 11523** **Kingdom of Saudi Arabia**
2.1	▪ The Beneficiary is: **Water Sector Trust Fund** **Ministry of Water & Sanitation and Irrigation**
2.1	▪ The Consultant Engineer is: **SCET-TUNISIE** **2 rue Sahab Ibn Abbad, Cité Jardins - 1002 Tunis Belvédère –** **P.O.Box 16,** **1002 Tunis, TUNISIA**
3.1	▪ Project Country: **Kenya** ▪ The Sites of Work: 42 Villages in 6 Counties (Garissa, Isiolo, Wajir, Samburu, Marsabit, and Mandera) of Kenya The villages list with constituencies, Counties and Coordinates is shown in appendix A. ▪ The Works ▪ The work at each and every site comprise of: (1) Conducting Environmental and Social Impact Assessment (ESIA) for each of the 42 wells in accordance with the

	provisions of the Environment Management and Coordination (Amendment) Act (2015) Cap 387 laws of Kenya and all the subsequent regulations under the Act. (2) Drilling of wells as shown in sites in appendix A and according to well drawing in figure 2 in appendix A and the specifications in section 6. This work including selection of sites within the village, hydrogeological and geophysical investigations for each well, EIA for each well, drilling with a final diameter of 12'' ¼ inches supply and installation of PVC casing, slotted PVC casing, sump pipes, filler gravel, clay, backfill material and cement grout and well head construction works. It also includes well development, test pumping both step and long duration and recovery, disinfection, bacteriological and chemical analysis, vertically and alignment tests, geophysical logging and report. (3) Supply and installation of Pumps and ancillaries: Minimum required discharge of wells is $3m^3$/hour. Well head is shown in figure 2 in appendix A. Specification of pumps and ancillaries are in Chapter 6 (4) Supply and installation of solar system and / or diesel generators for driving the submersible pump. Specifications are shown in Chapter 6. (5) Supply and installation 42 steel water tanks with capacity of either 100 m^3. Tanks specification shown in chapter 6. (6) Supply and installation of 42 pipe distribution systems from water tanks to tap post located in the villages served by the well systems. (7) Work also includes animation/sensitization which means beneficiaries contact with management and maintenance of the water system for awareness, during and after construction. Details specified in Chapter 6. (8) Training of maintenance team and providing spare parts as specified in bill of quantities.
3.2	▪ The work shall be completed within a maximum period of 24 months from start of works. The period includes the rainy season.
4.1	The language of the contract document is English.

4.2	The law that applies to the Contract is the law of the Republic of Kenya
4.3	The minimum insurance cover shall be: (a) The maximum deductible for the insurance of the works and Plant and Materials is 30 % the cost of these items. (b) The minimum cover for insurance of the works and of Plant and Materials in respect of the Contractors faulty design is 80 % the cost of these items. (c) The maximum deductible for insurance of equipment is 70 % the cost of these items. (d) The minimum cover for loss or damage of Equipment is 80 % the cost of these items. (e) The maximum deductible for insurance of other property is 30 % the cost of these items. (f) The minimum for insurance for other properties is 80 % the cost of these items. (g) The maximum cover for personal injury or death is 100,000 USD for the contract employee and for other persons.
5.1	The Contractor shall submit a revised Program for the works within 7 days of the delivery of the letter of Acceptance.
6.1	The period between program update is one month. The amount to be withheld for late submission of an update program is 10,000 USD.
6.2	The Defect Liability is 365 days
7.1	<u>Retention:</u> The proportion of payment retained is 5% of each invoice submitted by the Contractor.
7.2	<u>The liquidated Damage:</u> The Liquidated damage for the whole of the Work is $\frac{1}{540}$ of the contract price. The maximum amount of liquidated damage of the whole of the Works is 10% of the contract price.
8.1	The advance payment will be 20% of the contract price and will be paid to the Contractor not later than 15 days after submission of the bank guarantee.

9	The Performance Security shall be equivalent to 10% of the total amount of the contract price. The performance Security can be either a bank guaranty or a performance bond.
10.1 10.2	The standard forms of Performance Security acceptable to the employer shall be unconditional Bank guarantee of the type presented in section 5 of the Bidding document. The date by which operating and maintenance manuals and "as built" drawings are required is one month after completion date.
11	The amount to be withheld for failing to produce "as built" drawings and/or operation and maintenance manuals by the required date is 10 % of the total amount of the contract. The percentage to apply to the value of the work not completed is 100%.

SECTION 6

FORM OF BID, QUALIFICATIONS INFORMATION, TECHNICAL EVALUATION SHEET FOR BIDDERS, LETTER OF CCEPTANCE, AGREEMENT, BID SECURITY, TAKING-OVER CERTIFICATE AND DEFECTS LIABILITY CERTIFICATE

Project No.: P5/2019/Kenya

Tender No.: P5/2019/Kenya/Contractor

Project Title: The Saudi Program for Drilling of Wells and Rural Development in Africa: Phase V in the **Republic of Kenya**.

Contractor: …….

To: **The Saudi Fund for Development SFD**
P.O. Box: 50483
Riyadh, 11523
Kingdom of Saudi Arabia

Dear Sir,

1. Having examined the Conditions of Contract, Sketches, Technical Specifications, Bill of Quantities and all other documents received with the Invitation to Tender for the execution of the Works in connection with the above named Project and having acquainted ourselves with all the local conditions and Sites, we, the undersigned, offer to execute and complete such Works and remedy any faults and defects therein in conformity with the conditions spelt out in aforementioned documents for the sum (Contract Price) as stated in Section 8 (Bill of Quantities and Schedule of Prices) or such other sums as may be ascertained in accordance with the said conditions.

   It is understood, that the Contract Price is an absolutely fixed upper limit of the remuneration and payments due by the Employer and we agree to waive any rights which would have the effect that this Contract Price is exceeded.

2. We acknowledge that the enclosed Appendix to Tender forms part of our Tender.

3. We undertake, if our Tender is accepted, to commence the Works within the time required in the Contract Conditions, and to complete the whole of Works comprised in the contract within the time stated in the Contract Conditions.

4. We agree to be bound by this Tender for the period of 180 days from the submission date stated in the Invitation to Tender and it shall remain binding upon us and may be accepted at any time before the expiration of that period.

5. Unless and until a Contract Agreement is signed, this Tender, together with your written acceptance thereof, shall constitute a binding contract between us.

6. We understand that you are not bound to accept the lowest or any tender you may receive.

Dated this: ……Day of ……..

Signature: …….. In the capacity of ……

Duly authorized to sign Tenders for and on behalf of ……..

……

…….
(Contractor's name and address in block capitals, Official Stamp)

Encl.: APPENDIX TO TENDER

Qualifications information		
1. Individual Bidders or Individual Members of Joint Ventures	1.1	Constitution or legal status of Bidder (*Attach Copy*) Place of Registration: (*Insert*) Principal place of business: (*Insert*) Power of attorney of Signatory of Bid: (*Insert*)
	1.2	Total annual volume of construction work performed in the last five years in the internationally traded currency in the Bidding Data: (*Insert*)
	1.3	Work performed as prime Contractor on works of a similar nature and volume over the last five years. The values should be indicated in the same currency used for item 1.2 above. Also list details of work under way or committed, including expected completion date.

Duration	**Assignment name/ & brief description of main deliverables/outputs**	**Name of Client & Country of Assignment and Contact person**	**Type of work performed and year of completion**	**Approx. Contract value (in US$ equivalent)/ Amount paid to your firm**

	1.4	Major items of Contractor's Equipment proposed for carrying out the Works. List all information requested below. Refer also to Sub-Clause 4.3 (d) of the Instructions to Bidders.

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?)**

	1.5	Qualification and experience of key personnel proposed for administration and execution of the Contract. Attach biographical data. Refer also to Sub-Clause 4.5 of the instructions to bidders and Clause 4.1 of section 3 (instructions to bidders).

Position	**Name**	**Years of experience (general)**	**Years of experience in proposed position**

	1.6	Proposed subcontracts and firms involved, Refer to Clause 7 of Condition of Contract

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

	1.7	Financial reports for the last five years: Audited accounts for the last five years. List below and attach copies.

	1.8 1.9 1.10	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. Name, address, and telephone, telex, and facsimile numbers of banks that may provide references if contacted by the Employer. Information on current litigation in "which the Bidder" is involved.

Other party(ies)	Cause of dispute	Amount involved

	1.11	Statement of compliance with the requirements of Sub-Clause 3.2 of the Instructions to Bidders.
	1.12	Proposed Program (work method and schedule). Descriptions, drawings, and charts, as necessary, to comply with the requirements of the bidding documents.
2. Joint Ventures	2.1 2.2	The information listed in 1.1 – 1.11 above shall be provided for each partner of the Joint Venture (JV). The information in 1.12 above shall be provided for the joint venture.

	2.3	Attach the power of attorney of the signatory of the Bid authorizing signature of the Bid 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	Bidders should provide any additional information required in the Bidding Data or to fulfill the requirements of Sub-Clause 4.1 of the Instructions to Bidders, if applicable. The Contractor take the following: (a) Provide 2 new 4-wheel drive cars of reputable mark for the sole use of the Mission Leader of the Consultant Engineer (CE) and his crew. (b) Provide an office in his base camp fully furnished and equipped for the use of Consultant Engineer (CE) and his staff.

		(c) Provide accommodation, subsistence, and transportation at all sites camps for the Consultant Engineer (CE) and technicians.

Experience in SFD funded programs									
Appendix 3 to Tender Conditions									
Technical Evaluation Sheet for Tendering of Contractors									
Country: **Kenya**	Project No.: P5/2019/Kenya								
Date:	Tender No.: **P5/2019/Kenya/Contractor**								
		Company		**Company**		**Company**		**Company**	
1. Experience of the Company	Rating in %	Points, max 10	Valuation	Points, max 10	Valuation	Points, max 10	Valuation	Points, max 10	Valuation
Note: Points estimated from prequalification document									
a) Water supply and well construction	5								
b) Surface Construction	5								
c) Regional	2								
d) In the country	2								
e) Experience in SFD funded programs	10								
Total 1.	**24**								
2. Technical Proposal									
a) Overall Concept, Standards, Quantities	5								
b) Drilling Concept, Digging methods	5								
c) Supply network, tanks, solar pump etc.	4								
d) Surface Constructions	5								
e) Construction Materials	3								
f) Pumping and Testing Equipment	4								
g) Animation concept and staffing	3								
h) Maintenance, Spare Parts supply	4								
i) Organization of Works	3								
Total 2.	36								

3. Equipment for Execution of Works										
a) Drilling/Digging Equipment	4									
b) Equipment for surface installations	3									
c) Camps and supply installation	2									
Total 3.	9									
4. Drawings										
a) Completeness of construction drawings	5									
b) Quality of drawings, dimensions etc.	3									
Total 4.	8									
5. Timing										
a) Specification of Time Schedule	4									
b) Appropriateness	5									
Total 5.	9									
6. Staffing										
a) Project Management Staff	4									
b) Field Management Staff	5									
c) Field Team, Qualification, Number	5									
Total 6.	14									
Total 1 – 6*	100									
*** Minimum Percentage:** 70% of Technical Offer										
Final Ranking: Offer with lowest price of Tenderers meeting the requirements of Technical evaluation										

Letter of acceptance

(Date ……)

To: (name and address of the Contractor)

This is to notify you that your Bid dated [*date*] for execution of the [*name of the Contract and identification number, as given in the Contract Data*] for the contract Price [*amount in numbers and words*] [*name of currency*] is hereby accepted by our Agency.

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

Authorized Signature: …….
Name and Title of Signatory: …….
Name of Agency: ……

Attachment: Agreement

Agreement

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

Whereas the Employer is desirous that the Contractor executes / name and identification number of Contract (hereinafter called the Works) and the Employer has accepted the Bid by the Contractor for the execution and completion of such Works and the remedying of any defects therein.

Now this Agreement witness as follows:

1. In this Agreement, words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to, and they shall be deemed to form and be read and construed as part of this Agreement.

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

3. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the works and the remedying of defects wherein the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

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

The Common Seal of ……
was hereunto affixed in the presence of…….

Signed, Sealed, and Delivered by the said ……

in the presence of ……

Binding Signature of Employer ……

Binding Signature of Contractor …….

The Saudi Program for Drilling of Wells and

Rural Development in Africa; Phase V

SPECIMEN

Advance Payment Guarantee

Employer: The Saudi Fund for Development SFD
P.O. Box 50483
Riyadh, 11523
Kingdom of Saudi Arabia

Contractor: …….
……

Contract Date: ……

Project No.:	P5/2019/Kenya
Contract/Tender No.:	P5/2019/Kenya/Contractor
Object of Works:	Construction of about 42 Drilled Wells Equipped with Solar or diesel pumping generator, RC water tanks and pipelines connections to supply several villages in Garissa, Isiolo, Wajir, Samburu, Marsabit, and Mandera Counties in Kenya.
Contract Price:	US$.....

We here by undertake vis-à-vis the Employer to guarantee independently fulfillment of all of the Contractor's obligations arising from the aforementioned Contract, including any incidental claims, up to the amount of

US$.....

(in words: …….)

Explicitly waiving all objections and defenses, we undertake to render said payment upon receipt of the Employer first written demand, provided that the latter states that the Contractor has failed to observe all or part of his contractual obligations.

In case of any claim under this guarantee payments by the Guarantor shall be made to the account of the Saudi Fund for Development.

This guarantee shall become effective with the first advance payment made by the Employer and shall expire when the advance payment has been set off in full.

The Employer shall return this guarantee to us as soon as its validity expires.

.....
(Signature of the Guarantor, stamp)

The Saudi Program for Drilling of Wells and

Rural Development in Africa; Phase V

SPECIMEN

Performance Guarantee

Employer: The Saudi Fund for Development SFD
P.O. Box 50483
Riyadh, 11523
Kingdom of Saudi Arabia

Contractor: …….

Contract Date: ……

Project No.:	P5/2019/Kenya
Contract/Tender No.:	P5/2019/Kenya/Contractor
Object of Works:	Construction of about 42 Drilled Wells Equipped with Solar or diesel pumping generator, RC water tanks and pipelines connections to supply several villages in Garissa, Isiolo, Wajir, Samburu, Marsabit, and Mandera Counties in Kenya.
Contract Price:	US$.....

We here by undertake vis-à-vis the Employer to guarantee independently fulfillment of all of the Contractor's obligations arising from the aforementioned Contract, including any incidental claims, up to the amount of

US$.....(…..% of the Contract Price)
(in words: …….)

Explicitly waiving all objections and defenses, we undertake to render said payment upon receipt of the Employer first written demand, provided that the latter states that the Contractor has failed to observe all or part of his contractual obligations.

In case of any claim under this guarantee payments by the Guarantor shall be made to the account of the Saudi Fund for Development.

This guarantee shall become effective with the date of signing the Contract and shall remain valid until the date of issue of the last Taking-Over Certificate.

The Employer shall return this guarantee to us as soon as its validity expires.

.....
(Signature of the Guarantor, stamp)

The Saudi Program for Drilling of Wells and

Rural Development in Africa; Phase V

SPECIMEN

Defects Liability Guarantee

Employer: The Saudi Fund for Development SFD
P.O. Box 50483
Riyadh, 11523
Kingdom of Saudi Arabia

Contractor: …….

Contract Date: ……

Project No.:	P5/2019/Kenya
Contract/Tender No.:	P5/2019/Kenya/Contractor
Object of Works:	Construction of about 42 Drilled Wells Equipped with Solar or diesel pumping generator, RC water tanks and pipelines connections to supply several villages in Garissa, Isiolo, Wajir, Samburu, Marsabit, and Mandera Counties in Kenya.
Contract Price:	US$.....

We hereby undertake to grant the Employer an independent guarantee for the warranty claims to which he is entitled vis-à-vis the Contractor pursuant to the aforementioned Contract, including any incidental claims, up to the amount of

US$.....

(in words: …….)

Explicitly waiving all objections and defenses, we undertake to render said payment upon receipt of the Employer first written demand, provided that the latter states that the Contractor has failed to observe all or part of his contractual obligations.

In case of any claim under this guarantee payments by the Guarantor shall be made to the Account of the Saudi Fund for Development.

This guarantee shall become effective upon the date of payment of the retention money on the Contractor's account and shall expire upon the end of the Defects Liability Period, but only after receipt of the Defects Liability Certificate..

The Employer shall return this guarantee to us as soon as its validity expires.

.....
(Signature of the Guarantor, stamp)

The Saudi Program for Drilling of Wells and

Rural Development in Africa; Phase V

SPECIMEN

Taking-Over Certificate

1. This is to certify that the well/surface structure

   N^0 ……

   County …….

   Constituency ……

   Village …….

   Has been completed according to the Contract No. P5/2019/Kenya on ……..

2. The following minor defects and/or minor remaining works were found:
   a) Minor defects
   b) Minor remaining works
   c) Deadline for correction of defects and if applicable for completion works.

3. Remarks

   Place ……. Date ……

   The Engineer …… The Contractor ……

   The Government's Representative ……..

The Saudi Program for Drilling of Wells and

Rural Development in Africa; Phase V

SPECIMEN

Defects Liability Certificate

Contractor: ……

Project No.: P5/2019/Kenya

Contract/Tender No.: P5/2019/Kenya/Contractor

This is to certify that for site ……

1. The permanent Works have been completed according to the above mentioned Contract without defects.
2. The Contractor has fulfilled his obligations according to the Contract documents.

Place: ……..

Date: ……..

The Employer/The Engineer: ……..

The Saudi Program for Drilling of Wells and Rural Development in Africa, Phase V

Time Schedule

Months	December				January				February				March				April				May				June				July				August				September				October				November			
Weeks / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Submittal of the Master List (equipment, material, vehicules etc.) to obtain the tax Exemption																																															
Mobilization																																															
Animation/sensitization																																															
Hydrogeological and geophysical pre-investigations																																															
Drilling																																															
Development of drilled well																																															
Test pumping drilled well																																															
Construction of a concrete well head, galvanized steel well head and furnishing																																															
Supply and installation of submersible pumps including all accessories																																															
Supply and installation of a complete solar generator																																															
Supply and installation of a galvanized steel tank and tower with all necessary parts																																															
Supply and construction of a wire mesh fence																																															
Supply and installation of HDPE pipes (NOD 63 PN10)																																															
Construction of tap posts																																															
Construction of watering trough for the livestock																																															
Construction of laundry area																																															
Training of mechanics for the maintenance of Solar Water Supply Systems																																															

Months	January				February				March				April				May				June				July				August				September				October				November			
Weeks / Activity	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
Submittal of the Master List (equipment, material, vehicules etc.) to obtain the tax Exemption																																															
Mobilization																																															
Animation/sensitization																																															
Hydrogeological and geophysical pre-investigations																																															
Drilling																																															
Development of drilled well																																															
Test pumping drilled well																																															
Construction of a concrete well head, galvanized steel well head and furnishing																																															
Supply and installation of submersible pumps including all accessories																																															
Supply and installation of a complete solar generator																																															
Supply and installation of a galvanized steel tank and tower with all necessary parts																																															
Supply and construction of a wire mesh fence																																															
Supply and installation of HDPE pipes (NOD 63 PN10)																																															
Construction of tap posts																																															
Construction of watering trough for the livestock																																															
Construction of laundry area																																															
Training of mechanics for the maintenance of Solar Water Supply Systems																																															

SECTION 7

TECHNICAL SPECIFICATIONS

1. Introduction

The Contractor is required to closely observe this technical specification to execute the works in this project and to follow the instruction of the Consultant Engineer during the course of the project. However, the Contractor is required to put to the work equipment and tools in good working condition and in sufficient number to guarantee continuous work without stoppage besides providing qualified and experienced staff to perform the work to the state-of-the art and to the highest standard. The tenderer is supposed to have acquainted himself with the situation in Kenya and the sites of the work. He shall always put the goals of the Saudi Fund for Development of sponsoring the project. The execution of the work, the materials, and procedure shall depend on the known International Regulation and standard. Drawings and measurements are to be in SI - units.

This technical specification shall have precedence over any standards.

2. Organization of Works

Immediately following the signing of the contract and for a period not more than 2 months, the Contractor has to mobilize his equipment, materials, and personnel to his base camp. He has to prepare all construction methods, drawings, and final schedule of the work.

The Contractor has to collect all relevant information about the hydrogeology of sites to be executed. This will include:

- Interpretation of aerial photos
- Geophysical data

  The hydrogeological study shall be conducted for every site in an area bounded by a circle of 5 km. the study shall consist of:

1. Desk Study
   - Collection of existing data from relevant departments
   - Collection of available maps i.e. topographic, geological and meteorological

2. Field Survey
   - Field reconnaissance survey to locate vegetation, depression, houses, farms etc.
   - Well inventory within and around the village.

3. Assessment of data and information.
   - Based on the desktop study and field reconnaissance survey assessment, locations shall be chosen for detailed geophysical survey

4. Conducting three geophysical survey soundings in each location and setting priority of drilling according to the result of the survey.

All these works shall be under the direct supervision of the Consultant Engineer and the report of the study to be handed to him. A meeting shall follow this between the Contractor, the Consultant Engineer, and the representatives of the Water Sector Trust Fund.

The list of villages proposed is shown in Appendix A.

Based on the results of the geophysical survey, the consultation of the local beneficiaries and the water department, the location of each well will be marked on the ground in the presence of the Engineer. An Environmental and Social Impact Assessment (ESIA) shall be conducted for every site in accordance with the provisions of Environment Management and Coordination (Amendment) Act, 2015 (Cap 387 laws of Kenya)

In case the first hole does not produce the required quantity of water, 3m3/hr, the Contractor will drill other location in the site up to 3 trials. The cost of the negative drilling shall be included in the unit rates of the individual items of work in the Bill of Quantities and will not be paid to the Contractor.

The Contractor shall furnish his base camp, workshops, parking area, office building, stores, laboratories, etc. needed for the proper execution of the works. This will include but not limited to preparation of the space including grading, removal of shrubs, garbish, access roads, etc. the Contractor can use a government owned land close to the Centre of the area but if use private land he/she has to arrange with the owner on his own expense. To effectively and conveniently perform the project tasks, the Contractor may consider moving the base camp from one county to another for ease of access to the sites as applicable.

The base camp shall be in a central location to the project with consultation and agreement of the Consultant Engineer. Site camps shall be at drilling site locations. The main camp has to include a furnished office for the sole use of the Consultant Engineer staff. The office shall be provided with electricity, printing, and faxing machines and desktops computers.

The Contractor shall provide the Consultant Engineer technicians with accommodation, meals at the base camp and transport and accommodation at the sites.

The Contractor shall ensure security at the base camp, site camp and during the transport between base and site camp.

The Contractor has to provide 2 four wheel drive pick-ups (4WD) to the Consultant and one 4WD pick-up to the RE of the WSTF. The 4WD pick-ups have to be of a reputable brand. These cars will be handed at the end of the project to the Kenya Water Trust Fund.

A signpost with Project symbol shall be erected at the commencement of the work at each site and also a well identification plate shall be put at the site at completion of the working giving details of the well characteristics.

The Contractor has to select people from the village to form a committee for looking after the well management, maintenance, and operation. The committee is to be selected by the villagers under supervision of the Consultant Engineer.

3. Description of Works

This is the works under the Saudi Program of Drilling of Wells and Rural Development in Africa, Phase V in the Republic of Kenya. The program's goals are:

- To raise the standard of living of the rural population by long-term provision of a safe drinking water supply.
- To improve the water supply situation in rural areas to benefit as many people as possible and provide a basis for gradual development.
- To provide hygienically safe drinking water.
- To train local communities to operate and maintain the water points for a long term benefit.
- To help alleviate unemployment by giving job opportunities to local people.
- To spread the goodwill of the Kingdom of Saudi Arabia towards the poor Muslim communities in Africa.
- The work in this project is to supply 42 villages or/and group of village with hygienically safe drinking water from drilled wells equipped with submersible pumps driven by solar system or /and diesel generator, a water tank, a water pipe distribution system with tap post as close as possible to the beneficiary at each community.
- The drilled wells shall be drilled as boreholes of diameter 10" (254mm) cased with casings and screens with diameter of 8" (203mm) as appropriate with filter packs in the annular space and sealing with clay and cement. The casing is to bear 8 bar pressure and

screen opens 0.7 - 1 mm and total x section of opens is 7% of casing. Each drilled well shall be sealed by a concrete slab which bear the pumping equipment and protect the well from pollution. A well head shall be constructed to protect the well.

Fig. 1 in Appendix B give schematic drawing for the suggested well drilling.

- The water tanks shall be elevated steel tanks of capacities as specified in chapter 5 of this section and to be supported on steel structure and concrete foundation designed properly by the Contractor. The tanks shall be at the highest spot near to the well and raised to a maximum of 12m from the ground.
- Photovoltaic generator comprising the photovoltaic array, inventor combiner, cables steel structure on a concrete foundation. The panels can be Hyundai, JinkoSolar, Shuco, Amerisolar, SunPower, LG, Panasonic, Silfab, Q CELLS, Canadian Solar, Trina Solar, REC Solar, Bosch, BP, Lorentz, Mitsubishi, Sanyo, Sharp, or any approved known type.
- Submersible pump with ability to discharge the required yield for the given water head provided by the solar. Type Grundfos or equivalent.
- Reticulation system which takes water in HDPE pipes to public water taps in selected locations. The pipe diameter shall be (125, 110, 90, 75, 63and 50 mm) Length at each location is estimated as from the design. Wherever possible, technically and financially, the tap post shall be located in conformity with the needs of the beneficiaries. The tap posts supported by masonry wall on a concrete slab. A drawing of suggested tap post and number are shown in fig. (4) in Appendix B.
- Animation and sanitization: this activity involves enlightening end users with the water points; its maintenance and management. This activity shall start before all other activities and all during the project life.

  The main objective of animation sensitization is to ensure a long time drinking water at the target villages.
- In the bill of quantity there are no items for preparing access to sites for his equipment and personnel and he is supposed to include this in the priced items.

4. Well Drilling and Construction

4.1 General

The sites for drilling are in varied rock types ranging from crystalline (volcanic or metamorphic) and sedimentary rocks. The depth of drilling is estimated to be 200 meters. A successful well is the well giving a sustainable yield of ≥ 3m3/hr. Wells giving a yield less than this is considered a failure and will not be paid for.

In the selected counties of Marsabit, Samburu, Isiolo, Mandera, Wajir and Garissa, groundwater potential is low to medium. However, the amount of drilling meters for unsuccessful drilling shall be included in the price of the Bill of Quantities. No payment will be made for unsuccessful wells. In case of mistakes in drilling operation which lead to change of drilling locations the Contractor shall bear the cost of this relocation. It is therefore the responsibility of the contractor to ensure that an ideal location is chosen based on the geophysical investigations carried out.

A successful well is the well:

1. giving a sustainable yield of ≥ $3m^3$/hr,
2. whose water is compliant to the health and quality standards in Kenya for Groundwater KS 05-459 (1996),

However only the yield criteria will be applied to pay for successful boreholes.

As per the expert opinion, the success rate of boreholes in the six counties is as follows:

County	Number	%
Wajir	12	95%
Garissa	10	80%
Mandera	8	95%
Marsabit	7	80%
Samburu	3	80%
Isiolo	2	60%

In order to increase the success rate of the productive boreholes, the Contractor will carry out borehole site investigations for both priority and standby selected sites. **Drilling will only be carried out for sites with high prospects. It is proposed that at least 3 measurements be carried out at each site**.

4.2 Drilling Method

The method used for drilling shall be Rotary Drilling Technique or Down the Hole Hammer. The contractor shall be responsible for the drilling method or methods selected; neither the Client nor the Supervising Engineer shall be held responsible should the method or methods adopted fail in the objective of drilling to the depth required.

If down- the- hole hammer methods are to be deployed, the Contractor shall not use excessive pulldown on the bit. Should the borehole be skewed as a result of excessive pulldown, and the borehole not fit for purpose in consequence, the hole shall be deemed a Lost Bore. The Contractor shall therefore employ a stabilizer or stabilizers of appropriate diameter and mass when drilling.

Drilling fluid additives must be suited to environmental applications. Additives must be able to be denatured by exposure to soluble chlorine, and must not be prone to biodegradation or fermentation. Bidders shall provide details of the type(s) and manufacturer of additive(s) to be used, and will describe the means by which the additive(s) will be mixed. If fluid rotary flush methods are to be adopted, either artificial powder or liquid anionic polymeric additives must be used for viscosity enhancement; additives comprising bentonite or cellulose will not be acceptable as viscosity builders for use in these works. The judicious application of bentonite or cellulose or similar material will be acceptable as a means of preventing loss of circulation in those parts of the borehole located above or between aquifer zones provided their use is authorized in advance by the Engineer.

Bidders shall provide: –

a) A meter rate for drilling at 10”/254 mm from surface to depths of not more than 100 meters; Bidders should allow for 4,200 meters

b) A meter rate for drilling at 10”/254 mm from depths of 100 to 200 meters; Bidders should allow for 3,500 meters

c) A meter rate for drilling at 10”/254 mm from depths of 200 to 300 meters; Bidders should allow for 200 meters

4.3 Supply and Install Surface/ Temporary Casing

The borehole will be provided with up to six (6) meters of surface casing of diameter no larger than 12”/304 mm. This will form two purposes: 1) it will protect the top of the borehole from erosion from returning drilling fluids or artesian flow or both and 2) will form the sanitary seal casing in the borehole headworks.. Casing used as surface casing shall be mild steel of a specification suited to water well applications for installation to depths not exceeding 50 m depth; the specifications shall be given by Bidders in their proposals.

Site conditions may require temporary casing to be installed to depths greater than six (6) meters. The Contractor must ensure that sufficient temporary casing is deployed to site to allow installation to greater depths should this be necessary. Casing used as temporary casing shall be mild steel of a specification suited to water well applications for installation; the specification shall be given by bidders in their proposals.

Bidders shall provide: –

a) A meter rate for drilling at 12"/304 mm from surface to depths of not more than 6 meters; Bidders should allow for 252 meters
b) A meter rate for supply and installation of 12"/304 mm temporary surface casing from surface to depths of not more than 6 meters; Bidders should allow for 252 meters.

4.4 Sample Collection, Storage and Record Keeping

The Water Act (GoK 2002) requires that samples of strata drilled through be collected. For the purposes of these works, samples shall be collected at two (2) meter intervals and at prominent lithological boundaries. Samples shall be collected wet from the wellhead, after appropriate correction to account for rise time, and stored in sample boxes such that not less than 500 grammes of sample remain after drying. Samples will be sun-dried and sample logging will be conducted by the Engineer. After sample logging, the Contractor will bag each sample in a polythene bag of appropriate strength and size. Samples will be clearly marked with tie-on labels indicating date of collection, the depth interval and the borehole name and number. At the completion of the works bagged samples, collected by Contractor in sacks marked with the borehole number, will be delivered to Contractor's camp.

The Contractor shall record the depth of any zone of lost circulation for which no sample was taken. A log of the rate of penetration, in minutes per meter drilled, shall be kept. The depth of any voids, or of particularly rapid penetration, or significant changes in rig noise indicating changes in geological conditions, shall also be noted; such information will be recorded on a Daily Drilling Report (DDR) form. Bidders should submit a sample DDR with their proposals; if this does not meet the needs of this borehole construction program, a suitable DDR will be provided to the successful Contractor to use.

Water levels 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), and as required by the Water Act 2002 (Fourth Schedule). Water levels shall be measured using a sounding and/or lighting dipper approved in advance by the Engineer. It is acknowledged that if direct rotary fluid methods are used, it will rarely be possible to measure true water levels during the course of drilling. However, water level measurements will be

required during development operations, and the Contractor will ensure that a dipper is included with the drilling plant deployed for these works.

Bidders shall provide: –

A **unit rate** for collecting, drying, bagging, sacking and labelling samples collected at two (2) meter intervals; a total of 3950 samples should be provided for. The unit rate is deemed to include the collection of rate of penetration and other drilling information; and the collection of water levels as and when this is possible.

4.5 Supply and Install Permanent Casing and Screens

On completion of drilling and sample logging, and after showing the borehole clean to total depth, the Contractor shall install casing and screen according to the design provided by the Engineer. If the borehole is not clean to total depth it will be flushed again immediately prior to casing string installation.

Plain casing shall comprise new mild steel casings and screens. Mild steel casing and screen shall be suitable for installation in water wells deeper than 250 m depth. It shall have an internal diameter of not less than 8"/203 mm. Bidders shall present the specification of the casing and screen proposed for installation in borehole.

The screen shall comprise horizontal slots of open area not less than 6% and of slot size **0.5 mm**.

Casing and screen lengths of mild steel are to be connected by butt-welding or ring-welding.

The top of mild steel casing string at completion of construction shall terminate not less than 15”/0.4 m above original ground level.

Bidders shall provide: –

a) A **meter rate** for the supply and installation of a total of 6,198metres of plain mild steel casing, including jointing;

b) A **meter rate** for the supply and installation of 1,702metres of slotted mild steel screen, including jointing.

4.6 Supply and Installation of Gravel Pack

A gravel pack shall be installed in screened portions of the borehole.

The gravel must be clean well-rounded siliceous gravel with no more than 5% non-siliceous

material and of diameter 1 to 2 mm. Bidders will provide in their bids a particle size distribution curve from a reputable laboratory describing the gravel pack proposed for use in this program, as well as the bulk density of the pack material expressed as kg per m3.

The pack shall be inspected by the Engineer on site, and if excessively dirty, he will require that it be washed, to his satisfaction, before approving its installation into the borehole annular space; the costs associated with such washing shall be met by the Contractor, and the time spent doing so will be accounted as down-time.

Installation of gravel pack shall use water wash down via a tremie pipe. 65% chlorine granular calcium hypochlorite will be introduced into the annular space along with the pack material at a nominal concentration of 500 grammes per cubic meter of pack. This will break down any residual additive(s) (if used), and will partly disinfect the wellbore.

Gravel pack will be detailed in the borehole design prepared by the Engineer, together with the vertical intervals in the borehole it must extend through. Bidders shall describe in their proposals how they propose to measure the level of gravel pack during its installation.

Bidders shall provide: –

a) A **unit volume rate** for the supply and installation of clean 1 to 2 mm diameter gravel pack assuming a maximum volume of 126 m^3

The technical score of bidders who insist on providing a unit mass rate will be marked down by 10% of the final technical score, and will score no points for the supply and installation of gravel pack. In such cases the Engineer will calculate the approximate volume that the bidder has provided for as mass, and recalculate the price per unit volume.

4.7 Supply and Install Grout

Grout seals will be required in the borehole to provide a sanitary seal near ground level. This is essential to prevent vertical drainage of shallow aquifer waters into deeper aquifers. The vertical thickness of grout in the borehole shall not exceed 10 meters.

5% by volume bentonite clay/ordinary Portland cement/sand grout of bulk density 1.6 to 1.8 kgs/liter will be placed under positive pressure via a tremie pipe from the top of the highest gravel pack or inert material installed in the annular space. The annular space will be filled with grout to the design depth, after which the next gravel pack layer shall be installed (or inert material inserted). After the borehole has been gravel packed and grouted, the remaining

annular space shall be filled with inert material to a depth of 3 m bgl, and the balance grouted to surface + 0.4 m.

Bidders will describe the proposed grout installation and level measuring methods in their Method Statement.

a) A **unit volume rate** for the supply and installation of 5% by volume bentonite/OPC/sand grout. For the purpose of bids, bidders should assume a maximum of 21m3 of grout.

4.8 Insert inert backfill

Inert backfill (drill cuttings) will be inserted in the annular space of boreholes in vertical intervals in which neither grout nor gravel pack are required.

Bidders shall provide: –

a) A unit volume rate for the insertion of inert backfill, including measurement of depth to the top of inert backfill, where necessary. Bidders should allow for 42 m3.

4.9 Testing of Verticality, Alignment and Camera review

The Contractor shall do verticality and alignment test during the performance of work by any reasonable method for his own convincing to ensure lowering screens to the required depth. Only case instructed by the Consultant Engineer test for plumbness and alignment shall be made after the complete construction of the well and before its acceptance. The required test shall be by using plumb.

The Contractor is also required to undertake a camera review of the borehole to confirm the casings alignment and depth of the borehole. A camera review report shall be submitted before acceptance of the borehole

4.10 Development

After completion of drilling and placement of casing and screens, gravel and backfill etc. the borehole shall be developed in accordance with modern borehole construction practices, including airlift surging and possibly chemical development using a polyphosphate. It is expected that a total of 12 hours will be required.

Chemical development. This Specification allows for the possibility that chemical development will be required. The Contractor will include equipment and chemicals for chemical development, though there is no certainty that chemical development will be required. If clays are encountered and their removal is required, the Engineer will instruct the Contractor to commence development using chemical methods. If required, chemical

development will use an approved polyphosphate as a disaggregant that shall break down clays, silts, or other fine material adjacent to the wellbore where these occur within the productive part of the aquifer. The decision as to whether chemical development shall be adopted, and at what dosage rates, shall be made by the Engineer on the basis of observations made during drilling and sample logging.

Physical development. Physical development shall comprise airlift rawhiding. The use of an educator pipe effectively focuses the development energy to specific parts of the screen, allowing development in detail. Fines are flushed to the surface by airlift pumping. The Contractor shall provide a Method Statement describing the proposed methodology, including compressor characteristics and airline (if proposed). The Method Statement will explicitly explain how the materials selected for casing and screen shall take the stresses of airlift surging.

During development the following measurement shall be taken:

1. Static water level flowing the cleaning of the drilled well.
2. Discharge rates and sand content in g/m^3 during airlift at 15 minutes interval.
3. Total duration of the development.
4. Measurement in the period between completion of development and commencement of test pumping at suitable interval until static water reached.

Development will be considered complete only when less than 5 ppm of suspended solids remain in the water. The decision to declare development complete shall be the Engineer's.

Water levels in the borehole shall be monitored both before and after development, and at any appropriate interval during development.

After the development of the well and prior to test pumping the well shall be disinfected by introducing into the well a chlorine solution, so that the water in the well has a concentration of chlorine 200mg/L. The chlorine solution shall remain in the well for a period of at least three hours after being agitated to assure a proper mixing.

Bidders shall provide the following rate: –

a) A **unit time rate** for airlift rawhiding, for a total of 12 hours per borehole.

4.11 Test Pumping

The Contractor shall perform test pumping to establish well performance and yield of the borehole. A test-pumping unit shall be provided for the testing of the drilled borehole, which should include a submersible pump with a minimum capacity of 15 m3/hr at a head of 180 meters, a suitable control panel, rising main, electrical connections, and all other ancillary equipment required to carry out the specified tests.

Standard test pumping will consist of a 4-hour step-drawdown test, followed by a constant discharge test for a period of 24 hours. The latter may be extended at the discretion of the Supervising Engineer, e.g. if the water level has not stabilized after the 24 hours. The Contractor shall provide a suitable means of achieving and maintaining the rate of flows specified.

Step drawdown test

At the discretion of the Supervising Engineer, the bidder will conduct a step drawdown test of not less than four-hour duration. The well shall be pumped at a minimum of four separate discharge rates specified by the Supervising Engineer. Each step shall have a duration of at least one hour.

The change from one pumping rate to the next shall be effected without stopping the pump by means of a gate valve in the discharge pipe, or by any other means to be approved by the Supervising Engineer. The change from one step to the next shall take place in the shortest time possible. Water discharge measurements shall be taken at appropriate time intervals as instructed by the Supervising Engineer, while at the same time EC readings are to be taken.

Constant discharge test

At the discretion of the Supervising Engineer, a constant discharge test will be carried out for a maximum pumping stage of 24 hours, followed by a maximum of 12 hours of recovery observations. The discharge rate shall be specified prior to the test. During the test, water level and discharge measurements shall be made at time intervals specified by the Supervising Engineer.

Pumping test data shall be supplied to the Supervising Engineer from all pumping tests conducted at the borehole. These will show dates, water levels, discharge rates, electrical conductivity values, times of starting and stopping the pump, changes in discharge, weather, and other conditions that could affect the test data.

Water level observations

The bidder shall supply appropriate electric contact water level gauges for measuring water

levels in the borehole to the nearest 10 mm at pre-determined intervals. The minimum length of the electrical dipper shall be 250 meters. Wellhead arrangements shall permit these gauges to be inserted and passed freely. Hereto the bidder shall be required to install a dipping tube, minimum 3/4" inner diameter, lowered to approximately 2 meters above the pump intake or the anticipated maximum drawdown level.

Other methods for measuring water levels are subject to approval by the Supervising Engineer.

Electrical conductivity measurements

The bidder shall have an operational EC-meter on site to take electrical conductivity readings whenever required during drilling, development and test pumping.

Before testing, the borehole will be subject to a short-term test (calibration) to establish the approximate yield/drawdown properties and to decide upon pumping rates for step-drawdown or continuous yield tests. Sufficient time shall be allowed for the recovery of water level in the borehole between each type of test. This shall be at the discretion of the Supervising Engineer.

Discharge measurements shall be made by using a flow meter or otherwise approved calibrated measuring device. During test pumping, the discharge water will be diverted in an appropriate manner over a distance of at least 50 m downslope from the wellhead. This condition may not be required when the pumped aquifer is confined.

During all testing operations, once the flow rate has been determined and preliminary adjustments made, the measured discharge rate shall be maintained within 15% of the required rate for the duration of the test. Persistent fluctuations beyond this tolerance will require abortion of the test, for which payment shall not be made.

When continuous pumping at a uniform rate is specified, failure of the operation for a period greater than one percent of the elapsed pumping time shall also require abortion of the test.

Any test, which is aborted due to the reasons above, shall be repeated after recovery of the water level. No payment shall be made for aborted tests or for standing time during water level recovery after aborted tests.

Bidders shall provide the following rates: –

a) **A unite time rate** calibration, step drawdown and constant discharge test (assume 29 hours).
b) A **unit time rate** for recovery measurements for a total of 12 hours.

5. Contractor Water Sampling and Analysis

Full water chemistry analyses will be conducted on water removed from the borehole. Samples shall be collected immediately development is adjudged complete. These samples shall be tested for the parameters in the Table 1: –

Table 1: Chemical and bacteriological water quality analysis parameters

Substance/characteristic	Unit	Remarks
Electrical conductivity (at 25ºC)	µS/cm	In the field and laboratory
pH	Log ^{+}H	In the field and laboratory
Temperature	^{o}C	In the field
Total suspended solids	mg/l	Laboratory
Total hardness as $CaCO_3$	mg/l	Laboratory
Total phosphorus as P	mg/l	Laboratory
Phosphates as PO_4	mg/l	Laboratory
Ammonia as NH_3	mg/l	Laboratory
Nitrate as NO_3	mg/l	Laboratory
Nitrite as NO_2	mg/l	Laboratory
Calcium as Ca	mg/l	Laboratory
Magnesium as Mg	mg/l	Laboratory
Sodium as Na	mg/l	Laboratory
Potassium as K	mg/l	Laboratory
Iron as Fe	mg/l	Laboratory
Manganese as Mn	mg/l	Laboratory
Chloride as Cl	mg/l	Laboratory
Sulphate as SO_4	mg/l	Laboratory
Bicarbonate as HCO_3	mg/l	Laboratory
Carbonate as CO_3	mg/l	Laboratory
Fluoride as F	mg/l	Laboratory
Aluminium as Al	µg/l	Laboratory
Antimony as Sb	µg/l	Laboratory
Arsenic as As	µg/l	Laboratory
Barium as Ba	µg/l	Laboratory
Boron as B	µg/l	Laboratory
Bromide as Br	µg/l	Laboratory
Cadmium as Cd	µg/l	Laboratory
Chromium as hexavalent chromium	µg/l	Laboratory
Copper as Cu	µg/l	Laboratory
Cyanide as CN	µg/l	Laboratory
Iodide as I	µg/l	Laboratory
Lead as Pb	µg/l	Laboratory
Mercury as Hg	µg/l	Laboratory
Molybdenum as Mo	µg/l	Laboratory
Nickel as Ni	µg/l	Laboratory
Selenium as Se	µg/l	Laboratory
Silver as Ag	µg/l	Laboratory
Zinc as Zn	µg/l	Laboratory
Total coliform count	Counts/100 ml	Laboratory
Faecal coliform count	Counts/100 ml	Laboratory

Water samples for bacteriological analysis will be collected from borehole at the end of development; these will be collected and immediately shipped to an approved laboratory to comply with KS 05-459 (1996), which requires that samples are stored and transported at 4oC and that analysis starts within six (6) hours of sampling.

Bidders shall provide the following rates: –

a) A **unit rate** for the collection of water samples for chemical analysis, transport to the laboratory and the analysis itself. This must include the collection of electrical conductivity and temperature data at wellhead (one [42 No.] number);
b) A **unit rate** for the collection of water samples for bacteriological analysis, transport to the laboratory and the analysis itself (one [42 No.] number).

Contractor shall provide the name and address of the laboratory or laboratories that shall undertake chemical analyses and confirm that all of the above laboratory parameters can be determined by the laboratory or laboratories they have selected. Failure to provide both the names of the laboratories and their official statement that they are able to perform the analyses to the Specification given in the Table above will render a Bid non-responsive.

5.1 Well Head:

The well head will consist of a galvanized steel pipe DN 200 of 1m length flanged to the one side and to the other cemented in the annular space of the casing in a rectangular block 100 X 100 cm of reinforced steel. The block will have a total height of 80 cm. A sealing plate will be bolted to the flanged pipe and will be provided with lifting eye bolts and a flanged connection pipe to rising column (Rp2") and to a 90 E flanged bend (DN 50, mobile flange). Holes shall be provided in the sealing plate to introduce an air vent pipe, motor and control caudles, water dip tubing with screwed plug. A 90 E bend (DN 50) with an orfice for pressure gauge (manometer) will be bolted on the flange connection pipe. Following a pipe DN 50 will permit the connection of the well head to the water tank rising pipes. Sketch in fig.2 in Appendix B shows a suggested well head.

The cap shall be secured with a welded hasp that can be locked. The lock shall be of stainless steel and brass, so as to minimize the effects of corrosion; four (4) keys shall be provided for each lock.

Should the borehole be artesian, provision shall be made in the construction of the well cap to allow for the safe discharge of artesian flow away from the wellhead.

Bidders shall provide the following rates: –

A **unit rate** of borehole headworks complete.

5.2 Material for Drilled Wells

Additional to the materials mentioned before, the following materials shall be used.

5.2.1 Bottom Seal

The lower end of the casing/screen string shall be a sump pipe of 2m length of the same material and dimensions as the screens and casings. The bottom is closed by a wooden plug. A rubber seal assures the tightness of the bottom, which is fastened to the lower end of the sump pipe by metal screws.

5.2.2 Centralizers

The casing string shall be fitted with centralizers at specified intervals, the screen section with centralizers at 3-4 m intervals. The centralizers shall be of rigid PVC or of stainless steel.

5.3 Reporting, Logs, Records and Well Files

5.3.1 Logging, Records and Reporting

Daily logs and records are to be kept for each well site, which include the following information:

(a) Date, working hours,
(b) Stoppage, breakdowns,
(c) Shifting,
(d) Drilling/construction progress,
(e) Consumption of materials,
(f) Water inlets and yields, water levels, conductivity, pH, temperature,
(g) Drilling methods, equipment in use,
(h) Drilling string and assembly report, bit record report, drilling log, lithology log, and penetration rate log,
(i) Cross sections of the dug wells and the equipped drilled wells with all details on casing, screens gravel pack, sealing, grouting, positioning of pumps, provided with all dimensions,
(j) Casing tally report,
(k) Length, diameter and depth of installation of screens,
(l) Length, diameter and installation depths of casing,
(m) Verticality test(s) and alignment report,
(n) Well development,
(o) Pumping test and recovery test report,
(p) Water quality tests,
(q) All specific data and information requested in the relevant chapter, e.g. chapter. 9 and 10,
(r) Completed works, wells etc.

The logs have to be attached to the monthly reports and shall become part of the "Well File" to be set up for each well.

The Engineer shall have full access to all data and information as well as the right to witness all operations at any time. In the course of the execution of the works the Engineer may ask for additional data, information, and records that are of importance for the conditions encountered.

The Contractor shall submit to the Engineer monthly reports, in bound form, not later than the 5th working day of the following month. All reports have to be submitted in two (2) copies in English as hardcopy and on DVD as electronic version.

5.3.1"Well Files"

The Contractor has to establish and to submit with the application for the Taking-Over Certificate for each drilled well completed a separate "Well File" two (2) copies in English as hard copies and six (6) copies of the electronic versions (English) on CD/DVD.
The file has to contain, at least,

- Serial number of the well and village name
- Exact location with GPS co-ordinates
- Description of the well with location sketch
- Photo of the well
- As Built Drawing" (cross section and layout of the drilled wells and surface works with all dimensions)
- Borehole log
- Geophysical logs
- Development report, pumping test report
- Reports of all analysis executed
- Verticality test
- Record of testing and commissioning of hand pumps and equipment of drilled wells
- Operation/maintenance handbook(s)
- List of equipment, spare parts and tools
- Schedule for replacement of wearing parts, nomination of spare parts source.

Each "Well File" has to be approved by the Engineer.

6. WATER TANK

Contractor shall design the water tank with all structural drawings and provide to Consultant Engineer for approval.

Elevated steel water tanks

The elevated water tanks are all rectangular reservoirs built of steel with a liner, roof and distribution tap stands. As stipulated, the height of the tanks is 12m from ground level to the bottom of the tanks. The volume of the vessels is 100 m^3. The dimensions of 100 m^3 tank are base 8 meters by 5 meters and a height of 2.5 meters. The water tank itself is supported by 9 pillars interconnected with steel structure. The contractor to provide the final drawings for approval before construction

At very site a geotechnical investigation shall be carried to estimate the bearing capacity of the soil and allowable settlement and the chemical properties of the soil (sulphate & chloride contents) from this investigation the depth & type of footing of the water tank shall be decided.

The different stages of the water reservoir construction are then following:

- Excavation of the foundation
- Construction of foundation as one monolithic reinforced concrete slab (square form) on lean concrete layer
- Columns and Struts: The column base, whether riveted or welded, shall have sufficient area to distribute the column load over the concrete foundations without exceeding the specified bearing stress on the foundation and the connection of the column to the base plate shall provide for the maximum uplift, if the anchors are connected to the base plates and not to the column shaft.
- Column Splices: Column splices shall be designed to withstand the maximum possible uplift, or at least 25 per cent of the maximum compression whichever is greater. If column splices are riveted, the flanges only of rolled column sections need be spliced. Rolled channels, if used in columns, shall have both the flanges and webs spliced. For welded column splices the joints may either be butt welded or splice plates may be welded to both sections being joined.
- Bottom Struts: Bottom struts of steel or reinforced concrete shall be provided where necessary to distribute the horizontal reactions at the bases of the columns. These shall consist of struts connecting the foundation piers, or of structural members connecting the lower ends of the columns.
- Tension Members Carrying Wind and/or Earthquake Loads: Such members shall be designed to resist the wind load and the earthquake load if the latter is specified. It is not necessary to combine wind and earthquake loads but to

design for the maximum stress produced by either force. If the projected centers of gravity of tension members do not meet the projected center of gravity of structural members at the center of gravity of the columns, proper allowance shall be made for the eccentricity.

- Diagonal tension members shall be pre-stressed sufficiently to be taut when the tank is full. Such pre-stressing shall not be given consideration in the design of the members.
- Horizontal Girders: For elevated tanks with inclined or battered columns connecting to the tank shell a horizontal girder shall be provided to resist the horizontal component of the column loads. This girder shall be proportioned to withstand safely as a ring girder the horizontal inward component of the load on the top columns. If the centers of gravity of the horizontal girder, the top section columns and the tank shell do not meet in a point, provision shall be made in the design of each of them for stresses resulting from any eccentricity.
- Balcony Railing: If the horizontal girder is used as a balcony it shall be at least 24 in. in width and shall be provided with a railing at least 36 in. in height.
- Tank Plates: Plates for elevated tank bottoms, shells and roofs may be any desired shape. Tank plates shall be designed on the basis of the following maximum fiber stresses which shall be reduced for the joint efficiencies as specified elsewhere in these specifications. Plate surfaces susceptible to complete stress analysis shall be designed on the basis of a maximum fiber stress of 15,000 psi. Such plate surfaces include those not stressed by the concentrated reactions of supporting members or riser pipes. Plate surfaces not susceptible to complete stress analysis shall also be designed on the basis of the maximum fiber stress of 15,000 psi. after making reasonable allowances for such loads determined. The maximum fiber stress shall in no case exceed 11,000 psi. when calculated assuming that the concentrated reactions of supporting members are uniformly distributed between such reactions.

The works sequence for the construction of the different steel structures is here always: laying of reinforcement, construction of the tower and installing the steel tank.

Reinforcement of foundations has to first be inspected and accepted by the engineer.

Accessories for elevated Water Tanks

Each tank has to be provided with:

- **Shell Manhole**: A circular manhole 24 in. in diameter or an elliptical manhole 18x22 in. minimum size, with cover hinged to shell shall be furnished in the first ring of the tank shell.
- **Pipe Connection**: The top of the fitting shall be flush with the tank floor and provided with a removable silt stop 6 in. high.
- An **access ladder** with landings and cages as necessary and a valve operating platform
- **Screened roof vent** (150 mm) arranged to prevent entry of rain
- An **overflow set** to arrest operation at top water level
- A **separate inlet pipe** work from the well and discharging above top water level
- A **washout pipe** capable of draining the whole tank and controlled by a sluice valve (overflow and washout pipe are combined)
- **Outlet pipe** from the tank bottom controlled by a sluice valve accessible from ground level
- An **external water level indicator** (cat & mouse type) that will enable water levels to be observed from ground level
- **Lightning protector** (pole, lightning conductor, earthing).
- **Painting of the water tower and tank** will be done with three layers of paint. A grey oxide as an undercoat and two layers of aluminum paint.

7. SUBMERSIBLE SOLAR PUMPS

The Contractor will select the pump based on the test pumping results (Static level and dynamic level of the water in the borehole, the flow of the borehole) as well as the height of the water tank. Based on the expert judgement, three depths (100 m, 150 m, 200m) and a flow of 15 m3/h have been selected to size the pumps to be used in this tender. Grundfos pumps or equivalent are suggested for this project. The simulations resulted in the following pumps' choice:

Type of Pump Grundfos or equivalent	Number of pumps	Maximum Yield (m)	Qmin (m^3/hour)	Power of the Pump (Kw)
SP 17-12	7	100	15,93	7,5
SP 17-18	31	150	16,14	11
SP 17-23	4	200	15,14	13

The pump will only work during on PV energy and no battery storing is suggested. The minimum annual number of hours of sunshine is **1469**. The photovoltaic panels will be installed at a height of 1.60m from the ground. To acquire the best radiation intensity half of the panels will be tilted **8° to the north** while the other half, tilted **8° to the south**. 0 on the panels shall be avoided at all the time. While designing the PV installation an overpower is to be foreseen for the well-functioning of the pumps and to feeding the accessories as well as the inverter which will convert the current to AC:

Type of Pump Grundfos or equivalent	Power of the Pump (Kw)	Sunshine hours per year	Tilt angle / horizontal	Orientation	Peak power of the field (kWp)	Total Power (KW)	Over-power%
SP 17-12	7,5	1469	8°	0° / Nord	**6,2**	**9,1**	**22**
SP 17-18	11	1469	8°	0° / Nord	**10,2**	**15,0**	**37**
SP 17-23	13	1469	8°	0° / Nord	**12,4**	**18,2**	**40**

The Inverter shall be an advanced Solar inverter designed for use with large AC submersible pumps systems. It should be installed in an enclosure for water and heat protection. The specific features of the inverter include:

- Patented MPPT (Maximum Power Point Tracking) capability providing fast response, good stability and up to 99% efficiency.
- Supports motor soft start and gives full motor protection,
- IP65 protection guards suitable for harsh outdoor environments.
- The Inverter shall offer the following control functions:
- Settable minimum and maximum frequency and open circuit voltage.
- Display of operating parameters including frequency, voltage, amperage, input power and pump speed.
- Protection against over and under voltage, over current, system overload and module over temperature.
- Fault detection with error code display.

The solar panels shall be connected among themselves as all cables of the array are connected to a junction or combiner box. The solar panels shall be:

- High module conversion efficiency superior to 19 % by using Passivated Emmiter

Rear Contact (PERC) technology,

- The modules should be monocrystalline,
- Low degradation and excellent performance under high temperature and low light conditions,
- Robust aluminum frame ensures the modules to withstand wind loads up to 2400Pa. the frame will supported by a reinforced concrete ground beam. A particular attention will be provided to the alignment of the support (horizontality) and to the tilt of the panel.
- High reliability against extreme environmental conditions (passing salt mist, ammonia and hail tests).
- Potential induced degradation (PID) resistance.
- Positive power tolerance of 0 ~ +3 %.

All drawings and calculations and computer input and output shall be presented to the Consultant Engineer for approval. A set of spare parts including the followings shall be provided at each site:

a) DC Breakers
b) AC Breakers
c) Fuses

The Bidders shall provide the following rates: –

a) A **unit rate** for supply seven (7 No.) submersible pump (3 Phase). Quote for Grundfos SP 17-12 (HMT 100m, 7.5Kw, 3 x380v, Qmin 15m3/h)- subject to change by the Engineer);
b) A **lump sum rate** for delivery, transport, insurance and installation one submersible pump (SP 17-12).
c) A **unit rate** for supply of seven (31 No.) submersible pump (3 Phase). Quote for Grundfos SP17-18 (HMT 150m, 11Kw, 3 x380v, Qmin 15m3/h) -subject to change by the Engineer);
d) A **lump sum rate** for delivery, transport, insurance and installation one submersible pump (SP 17-18).
e) A **unit rate** for supply of four (4 No.) submersible pump (3 Phase). Quote for Grundfos SP17-23 (MT 200m, 13Kw, 3 x380v, Qmin 15m3/h) - subject to change by the Engineer;

f) A **lump sum rate** for delivery, transport, insurance and installation one submersible pump (SP 17-23).

g) A **lump sum rate** for Supply and installation of 7 solar power system to drive 7.5 kw motor (SP17-12). The minimum annual number of hours of sunshine is 1469. The tilt is 8°, The overpower is 22%. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to 19 % including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.

h) A **lump sum rate** for Supply and installation of 31 solar power system to drive 11kw motor (SP17-18). The minimum annual number of hours of sunshine is 1469. The tilt is 8°, The overpower is 37%. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to 19 % including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.

i) A **lump sum rate** for Supply and installation of 4 solar power system to drive 13 kw motor (SP17-23). The minimum annual number of hours of sunshine is 1469. The tilt is 8°, The overpower is 40%. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to 19 % including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.

Rising mains

The installation will include a 2" (50 mm) galvanized steel rising main, submersible cable, electrode pencils, electrode cable, a non-return valve just above the pump, a 25-32 mm dipper line, and all other items necessary for proper functioning of the pump. As an alternative to the control panel and coupled start/stop electrodes, a CU3 control unit or similar may be installed. All the Items to be installed shall be subject to confirmation and approval by the Supervising Engineer.

All items will be of high quality, and suitable to function properly in tropical conditions. Spare parts of the equipment to be supplied and installed shall as much as possible be available in Kenya. The bidder shall furnish the Engineer of the addresses of the Suppliers of such spare parts.

Additional ancillary equipment will be supplied to the system to supply the above-mentioned submersible pump with the required electricity to pump 15 m3/hour with a head of about 200 metres. The system will be installed including all necessary items, such that the pump can function properly. This includes (starting from the end of the rising main): a union to be able to disconnect the delivery pipe and the rising main, a pressure gauge, a control gate valve, a control panel (with low/high level cut-outs, phase failure and indicator lights, switch-over gear etc.), non-return valve, a level cut out, a kit for repair and maintenance of the whole pumping unit, including 2 splicing kits and all other items necessary for proper functioning of the system.

Bidders shall provide the following rates: –

a) A **meter rate** for supply and installation of 50mm diameter galvanized steel pipes, heavy duty class C as rising main (including fittings); a total length of 7,144 meters.

b) A **meter rate** for supply and installation of 25 mm diameter uPVC airline; a total length of 7,144 metres.

c) A **meter rate** for supply and installation of electrical submersible cable 3 phase 8mm for submersible pump SP 17- 12 to the surface; a total length of 602 meters.

d) A **meter rate** for supply and installation of electrical submersible cable 3 phase 12mm for submersible pump SP 17- 18 to the surface; a total length of 5,890 meters.

e) A **meter rate** for supply and installation of electrical submersible cable 3 phase 16mm for submersible pump SP 17- 23 to the surface; a total length of 960 meters.

f) A **lump sum rate** for electrical connection to control panel, over a distance of approximately 20 meters including two splicing kits, underground armored cable, 25mm uPVC pipe and additional items required for proper operation.

g) A **unit rate** for Grundfos CU3 control unit for pump protection

8. WATER DISTRIBUTION SYSTEM

The water from the water tanks shall be transferred by gravity to the water taps post near to the beneficiaries. High density polyethylene pipe (HDPE) is suggested. The pipes are to be buried in trenches of depth 50 - 100cm as shown in sketch in fig. 5 in Appendix B.

The Contractor has to conduct a detailed topographical survey. The survey shall include an area of 5km circle around the center of the concerned village. According to this survey, the position of the water tank which shall be in the highest point and the tap posts locations shall be decided. The tap post has to be located with reasonable slopes and an end of dense population avoiding very low spots. According to the slopes and distance and required discharge to the tap post, the

pipes layout, diameter, thickness and pressure is to be decided. Standards used drawings, calculation and computer input and output shall be forwarded to the Consultant Engineer for approval. The service pressure of a tap post shall not be less than 1 bar.

The Contractor is required to give detailed method statement and shop drawings for every road crossing to be approved by the consultant engineer. Expected methods is either by cutting the existing road at the route of the pipes and lying the pipes and compacting and reinstate the road and making a temporary path for the traffic or make a tunnel under the road.

9. TAP POSTAND WATERING TROUGH

The Contractor will have to implement for each village:

a) A kiosk at a distance of at least 100 m from the borehole location,
b) Kiosk at the primary school within the village,
c) A watering trough for livestock located at a distance of at least 400 m from the borehole.

Upon the instruction of the Consultant, the distribution network might be extended to the mosque and to the dispensary

10. CONCRETE WORK

Transport and placing of concrete shall be done by means which will prevent segregation or loss of the ingredients.

The placing of concrete in hot weather requires the following steps to be taken:

- Watering of the sub grade, form work and steel reinforcement before placing concrete. Care should, however, be taken to ensure that there is no free-standing water.
- Stacking the aggregates under shade or spraying the aggregates with water, but there shall be adequate drainage of the sprinkled water.
- Covering the freshly laid concrete with burlap, polyethylene or similar material.
- Sprinkling the freshly laid concrete with water after one hour or so.
- Speedily placing and finishing the concrete.

Concrete Tests

Suitable equipment for testing by the Consultant Engineer the concrete strength shall be made available by the Contractor. (Concrete test hammer e.g. “Schmidt”)

Required strengths

All reinforced concrete shall have the strength 30 MPa.

Concrete without reinforcing and lean concrete shall have the strength 15 MPa.

Masonry

The scope of work covered by this section shall be deemed to comprise the furnishing and installing of all brick work and concrete blocks. It shall also include the supply of the appertaining materials and structural parts, scaffolding, offloading on site and all operations in connection with masonry works.

Materials

The materials shall be protected from rain and inclement weather all to the satisfaction of the Engineer.

The cost of covering materials shall be deemed to be included in the offer for the brick work and masonry. The masonry works shall be of local materials e.g. concrete blocks, plastered bricks, rocks. The quality of each material shall conform to the requirements of the respective standards.

The binding agents shall be stored dry. The aggregates shall be free of impurities and protected from being contaminated.

SECTION 8

BILL OF QUANTITIES

Item No.	Description	Unit	Qty.	Price in US$	
				Unit	Total
1	**Lot 1: Mobilization, Demobilization**				
1.1	Mobilization of all necessary plant, materials, and maintenance of Camp.	LS	1		
1.2	Demobilization at completion of Contract.	LS	1		
1.3	Providing Security (base camp, site camp, transport between base camp and site camp)	LS	1		
1.4	Transport and set up at well sites	pcs	42		
1.5	Transport and set up for Surface installations	pcs	42		
1.6	***Providing facilities for the WSTF***				
1.6.1	4x4 vehicle (Toyota, Nissan, Mitsubishi)	pcs	1		
1.7	***Providing facilities for Consultant Engineer***				
1.7.1	4x4 vehicle (Toyota, Nissan, Mitsubishi)	pcs	2		
1.7.2	Furniture office for the consultant engineer at the base camp this will include office in the base camp fully furniture with all necessary equipment and tools. Beside accommodation and transportation of technicians at the base camp and site.	u	1		
1.8	Domestic flight tickets	pcs	75		
1.9	Arrangements for Saudi Fund Follow up Missions	u	1		
1.10	Ten minutes promotional video of the project and the SFD. The content of the narrative is to be agreed with the SFD and will be done in Arabic, English and Swahili	u	1		
Total Lot 1					
2	**Lot 2: Well Drilling & Construction**				
2.1	Hydrogeological and geophysical pre-investigations.	LS	1		
2.2	Drilling at a diameter 12"	m	252		
2.3	Supply and installation of mild steel 12" temporary casing	m	252		
2.4	Drilling				
2.4a	Drilling with a final diam. of 10” to a depth of 100m	m	4 200		
2.4b	As above between 100 and 200 meters	m	3 500		
2.4c	AS above between 200 and 300 meters	m	200		
2.5	Supply and installation of mild steel 8" casing	m	6 198		
2.6	Supply and installation of slotted mild steel screens	m	1 702		
2.7	Sampling and storing of drilling samples at 2 m interval	No.	3 950		
2.8	Supply and installation of gravel pack.	m3	126		
2.9	Supply and installation of grout material	m3	21		
2.10	Supply and installation of inert back fill material	m3	42		
2.11	Development of Drilled Well.	Hours	504		
2.12	Test pumping				
2.12a	Test pumping of Drilled Well (calibration, step drawdown and constant discharge test (assume 29 hours))	Hours	1 218		

2.12b	Recovery measurements (assume 12 hours)	Hours	504		
2.13	Camera review and reporting	No.	42		
2.14	Water Quality Analysis				
2.14a	Chemical analysis of water sample	No.	42		
2.14b	Bacteriological analysis of water sample	No.	42		
2.15	Disinfection of Drilled Well	pcs	42		
2.16	Temporary wellhead capping and lock	No.	42		
Total Lot 2					
3	**Lot 3: Surface Installations**				
3.1.	Supply of Project Symbol	pcs	42		
3.2	Supply of brass ident. plate.	pcs	42		
3.3	Water Tank				
3.3a	Design & construction of elevated steel water tanks of 100 m3 capacity including supply of materiel, excavation of foundation and columns, painting etc.	pcs	42		
3.3b	Design & construction of elevated steel water tanks of 50 m3 capacity including supply of materiel, excavation of foundation and columns, painting etc.	pcs	Rate Only		
3.3c	Design & construction of elevated steel water tanks of 30 m3 capacity including supply of materiel, excavation of foundation and columns, painting etc.	pcs	Rate Only		
3.4	Preparation of a platform and site clearance for the installation of the solar panels, water tanks etc.	pcs	42		
3.5	Construction of a complete Kiosk (2,5 m x 2,5 m) with two taps, water meter, masonry walls, corrugated iron sheet, soak pit, lockable door and window, drainage pipe and all necessary works.	pcs	84		
3.6	Construction of a complete watering trough for livestock	pcs	42		
3.7	Supply and construction of a wire mesh fence	ml	4 200		
3.8	Supply and installation of water pipeline and fittings from well to the elevated tank. Pipes class C 50mm and fitting (water meter, valves etc.) as per figure 2 of the tender annexes	m	630		
3.9	Supply and installation of HDPE pipes (NOD 90 PN10)	m	21 000		
3.10	Supply and installation of HDPE pipes (NOD 50 PN10)	m	10 500		
3.11	Supply and installation of HDPE pipes (NOD 25 PN10)	m	840		
3.12	Valve for HDPE90	pcs	84		
3.13	Valve for HDPE50	pcs	168		
Total Lot 3					

4	**Lot 4: Submersible pumps and PV generation**				
4.1	Supply and delivery of SP14-15 or equivalent				
4.1a	Supply submersible pumps Grundfos **SP 14-15** or similar: HMT 60m, 4Kw, 3 x380v, Qmin 15m3/h)	pcs	Rate only		
4.1b	Delivery, transport, insurance and installation of submersible pumps (SP14-15).	pcs	Rate only		
4.2	Supply and delivery of SP17-12 or equivalent				
4.2a	Supply submersible pumps Grundfos **SP 17-12** or similar: HMT 100m, 7.5Kw, 3 x380v, Qmin 15m3/h)	pcs	7		
4.2b	Delivery, transport, insurance and installation of submersible pumps (SP17-12).	pcs	7		
4.3	Supply and delivery of SP17-18 or equivalent				
4.3a	Supply submersible pumps Grundfos **SP17-18** or similar: HMT 150m, 11Kw, 3 x380v, Qmin 15m3/h)	pcs	31		
4.3b	Delivery, transport, insurance and installation of submersible pumps (SP17-18).	pcs	31		
4.4	Supply and delivery of SP17-23 or equivalent				
4.4a	Supply submersible pumps Grundfos **SP17-23** or similar: HMT 200m, 13Kw, 3 x380v, Qmin 15m3/h)	pcs	4		
4.4b	Delivery, transport, insurance and installation of submersible pumps (SP17-23).	pcs	4		
4.5	Pump fittings				
4.5a	Supply and installation of 50mm diameter galvanized steel pipes, heavy duty class C as rising main (including fittings).	m	7 144		
4.5b	Supply and installation of 25 mm diameter uPVC airline.	m	7 144		
4.6	Supply and installation of the submersible cables				
4.6a	Supply and installation of mm diameter submersible for SP14-25 or equivalent	m	Rate only		
4.6b	Supply and installation of the 8mm diameter cable for SP 17-12	m	602		
4.6c	Supply and installation of the 12mm diameter cable for SP 17-18	m	5 890		
4.6d	Supply and installation of 16 mm diameter submersible cable for SP17-23	m	960		
4.7	Supply grundfos CU3 control unit for pump protection	Pcs	42		

4.8	PV power System				
4.8a	Supply and installation of a solar power system to drive **4 kw** motor (**SP14-15**). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **20%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	Rate only		
4.8b	Supply and install. of solar power system to drive **7.5 kw** motor (**SP17-12**). The minimum annual number of hours of sunshine is **1469**. The tilt is 8°, The overpower is **22%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	7		
4.8c	Supply and installation of solar power system to drive **11kw** motor (**SP17-18**). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **37%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	31		
4.8d	Supply and installation of solar power system to drive **13 kw** motor (SP17-23). The minimum annual number of hours of sunshine is **1469**. The tilt is **8°**, The overpower is **40%**. The Inverter shall be should be an advanced Solar inverter designed for use with large AC submersible pumps systems. The solar panels shall be monocrystalline with a module conversion efficiency superior to **19 %** including robust aluminum frame including control panel. The system shall comply to the technical specifications item 5 of the tender document.	Pcs	4		
	Total Lot 4				

5	**Lot 5: Training of Service Personnel and Maintenance**				
5.1	Supply Tutorial material for drilled wells and PV operation and maintenance	LS	1		
5.2	O&M Training for Water Supply Systems and PV system	Pcs	42		
5.3	Supply of tool boxes suitable for maintenance of Water Supply Systems.	Pcs	42		
Total Lot 5					
6	**Lot 6: Animation and sensitization**				
6.1	Animation and sensitization services for Wells and Water Supply Systems.	Pcs	42		
6.3	Reporting : Borehole report, Monthly, Quarterly, final Reports	LS	1		
Total Lot 6					
Total					

Personnel Charges

Item	Profession	Unit	Unit Price US-Dollar
1	Project Manager	Month	
2	Civil Engineer	Month	
3	Well Driller	Month	
4	Hydrogeologist	Day	
5	Hydrogeologist	Month	
6	Geophysicist	Day	
7	Geophysicist	Month	
8	Sociologist / animation expert	Day	
9	Commercial Clerk	Day	
10	Foreman	Month	
11	Foreman	Day	
12	Mason	Day	
13	Carpenter	Day	
14	Steelflixer	Day	
15	Electrician	Day	
16	Machine operator	Day	
17	Driver	Day	
18	Semiskilled Laborer	Day	
19	Unskilled	Day	
20	Additional Labor force if	Day	
21	Surveyor Engineer	Month	
22	Autocad Operator	Month	
23	Solar System Expert	Month	
24	Skilled labor	Month	
25	Unskilled labor	Month	
26	Crane diver	Month	

Equipment Charges

Item No	Equipment	Unit	Unit Price US-Dollar
1	Drilling rig	Month	
2	Drilling compressor	Month	
3	Development compressor	Month	
4	Excavation compressor	Month	
5	Generator sets	Month	
6	Truck	Month	
7	Pick-up cars	Month	
8	Concrete mixer	Month	
9	Crane truck	Month	
10	5 doors 4*4 car	Month	
11	Submersible pump	Month	
12	Solar panel	Month	
13	Dip meter		
14	Stop watch		
15	Welding machine		
16	Water tanker		
17	7 ton crane truck		

Materials Charges

Item No	**Material**	**Unit**	**Unit Price US-Dollar**
1	Cement	ton	
2	Gravel	M^3	
3	Sand	M^3	
4	Mild Steel	ton	
5	Filter Gravel for Drilled Wells, acc. To DIN 4924 Sealing Clay	M^3	
6	Fuel (Diesel / Gazoil)	l	
7	Mild Steel -Screen 6"	M	
8	Mild Steel -Casing 6"	M	
9	HDPE 90	M	
10	HDPE 50	M	
11	HDPE 25	M	
12	Galvanized pipes 2"	M	

APPENDIX A: PRIORITY VILLAGES (with Network Systems)

NOTE: As per the implementation of the project, the Client has the right to set new priority list as long as the borehole falls within the Project area Counties.

No	Village	District/Constituency	Region/ County	Population	Coordinates	
					Longitudes	Latitudes
1	Yussuf Haji Secondary	Ijara Constituency	Garissa	4,600	40° 9' 24.02"	1° 41' 48.88"
2	Goreale	Lagdera Constituency	Garissa	8,386	39° 43' 55.17"	0° 2' 12.24
3	Kulan	Daadab Constituency	Garissa	10,382	40° 38' 27"	0° 13' 0.15"
4	Abalatiro Primary School	Ijara Constituency	Garissa	7,444	40°15’0	-1°97'3889
5	Gababa Primary School	Ijara Constituency	Garissa	4,730	40° 30’ 4’’	-1°58'0833
6	Kotile Primary School	Ijara Constituency	Garissa	5,000	40°10’50	-1°98'0278
7	Hara Primary School	Ijara Constituency	Garissa	5,370	40°13’29	-1°85'2778
8	Madhax Gesi	Fafi Constituency	Garissa	3,800	40°03’34	-1°28'4444
9	Abaq-dheere	Fafi Constituency	Garissa	2,112	039°50’45	0°78'3056
10	Wayaana jibril	Lagdera Constituency	Garissa	176	39°20’75	0°06'4444
11	Sitawario	Wajir East	Wajir	1,700	40°39’ 5129	01°07’46.9
12	Arba Kharansu	Wajir East	Wajir	1,800	40° 17’ 44.31	01°46’ 32,35
13	Guticha	Wajir South	Wajir	746	39° 45’ 21.49	01°12’ 57.19
14	Agtalehel Junction	Wajir South	Wajir	2,500	40° 39’51.29	01°07’46.91
15	Wargadud	Tarbaj	Wajir	2,384	40° 21’38.70	02°18’33.81
16	Elben	Tarbaj	Wajir	2,576	40. 11’ 7.3	02°18’11.38
17	Fatuma Nur	Wajir West	Wajir	599	39° 32’ 58.15	01°54’ 45.09
18	Adan Awele	Wajir West	Wajir	4,198	39° 17’ 9.09	02°08’ 23.49
19	Bute Town	Wajir North	Wajir	6,089	39°25 10.62	03°21’ 32,17
20	Athathijole	Wajir North	Wajir	1,683	39° 27’40.24	3°20’ 14.97
21	Tula Tula	Eldas	Wajir	12,347	39.49’ 23.26	01°53’ 36.26
22	Liban Dela Ward	Eldas	Wajir	2,206	39°45’ 45.52	02°36’ 30.13
23	Keleswa	Samburu North	Samburu	1,800	036° 59.473’	01°54'665’
24	Nool Kera	Samburu Central	Samburu	1,900	036°32.750’	01°00'351’

No	Village	District/Constituency	Region/ County	Population	Coordinates	
					Longitudes	**Latitudes**
25	Pura	Samburu Central	Samburu	3,581	036° 32.111’	01°07'932’
26	Dhemo	North Horr	Marsabit	2,400	030°91’76	04°54'722’
27	Qoloba	North Horr	Marsabit	2,300	036°4462’	05°08'789’
28	Urweno/Kargi	Saku Constituency	Marsabit	5,836	028°5545’	03°54'730’
29	Tula Worabesa (Bubisa)	Laisamis	Marsabit	6,307	029°1848’	04°04'513’
30	Forole	Laisamis	Marsabit	2,580	041°0627’	03°85'183’
31	Songa	Moyale	Marsabit	1,614	024°8256’	03°89'061’
32	Burri Aramia (Korr)	Moyale	Marsabit	3,332	021°7917’	03°33'106
33	Kinna Moliti	Isiolo South	Isiolo	2,300	029°8996’	03°99'503’
34	Merti Town	Isiolo North	Isiolo	1,790	38°666025	1°06'1004
35	Lafey	Mandera East	Mandera	3,000	41° 11' 1.985"	3° 8' 57.95185"
36	Omar jillow	Mandera East	Mandera	1,503	41° 39' 45.478"	3° 45' 14.7636"
37	Qurdobow	Mandera North	Mandera	3,500	40° 29' 28.9824"	3° 20' 38.2992"
38	Birkan	Banissa	Mandera	5,109	40° 06' 45.2088"	3° 57' 24.1776"
39	Andarak	Banissa	Mandera	3,000	40° 26' 45.3084"	4° 08' 29.4936"
40	Burmayo	Mandera South	Mandera	2,639	40° 16' 13.1124"	2° 58' 48.2160"
21	Midina	Mandera West	Mandera	2,400	40° 01' 33.8340"	"3° 37' 13.22'40"
42	Komor Ele	Arabiya	Mandera	3,000	41° 42' 41.9328"	3° 48' 10.0584"
TOTAL				150 719		

STAND BY VILLAGES

No.	Village	District/ Constituency	Region/ County	Population	Longitudes	Latitudes
1	Eldhere	Lagdera Constituency	Garissa	4,400	38.861742	0.608131
2	Jarirod-Garissa	Garissa Township	Garissa	4,000	39.712778	-0.561667
3	Gerille	Ijara Constituency	Garissa	3,800	40.501111	-1.575278
4	Bodhai	Ijara Constituency	Garissa	4,000		
5	Amuma	Ijara Constituency	Garissa	4,230		
7	Taqal	Fafi Constituency	Garissa	2,133	39.851667	-0.818333
8	Wajir Bor	Wajir East	Wajir	3,502		
9	Qarsa	Wajir East	Wajir	2,215		
10	Dadajabula	Wajir South	Wajir	3,000	39.400	1.805975
11	Jilalow	Wajir South	Wajir	No data		
12	Baji	Wajir West	Wajir	2,900		
13	Uthule	Wajir South	Wajir	2,400		
14	Dambas	Tarbaj	Wajir	2,919		
15	Sarman	Tarbaj	Wajir	2,082		
16	Omar Dagale	Wajir South/West	Wajir	3,000	39.814774	1.905975
17	Una Salat	Wajir South	Wajir	3,000	39.214774	1.805975
18	Nturusi	Laisamis	Marsabit	3,800		
19	Libehia	Mandera East	Mandera	3,000	41.527549	3.835371
20	Hardawa	Banisa	Mandera	3,000	40.393317	4.116979
21	Tawfig	Mandera North	Mandera	2,800	41.196202	3.884912
22	Kobeturti	Mandera West	Mandera	3,000	39.851134	3.809988
23	Kabo village	Mandera	Mandera	3,870	41.219948	3.271105
24	Malka Galla	Isiolo North	Isiolo	1,700		
25	Ngalababiea daaba/ Athunyen	Isiolo North	Isiolo	1,500		
26	Noleya	Wajir South	Wajir	3,300		
27	Bula Abaq-Meri	Wajir South	Wajir	1,578		
28	Abaq Mathobe	Wajir South	Wajr	711		

29	Omar Dagale	Wajir West	Wajir	3,000		
No.	**Village**	**District/ Constituency**	**Region/ County**	**Population**	**Longitudes**	**Latitudes**
30	Loon Kolin	Samburu Central	Samburu	1,907		
31	Maendeleo	Isiolo North	Isiolo	3,300		
32	Gafarsa	Isiolo South	Isiolo	4,480		
	TOTAL					

APPENDIX B: DRAWINGS

FIGURE 1: SCHEMATIC DRAWING OF DRILLED WELLS

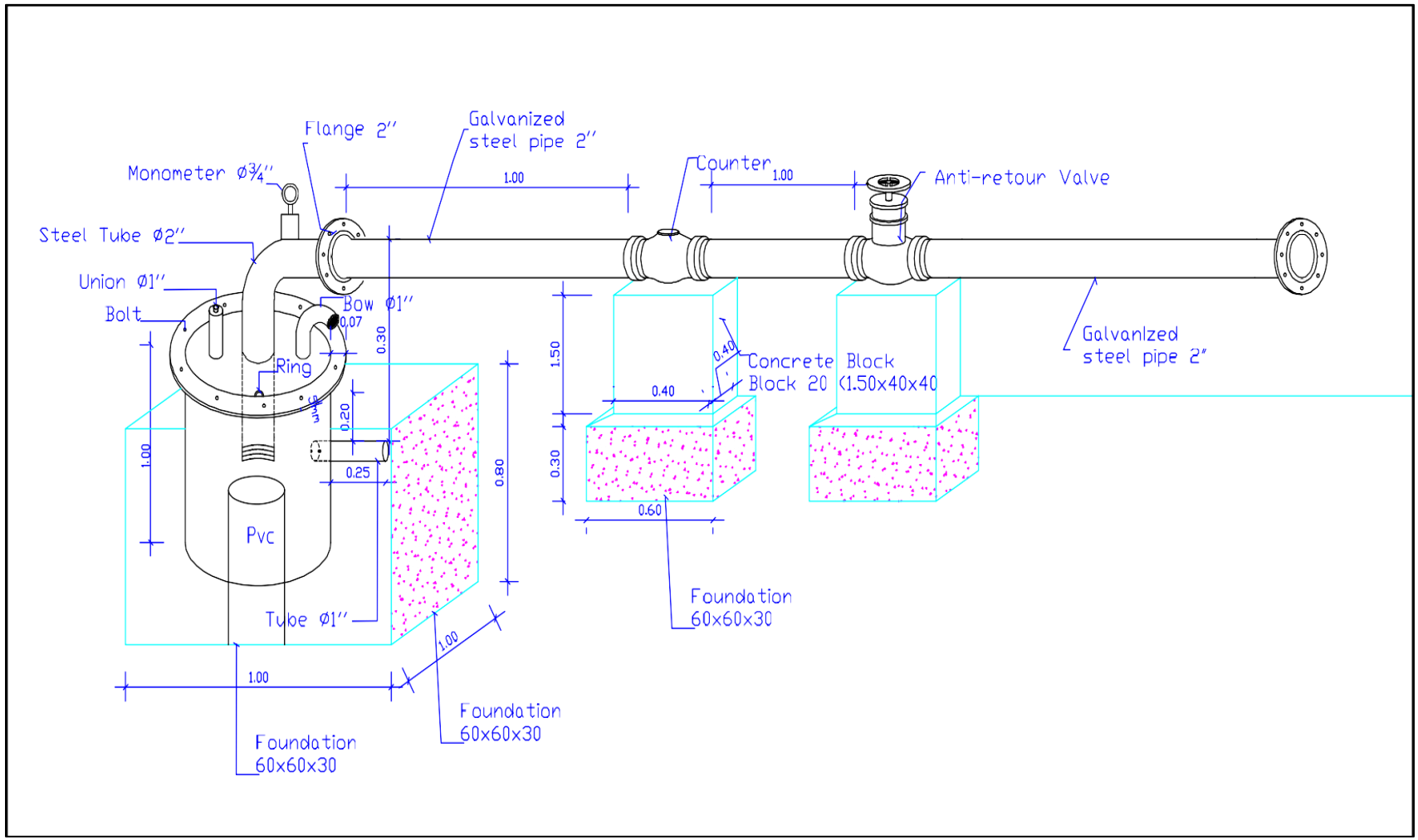
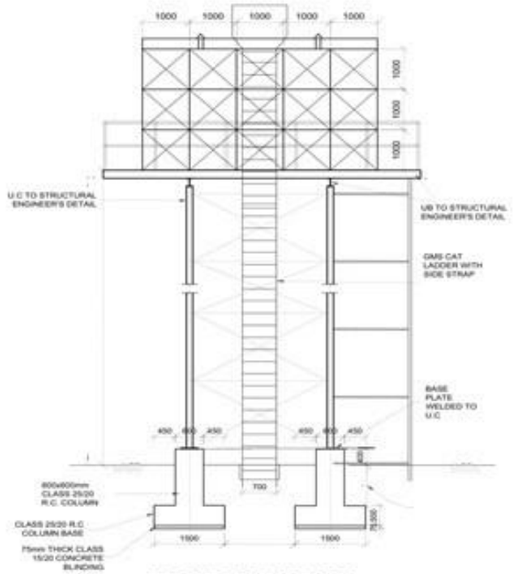


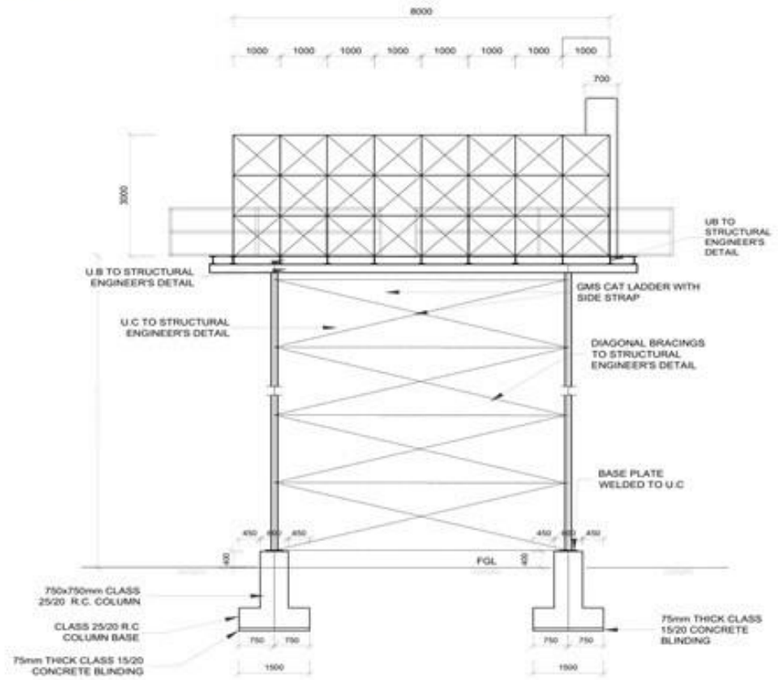
FIGURE 2: LAYOUT OF WELL HEAD, MANIFOLD FOR WATER DISTRIBUTION SYSTEMS

100M³ WATER TANK



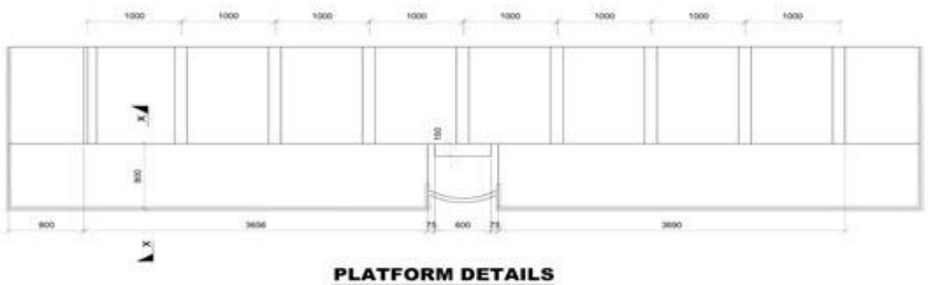
FRONT ELEVATION

1:100



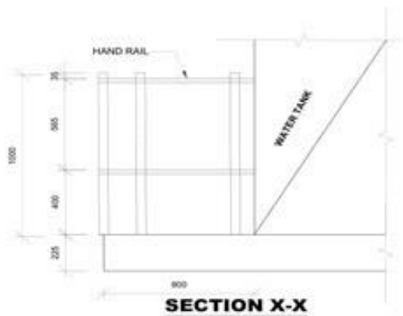
SIDE ELEVATION

1:100



PLATFORM DETAILS

SCALE 1:50



SECTION X-X

1:25

This drawing is for bidding purposes only and cannot be construed to be the final design

FIGURE 3: 100 m3 WATER TANK

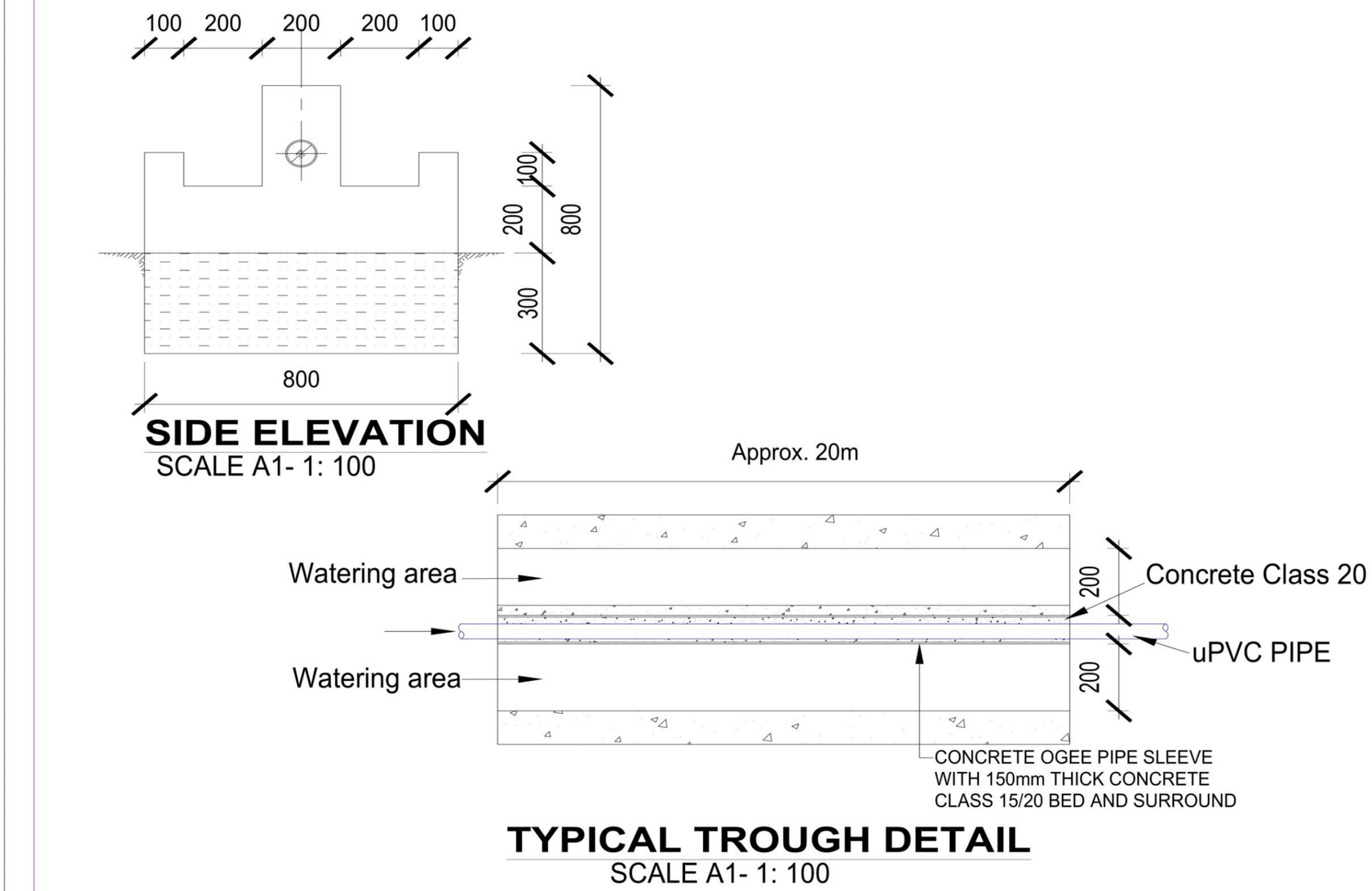


FIGURE 4: TYPICAL TROUGH

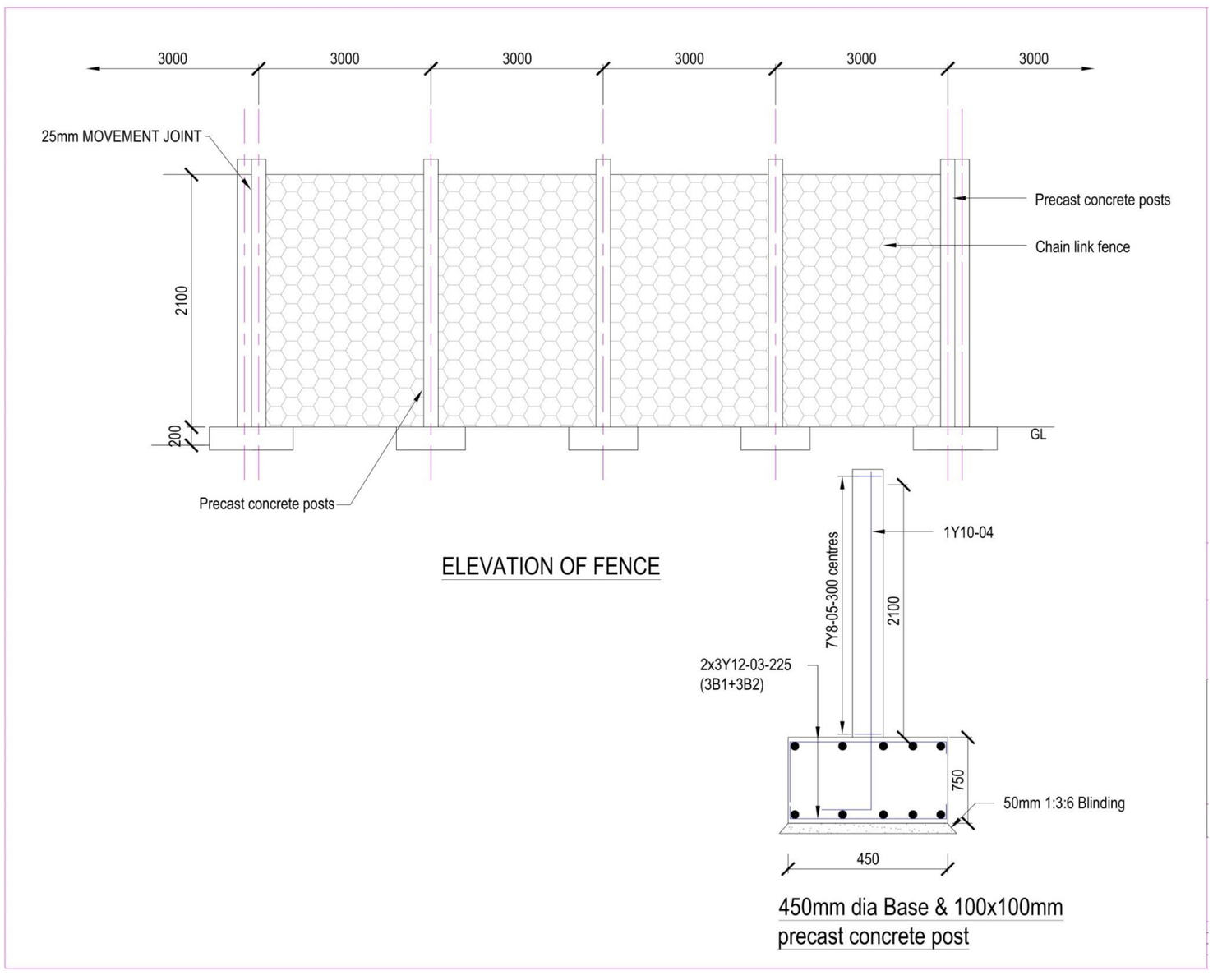


FIGURE 5: FENCE DETAIL

The Saudi Program for Drilling of Wells and Rural Development in Africa, Phase V

Republic of Kenya

The Construction of 42 Drilled Wells Equipped with Solar pumping generator and pipelines connections to supply several Villages in Mandera, Wajir Garissa, Marsabit, Isiolo, and Samburu regions

PROJECT NO.: P5/2019/Kenya

Appraisal Report

Ref. : A20-27
Date: July 2021

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EXECUTIVE SUMMARY

The Government of the Kingdom of Saudi Arabia has grant geared towards implementation of the Fifth Phase of the Saudi Program for Drilling of Wells and Rural Development in Africa, which will focus on improving quality and quantity of heathy drinking water in Kenya. The fifth phase of the program will be implemented under the supervision of the Saudi Fund for Development (SFD) through Water Sector Trust fund (WSTF) in Kenya.

For this project groundwater exploration and development is targeted in six counties namely Wajir (12 boreholes), Garissa (10 boreholes), Mandera (8 boreholes), Marsabit (7 boreholes), Samburu (3 boreholes) and Isiolo (2 boreholes). Geologically, the areas targeted for borehole drilling are in crystalline (volcanic or metamorphic) and sedimentary rocks.

The Location of the boreholes is provided in the **Google Map** with the following annotations:

- Green for priority boreholes,
- Yellow for standby boreholes and,
- Blue for existing boreholes.

The boreholes will be constructed at different depths depending on groundwater occurrence and distribution in each of the targeted areas. The borehole drill depths will be determined at the hydrogeological survey stage. The contractor is expected to hire services of a hydrogeological expert who is to carrying borehole site investigations at each of the pre-selected village and ascertain the exact location for borehole drilling as well as borehole depth.

For the purpose of the tendering process existing borehole data near a pre-selected site was evaluated from which the following tentative borehole depths have been adopted namely:- 100 metres, 200 meters and 250 meters.

All the 42 boreholes will be drilled at a diameter of 12”/304 mm to a depth of the six (6) metres. This section of the borehole will be installed with 12”/304 mm diameter surface casing, which will serve two purposes namely to protect the top of the borehole from erosion from returning drilling fluids or artesian flow or both and to provide the sanitary seal casing in the borehole headworks. Casing used as surface casing shall be mild steel of a specification suited to water well applications.

As from a depth of the 6 metres, all the boreholes will be drilled at a diameter of 10” (254mm) to completion depth as will be determined during the hydrogeological survey. The borehole will be installed with 8” 203 mm plain casings and screens. The annular space between the borehole and casing/screens will be filled with gravel pack only for sections that are aquiferous. Above the upper most of gravel pack the borehole will be filled with inert backfill. In order to avert any surface pollution, a grout seal will be installed up to the top of the highest level of inert material to surface + 0.4 m.

After completion of drilling and placement of casing and screens, gravel and backfill etc the borehole shall be developed in accordance with modern borehole construction practices, including airlift surging and possibly chemical development using a polyphosphate. It is expected that a total of 12 hours will be required. Subsequently, test pumping comprised of calibration test, 4-hour step-drawdown test followed by a constant discharge test for a period of 24 hours.

Full water chemistry analyses will be conducted on water removed from the borehole. Samples shall be collected immediately development is adjudged complete. In addition, water samples for bacteriological analysis will be collected from borehole at the end of development; these will be collected and immediately shipped to an approved laboratory to comply with KS 05-459 (1996).

The Contractor will select the pump based on the test pumping results (Static level and dynamic level of the water in the borehole, the flow of the borehole) as well as the height of the water tank. Based on the expert judgement, three depths (100 m, 150 m, 200m) and a flow of 15 m3/h have been selected to size the pumps to be used in this tender. Grundfos pumps or equivalent are suggested for this project. The simulations resulted in the following pumps' choice:

Type of Pump Grundfos or equivalent	**Number of pumps**	**Maximum Yield (m)**	**Qmin (m^3/hour)**	**Power of the Pump (Kw)**
SP 17-12	7	100	15,93	7,5
SP 17-18	31	150	16,14	11
SP 17-23	4	200	15,14	13

The other installations done together with the submersible include a 2" (50 mm) galvanized steel rising main, submersible cable, electrode pencils, electrode cable, a non-return valve just above the pump, a 25-32 mm dipper line, and all other items necessary for proper functioning of the pump. As an alternative to the control panel and coupled start/stop electrodes, a CU3 control unit or similar may be installed. All the Items to be installed shall be subject to confirmation and approval by the Supervising Engineer. All items will be of high quality, and suitable to function properly in tropical conditions. Spare parts of the equipment to be supplied and installed shall as much as possible be available in Kenya.

A successful well is the well:

1. giving a sustainable yield of $\geq 3m^3$/hr,
2. whose water is compliant to the health and quality standards in Kenya for Groundwater KS 05-459 (1996),

However only the yield criteria will be applied to pay for successful boreholes.

As per the expert opinion, the success rate of boreholes in the six counties is as follows:

County	**Number**	**%**
Wajir	12	95%
Garissa	10	80%
Mandera	8	95%
Marsabit	7	80%
Samburu	3	80%
Isiolo	2	60%

In order to increase the success rate of the productive boreholes, the Contractor will carry out borehole site investigations for both priority and standby selected sites. **Drilling will only be carried out for sites with high prospects. It is proposed that at least 3 measurements be carried out at each site.**

To overcome the issues related to fuel supply and cost, the submersible pumps will be driven by solar power.

The PV system shall provide enough energy for the submersible pump and accessories to deliver the water of the well to the 100 m^3 water tank at height of 12 m from ground level. No battery is foreseen in the project and the minimum annual number of hours of sunshine is **1469** (data collected from the meteorological station at Jomo Kenyata international Station). The photovoltaic panels will be installed at a height of 1.60 m from the ground. To acquire the best radiation intensity half of the panels will be tilted **8° to the north** while the other half, tilted **8° to the south**. While designing the PV installation, the Contractor shall foresee an overpower for the well-functioning of the pumps and to feeding the accessories as well as the inverter which will convert the current to AC:

Type of Pump Grundfos or equivalent	**Power of the Pump (Kw)**	**Sunshine hours per year**	**Tilt angle / horizontal**	**Orientation**	**Peak power of the field (kWp)**	**Total Power (KW)**	**Over-power%**
SP 17-12	7,5	1469	8°	0° / Nord	**6,2**	**9,1**	**22**
SP 17-18	11	1469	8°	0° / Nord	**10,2**	**15,0**	**37**
SP 17-23	13	1469	8°	0° / Nord	**12,4**	**18,2**	**40**

The Inverter shall be an advanced solar inverter to be installed in an enclosure for water and heat protection. The specific features of the inverter include:

- Patented MPPT (Maximum Power Point Tracking) capability providing fast response, good stability and up to 99% efficiency.
- Supports motor soft start and gives full motor protection,
- IP65 protection guards suitable for harsh outdoor environments.

The Inverter shall offer the following control functions:

- Settable minimum and maximum frequency and open circuit voltage.
- Display of operating parameters including frequency, voltage, amperage, input power and pump speed.
- Protection against over and under voltage, over current, system overload and module over temperature.
- Fault detection with error code display.

The solar panels shall be connected among themselves as all cables of the array are connected to a junction or combiner box. The solar panels shall be:

- High module conversion efficiency superior to **19 %** by using Passivated Emmiter Rear Contact (PERC) technology,

- The modules should be **monocrystalline**,
- Low degradation and excellent performance under high temperature and low light conditions,
- Robust aluminum frame ensures the modules to withstand wind loads up to 2400Pa. The frame will be supported by a reinforced concrete ground beam. A particular attention will be provided to the alignment of the support (horizontality) and to the tilt of the panel.
- High reliability against extreme environmental conditions (passing salt mist, ammonia and hail tests).
- Potential induced degradation (PID) resistance.
- Positive power tolerance of 0 ~ +3 %.

It is designed that water from each borehole will pumped into an elevated rectangular steel tank. Therefore, the project has designed for 42 elevated steel tanks with a capacity of 100 m^3 each. As stipulated, the height of the tanks is 12 m from ground level to the bottom of the tanks. At every site, a geotechnical investigation shall be carried to estimate the bearing capacity of the soil and allowable settlement and the chemical properties of the soil (sulphate & chloride contents) from this investigation the depth & type of footing of the water tank shall be decided.

The water from the water tanks shall be transferred **by gravity** to the water taps post near to the beneficiaries. High density polyethylene pipes (HDPE) are suggested. It is designed that for each village water supply system will comprise of a main water primary truck extending over a distance of 500 metres. The secondary system will comprise of supply to the school within a distance of 250 metres, as well as Kiosk for public water supply. At the end of the primary truck a cattle trough will be installed 400 metres away. Upon the instruction of the Consultant, the distribution network might be extended to the mosque and to the dispensary. The construction of a complete Kiosk with lockable door and window will include two taps and water meter, soak pit, drainage pipe and all necessary works, furnishing of all necessary parts, masonry walls and corrugated sheet as a roof.

CHAPTER I: INTRODUCTION

1.1 INTRODUCTION

The Government of the Kingdom of Saudi Arabia is desirous to assist and to strengthen the relations with the Countries of Africa to cope with the needs of the healthy drinkable water by means of implementing the Fifth Phase of the Saudi Program for Drilling of Wells and Rural Development in Africa. The Fifth phase of the program will be implemented under the supervision of the Saudi Fund for Development (SFD).

The objectives of the entire program are as follows:

1. To raise the living standard of the rural population by long-term provision of a safe drinking water supply
2. To improve the water supply situation in rural areas to benefit as many people as possible, and provide a basis for gradual development
3. To provide hygienically safe drinking water
4. To give preference to cost-effective solutions and installations easy to operate and maintain by the target groups
5. To use high-quality, durable materials requiring a minimum of maintenance and repair, for all constructions
6. To help alleviate unemployment by giving preference to labor-intensive construction work
7. To spread the goodwill of the Kingdom of Saudi Arabia through the generous donation to the peoples of Africa in their time of need.

1.2 AGREEMENT SIGNATURE

Further to the evaluation of the SFD, the Consulting Engineer Contract has been awarded to SCET-Tunisie on October 5, 2020. The Water Sector Trust Fund (WSTF), representative of the Republic of Kenya, signed with SCET-Tunisie the consultancy Service Agreement on November 18, 2020.

1.3 SCOPE OF THE PROJECT:

The assignment covers the Design and Supervision of the Construction of 42 Drilled Wells to Supply several villages in the counties of Mandera, Wajir, Garissa, Marsabit, Isiolo and Samburu in Kenya. This project aims to provide drinking water, a "source of life" to more than 150,000 people. The facilities to be provided must be easy to operate and maintain by the local populations. Considering that the location of the boreholes may not necessarily be close to transmission lines and because of fuel supply issues, the option of equipping the wells with solar pumping generators would be the first option to consider since it is the most cost-effective solution.

CHAPTER II: BACKGROUND INFORMATION ON THE PROJECT AREA

2.1 MANDERA COUNTY

This section provides a brief description of the Mandera County (Fig. 2.1) in terms of location and demographic characteristics, topography, geology and hydrogeology.

2.1.1 Location and demography

Mandera County is located in northeastern Kenya. It is the farthest county to the northeastern horn of Kenya at about 700Km from the Country's capital, Nairobi. Bounded by latitudes 2° N and 4° 30' N and longitudes 39° 30'E and 42° E by approximation (Fig. 2.1).

Mandera County covers an area of 25,991.5 Km^2. It borders Ethiopia to the North, Somalia Republic to the East, and Wajir County to the South - West (Mandera County CIDP 2018-2022, 2018).

Administratively, the county is divided into seven administrative sub-counties namely: Banisa, Lafey, Mandera West, Mandera East, Mandera North, Kutullo, and Mandera Central. These sub-counties are further sub-divided into 27 divisions, 119 locations, and 174 sub-locations (Table 2.3). The county has six parliamentary constituencies namely: Mandera East, Banisa, Mandera West, Lafey, Mandera North, and Mandera South. Moyale town is the county headquarters.

The Kenya Population and Housing Census (KPHC) of 2019 (Table 2.1 and table 2.2), put the county population at 867,457 persons (434,976 Male, 432,444 Female, and 37 intersex),

Table 2.1: Population Distribution by Sex, Number of Households, Land Area, Population Density, and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Mandera West	98,300	48,166	50,130	4	14,274	4,018	24
Banisa	152,598	78,301	74,288	9	24,285	3,944	39
Kutulo	72,394	35,799	36,593	2	9,446	2,509	29
Lafey	83,457	40,476	42,976	5	11,597	3,795	22
Mandera Central	157,220	71,688	85,527	5	21,140	4,032	39
Mandera East	159,638	83,538	76,095	5	25,904	2,506	64
Mandera North	143,850	77,008	66,835	7	19,117	5,138	28

(Source: KNBS, 2019)

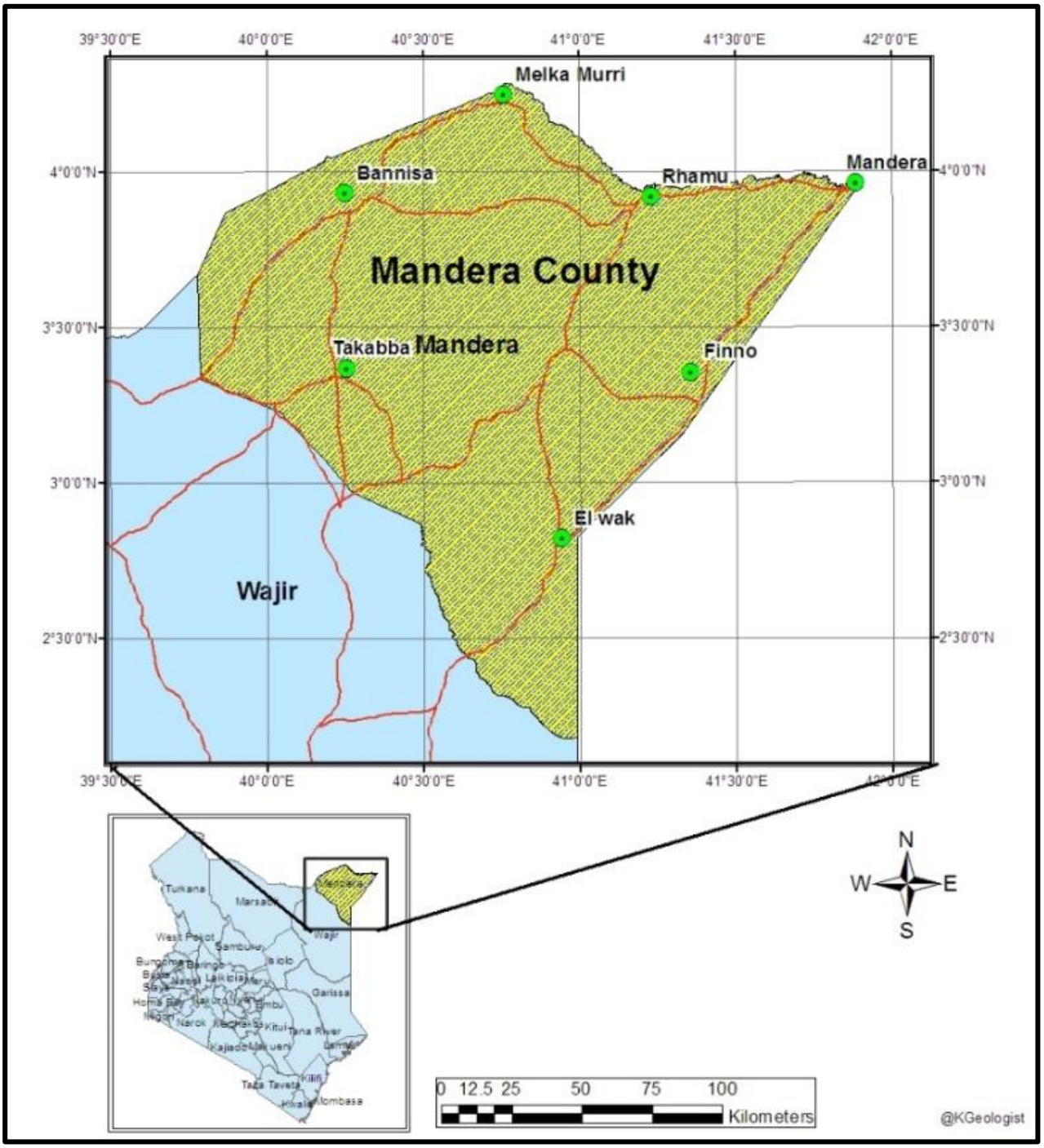

Figure 2.1: Location of Mandera County.

Table 2.2: Population Distribution by Number of Households, Land Area, Population Density, and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. km	Density
Mandera West	Dandu	Burduras East	Burduras East	3,675	533	17.4	211
		Burduras West	Burduras West	4,886	868	50.8	96
		Dandu	Dandu	10,412	1,531	381.4	27
			El-Danaba	5,651	903	138.8	41
		Gither	Gither	10,843	1,697	603.3	18
			Sake	4,270	632	124.4	34
		Kubihalo	Kubihalo	3,495	584	252.6	14
	Takaba	Darwed	Awacho Sambur	7,565	1,040	453.5	17
		Didkuro	Didkuro	4,953	641	238.3	21
		Dududle	Dududle	3,327	427	393.1	8
		Lagsure North	Lagsure North	1,738	238	158.1	11
		Lagsure South	Bulla Mpya	2,439	347	129.7	19
		Sukela Kuli	Sukela Kuli	1,228	165	280	4
		Takaba	Ardahalo	4,874	793	51.9	94
			Kubdishan	2,896	411	448	6
			Takaba	21,519	2,874	30	716
		Wangai Dahan	Qoqaye	1,431	197	166.3	9
			Wangai Dahan	3,098	393	100.3	31
Banisa	Banisa	Banisa	Banisa	18,430	3,463	139.8	132
			Gurdis	2,308	387	264	9
		Chiracha	Chiracha	3,036	495	95	32
		Derkale	Burashum	4,083	720	257.7	16
			Derkale	6,025	833	175.4	34
			Kukub	3,270	542	54.1	60
			Tarama	3,305	512	68.7	48
		Eymole	Ameyi	2,044	383	80.1	26
			Eymole	10,493	1,810	94.9	111
		Lulis	Awal Yattani	4,379	864	132.8	33
			Lulis	10,828	2,243	137.2	79
	Kiliwehiri	Kiliwehiri	Birkan	5,109	635	101.7	50
			Kiliwehiri	11,594	1,554	125.9	92
			Umur	1,760	271	27.3	64
		Funan Teso	Goljo	10,077	1,577	172.8	58
			Funan Teso	5,791	896	106.2	55
			Khot Khot	2,990	470	55.7	54

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. km	Density
	Malkamari	Arda Garbicha	Arda Garbicha	458	84	13.1	35
			Nitiyaya	644	86	35.6	18
		Guba	Choroko	6,616	871	196.1	34
			Guba	9,553	1,652	361.8	26
			Tarbey	5,764	963	198.4	29
			Juruqo	850	104	108.2	8
		Hullow	Hullow	8,654	890	269.4	32
		Malka Ruqa	Malka Ruqa	3,695	454	145.1	25
		Malkamari	Domal	1,851	276	20	93
			Malkamari	9,021	1,250	507	18
Kotulo	Borehole II	Borehole II	Borehole II	14,764	1,942	219	67
		Dabacity	Dabacity	4,368	511	67.4	65
		Dimu	Dimu	1,530	204	83.7	18
	Elram	Elram	Abey Umur	1,084	152	231.1	5
			Elram	5,127	688	117.1	44
		Garsesala	Garsesala	9,274	1,012	401	23
	Kutayu	Kutayu	Kutayu	6,287	910	532.8	12
			Nyatalio	2,410	316	183.3	13
	Kotulo	Bojigarse	Bojigarse	2,399	365	77.1	31
		Harwale	Harwale	5.332	748	269.1	20
		Kotulo Town	Kotulo Town	16,856	2,163	34.6	487
		Lehehe	Lehehe	1,541	254	109.4	14
		Malbe	Malbe	1,422	181	183.7	8
Lafey	Lafey	Alungu	Alungu Gof	6,690	816	494.6	14
		Bulla Alungu	Bulla Alungu	7,249	927	113.3	64
		Damasa	Damasa	7,276	1,077	101.3	72
		Fino	Fino	4,388	745	365.4	12
			Hareritur	2,320	456	87.3	30
		Kabo	Kabo	3,870	589	347.4	11
		Kamora Liban	Kamora Liban	4,455	637	79.1	56
		Lafey Central	Lafey Central	18,603	2,474	276.6	67
		Lafey South	Lafey South	2,237	309	79.3	28
		Sheikh Barrow	Sheikh Barrow	2,577	379	262.9	10
	Sala	Jabi East	Jabi East	2,358	234	235.2	10
		Sala	Sala	3,792	486	393.2	10

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. km	Density
	Warankara	Bamboo	Bamboo	2,084	305	19.8	105
			Barmilla	1,891	273	131.1	14
		Gari	Gari	5,651	732	146.2	39
		Warankara	Safo	1,998	260	225	9
			Warankara	5,718	898	437.7	13
Mandera Central	Elwak	Bulla Afya	Bulla Afya	9,419	1,113	14.4	653
		Elwak South	Elwak South	36,188	4,621	161.3	224
		Elwak Town	Dawder	2,557	359	181	14
			El-Adi	7,958	1,283	117.2	68
			Elwak Town	16,166	2,330	304.7	53
		Udole	Udole	4,616	809	185.1	25
		Wante	Elgolicha	2,970	448	84.1	35
			Wante	4,241	525	117.9	36
	Qalanqalesa	Fincharo	Dololo	1,792	276	1.8	995
			Fincharo	6,109	1,000	309.7	20
		Qalaqalesa	Qalaqalesa	4,764	773	119.6	40
		Qarsadamu	Qarsadamu	4,419	567	135.7	33
	Shimbir Fatuma	Burmayo North	Burmayo North	1,569	267	241.8	6
		Burmayo South	Burmayo South	1,070	173	5	214
			Garsedam	523	88	3.6	146
		Chachabole	Chachabole	4,609	548	169.7	27
			Kob-Adadi	2,801	350	336.6	8
		Shimbir Fatuma	Shimbir Fatuma	15,784	2,103	341.9	46
	Wargadud	Wargadud	Buqe	1,834	250	128.7	14
			Elele	2,923	421	140.4	21
			Ireskinto	2,707	248	80.5	34
			Wargadud	13,461	1,460	325.6	41
	Sukela Tinfa	Sukela Tinfa	Sukela Tinfa	1,137	164	88	13
		Wargadud East	Wargadud East	4,508	596	232.7	19
		Qurahmahdow	Qurahmahdow	3,095	368	204.6	15
Mandera East	Arabia	Arabia	Arabia	6,153	1,064	670.9	9
		Omar Jillow	Omar Jillow	1,503	403	89.4	17
	Libehiya	Farey	Farey	528	81	45.3	12
		Libehiya	Libehiya	2,432	386	244.8	10

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. km	Density
			Qurader	893	168	102.6	9
		Odha	Bamboo	441	133	154.6	3
			Odha	1,370	273	247.9	6
		Serohindi	Harar	201	26	43.1	5
			Serohindi	1,113	129	31.9	35
	Hareri	Aresa	Aresa	3,344	555	79.8	42
		Hareri	Hareri	2,152	389	85.8	25
		Qumbiso	Qumbiso	1,866	299	114.7	16
	Khalalio	Bella	Bella	1,560	204	3.7	421
			Matasafara	1,356	134	8.8	154
		Bulla Haji	Bulla Haji	510	59	3.8	135
		Bur Abor	Bur Abor	1,461	150	6	244
			Sharif	892	155	33.7	26
		Fikow	Fikow	349	60	10.8	32
		Gadudia	Gadudia	2,378	351	25.2	94
		Garbaqoley	Garbaqoley	978	111	79.8	12
		Gingo	Darika	1,413	290	2.3	614
			Gingo	732	99	1.5	502
			Meygag	267	52	0.3	765
		Hareri Hosle	Bidha	442	73	81.1	5
			Hareri Hosle	819	152	80.3	10
			Kamor Ele	301	50	41.8	7
		Karo	Karo	326	61	72.3	5
			Sidahjirot	669	103	35.7	19
		Khalalio	Khalalio	1,871	348	9.1	206
			Lemanded	1,413	192	3.9	364
	Central	Barwaqo	Bakolow	3,960	720	27.6	143
			Barwaqo	5,212	1,062	2.8	1,890
		Border Point One	Border Point One	9,768	1,626	9.6	1,022
		Bulla Jamhuria	Bulla Jamhuria	7,409	1,108	0.9	8,623
			Bulla Nguvu	3,086	502	0.9	3,283
			Bulla Power	7,695	1,249	4	1,937
		Bulla Mpya	Bulla Mpya	10,529	1,756	3	3,471
		Central	Central	13,542	2,556	2.6	5,295

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. km	Density
		Kamor	Kamor	9,399	1,169	2.6	3,667
		Neboi	Neboi	14,557	2,398	654	
		Shafshafey	Shafshafey	23,576	3,409	16.8	1,403
		Township	Township	11,172	1,769	2	5,529
Mandera North	Ashabito	Ashabito	Ashabito	8,748	1,301	347.7	25
		Gofa	Gofa	4,159	708	769.1	5
		Guticha	Guticha	5,608	955	471.7	12
		Kubi	Kubi	4,435	474	247.9	18
		Marothile	Marothile	6,565	622	86.6	76
		Ogorwein	Ogorwein	6,471	671	301.1	21
		Shirshir	Shirshir	6,005	656	447.1	13
	Olla	Barwaqo	Barwaqo	1,303	143	87.4	15
		Lanqura	Lanqura	4,605	509	488.2	9
		Olla	Kobandaqa	931	138	32.4	29
			Olla	7,522	1,014	661.3	11
		Sarman	Sarman	2,082	347	89.4	23
	Rhamu	Bulla Dodey	Bulla Dodey	5,061	840	11.1	456
			Jabibar	4,408	622	177	25
		Girissa	Girissa	10,342	1,399	12.5	830
		Rhamu	Rhamu	19,356	2,674	78.3	247
		Shantoley	Shantoley	8,474	1,234	5.8	1,473
	Rhamu Dimtu	Garse	Garse	4,368	654	122.2	36
		Kalicha	Kalicha	7,636	794	91.3	84
		Mado	Mado	5,751	471	39.2	147
		Rhamu Dimtu	Harare	1,042	127	262.5	4
			Qorahey	4,315	636	76.5	56
			Rhamu Dimtu	9,367	1,286	90.2	104
		Yabicho	Yabicho	5,296	842	141.8	37

Table 2.3: Administrative and political units (Source: Mandera County Development Profile (2013))

Sub-Counties	Area (km^2)	Divisions	Area (km^2)	No. of Locations	No. of Sub-Locations
Banisa	3,356.1	Banisa	1179.5	4	9
		Malkamari	1864.3	5	6
		Kiliweheri	312.3	1	3
Mandera West	4,778.5	Takaba	3143.4	7	11
		Dandu	1635.1	6	7
Mandera East	2,797	Khalalio	495	9	17
		Hareri	580	3	3
		Libehiya	679	4	7
		Central	105	9	12
		Arabia	938	2	2
Lafey	3,378	Sala	618	1	1
		Fino	947	1	2
		Lafey	856	5	5
		Warankara	957	3	5
Mandera North	5,533.5	Rhamu Rhamu/Dimtu	147.3 935.2	3 4	4 5
		Ashabito	4,451	8	8
Mandera South	6,148.4	Elwak Shimbir Fatuma	814.1 1,324.4	5 4	7 6
		Wargadud	1,127.8	3	8
		Qalanqalesa	1,044.9	5	6
		Kutulo	1,837.2	5	7
TOTAL	**25,991.5**	**22**	**25,991.5**	**97**	**141**

2.1.2 **Topography**

Mandera County is marked by low lying rocky hills located on the plains that rise gradually from about 400 m a.s.l in the south near El-wak to about 970 m a.s.l near the border with Ethiopia to the north-west near Banisa and surrounding areas. It is these highlands that form the source and catchment for major rivers that flow through the county. The rest of topography is low lying, ranging from 250 m to 700 m a.s.l. characterized by dense vegetation with thorny shrubs of savannah type. This is especially found along foots of isolated hills. These areas are

covered by bushes, shrubs, boulders and invasive *prosopis juliflora* 'mathenge' coverage (FCIDP, 2017). The county near and around Mandera town is low lying at below 500 m a.s.l. This is well depicted in Figure 2.2 and drainage is shown in Figure 2.3.

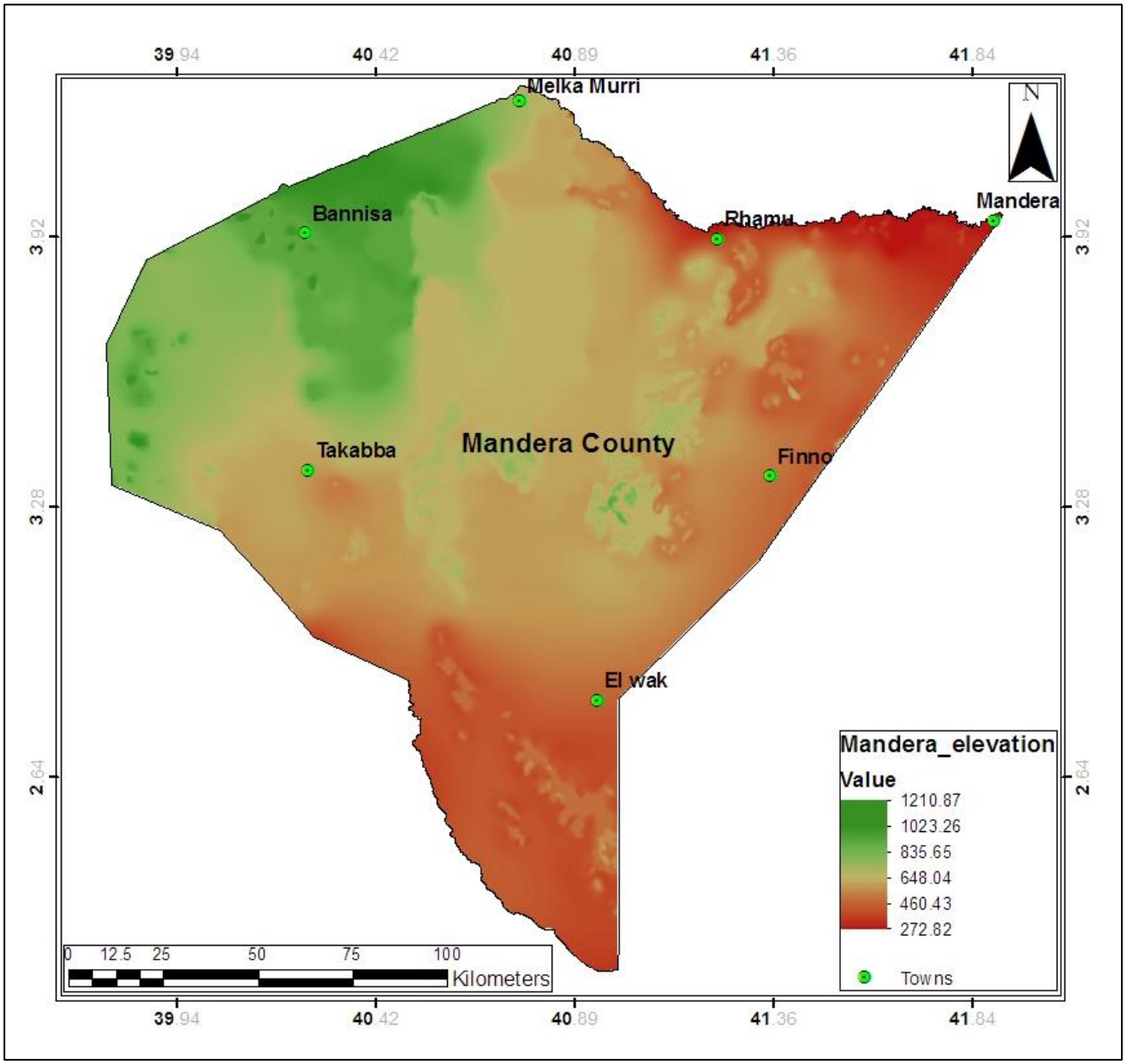

Figure 2.2: Topographical map of the Mandera County showing chages in relief

(Earthview Ltd 2016)

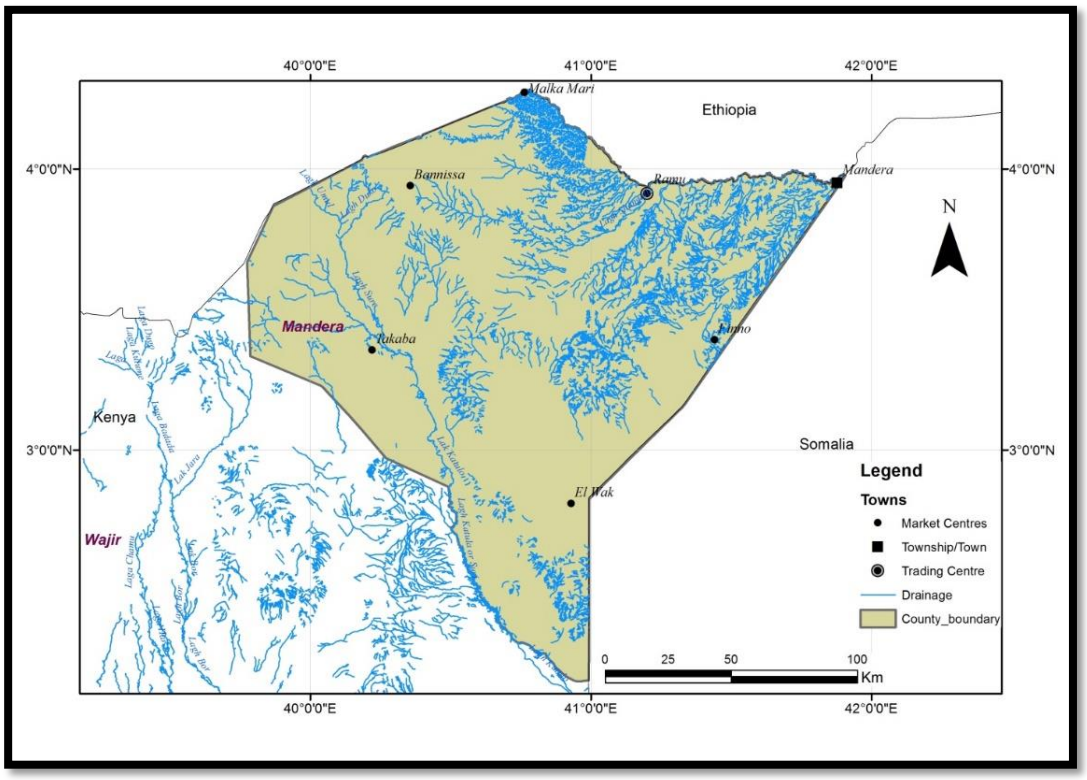

Figure 2.3: Drainage pattern of Mandera County and surrounding areas to the south west (Earthview Ltd 2016).

2.1.3 **Geology**

Geologically, the oldest rocks in Mandera County belong to Precambrian age that include gneiss, schist, quartzite, amphibolite, and granulite, which are localized on the western part covering Dandu, Tabaka and western part of the Banisa areas. The dominant sedimentary rocks include the Mansa Guda Formation of the Triassic age; Mandera Series and Daua Limestone Series of Jurassic age; and Marehan Series of Cretaceous age. The younger deposits include Pliocene deposits comprised of interbedded clay, sand and weathered gravel in clay matrix. In addition, the major drainage ways (e.g. Daua river basin) are characterized by alluvial sand, silts and clays. Notably, the Triassic, Jurassic, and Cretaceous sediments were deposited successively in a subsiding basin with the centre of the basin near El Wak area. The strata dip generally at angles of 1° to 3° toward the center. Locally, folding and faulting have modified the basic simple pattern of the structural basin.

The Mansa Guda Formation outcrops in a narrow band trending north from Tarbaj village in Wajir County to Bur Mayo village in south western part of the Mandera County. Surface exposures of the formation consist of unfossiliferous sandstone and conglomerate. The Jurassic rocks occurring as two series (Mandera Series and underlying Daua Limestone Series) overlie Mansa Guda Formation. The Jurassic rocks include limestone, mudstone, shale, and sandstone, lithologies. The sedimentary deposits of the Cretaceous age include sandstone, shale, and siltstone that occupy the central part of the structural basin in Mesozoic rocks centered at El Wak and are prominently exposed where they cap the hills and ridges of eastern Mandera County. The rocks that commonly weather to a reddish color belong to the upper part of the Marehan Series, whose lower part is known as the Danissa Beds that consist generally of lenses of interbedded limestone, shale, siltstone, and sandstone. The deposits of the Cenozoic and

Quaternary periods are very rare in Mandera County. The unconsolidated valley fill of some of the northern plains near the Ethiopian border that include gravel and lateritic horizons, may be of late Pliocene age. Other deposits of Quaternary age include Pleistocene lacustrine sediments in the vicinity of El Wak. Holocene alluvial sediments are confined in the channels of the major watercourses and in narrow adjacent flood plains.

Structurally, Mandera County lies within the Mandera basin, a southern termination of the Ethiopia/Somalian Ogaden basin which is a huge North - South trending syncline. It forms the western flank strongly dipping to the east towards Somalia with the dip axis of the syncline occurring in Ethiopia and Somalia.

2.1.4 **Hydrogeology**

The existing borehole data indicate following distribution of boreholes within different geological units: 3 boreholes within Precambrian rocks; 5 boreholes within the Jurassic Murri Limestone rocks; 13 boreholes within the Jurassic Daua Limestone rocks; and 66 boreholes drilled within the Cretaceous Sediments that cover the entire eastern part of the Mandera County (Fig. 2.4).

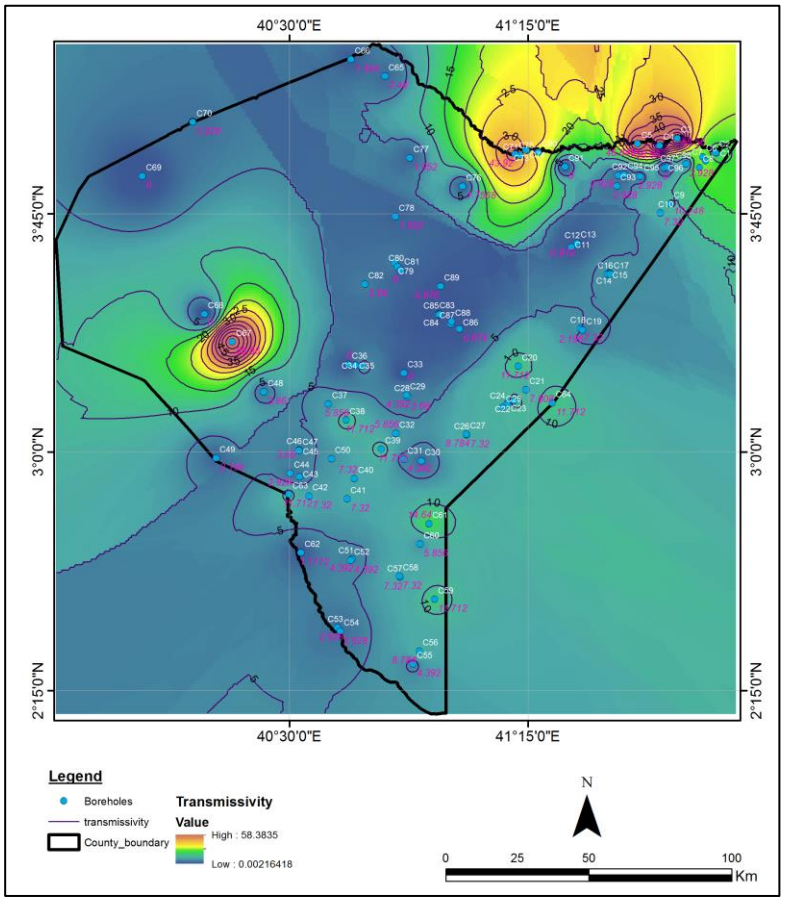

Figure 2.4: Hydrogeological map of Mandera County

2.2 WAJIR COUNTY

2.2.1 Location and demography

Wajir County is located in the North Eastern region of Kenya (Fig. 2.5). The county lies between latitudes 3^0 N 60'N and 0^0 20'N and Longitudes 39^0 E and 41^0 E and covers an area of 56,685.9 sq, km. It borders Somalia to the East, Ethiopia to the North, Mandera County to the Northeast, Isiolo County to the South West, Marsabit County to the West and Garissa County to the South.

Administratively, the county comprises of six sub-counties namely Wajir East, Tarbaj, Wajir West, Eldas, Wajir North, and Wajir South (Fig. 2.6). It's further divided into 30 wards as indicated in Table 2.4.

Table 2.4: Area by Sub-county and ward (CIDP, 2018)

Constituency/Sub-	Wards	Area (sq. Km)
Wajir East	Wagberi Township Barwaqo Khorof Harar	4,007.8
Tarbaj	Elben Sarman Tarbaj Wargadud	9,439.4
Wajir West	Arbajahan Hadado/Athibohol Adamasajide Wagalla/Ganyure	9,010.7
Eldas	Eldas Della Lakoley south/Basir Elnur/TulaTula	4,077.8
Wajir South	Benane Burder Dadajabula Habaswein Lagbogol south Ibrahim Ure Diff	21,595.7
Wajir North	Gurar Bute Korondille Malkagufu Batalu Danaba	8,554.5
	Total	**56,685.9**

Figure 2.5: Location of the County in Kenya

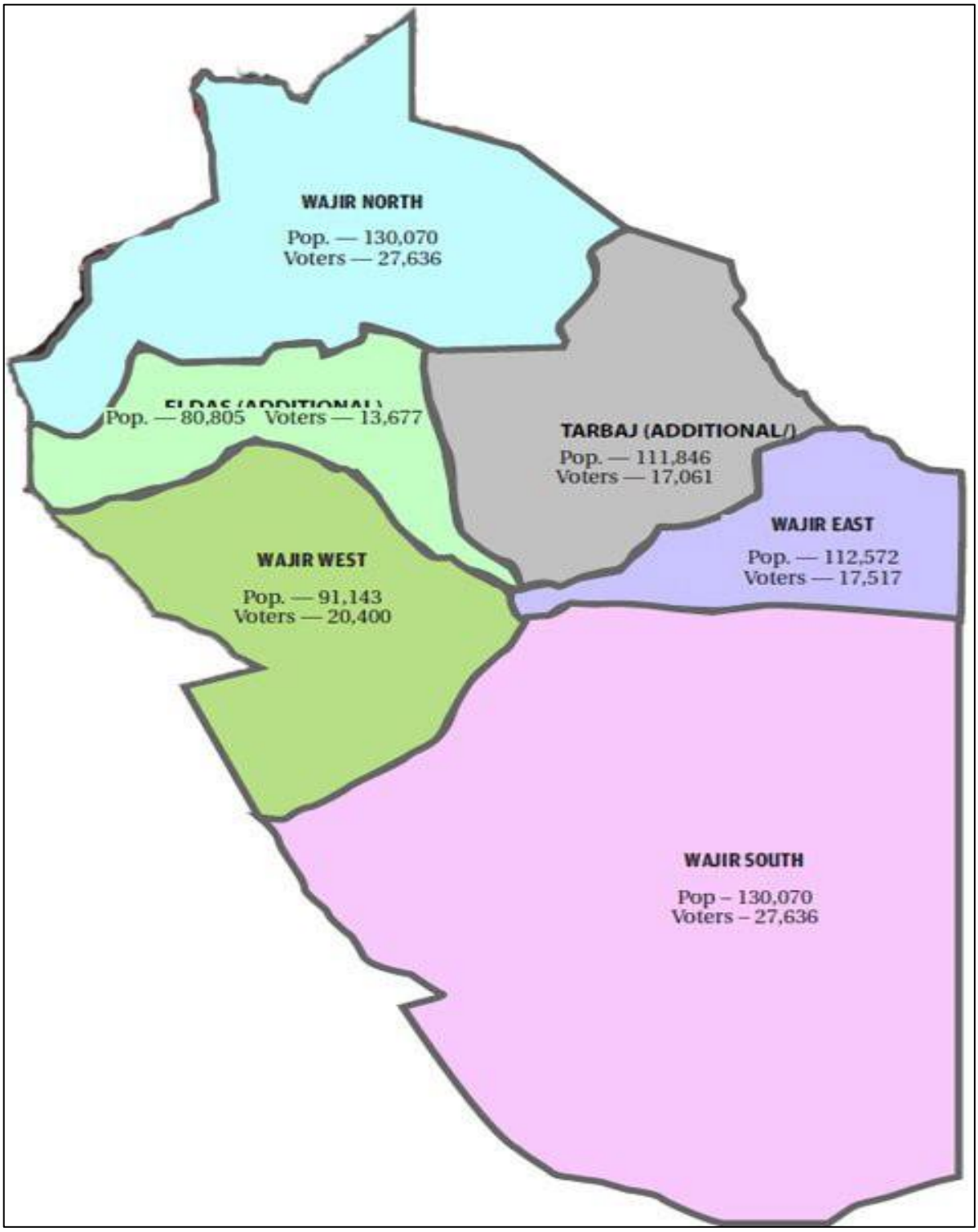

Figure 2.6: County's Administrative and Political Units (the map of the county's administrative and political units)

The Kenya 2019 Population and Housing census indicate that the county had a total population of 781,263 (415,374 Males, 365,840 Females, and 49 Intersex) table 2.5 and table 2.6, below shows the population by sex and sub-county.

Table 2.5: Population Distribution by Sex, Number of Households, Land Area, Population Density, and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Buna	49,886	26,796	23,088	2	6,480	3,888	13
Eldas	88,509	44,743	43,759	7	13,961	4,492	20
Habaswein	174,134	94,613	79,505	16	31,292	10,912	16
Tarbaj	57,232	27,141	30,086	5	9,309	9,608	6
Wajir East	110,654	59,359	51,292	3	18,674	4,053	27
Wajir North	62,206	31,990	30,209	7	10,490	4,042	15
Wajir South	116,814	64,947	51,864	3	21,364	10,734	11
Wajir West	121,828	65,785	56,037	6	16,362	9,044	13

(Source: KNBS, 2019)

Table 2.6: Population Distribution by Number of Households, Land Area, Population Density, and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
Buna	Buna	Batalu	Basnecha	759	127	11.3	67
			Batalu	1,206	149	129.1	9
			Kurow	259	29	32.9	8
		Bute Wayama	Bute Wayama	378	40	29.9	13
			Sala	563	91	506	1
		Boji	Boji	1,917	269	355.5	5
		Buna	Beramo	1,948	212	31.2	62
			Buna	7,707	852	9.9	777
			Funanbua	1,619	209	13.1	124
			Garseake	780	92	353.1	2
		El-Boruido	El-Boruido	442	62	443.6	1
		Ingirir	Ingirir	1,118	127	323.1	3
			Jibder	1,565	203	52.6	30
		Malkagufu	Fulo	912	140	51.4	18
			Malkagufu	2,124	236	178.1	12
		Masalale North	Masalale North	1,078	121	79.7	14
	Korondile	Basir North	Basir North	662	110	71.9	9
		Golbo	Golbo	848	138	100.1	8
			Jarte West	478	78	62.7	8
		Korondile	Kobole	512	82	48.6	11
			Korondile	8,543	1,156	49.1	174
			Nyatta	1,472	221	101.8	14
		Lakole North	Bitoyrebay	1,915	219	199.9	10
			Lakole North	1,171	123	118.2	10
			Saa-Kuno	719	82	79.6	9
		Lensayu	Kobedatacha	933	98	65.2	14
			Lensayu	4,361	692	178.9	24
		Harade	Harade	1,909	271	77.9	24
			Welmarer	1,641	194	71.4	23
		Sirey	Sirey	347	57	61.5	6
Eldas	Anole	Anole	Anole	6,190	1,081	192.7	32
		Jukala	Jukala	1,528	221	21	73
			Towfiq	1,635	238	47.3	35
		Majabow	Majabow	1,168	167	16.5	71
		Malkaguful South	Malkaguful South	2,003	290	21.8	92
		Waradey	Waradey	4,662	640	62.3	75

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Wargadud	Wargadud	5,704	830	105.6	54
	Dela	Abdiwaqo	Abdiwaqo	8,510	1,486	484.2	18
		Dela	Dela	4,751	709	358.5	13
			Haragal West	580	86	53.6	11
		Dela Yare	Dela Yare	2,206	343	127.4	17
	Eldas	Areswarji	Areswarji	4,016	558	281.4	14
		Basir	Basir	392	67	2.9	136
		Bullashair	Bullashair	2,682	398	7.7	348
		Dadhantalai	Dadhantalai	2,069	325	85.4	24
		Eldas	Eldas	3,899	691	11.7	333
			Wagberi	5,689	1,000	39.8	143
		Kikiley	Kikiley	4,965	752	574.2	9
		Lakole South	Lakole South	8,248	1,251	1,245.6	7
		Masalale	Masalale	5,890	964	256.4	23
	El-Nur	Balatun Amin	Balatun Amin	2,522	349	99.1	25
		Biad	Biad	1,898	294	39.2	48
			Elyunis West	621	113	110.7	6
		Dodha	Dodha	1,003	154	2.7	368
		El-Nur	El-Nur	5,746	867	235.9	24
		Towhiid	Towhiid	527	87	8.2	64
Habaswein	Banane	Banane	Banane	13,863	2,003	654.4	21
		Dabley	Dabley	3,669	619	585.7	6
		Ildalata	Turguda	3,006	601	85.9	35
		Sala	Sala	4,376	627	294.6	15
		Sarif	Sarif	19,300	2,911	1,613.1	12
	Dadajabulla	Broon	Broon	1,363	191	58.1	23
		Dadajabulla	Dadajabulla	14,828	2,782	280.2	53
		Elima Dagol	Elima Dagol	1,253	187	233	5
		Garaska	Garaska	2,817	527	402	7
		Getwab	Getwab	1,595	287	335.2	5
		Lagdub	Lagdub	2,912	498	160.8	18
	Habaswein	Abakore	Abakore	10,941	2,467	609.1	18
		Abore	Abore	591	102	263.1	2
		Alidumal	Alidumal	390	57	365.5	1
		Dalsan	Dalsan	3,295	624	161.9	20
		Dilmanyale	Dilmanyale	8,364	1,412	168.2	50
			Dulgub	1,139	168	213.7	5
		Fadiwein	Fadiwein	2,678	497	344.1	8

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Habaswein	Central	7,035	1,447	0.8	8,404
		Karu	Allanus	1,562	380	485	3
		Kibilay	Bulla Juu	5,460	1,190	15.4	355
			Kibilay	1,952	416	0.3	7,449
		Lagbogol	Lagbogol	2,881	488	58.7	49
		Lagdima	Lagdima	2,390	464	176.3	14
		Mathahlibah	Mathahlibah	848	188	163.9	5
		Meri	Aqal Aar	2,085	356	109.2	19
			Meri	3,899	871	145.7	27
		Ndege	Ndege	14,689	2,991	33.7	436
		Siligle	Siligle	6,217	1,226	76.9	81
		Tesorie	Tesorie	3,815	714	305.9	12
		Udhole	Udhole	416	63	203.1	2
	Sabuli	Dagahley	Abdille Gab	1,130	172	56.4	20
			Dagahley	5,273	824	261.1	20
			Mathahbaqay	813	87	91.8	9
			Welari	1,975	260	206	10
		Darfur	Darfur	596	84	158.6	4
		Fini	Fini	3,550	535	133	27
		Lambaraha	Lambaraha	2,110	340	110	19
		Sabuli	Arablow	421	118	91.4	5
			Iskedeg	1,405	336	154.5	9
			Sabuli	3,889	674	61.9	63
			Shidley	1,808	237	325	6
		Shimbirirbul	Shimbirirbul	1,535	271	659.6	2
Tarbaj	Kotulo	Ausmudule	Ausmodule	642	114	566.8	1
			Kajaja II	1,366	254	220	6
		Bojigaras	Bojigaras	894	125	114.5	8
		Dasheg	Dasheg	2,527	385	267.5	9
			Kajaja I	1,660	230	32.4	51
		Kotulo	El-Kotulo	773	126	95	8
			Kotulo	4,354	653	724.3	6
		Lafaley	Jowhar	1,637	300	45.5	36
			Lafaley	2,456	402	324.2	8
		Wargadud	Hungai	1,689	251	263.1	6
			Wargadud	2,384	366	650.4	4
	Mansa	Burmayo	Burmayo	2,036	318	420.1	5
		Elben	Elben	2,576	332	368.0	7

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Mansa	Mansa	3,163	561	1,346.8	2
		Ogarale	Ogarale	867	129	382.7	2
	Sarman	Dambas	Dambas	2,919	471	435	7
			Jaijai	856	143	51.4	17
			Machine Ben	885	112	38.4	23
		Dunto	Basanija	799	150	91.5	9
			Dunto	2,170	277	497.3	4
		Gunana	Gunana	2,721	556	387.8	7
			Korama	1,340	285	13.9	96
		Sarman	Berjanai	1,244	186	31	40
			Sarman	2,240	434	415.3	5
	Tarbaj	Haragal	Haragal	1,855	286	370.8	5
			Majabow	1,250	220	171.6	7
		Katote	Hassan Yarow	1,804	286	118.5	15
			Katote	2,409	376	426.3	6
		Tarbaj	Elyunis	1,142	193	236.1	5
			Tarbaj	3,985	785	502.2	8
Wajir East	Central	Alimalow	Alimalow	3,819	538	0.9	4,313
		Baraza Park	Baraza Park	2,124	583	0.4	5,010
		Barwaqo	Barwaqo	8,498	1,702	10.1	839
		Maalim Salat	Elmi	1,213	416	27.3	44
			Maalim Salat	9,427	1,802	8	1,183
		Furaha	Bulla Gadud	2,686	409	4.7	568
			Furaha	2,817	379	4	698
		Got-Rahma	Got-Rahma	596	112	8.9	67
		Halane	Halane	9,332	1,239	5.9	1,576
		Hodhan	Hodhan	2,781	705	17.3	161
		Jogbaro	Got-Ade	12,329	2,311	10.2	1,212
			Makoror	9,793	1,770	13	755
		Jogoo	Jogoo	11,110	1,419	1.4	8,167
		Township	Township	3,638	978	1	3,550
		Wagberi	Wagberi	9,775	1,221	10.7	918
	Khorof Harar	Khorof Harar	Gurmarey	150	26	99.7	2
			Khorof Harar	6,136	841	288.5	21

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Qarsa	2,215	314	813.9	3
	Wajir Bor	Arbaqeramso	Arbaqeramso	3,436	542	134.9	25
			Lanbib	1,936	323	34.8	56
		Andaki East	Andaki East	793	66	538.7	1
		Konton	Konton	1,060	166	285.5	4
		Riba	Riba	1,488	294	1,084.8	1
		Wajir Bor	Wajir Bor	3,502	518	648.9	5
Wajir North	Bute	Bute	Bute	6,089	1,140	23.1	264
			Butegodha	1,519	253	61.1	25
		Dugo	Dugo	1,983	297	53.5	37
		Godoma	Godoma	2,455	392	25.5	96
		Gumar	Gumar	2,925	840	67.1	44
		Hote	Hote	2,831	327	155.6	18
		Ogorji	Adadijole	1,683	238	103.6	16
			Jarti	372	53	9.4	40
			Ogorji	1,570	280	498.3	3
		Walenstutu	Walenstutu	5,365	1,091	82.6	65
		Watiti	Watiti	4,977	594	40.6	123
	Gurar	Ajawa	Ajawa	4,367	525	224.2	19
		Bosicha	Bosicha	1,428	259	172.6	8
		Danaba	Danaba	3,335	467	4.4	766
			Hadaraka	1,614	227	160.8	10
		Garkilo	Basakorow	458	80	48.4	9
			Garkilo	1,359	206	63.1	22
		Gulani	Bolowle	224	29	59.9	4
			Gulani	358	52	102.6	3
		Gurar	Gurar	3,644	545	169.2	22
		Qarari	Qarari	599	102	505.2	1
		Qarsabula	Qarsabula	1,018	232	110.0	9
		Qarsasare	Qarsasare	667	142	223.8	3
		Quadama	Quadama	2,533	471	648.1	4
Wajir South	Burder	Abaqdere	Abaqdere	3,892	782	137.1	28
		Burder	Burder	4,590	984	657.1	7
			Gulledere	766	185	448	2

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Rababale	693	141	115	6
			Welgaras	3,302	532	197.2	17
		Ibrahim Jilibey	Ibrahim Jilibey	1,524	305	114.7	13
		Shimbirey	Shimbirey	2,716	504	228.5	12
	Diff	Alio Ismail	Alio Ismail	3,500	498	464.6	8
		Aqta Lahel	Aqta Lahel	2,505	463	226	11
		Baldos Dugow	Baldos Dugow	1,192	117	3	404
			Bula Gumar	2,156	311	11.6	186
		Diff	Diff	11,097	2,136	786.2	14
		Hambalash	Hambalash	5,056	789	539.6	9
		Qarurah	Qarurah	2,034	430	126.7	16
		Salalma	Bali Yarey	1,908	238	177.9	11
			Salalma	8,669	1,463	431.1	20
	Kulaaley	Bilbur - Bor	Lamanded	1,150	152	114.3	10
			Bilbur – Bor	1,665	187	150.3	11
			Sukela	1,482	299	202.8	7
		El - Adow	El – Adow	1,861	373	52.7	35
			Meygag	1,914	381	127.3	15
		Eyrib	Eyrib	3,692	739	232.3	16
		Hubsoy	Hubsoy	1,868	449	335.5	6
			Nolley	2,046	702	468.3	4
		Khumbi	Khumbi	406	81	11.1	37
		Kulaaley	Kulaaley	3,667	709	145.8	25
			Leheley	10,923	1,613	423.5	26
		Kursin	Kursin	2,240	414	68.9	33
			Qoqar	3,838	834	430.7	9
		Machesa	Machesa	9,396	1,161	1,122.5	8
	Wajir – Bor South	Argane	Argane	1,842	424	486.8	4
		Handaki	Handaki	1,865	432	262.0	7
		Ibrahim Ure	Ibrahim Ure	4,248	842	640.5	7
		Wajir – Bor South	Wajir – Bor South	3,213	625	220.3	15
		Gerille	Gerille	3,898	1,069	574.4	7
Wajir West	Ademasajida	Ademasajida	Ademasajida	13,892	1,320	16.4	847

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Hadado South	Hadado South	6,833	702	399.8	17
		Kanchara	Guticha	746	107	77.8	10
			Kanchara	2,133	322	119	18
		L.M.D	L.M.D	634	121	13.6	46
			Req North	344	63	173.8	2
		Lagdima	Lagdima	1,228	222	78.2	16
		Lolkuta South	Lolkuta South/Gesdor	1,888	383	180.4	10
	Arbajahan	Adan Awale	Adan Awale	4,198	579	1,118.2	4
		Arbajahan	Arbajahan	6,672	872	563.8	12
			Kara	3,458	426	218.9	16
		Garse Koftu	Garse Koftu	4,423	459	610.7	7
			Welathi	726	87	174.3	4
	Griftu	Dadach Ano	Dadach Ano	1,322	199	21.9	60
		Boa	Boa	1,090	146	42.7	26
		Griftu	Griftu	675	98	466.1	1
			Griftu Township	2,475	455	0.6	3,915
			Jaghir	4,679	690	25.5	183
		Kurman	Kurman	3,900	579	51.1	76
		Matho	Matho	1,449	257	87.9	16
		Tulatula	Abaq Mathobe	711	71	254.5	3
			Margo Harun	1,187	159	140.1	8
			Tulatula	12,347	1,037	286.3	43
		Fatuma Nur	Fatuma Nur	599	95	199.9	3
	Hadado	Athibohol	Athibohol	2,160	283	630.1	3
		Gothey	Gothey	620	97	324.1	2
		Hadado North	Hadado North	6,596	1,056	762.6	9
		Hadado Waberi	Hadado Waberi	1,193	209	193.6	6
	Lagbogol	Korich	Korich	729	123	124.2	6
		Lagbogol North	Busbus	3,102	470	61.2	51
			Lagbogol North	5,545	997	175.4	32
	Wagalla	Barmish	Barmish	4,271	465	842.9	5
		Bojiheri	Bojiheri	1,219	226	122.2	10
		Ganyure	Badada	120	25	9.1	13

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Ganyure	1,342	336	54.3	25
			Wechir	779	154	20.1	39
		Kalkacha	Kalkacha	509	76	12.6	40
		Kukala	Kukala	5,275	762	36.6	142
		Lagbor	Lagbor	584	103	114.3	5
		Maumau	Maumau	1,234	217	26	48
		Shanta Abaq	Shanta Abaq	5,370	633	119.8	45
		Wagalla	Wagalla	3,671	681	93.2	39

2.2.2 **Physical and Topographic features**

Wajir County is a featureless plain and lies between 150 metres and 460 metres above sea level and along latitude 1°45'N and longitude 40°4'E.

Its Altitude is 244 m (801 ft.). The plain rises gently from the south and east towards the north rising to 200 metres at Buna and 460 metres at Bute and Gurar at the foothills of Ethiopian highlands.

The county is prone to seasonal flooding during the rainy seasons which make roads impassable affecting accessibility to vital services. It has seasonal swamps which together with drainage lines serve as grazing zones during dry season and for cultivation during the rainy seasons. The seasonal swamps are in Lagboghol area and in the western and southern part of Habaswein area. The county is generally covered with young sedimentary rocks with loamy soils in the north bordering the Ethiopian highlands. The county has considerable deposits of Limestone and sand which are used in the local building industry

2.2.3 **Geological setting**

The general and detailed geology of the Wajir County was carried out extensively by Joubert (1963). In his report he indicated that the general geology of the area is composed of sedimentary rocks of Triassic to Recent. These rocks are divided into three divisions that is, (1) Mansa Guda Formation composed of quartzitic boulders and pebbles derived from its conglomerates (2) The Daua Limestone Series in this area consists of a lower fossiliferous limestone succession of Toarcian age which is an extension of the Didimtu (Table 2.7). Beds of the area further north, overlain conformably by a series of brown and grey fragmental argillaceous or finely recrystallized limestones and (3) The Pleistocene valley formation formed by the extensive continental erosion during the Tertiary era. This erosion gave rise to deep wide valley west and south of the area occupied by the Mesozoic sediments, but the valley was filled up during the Pleistocene by limestones and gypsum of lacustrine origin and by clay-bound sands and sandstone of fluviatile origin. These Pleistocene deposits are representatives of the pluvial phases of the period while the widespread red sandy soil of Wajir has been derived from red ferruginous sandstones indicative of an interpluvial stage.

Table 2.7: Stratigraphic table (after Joubert, 1963)

Period	Formation	Lithology
Recent		Sandy soils
Pleistocene	Wajir Beds	Gritty soils Laminated limestones Impure 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; 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 explain 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, equivalents of the Merti Beds, found in a wide belt from NW of Habaswein 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).

2.2.4 **Hydrogeological setting**

The aquifers in this region are mainly shallow and unconfined consisting of more or less permeable horizons in Wajir Beds (Kuria, 2013). These aquifers consist mainly of the arenaceous impure limestones underlain by sands and silts. The groundwater occurs at depths of 6 m below the ground surface level and the assumed thickness of the water bearing zones is about 2-15 m. The shallow dug wells in Wajir area exceed some 5 m3 /hr and 2 m3 /hr in roughly 40 % and 60% of the cases respectively (Kuria, 2013) with apparent transmissivitiesof 80 to 300 m^2/day. The watertable follows the generally flat topographic surface, which is sloping with a general dip of 1.6 m per km from NNW to SSE.

There is a hypothesis put forward that the shallow groundwater in this region circulates partly in small local flows, recharged and drained by boreholes and the deep rooted vegetation. This is supported by local recharge and drainage from rainfall and the heterogeneous porous and permeable limestone, the presence of numerous cones of depression and randomly scattered pattern of water quality variation (Kuria, 2013, Osman 2011).

Other hydrogeological research works done in the region, include the study of Merti aquifer by Luedeling et.al, (2015). Their work titled "water for Wajir," involved decision modelling for the Habaswein-Wajir Water Supply Project in Northern Kenya. In the modelling they carried out the study of hydrogeology of the Merti aquifer. The county government of Wajir had proposed a piped water supply project to Wajir town from the Merti aquifer. The purpose of their study was to apply hydrogeology knowledge to predict the effect of the pipeline project on the groundwater system, and also stating the possible uncertainty in the predictions. Their prediction was based on drawdown of groundwater levels that would eventually lead to the drying up of the borehole as well as the deteriorating water quality as a result of displacement of fresh water by saline water in the aquifer in a 30 year time period. Using the stochastic-deterministic modelling, they found out that there is a higher annual probability to the risk of saline water upconing (1.0-2.5% per year) than to wells running dry (0.5-1.2%). While this may seem low, it corresponds to risks 25-55% and 15-30% over the 30 year time frame considered by the model.

Kuria & Kamunge (2012) determined the recharge zone of the Merti Aquifer using geospartial technologies. This was integrated with geochemistry. Based on the available data, they found that the recharge mainly occurs along the Ewaso Ng'iro River. This supports previous works done by (Krhoda, 1989, Swarzenski & Mundorff, 1977) who had also indicated that recharge is mainly by river Ewaso Ng'iro. Mwango et.al. (2002) indicated that recharge of the Merti aquifer is mainly from Yamicha-Marsabit area as well as Ewaso Ng'iro. (GIBBS Africa Ltd., 2004) summarized ways in which Merti aquifer is recharged. They identified three ways, which are, (1) Recharge via the bed of the Ewaso Ng'iro river: the Ewaso Ng'iro is partly situated above the Merti Aquifer. (0.9 mm^3/yr). (2) Local recharge through volcanic rock plateau: (2.4 mm^3/yr). (3) Recharge via the bed of the Lagh Dera: (1.2 mm^3/yr).

The International Atomic Energy Agency (IAEA, 2001) applied integrated isotope and conventional hydrogeological techniques for managing groundwater Resources in the Merti Aquifer. Their main goal was to determine the long-term sustainability and water quality needs for human or livestock consumption and irrigation. They collected and analysed 63 samples for their preliminary work and the results are as shown in figure 2.7 below. These results show most Merti groundwater samples clustering close to the river water composition, with minimal evaporative effects. They recommend more research to be carried out so as to define the local meteoric water line and the composition of rainfall and runoff that could contribute to recharge.

The hydrogeological setting is defined by aquifer zones whose parameters that define the aquifer characteristics of Wajir are presented below.

Lithology and geometry

The widely exploited shallow aquifer in the Wajir 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.

Well yield

Pumping tests suggest that the sustained yield of shallow dug wells in the Wajir 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 metre 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.

Hydraulic aquifer properties

Pumping tests results show local "apparent' transmissivities from less than 80 to 300 m2/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.

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 drawdowns. It is questionable, however, whether this was always due to poor aquifer characteristics or to poor well construction.

Water quality

Water quality issues in the proposed study area have been mentioned in several research works. These include (Osman 2011, Mwango et.al. 2002, Luedeling et.al. 2015). Osman et.al. (2014) carried extensive research on the deteriorating water quality and the vulnerability of the aquifers. He then related the effects of poor water quality to the overall health of the dwellers in Wajir town. In his research he found that the groundwater in the area has greatly been polluted by pit latrines which have consequently led to the increased

cases of cholera. The water sampled in the area was also found to have high Lead content; this discovery is part of the quest in this this research to find out the relationship between the geology and the heavy metal prevalence in the area.

The most significant aquifer in Wajir County is Merti Aquifer. In Wajir County the aquifer is marked by Habaswein-Dilmanyale aquifer located to the south of Wajir. The local aquifer is part of the much larger cross-boundary Merti Aquifer. The study is defined by latitudes 0°50'N to 1°00' N and longitudes 39°30'E to 40°30'E. The Merti Aquifer is located the northeast of Kenya in Isiolo- , Marsabit-, Garissa- and Wajir County. It stretches from Mt. Marsabit in the north to the town of Liboi and beyond into Somalia in the southeast, bordered by Mount Kenya in the west and Wajir in the east. An outline of the Merti Aquifer is provided in Figure 2.7.

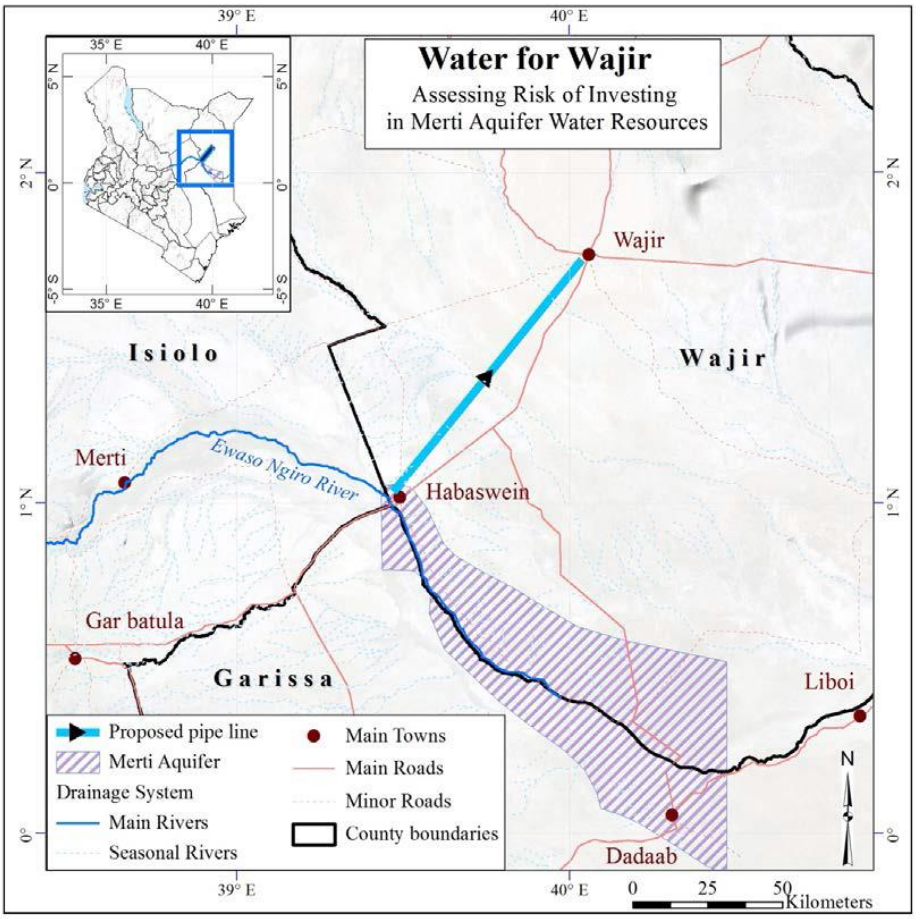

Figure 2.7: Overview map of the study area with the location of the Merti Aquifer, Ewaso Ng'iro River, Wajir and Habaswein.

2.3 GARISSA COUNTY

2.3.1 Location and demography

Garissa County is an administrative county in the former North Eastern Province of Kenya. The County is most known for Garissa town and Dadaab refugee camp which is the largest refugee camp in the world. Garissa County is bound by Tana River County to the West and South West, Lamu County to the South, Republic of Somalia to the East and South East, Wajir County to the North and Isiolo County to the North East. The Ewaso Ngiro River forms the Northern boundary with Wajir County. Garissa County is low lying, with altitudes ranging between 70m and 400m above sea level. Figure 2.8 shows the location of Garissa County in the Kenya Country map.

The size of Garissa County has been variously reported in different reports. The Kenya National Population and Housing Census of 2019, which is the official government document on population and population density has put the size of Garissa County at 44,580km^2, however the size from GIS shape files is 45,281km^2. The difference can be explained by the disputed 10km offset from the Tana River as the official boundary. As can be seen in Figure 2.8 below, the County is oblong in shape, being longer in the North West to South East direction than it is wide in the East West direction. The County is entirely bound within latitudes 1º N, 2ºS and longitudes 38º 42’ E and 41º 36’E.The straight-line vertical distance from the northernmost end of the County at Shant-Abak, Garufa to the southernmost at Masalani Mnazini is 330 km. The straight-line horizontal distance from the Easternmost tip at Hulugho near Kiunga border to the westernmost tip at Benane is 335 km. The longest distance within the County is the straight-line diagonal distance from Benane tip to Hulugho tip near Kiunga which is about 390 km.

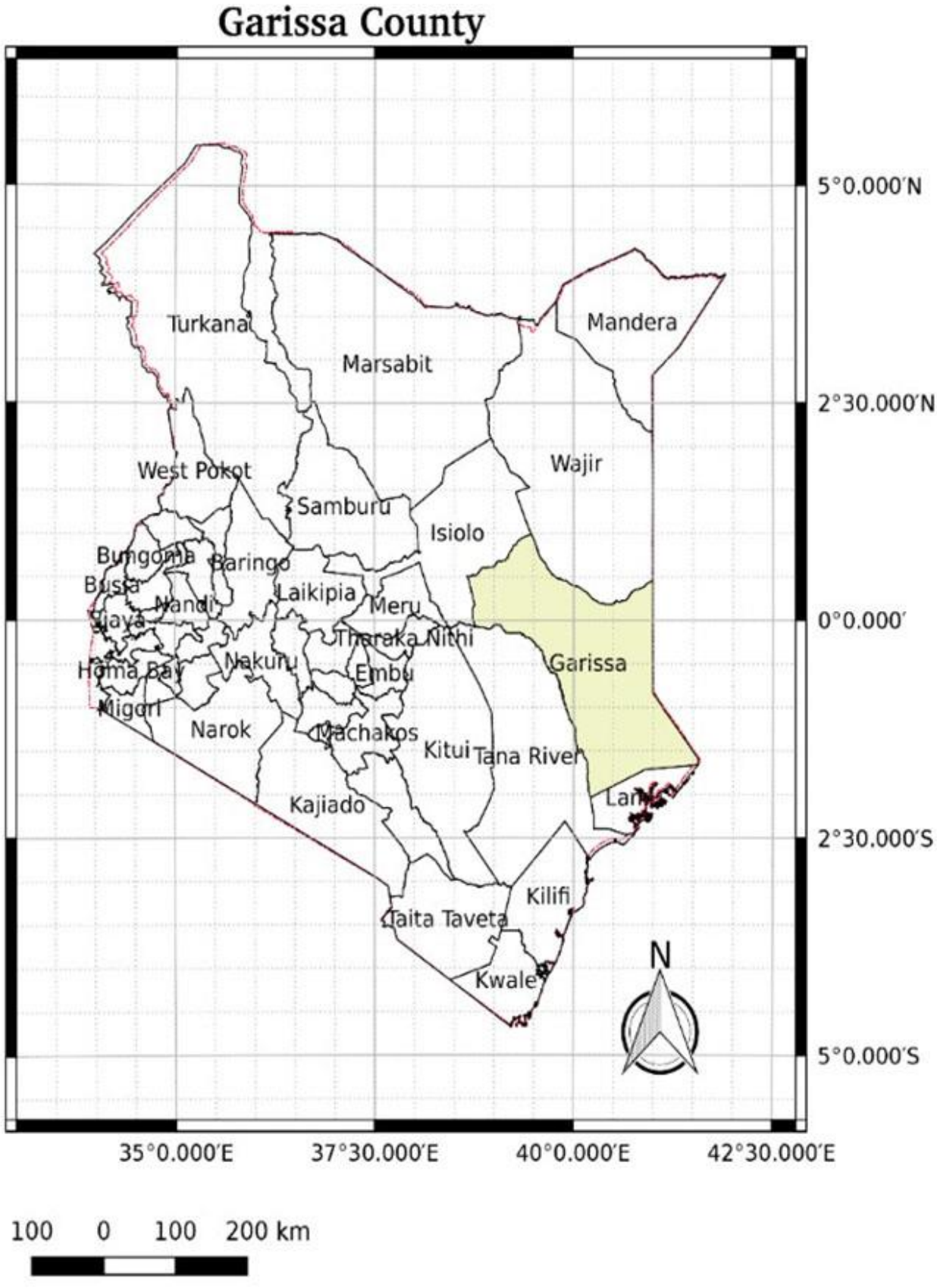

Figure 2.8: Location of Garissa County within Kenya

According to the 2019 Kenya Population and Housing Census Garissa County has a population of 841,353 people (458,975 Males, 382,344 Females, and 34 Intersex).

The population presented in Table 2.8 and 2.9 is as given by the National Population and Housing Census and Figure 2.9 below show the population distribution in Garissa County.

Table 2.8: Population Distribution by Sex, Number of Households, Land Area, Population Density and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Balambala	32,257	20,277	11,979	1	4,337	3,684	9
Dadaab	185,252	99,059	86,185	8	35,793	6,415	29
Fafi	134,040	72,617	61,413	10	23,671	15,050	9
Garissa	163,914	83,460	80,449	5	30,518	3,318	49
Hulugho	133,984	78,460	55,898	5	20,254	7,737	17
Ijara	141,591	80,458	61,129	4	18,481	2,453	58
Lagdera	50,315	25,023	25,291	1	8,340	6,096	8

(Source: KNBS, 2019)

Table 2.9: Population Distribution by Number of Households, Land Area, Population Density, and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
Balambala	Balambala	Balambala	Balambala	3,336	440	20	166
			Buradansa	1,238	170	11.2	110
		Dujis	Dujis	1,084	143	223.9	5
			Shidle	149	31	409.3	-
		Jarajara	Jarajara	1,513	162	63	24
			Kone	685	90	48.6	14
		Ohio	Abdigab	247	48	297.3	1
			Ashadin	355	73	475.9	1
			Ohio	446	60	153.1	3
	Danyere	Danyere	Danyere	2,243	164	27.3	82
			Urgaad	942	116	480.3	2
		Libahlow	Dogob	743	107	476.4	2
			Libahlow	1,409	168	208.0	7
		Mudey	Mudey	2,636	431	109.7	24
	Saka	Daley	Daley	2,941	300	80.8	36
		Kasha	Dabeley	938	82	67.1	14
			Kasha	1,925	223	40.8	47
		Kuno	Kuno	2,004	225	26.2	76
		Saka	Hadley	1,720	254	79.6	22
			Saka	5,127	609	137.1	37
			Saka Junction	576	90	248.3	2
Dadaab	Dadaab	Abakaile	Abakaile	7,774	1,850	880.6	9
		Alango Arba	Alango Arba	2,339	344	409.3	6
		Alikune	Alikune	7,089	1,389	412	176
		Dadaab	Dadaab	56,597	12,245	484.9	117
		Dagahaley	Dagahaley	42,860	9,060	137.8	311
		Kumahumato	Kumahumato	7,749	1,472	226	6
		Labisigale	Labisigale	4,567	828	85	54
			Welhar	4,201	620	81.1	52
		Mathagis	Mathagis	4,106	471	151.7	27

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
	Dertu	Dertu	Dertu	10,508	1,474	655.2	16
	Liboi	Damajale	Damajale	9,872	1,631	1,166.6	8
			Kokar	4,193	645	956.8	4
		Kulan	Kulan	10,382	1,486	187.8	55
		Liboi	Harhar	2,610	360	145.4	18
			Liboi	10,405	1,570	434.5	24
Fafi	Bura	Bura	Bura	7,133	1,653	1,853.9	5
			Jambele	2,474	1,274	832.6	9
		Guyo	Guyo	2,227	306	1,021.3	2
		Kamuthe	Kamuthe	5,100	1,088	534.9	10
			Warable	3,561	759	416.4	9
		Mansabubu	Garasweino	2,620	512	675.7	4
			Mansabubu	2,868	463	651.1	4
		Nanighi	Abaqdera	2,112	433	90.9	23
			Nanighi	6,718	1,241	862	8
	Galmagala	Bulla Golol	Bulla Golol	2,234	345	144.2	15
			Hajijimay	2,634	351	943.8	3
		Galmagala	Doi	629	54	20.8	30
			Galmagala	3,056	583	154.4	20
			Marerkader	816	106	676.7	1
		Gubis	Dekaharja	588	64	26.4	22
			Gubis	1,662	254	162.9	10
	Jarajila	Alinjugur	Alinjugur	5,147	833	151.1	34
		Amuma	Amuma	3,599	552	774.8	5
		Fafi	Fafi	10,007	1,869	3,213	3
		Hagadera	Hagadera	60,448	11,098	597.1	101
		Ruqa	Ruqa	841	110	2,182.6	-
		Wel Merer	Wel Merer	5,588	655	383.9	15
		Yumbis	Yumbis	1,978	342	483.4	4
Garissa	Central	Galbet	Galbet	21,047	4,272	8.6	2,445
		Iftin East	Iftin East	15,034	3,325	6.2	2,408
		Iftin West	Iftin West	13,774	2,821	5.8	2,372

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Madina	Madina East	24,991	3,943	25.6	975
			Madina West	9,496	1,517	19.9	478
		Modika	Modika	3,068	763	512	6
		Township	Township	14,911	3,279	2.3	6,444
		Waberi East	Waberi East	17,887	3,224	57.3	312
		Waberi West	Tawakal	2,346	390	0.9	2,727
			Waberi West	12,845	2,143	3.3	3,850
	Korakora	Bouralgy	Bouralgy	3,423	554	183.8	19
		Jarriot	Jarriot	1,219	240	38.6	32
		Korakora	Eldert	822	129	317.2	3
			Korakora	2,917	445	80	36
	Sankuri	Abdisamit	Abdisamit	1,796	360	243.1	7
			Laago	1,414	304	595.2	2
			Owliya	1,341	238	494.5	3
		Raya	Atheyley	1,325	239	20	66
			Raya	2,570	484	73.3	35
		Sankuri	Balich	4,462	636	30.3	147
			Dololo	1,636	277	52.5	31
			Sankuri	2,575	390	52.7	49
			Shabah	876	144	6.9	126
			Shitle	901	152	252.6	4
		Shimbirey	Shimbirey	1,238	249	235.3	5
Hulugho	Bodhai	Bodhai	Bodhai	4,939	649	387.4	13
			Dololo	1,845	259	373.4	5
		Jalish	Bultohama	3,721	615	210.5	18
			Falama	4,396	631	271.4	16
			Jalish	4,469	647	189.7	24
	Hulugho	Boma	Boma	2,954	415	836.2	4
		Elkambere	Elkambere	7,517	1,071	171.5	44
			Kurde	3,451	516	254.6	14
			Sarira	3,105	554	80.2	39
		Garabey	Garabey	3,128	378	66	47

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Sinai	3,742	522	59.6	63
		Gesireb	Gesireb	4,081	548	31.4	130
		Hadi	Hadi	1,994	380	764.2	3
			Ire	2,214	410	715	3
		Hulugho	Hulugho	15,305	2,291	10.3	1,491
		Jilomata	Jilomata	3,121	417	63	50
		Koran Hindi	Doi	3,636	634	31.4	116
			Koran Hindi	3,700	733	128.9	29
		Muftu	Muftu	2,416	381	33.1	73
		Tumtish	Tumtish	3,223	507	141.5	23
		Wardeijab	Wardeijab	3,180	460	686.8	5
	Sangailu	Ege	Ege	8,810	931	443.7	20
		Gedilun	Gedilun	3,464	580	384.4	9
		Handaro	Handaro	4,426	686	251.5	18
			Sabenal	862	134	248.1	3
		Mare	Mare	13,627	1,968	562.4	24
		Sangailu	Mataarba	3,981	703	236	17
			Sangailu	6,008	1,134	11.1	541
		Wakab-Harey	Wakab-Harey	6,669	1,100	93.1	72

Sub-County	Division	Location	Sub-Location	Population 2019 census	Households	Land area Sq. Km	Density
Ijara	Ijara	Bula Golol	Bula Golol	5,396	499	48.7	111
		Ijara	Ijara	10,659	1,324	12.2	874
			Wardegoga	5,971	757	116.7	51
		Sangole	Bulla Wacha	2,339	281	74.5	31
			Sangole	3,252	379	138.8	23
	Kotille	Abalatiro	Abalatiro	7,444	846	22.1	337
		Korisa	Korisa	4,419	666	157.9	28
		Kotille	Bula Waride	2,765	384	12.4	223
			Kotille	8,001	990	50.4	159
	Masalani	Gababa	Abdigure	1,174	149	101.5	12
			Gababa	4,730	664	311.1	15
		Gumarey	Gumarey	12,115	1,620	86.9	139
		Hara	Hara	5,370	709	77	70
			Qarmadha	3,157	454	198.1	16
			Rahma	1,873	235	177.3	11
		M. Dahir	M. Dahir	22,729	3,062	144.1	158
		Masalani	Masalani	15,429	2,356	8.6	1,792
		Torabora	Bula Haji	9,296	1,314	17.2	539
	Ruqa	Gerille	Gerille	5,425	613	103.9	52
		Ruqa	Ruqa	5,045	529	166.8	30
		Warsame	Warsame	5,002	650	426.8	12
Lagdera	Benane	Benane	Benane	1,173	333	48.3	24
			Hagarjerer	1,219	170	87	14
		Eldere	Ali Sagar	44	44	214.1	-
			Bullo	470	76	25.6	18
			Eldere	1,187	263	75.8	16
		Tokojo	Tokojo	754	158	220.7	3
	Modogashe	Barkuke	Garse	655	77	51.3	13
		Ilan	Ilan	3,791	677	463.8	8
		Maalimin	Dihile	2,654	399	986.2	3
			Maalimin	2,127	331	117.8	18
			Wayamajibril	226	38	184.8	1

Sub-County	Division	Location	Sub-Location	Population 2019 census	Households	Land area Sq. Km	Density
		Modogashe	Janju	432	70	134.2	3
			Jilango	2,687	454	325.4	8
			Modogashe	7,892	1,413	419.9	19
	Shant Abaq	Afwein	Afwein	4,569	782	1,422.4	3
		Baraki	Baraki	4,804	666	336.5	14
		Goreal	Goreal	8,386	1,571	385.2	22
		Gurufa	Cheron	2,477	347	255.1	10
			Gurufa	4,391	589	262.1	17
		Shant Abaq	Shant Abaq	377	52	80	5

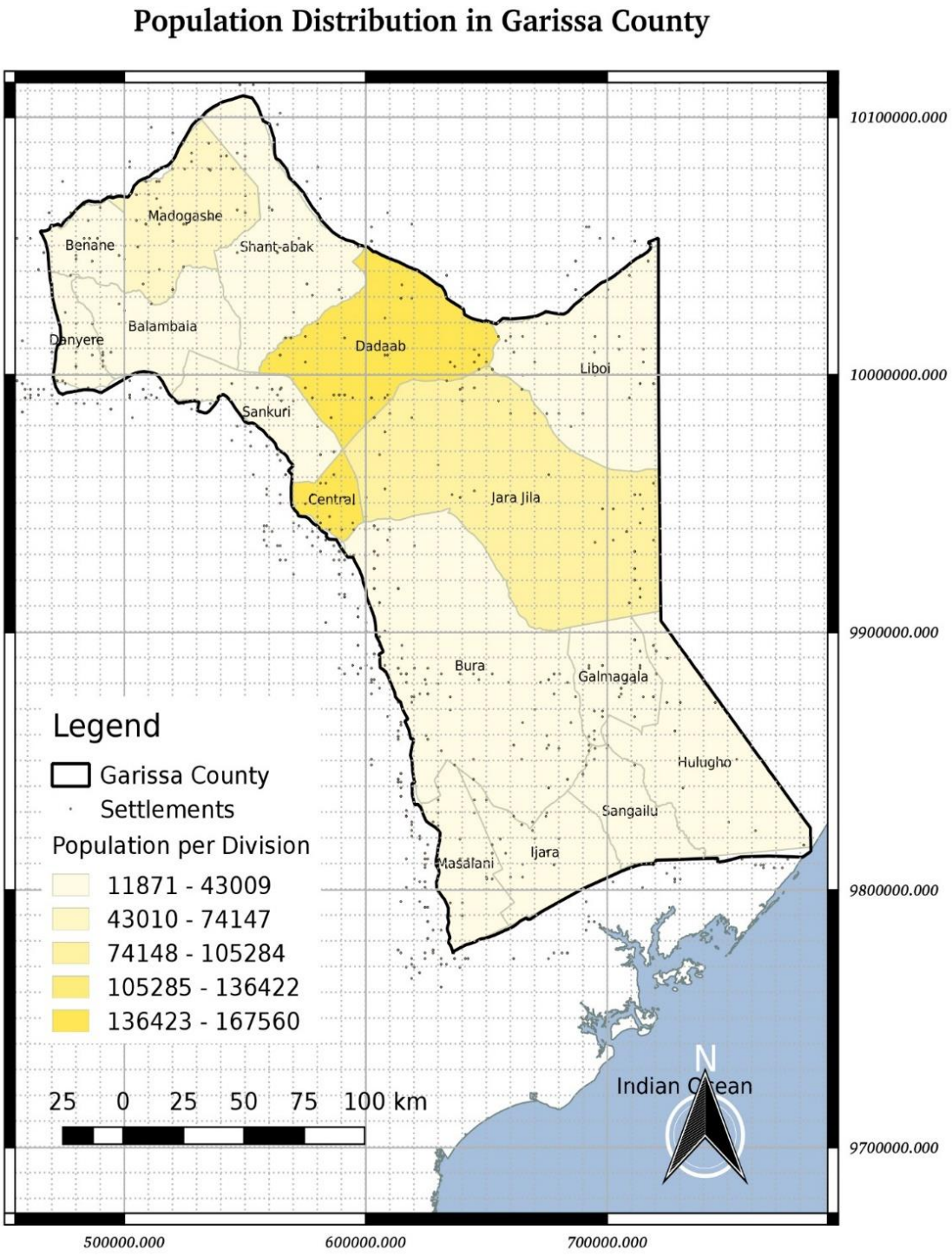

Figure 2.9: Population distribution in Garissa County

2.3.2 **Administrative boundaries**

In total, there are seven (7) sub-counties and seventeen (17) administrative divisions headed by Assistant County Commissioners. Table 2.10 shows the sub-counties and administrative divisions with their respective areas while Figure 2.10 shows the map of the Sub-Counties in large font and their divisions in smaller font.

Table 2.10: Administrative Boundaries of Garissa County

County	Sub County	Division	Area	2009 Population	2016 Population	Population Density
Garissa County	Balambala	Danyere	1,140.00	24,820	30,943	27
		Balambala	1,909.20	30,655	38,217	20
		Sankuri	1,897.30	17,634	21,984	12
	Sub-County Totals		**4,946.50**	**73,109**	**91,144**	18
	Township	Central	687.10	116,953	145,804	212
	Sub-County Totals		**687.10**	**116,953**	**145,804**	212
	Lagdera	Benane	842.10	20,231	25,222	30
		Modogashe	2,026.60	41,374	51,580	25
		Shant-Abak	3,650.00	31,031	38,686	11
	Sub-County Totals		**6,518.70**	**92,636**	**115,488**	18
	Dadaab	Daadab	3,535.90	134,404	167,560	47
		Liboi	3,605.60	18,083	22,544	6
	Sub-County Totals		**7,141.50**	**152,487**	**190,104**	27
	Fafi	Bura	5,246.30	12,645	15,764	3
		Galmagala	1,346.60	9,522	11,871	9
		Jarajilla	8,876.20	73,045	91,064	10
	Sub-County Totals		**15,469.10**	**95,212**	**118,700**	8
	Ijara	Masalani	1,550.00	32,375	40,362	26
		Ijara	1,430.20	11,474	14,305	10
	Sub-County Totals		**2,980.20**	**43,849**	**54,666**	18
	Hulugho	Hulugho	3,729.40	20,953	26,122	7
		Bodhai	889.80	4,581	5,711	6
		Sangailu	2,217.90	23,280	29,023	13
	Sub-County Totals		**6,837.10**	**48,814**	**60,856**	9
COUNTY TOTALS			**44,580.20**	**623,060**	**776,762**	17

Source: KNBS-2009 Population and Housing Census

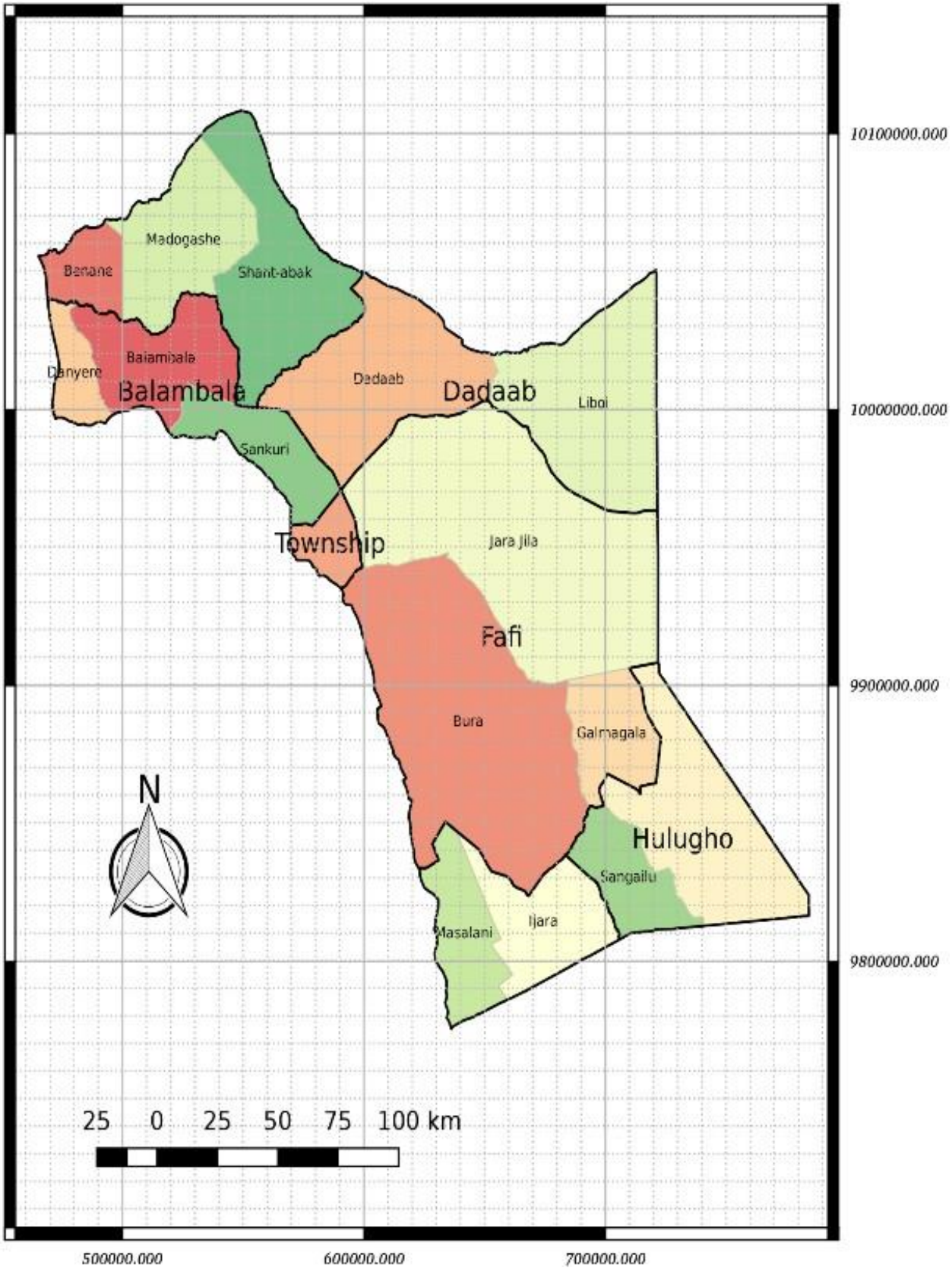

Figure 2.10: Administrative boundaries of Garissa.

2.3.3 **Topography**

Garissa County is generally flat and low lying. Figure 2.11 shows that the topography varies from 50 m amsl at Boni forest reserve to about 450 amsl at Benane. The upper Garissa is steeper than the lower Garissa and generally drains towards the Ewaso Ngiro River. The general slope south eastwards towards the ocean is 0.09%.

2.3.4 **Geological setting**

Garissa County is geologically part of the Anza rift basin with accumulation of up to 4000 m of Maastrichtian-Paleogene continental clastics. The basin runs inland from the coast in north-western direction, and links the Lamu embayment of southern Kenya with the South Sudan rifts. Within Garissa, it constitutes the rift termination zone of the Central African Rift System in north east part of Kenya.

Faulting in this basin was initiated in the Mesozoic period and has intermittently been activated through to Tertiary period with creation of deposit centres filled primarily with fluvial-lacustrine, deltaic and marine sediments. This geological and structural setting has shaped the hydro geological setup of Garissa County significantly.

Stratigraphic sequence for Garissa County can be summarised as follows:

1. Recent Superficial Deposits
   a. Alluvial sands, silt and clay
   b. Colluvium

2. Sedimentary rocks
   a. Quaternary deposits
   b. Undifferentiated Quaternary and Tertiary Beds
   c. Tertiary deposits

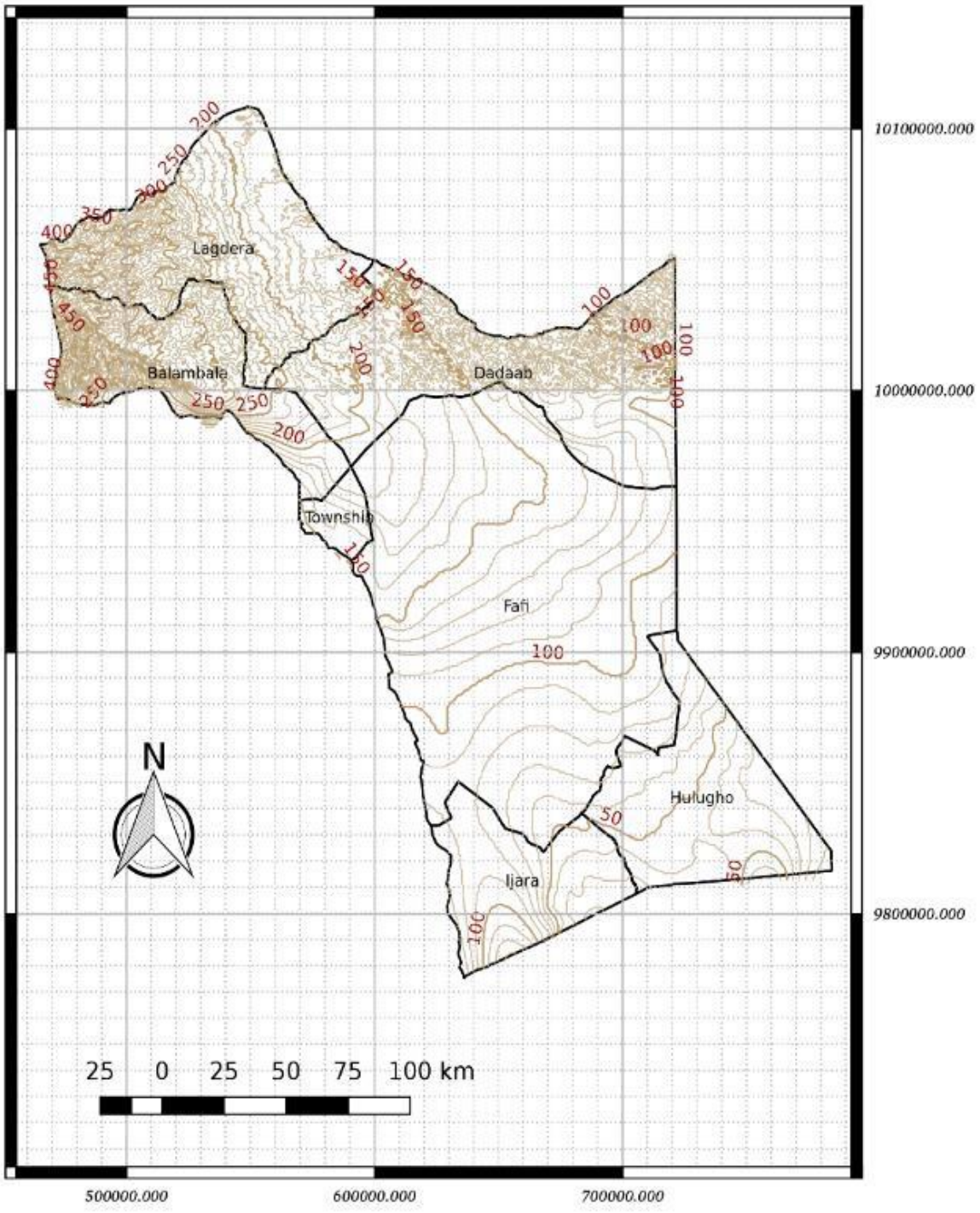

Figure 2.11: Topography of Garissa County

2.3.5 **Hydrogeological setting**

The hydrogeological zones in this region are defined by the surface and subsurface interaction of Tana aquifers, Merti aquifer, and the local seasonal river system. Tana and Ewaso Ngiro rivers are the major drainage systems that recharge the groundwater while the surface runoffs along the ephemeral rivers contribute mainly to the source of the shallow wells and water pans.

Groundwater occurrence is confined to the thick sediments that transmit water into the abstraction points that include boreholes, shallow wells, and springs.

Groundwater flow and quality (salinity) is influenced by the geology, structural orientation of the rock formation and the time taken by the water within the rocks.

Water Quality

Garissa County is an ASAL area where groundwater is the main water resource. Whereas surface water is more prone to bacteriological pollution since it is more easily accessible by pathogens, groundwater is more prone to chemical pollutants which are normally leached from the rocks through which the ground water percolates or in which it is stored. Garissa County being dependent on groundwater for the most part, and salinity being a major problem, an attempt was made to show the distribution of the various common chemical parameters with health implications.

The various sources of water for all uses include the River Tana, laghas, boreholes, dams, pans and springs. Representative samples were collected according to internationally approved methods of sample collection, transportation, and testing and data analysis. Over 96 boreholes, 45 water pans, several points of the River Tana, numerous shallow wells, and springs were sampled across the county and physical, chemical and biological parameters ascertained. From the results obtained the major findings were high total water hardness, total alkalinity, fluoride, chloride, and turbidity. Other aesthetic parameters included the taste, odour, and colour.

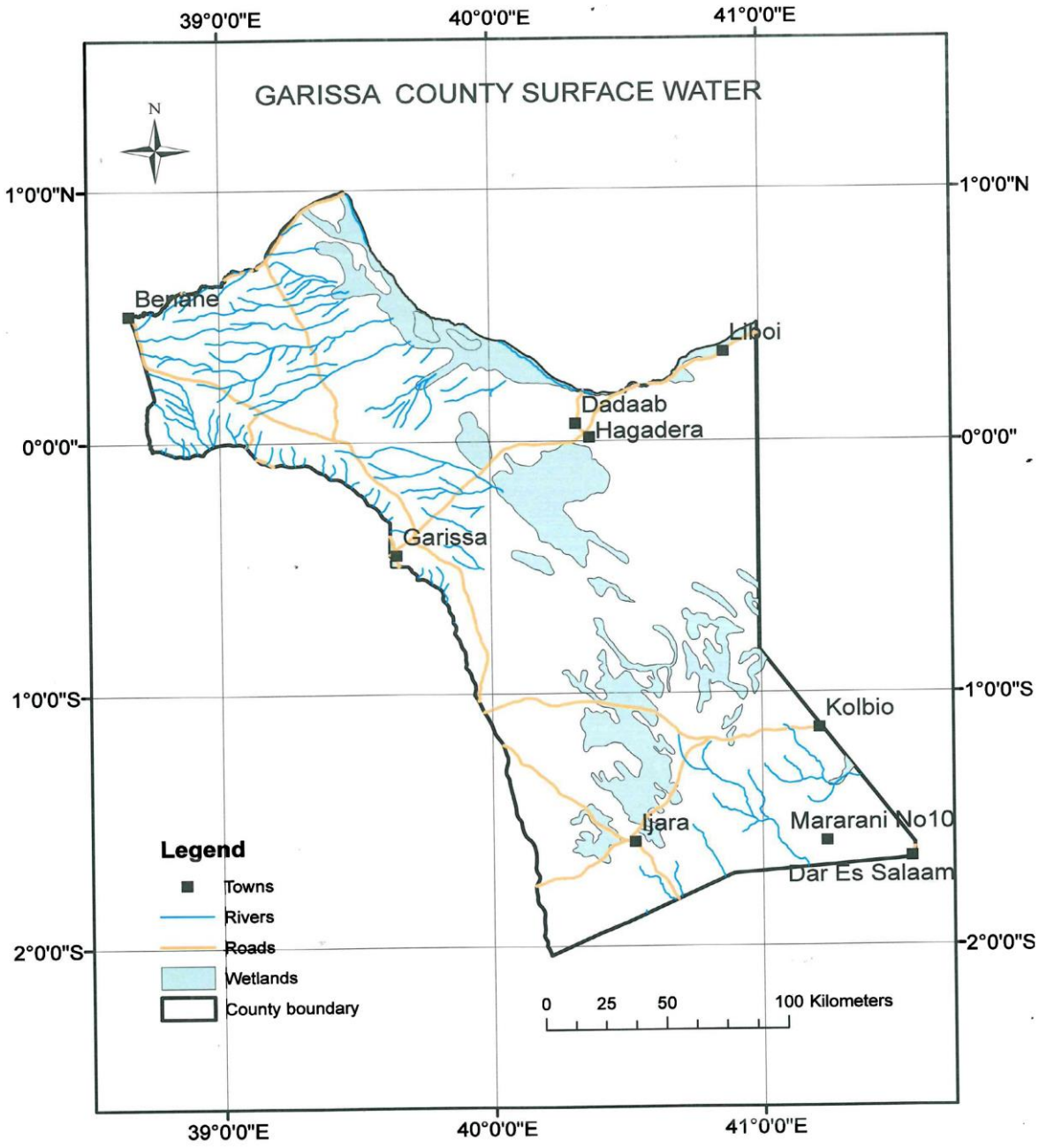

Figure 2.12: Distribution of surface water

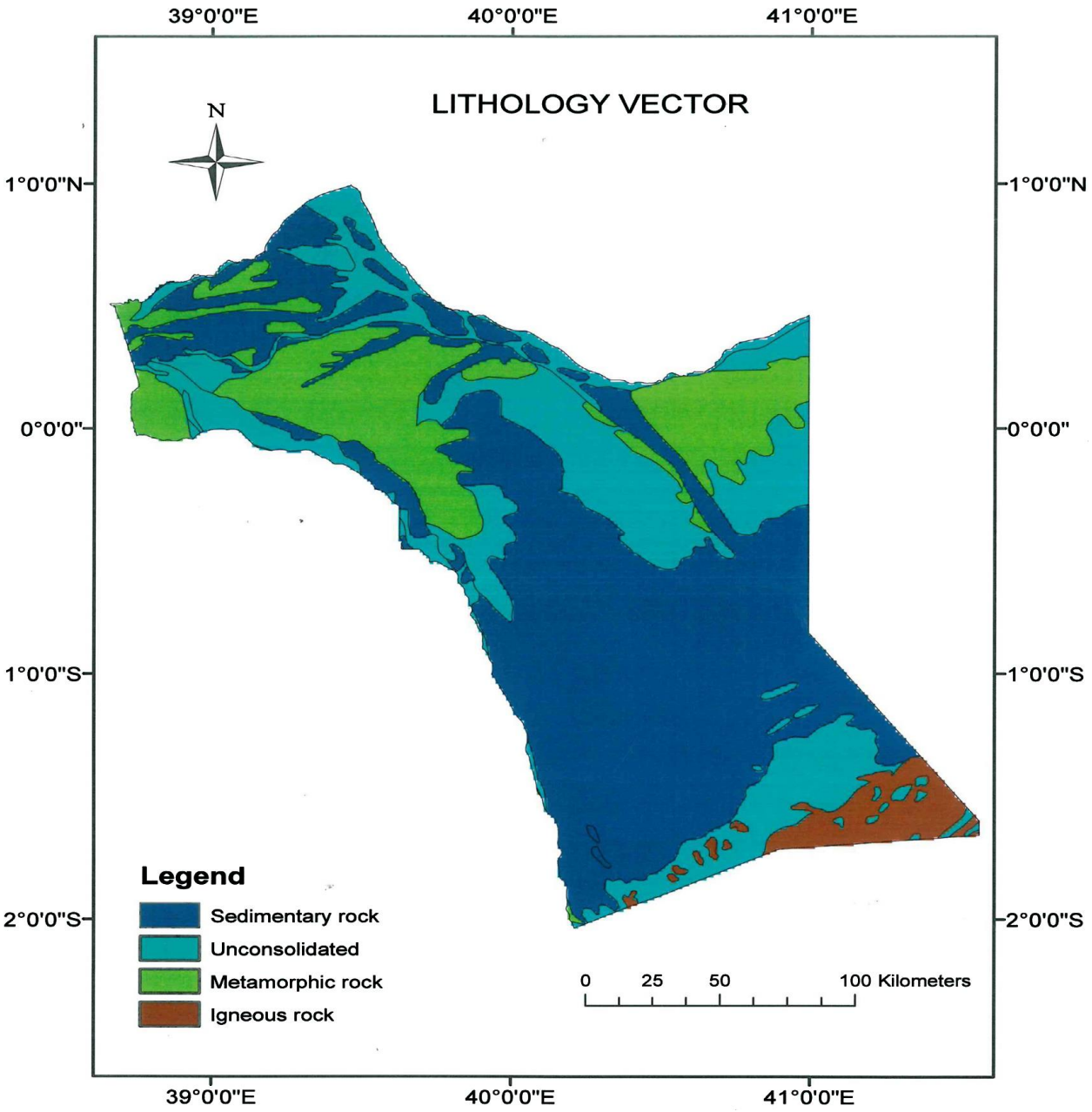

Figure 2.13: Underlying rock formation in Garissa Country

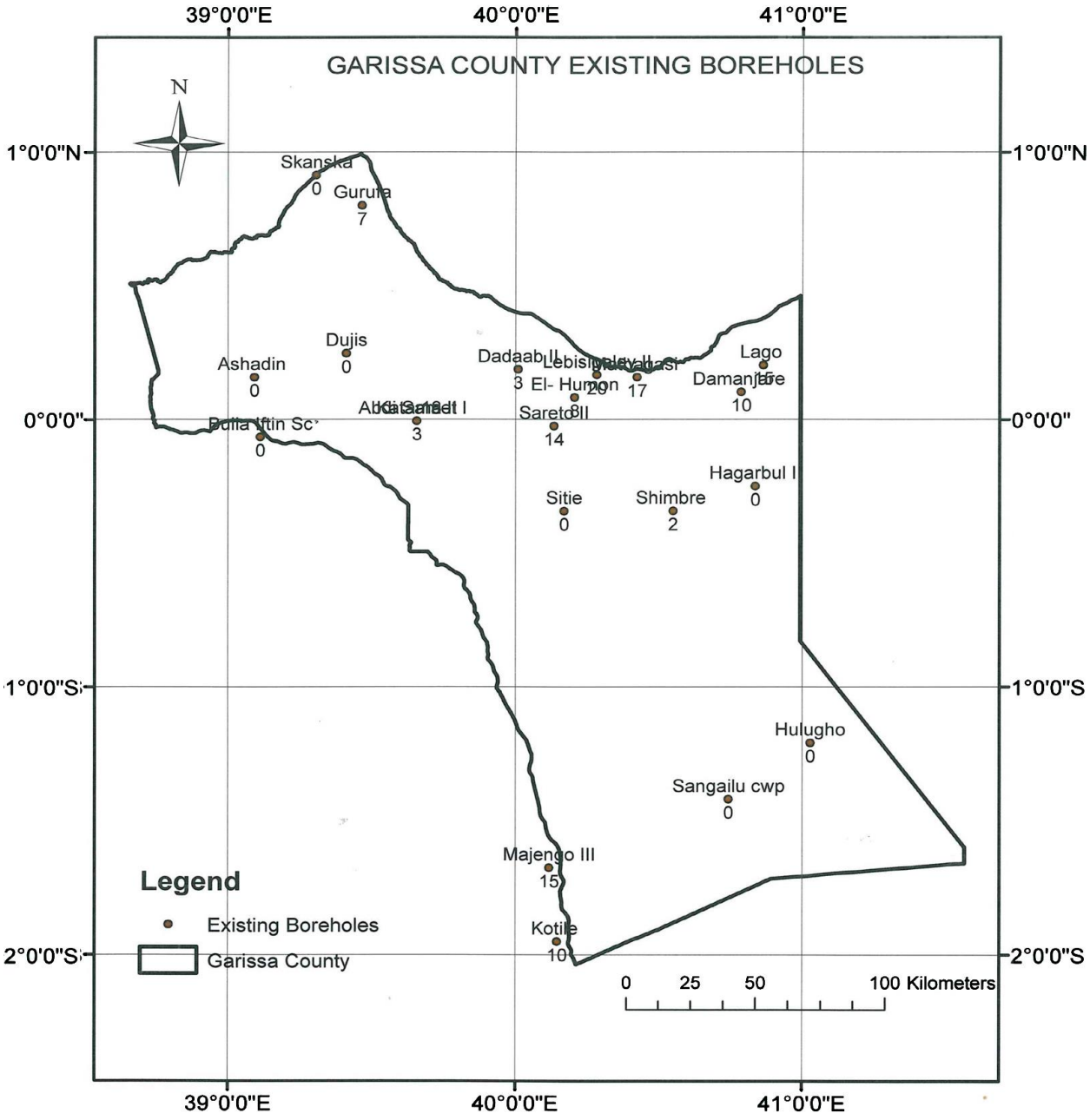

Figure 2.14: Map showing location of existing boreholes and their yields

2.4 MARSABIT COUNTY

2.4.1 Location

Marsabit County set in the former Eastern Province and some 550 km north of Nairobi is one of the existing 47 Counties set after propagation of the new Constitution in year 2010. It is the largest county in Kenya covering 70, 961 km^2. Marsabit borders three counties; Wajir to the east, Turkana to the west and Isiolo to the south. It also borders the country of Ethiopia to the north (Fig. 2.15).

It can be located on SK Sheet No. NA-37-6 scale 1:250,000 at coordinates 38^0 East of Greenish and 2020' North. It is situated within Mount Marsabit Forest Reserve in the Northern Region of Marsabit County.

The county is said to have been named after a Burji farmer called Marsa who was brought to Marsabit (from Ethiopia) by colonialists to teach the locals how to grow crops.When his name was called out by his masters, Marsa used to answer "Abet"(Yes in Amharic) and this led to the creation of the name Marsa-Abeit-which later became Marsabit.

Marsabit Town is located in Central Division, Marsabit Central Sub-County, Marsabit County.

It consists of 3 Locations and 6 sub locations as detailed below:

- ✓ Nagayo location consisting of 2 sub-locations of Nyayo Road and Majengo
- ✓ Dakabaricha Location consisting of 2 sub-locations of Mataarba and Dakabaricha and
- ✓ Mountain Location consisting of 2 sub locations of Township and Wabera.

Figure 2.15: Location of Marsabit County in the Kenya map.*(Source: KNBS)*

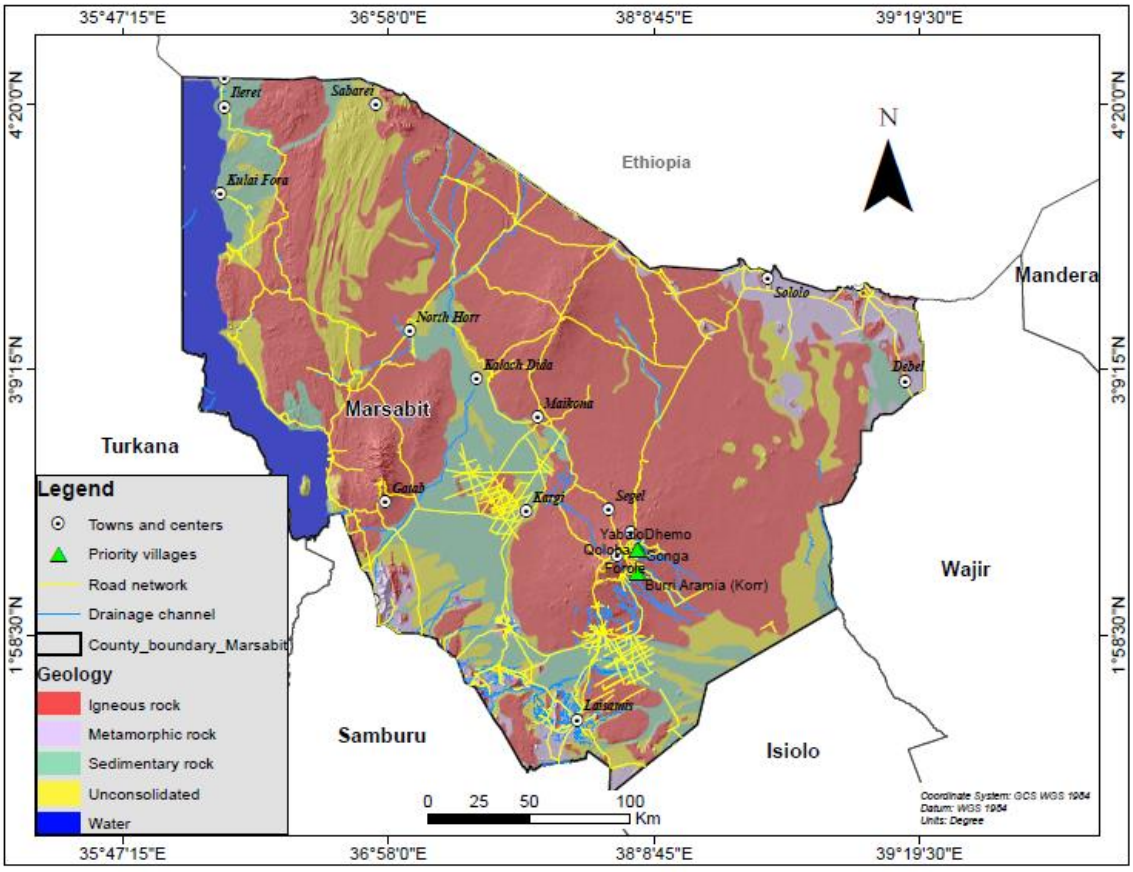

Figure 2.16: Marsabit County constitutes four constituencies: North Horr, Laisamis, Saku and Moyale.

2.4.2 **Demography**

The county of Marsabit has a population of 459,785 785 of which 243,548 are males, 216,219 females and 18 Intersex people. .

Marsabit County is populated by various ethnic communities including the Cushitic Rendille, Gabbra and Borana as well as the Nilotic Samburu and Turkana which constitutes the population of Marsabit Town. Table 2.11 below shows the population by sex and sub-county.

Table 2.11: Population Distribution by Sex, Number of Households, Land Area, Population Density, and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Loiyangalani	35,713	17,659	18,051	3	7,774	11,789	3
Marsabit Central	79,181	40,956	38,214	11	15,849	2,143	37
Marsabit North	54,297	30,091	24,205	1	7,521	19,837	3
Marsabit South	65,376	33,215	32,161	-	11,615	8,447	8
Moyale	108,949	56,440	52,508	1	17,709	3,327	33
North Horr	71,447	41,719	29,726	2	9,789	19,337	4
Sololo	44,822	23,468	21,354	-	7,238	6,064	7

(Source: KNBS, 2019)

Table 2.12: Population Distribution by Number of Households, Land Area, Population Density and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
Loiyangalani	Kargi	Kargi	Kambinye	4,102	820	1,748.2	2
			Kargi	5,836	1,215	1,429.9	4
		Kurkum	Kurkum	829	183	1,147	1
		South Horr	Arge	1,953	352	1,023.4	2
			Kurungu	905	183	282.8	3
			South Horr	1,964	437	32.7	60
	Loiyangalani	Loiyangalani	El Molo Bay	2,422	568	521.8	5
			Gas	1,326	302	1,219.1	1
			Loiyangalani	7,815	1,775	988.2	8
			Moite	2,340	581	615.3	4
		Mt. Kulal	Arapal	1,063	264	1,080.5	1
			Larachi	283	52	13.7	21
			Mt. Kulal	2,868	618	558.5	5
			Olturot	2,007	424	1,128	2
Marsabit Central	Central	Dakabaricha	Dakabaricha	6,771	1,387	6.3	1,068
			Mata Arba	1,995	392	4.5	445
		Hulahula	Hulahula	3,029	540	318.5	10
			Ogicho	1,046	223	229	5
		Jirime	Jirime	1,511	318	194.8	8
			Milima Mitatu	3,584	722	250.8	14
		Karare	Karare	3,032	591	179.9	17
			Karare Scheme	1,596	308	52.4	30
		Mountain	Township	4,348	1,158	90.4	48
			Wabera	6,662	1,753	1	6,726
		Nagayo	Majengo	10,313	2,202	5.8	1,774
			Nyayo Road	3,819	925	0.4	8,636
		Songa	Kituruni	1,595	346	154.6	10
			Leyai	511	105	46.5	11
			Songa	1,614	324	48.4	33
	Dirri	Qilta Korma	Gar Qarsa	1,911	325	103.1	19
			Qilta Korma	4,311	686	9.2	467
		Sagante	Goro-Rukesa	5,062	932	98.3	52
			Sagante	2,575	434	5.7	448

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
	Gadamoji	Dirib Gombo	Dirib	3,543	575	93.9	38
			Qachacha	4,156	739	110.5	38
		Jaldesa	Badassa	3,457	445	55.9	62
			Jaldesa	2,740	419	83	33
Marsabit North	Kalacha	El-Gade	El-Gade	3,023	490	966.4	3
			Rage	732	133	168.7	4
		Kalacha	Iller	2,112	327	388.1	5
			Kalacha	3,422	554	276.7	12
	Maikona	Forole	Forole	2,580	376	373.3	7
		Hurri Hills	Burarat	937	127	432.4	2
			Hurri Hills	8,135	1,045	1,141.5	7
		Maikona	Arano	1,083	165	1,672.4	1
			Maikona	9,469	1,021	623.5	15
			Medate Kuro	1,653	239	459.5	4
	Turbi	Bubisa	Bubisa	6,307	885	2,952.5	2
			Oronder	1,364	173	2,687.5	1
		Burgabo	Burgabo	1,975	325	1,334.4	1
			Tigo	844	141	383.4	2
		Shurr	Hawaye	768	127	473.1	2
			Shurr	1,024	145	2,584.8	-
		Turbi	Demo	2,361	380	1,858.7	1
			Turbi	6,508	868	1,060	6
Marsabit South	Korr	Balah	Balah	3,287	551	65.1	51
			Hafare	7,604	1,187	307.1	25
		Illaut	Illaut	3,401	571	525.9	6
		Ngurunit	Lonyaripechau	3,151	683	498.2	6
			Mpagas	418	80	146.6	3
			Ngurunit	3,090	588	265.6	12
		Korr	Halisurwa	4,589	652	29.6	155
			Korr	3,332	580	22.2	150
			Orotilkes	3,868	591	619.3	6
	Laisamis	Koya	Koya	2,718	476	1,948.3	1
			Sakardalla	2,009	377	1,361.2	1
		Laisamis	Laisamis	4,970	907	58.2	85

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Nairibi	874	180	73.2	12
			Silapani	1,656	296	126.3	13
		Lontolio	Lontolio	1,219	270	64.1	19
			Losidan	1,652	354	309.3	5
			Ndikir	1,652	311	209.8	8
		Merille	Irir	1.471	275	174	8
			Merille	4,743	985	155.3	31
	Logologo	Kamboe	Kamboe	2,377	388	72.7	33
		Logologo	Gudas/Soriadi	2,341	447	372.3	6
			Lbarok	1,238	191	1,002.9	1
			Logologo	2,463	436	38.3	64
			Lokilelengi	1,253	239	2.0	614
Moyale	Central	Biashara/ Gurumesa	Gurumesa	6,085	1,141	1	6,067
		Bori	Bori	4,700	593	207.6	23
			Qate/Taluroba	4,871	641	1,446	3
		Butiye	Butiye	6,782	1,115	3.1	2,175
			Goromuda	6,235	992	10.2	611
		Heilu	Heilu	8,490	1,289	7.9	1,081
			Mansile	2,061	358	16.9	122
		Kinisa	Kinisa	3,595	640	24.4	148
		Lami	Lami	7,243	987	0.7	9,690
		Manyatta	Manyatta Burji	5,098	841	2.7	1,882
		Somare	Somare	2,405	413	24.2	100
			Teso	1,064	153	35.1	30
		Township	Sessi	11,461	1,580	2.3	4,931
			Township	7,434	1,339	1	7,819
	Golbo	Dabel	Dabel	3,601	647	31.7	114
			Dirdima	423	71	52	8
			Golla	1,530	228	218.9	7
			Guyo Timo	1,064	161	443.8	2
			Misa	679	120	242.6	3
		Godoma	Godoma	3,281	674	44.6	74
			Godoma Didiqo	2,346	420	76.3	31

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Nana	Nana	4,862	791	82.2	59
			Yaballo	3,744	684	39.6	95
		Odda	Funanyatta	3,867	773	244.8	16
			Odda	6,028	1,053	67.9	89
North Horr	Dukana	Balesa Ririba	Balesa	7,478	1,080	1,268.1	6
		Balesa Saru	Balesa-Saru	3,290	470	1,194.5	3
			Bulluk	12	2	1,187.2	-
			Sabare	576	129	852.7	1
		Dukana	Dukana	15,497	1,652	1,868.1	8
		El Hadi	El Hadi	3,589	507	1,034.1	3
			Marine	882	123	472.6	2
	Ileret	Ileret	Ileret	18,233	2,166	1,973.4	9
	North Horr	Galas	Charigollo	1,970	334	1,178.5	2
			Galas	3,547	526	447.3	8
		Malabot	Malabot	2,592	419	1,112.2	2
		North Horr	Darade	72	10	2,416.9	-
			Elbeso	2,091	343	1,019.4	2
			North Horr	8,719	1,498	1,231.9	7
			Qorqa	2,825	460	779.2	4
	Sibiloi National Park	Sibiloi National Park	Sibiloi National Park	74	70	1,300.8	-
Sololo	Obbu	Amballo	Amballo	894	125	1,272.1	1
			Bodhodha	758	112	467.8	2
		Anona	Anona	2,092	392	16.8	125
		Dambala Fachana	Dambala Fachana	3,137	456	134.6	23
			Garba	440	71	311.5	1
		Sololo Ramata	Ramata	8,932	1,606	48.1	186
		Waye	Mado Adi	2,427	386	14.7	165
			Waye Godha	1,527	248	55.4	28
		Sololo-Makutano	Sololo-Makutano	2,577	457	235.1	11
	Urban	Golole	Golole	2,701	450	55.7	49

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Karbururi	1,818	346	27.7	66
		Rawana	Banale	3,897	491	608.8	6
			Rawana/Tito	5,470	887	2,417.6	2
		Uran	Lataka	2,259	330	63.6	35
			Uran	2,876	418	16.1	178
		Walda	Walda	3,017	463	318.5	9

2.4.3 **Geology**

The geology of the Marsabit region consists of a massive alkaline basaltic rock system that overlies Precambrian basement rock complex at depth. These volcanic rocks referred to as the Marsabit Shield cover the entire mountain forming basaltic lapilli breccia volcanic ash cones, and cinder cones interlayered with extensive olivine basalt flows. These miocene-oligocene basalts unconformably overlie undifferentiated basement rock system at depth.

The formation of the Marsabit Shield (evolution of Marsabit Mountain), took place in a series of volcanic eruptions.

Volcanism in the Marsabit Shield commenced at the same time with the Rift system faulting in the Pliocene and continued into the Quaternary period according to the recorded basal basalt rock ages dated 2.5 and 0.5 million years respectively. The volcanic centers comprising of cinder cones and block and ash cones (or maars) are concentrated trending northwest and northeast through the shield summit. The initial lava flows are uniformly thin and laterally extensive fissure controlled basal basalts erupted during the late Miocene to Pliocene periods. Subsequent violent eruptions during the Quaternary period produced intervals of pyroclastic accumulations from cinder cones and maars with faulting accompanying volcanism. The major faults were concealed by later volcanic flows with eruptions of narrow lava tongues of olivine basalts emerging from the cones.

Subsequent violent eruptions during the Quaternary period produced intervals of pyroclastic accumulations from cinder cones and maars with faulting accompanying volcanism. The major faults were concealed by later volcanic flows with eruptions of narrow lava tongues of olivine basalts emerging from the cones.

The eastern volcanic complex in including the Marsabit town best describes the geology of the surveyed area. The Huri Shield and Marsabit shield being the main source of the widespread volcanic ashes and basaltic breccia. They share a basalt platform, the south end of the Huri Shield form a raised plateau abutting into the Chalbi playa. Elevated piles of Basalt blocks are separated by irregular hollows partly infilled by unconsolidated sediments.

The Marsabit shield has a more varied morphology caused by the different weathering characteristics of the assorted volcanic lithologies. The shield itself has a typical shallow dome shape profile with overall surface slope of less than 60. The Basal platform is exposed east of Maikona where its most distinguishing features are a massive concentration of dark circles on aerial photographs due to the abandoned rock foundations of the former Rendile settlements.

According to Charsley (1986), Basalts underlying the Huri shield were extruded from fissure sources during the late Miocene and stating that Volcanism of the Marsabit shield commenced in the Pliocene, 2.5 Ma. The Marsabit shield has an oval plan with a NE – SW long axis of about 90km. The volcanic centres are concentrated in two belts, about 15km wide, trending NW and NE through the summit of the shield. The Marsabit shield has a surface area of about 6300 km^2 with a total volume of 910 km^3 of basaltic material with a summit thickness of 1200 m of intercalated basaltic lavas and pyroclasts. The individual flow units have thicknesses from about 5 to 20 m whereas the various pyroclastic wedges may be up to 200 m of maximum thickness.

The platform basalt exposed south east of Moikona is a homogenous well jointed and locally well-developed vertical columnar joints, aphanitic basalt weathering to shades of dark brown. Immediately north of Moikona the Huri Shield consists of several flows stacked on top of each other to define a scarp which is about 30 m high. The basalts are well jointed, vesicular with a ferromagnesian phase weathering to orange brown against a dark brown background. Secondary carbonates are common along joint planes.

Figure 2.17: Basaltic blocks near cinder cones

Most of the cinder cones consist of red brown weathering, thickly bedded lapilli breccia. The beds have radial dips of up to 400. Although basal beds tend to sub horizontal, i.e. the dip angles increase up the succession. Angular scoriaceous basalt lapilli are the principal component of breccias with minor convoluted bombs and blocks of the same material up to 40cm in length. Secondary carbonate cement is ubiquitous: a friable red brown matrix is confined to discrete beds.

The largest intrusive is the discordant vertical granite sheet cropping out on the northern summit of Halisurwa. This is a massive, pink weathering, feldspathic rock with euhedral quartz grains visible in hand specimen. Minor intrusives include quartz reefs and stringers, carbonate veins in marbles, white mica bearing felsic veins quartzofeldspathic pegmatites and grey microgranite dykes. The latter are relatively common, especially to the east of Korr Mission. They have sharply discordant contacts with the host gneisses and are 1m thick.

The quaternary sediments covering this complex include the Pleistocene lacustrine depostits at Olturot: a pan like depression in basalts on the margin of the NW Volcanic province at Olturo. It consists of mounds and composed of a dull white, earthy calcareous (micritic) sediment containing fine root strands and complete mollusc shells. The soils and superficial sediments including the North West volcanic province overly the platform basalts between the Asie and Kulal shields, relatively deep, friable, strongly calcareous and sodic gravel sands.

Soils

The higher parts of Mts. Marsabit have rich volcanic soils which are well developed and have high water retention capacity. On the lower slopes of the mountains, the soils are basically cambisols. In some areas they are moderately deep clay loams; in others, the soils are stony or rocky. These soils are generally suitable for agriculture and dairy farming in those places with sufficient rainfall.

2.4.4 **Topography**

The Marsabit area can be divided into three physiographic units: The lava-capped plateaus which rise from 50 to 200 feet above the plain, the dissected plain surface, which slopes downwards in a north-easterly direction and the residual hills standing well above the level of the plain, with summit heights ranging from 2,645 feet to 5,746 feet.

Mount Marsabit is an extinct volcano surrounded by expansive low lying arid plains formed of weathered lava flows ranging in altitude from 300 to 900 m above sea level that slopes gently towards South East. The highest point of the mountain is 1920 m above sea level.

Although Marsabit is the second largest and driest district in Kenya, the mountain area benefits from its high elevation and receives a biannual distribution of rainfall ranging from 600 mm to 1000 mm annually. The combined effect of high altitude and fairly good rainfall enables a tropical rainforest to thrive on nearly 80% of the entire mountain area. Over the past four decade, 60 %(40,000 Ha) of the riparian forest has been opened up for farming and settlement development (including the District Headquarters). The remaining 40% (15, 280 Ha) is the gazetted forest area, which is also the Marsabit National Park, which was home to legendary elephant Ahmed

Marsabit Town is founded on Mount Marsabit and it is embedded between three other hills. It generally slopes from North East to South West Marsabit Town and has three distinct drainages as follows:-

1. Jaldesa lagga passing below the District headquarter. It drains most of Mountain Location which forms most of the Central Business District of Marsabit Town.

2. Hari Henry Drainage –It drains Nagoya and Part of Dakabaricha locations.

3. Halbota Pan-Slaughter House/Senegai Airstrip drainages the remaining part of Marsabit Town constituting 25%.

2.4.5 **Hydrology**

There are three principal water horizons in the district; the upper horizon of mountains and hills, over 1500 m to the summits of mount Marsabit and Kulai where there are a number of springs; the second horizon 1,200 m to 1,500 m still on the mountains, on mount Marsabit springs like Badassa, Songa and Balesa Bongole are at these levels. The rest of the district which generally lies between 400 m – 460 m depends mostly on underground water. In these areas, the ground water table varies greatly.

2.4.6 **Hydrogeology**

According to investigation undertaken on Marsabit Town, the ground water potential is rated as low.

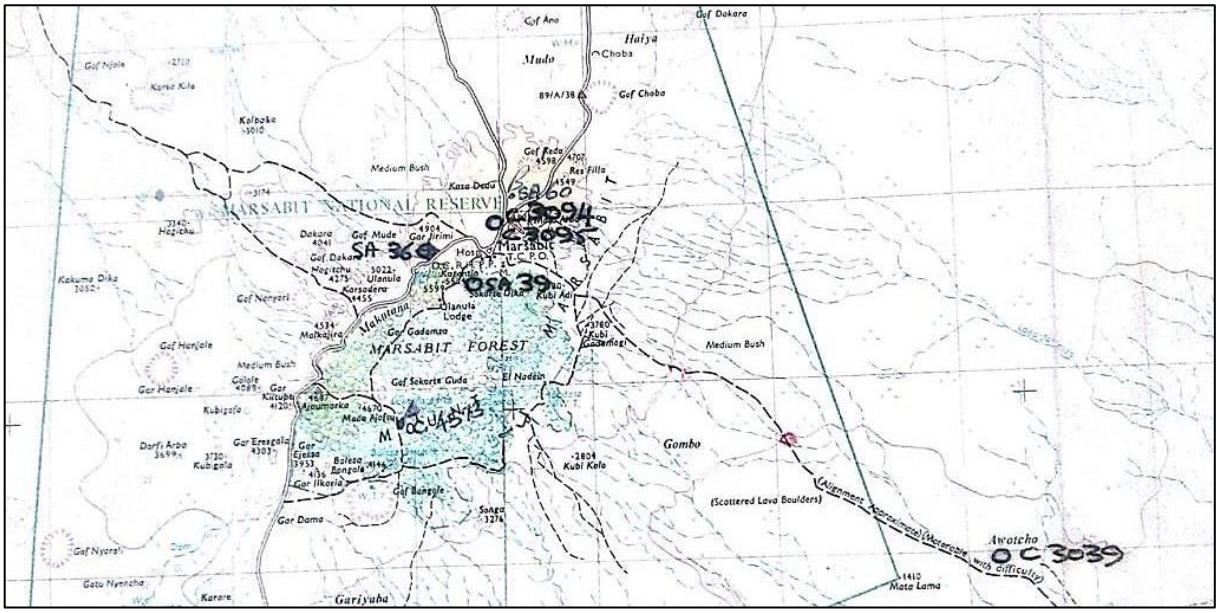

Figure 2.18: Map extract showing the proposed borehole site and the surrounding boreholes (Map sheet No: NA – 37 - 6, Y 503 Series: Mount Marsabit)

2.5 SAMBURU COUNTY

2.5.1 Location

Samburu County lies within the Arid and Semi-Arid parts of Kenya and has an area of 21,022.1 Km^2. It is situated in the northern part of the Great Rift Valley. Samburu is bordered by Turkana to the Northwest, Baringo to the Southwest, Marsabit to the Northeast, Isiolo to the East and Laikipia to the South. The county lies between latitudes 0°30' and 2° 45' north of the equator between longitudes 36°15' and 38° 10' east of the Prime Meridian.

Samburu County borders Baringo County to the west, Laikipia County to the South, lsiolo County to the East, Turkana County to the northwest (Fig. 2.19).

It has an area of approximately 20,182.50 (2019) sq.km and a population density of 15.26.

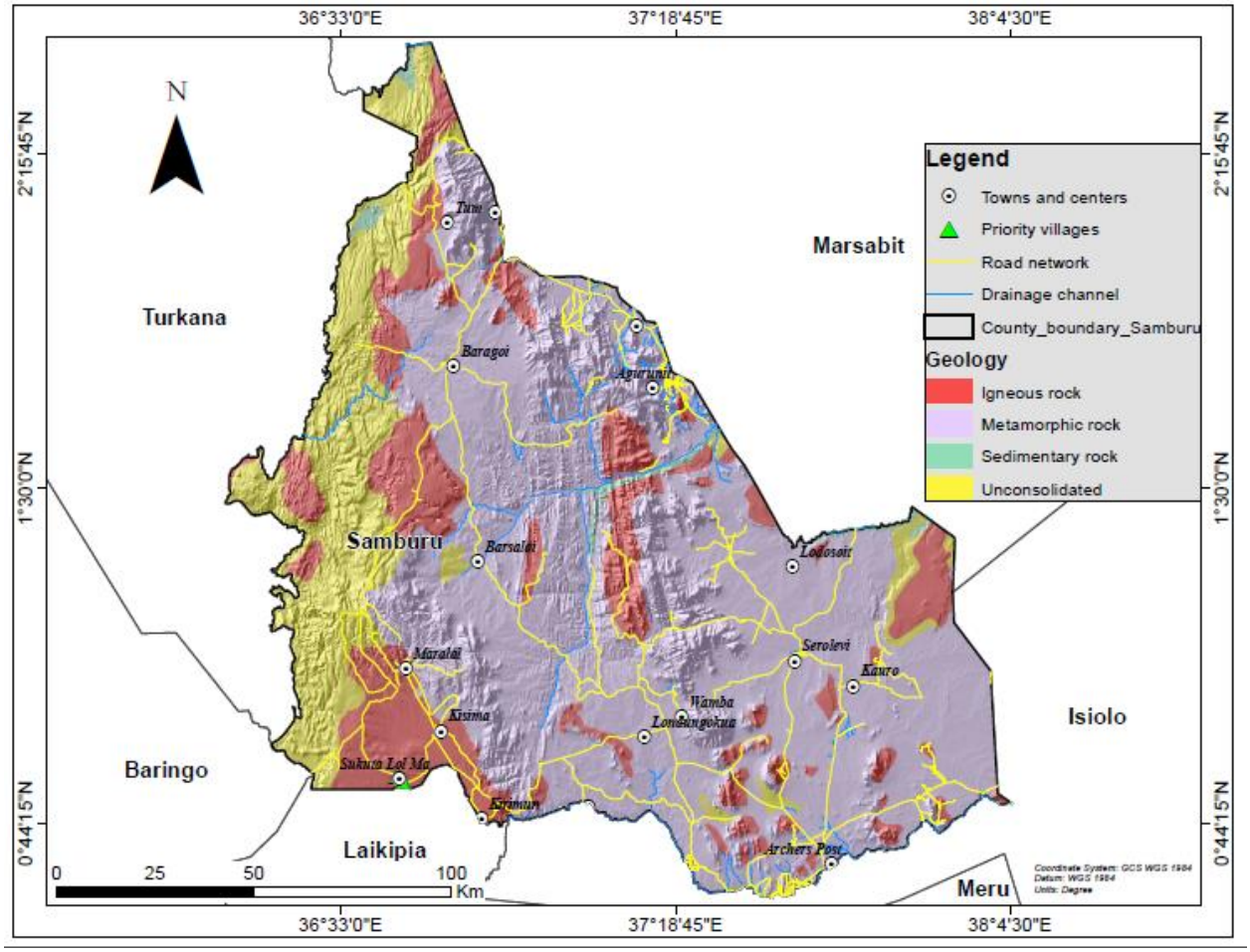

Figure 2.19: Samburu County

2.5.2 **Demography**

2.5.2.1 ***Population Size and Composition***

According to the 2019 Population and Housing Census, the population of Samburu County was 310,327 (156,774 Males, 153,546 Females, and 7 Intersex). Table 2.13 presents population by sex and sub-county.

Table 2.13: Population Distribution by Sex, Number of Households, Land Area, Population Density and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Samburu Central	164,942	83,633	81,307	2	34,202	3,699	45
Samburu East	77,994	38,211	39,782	1	18,424	10,016	8
Samburu North	67,391	34,930	32,457	4	13,284	7,375	9

(Source: KNBS, 2019)

Table 2. 14: Population Distribution by Number of Households, Land Area, Population Density and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
Samburu Central	Kirisia	Barsaloi	Barsaloi	1,901	396	183	10
			Lulu	1,287	279	59.3	22
			Soit Naibor	1,197	250	105.2	11
		Lbukoi	Lbukoi	1,274	317	215.4	6
			Moru	2,207	479	225.1	10
		Maralal	Ledero	1,506	278	22.3	67
			Lkuroto	3,072	542	21.4	143
			Lpartuk	4,805	922	44.5	108
			Maralal	16,6.2	4,810	22.9	727
			Milimani	7,209	1,533	32.5	222
			Ngari	7,285	1,418	64.1	114
			Shabaa	8,973	2,306	19.6	458
		Opiroi	Lorrok-Lolmongo	1,613	336	41.9	38
			Mabati	1,778	330	117.8	15
			Opiroi	4,507	861	154.9	29
		Sirata Oirobi	Lemisigiyoi	1,926	381	21.7	89
			Ngenjuemuny	1,275	237	19	67
			Sirata Oirobi	1,556	298	15	104
	Lorroki	Amaya	Longewan	3,032	513	76.9	39
			Amaiya/ Mukekamar	2,699	444	58.8	46
			Nasur	1,852	291	47.9	39
		Baawa	Baawa	3,348	660	32.3	104
			Llkiloriti	2,601	452	35	74
			Nauneri	3,828	664	79.5	48
		Kirimon	Garma	2,116	427	42.9	49
			Kirimon	2,767	847	48.8	57
			Mugur	2,524	548	69.4	36
		Kisima	Laangatolia	3,483	762	33.4	104
			Lmisgiyioi	1,765	335	45	39
			Mbaringon	2,801	526	23.6	119

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Lodokejek	Lodokejek	6,603	1,330	102.9	64
			Nonkeek	1,608	379	182.6	9
		Suguta Marmar	Logorate	3,707	673	73.7	50
			Lolmolok	7,842	1,384	221	35
			Suguta Marmar	5,695	1,306	85.3	67
	Malaso	Angata Nanyokie	Angata Nanyokie	2,056	368	21.9	94
			Loibashai	1,609	293	53.8	30
			Morijo	5,161	920	119.4	43
		Poro	Lporokwai/ Malaso	1,947	387	18.5	105
			Mugur	1,705	303	20.6	83
			Seketet	3,582	637	55.3	65
			Siambu	2,383	349	267	9
		Loosuk	Loosuk	4,570	943	46.6	60
			Malaso	2,738	509	38.3	71
			Pura	3,581	568	143.7	25
			Tinga	7,366	1,398	239.1	31
Samburu East	Sereolipi	Ndonyo Wasin	Ndonyo Wasin	4,296	1,102	1,007.9	4
		Sereolipi	Sereolipi	2,956	826	1,230.5	2
	Wamba	Koiting	Koiting	3,305	643	628.4	5
			Lpashie	1,354	316	34.6	39
		Lodungokwe	Lengei	1,459	302	96.2	15
			Lpuss	1,234	263	137.6	9
			Ltirim	1,414	288	59.5	24
			Sesia	2,542	597	251.4	10
		Nairimirimo	Lmarmario	1,585	371	104.5	15
			Lorok Onyokiea	2,464	658	350.1	7
			Raraiti	1,175	269	131.5	9
			Suari	4,629	898	396.7	12
		Ngilai Central	Ngilai Central	4,890	1,092	339.2	14
		Ngilai West	Golgotim	2,877	655	253.6	11

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Lkisin	2,480	614	126.6	20
		Nkare Narok	Nkare Narok	3,289	689	554.5	6
		Nkaroni	Nkaroni	2,475	616	204.7	12
			Resim	1,675	386	108	16
			Silango Nanyekie	1,698	432	163.3	10
		Wamba	Matakwani	3,900	894	62.2	63
			Wamba	7,700	1,892	14.4	535
	Waso	Waso East	Archers Post	7,957	2,060	270.9	29
			Laresoro	1,256	314	28.2	45
			Losesia	1,144	437	2,697.7	-
		Waso West	Lengusaka	1,094	232	150	7
			Lerata	1,057	203	200.1	5
			Lpus Leluai	3,191	655	206.9	15
			Ngutuk Ongiron	1,536	443	81.1	19
			Remot	1,362	277	125.1	11
Samburu North	Baragoi	Baragoi	Baragoi	4,542	1,225	575.5	8
			Bendera	1,746	366	6.6	265
			Nalingangor	2,011	432	223.7	9
		El-Barta	Masikita	2,963	538	264.7	11
			Ngilai	4,354	760	114.5	38
		Latakweny	Latakweny	2,384	531	248.8	10
			Loikumkum	5,769	1,117	607.8	9
		Marti	Kalele	1,516	378	135.7	11
			Lokorkor	784	156445	2	
			Moruakiring	521	97	729.3	1
		Nachola	Nachola	2,450	396	15.6	157
			Nakupurat	2,010	319	48.5	41
			Terter	1,586	294	7	225
		Ndoto	Lesirikan	3,563	720	384.1	9
			Loodua	3,920	726	110.2	36

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Seren	1,466	301	226.9	6
		Suyan	Marti	829	135	144.2	6
			Suyan	808	174	245	3
	Nyiro	Arsim	Arsim	1,511	358	211.4	7
			Illaut	1,207	250	85.4	14
			Ngurunit	544	116	172.8	3
		Kawop	Lonyangaten	4,168	661	34.8	120
			Losurkoi	1,217	143	1,245.2	1
			Nakweei	1,195	541	5.8	207
		Parkati	Parkati	1,115	232	30.8	36
			Lkayo	231	-	339	1
		South Horr	Loonjorin	1,907	359	117.2	16
			South Horr	4,804	1,040	101.8	47
		Tuum	Ejuk	768	156	94.7	8
			Tuum	1,939	426	143.1	14
		Waso Rongai	Lkotikal	852	184	59.5	14
			Simale	1,183	221	162.1	7
			Waso Rongai	1,528	297	38.6	40

2.5.3 **Administrative boundaries**

The County is administratively divided into three sub-county, 7 divisions, 14 locations and 106 sub- locations as shown in Table 2.15.

Table 2.15: County Administrative Units

Sub-county	Division	Area (km²)	No. of Locations	No. of Sub-locations
Samburu Central	Lorroki	1,399.30	6	17
	Kirisia	1,237.70	5	18
	Malasso	1,300.30	3	11
Samburu East	Wamba	4,670.80	8	19
	Waso	5,378.90	4	10
Samburu North	Baragoi	4,024.40	7	17
	Nyiro	3,010.70	6	16
Total		**21,022.10**	**39**	**108**

Source: County Commissioner's Officer's Office, Samburu, 2012

According to the table 2.14 above, Waso is the largest division occupying 5,378.90 Km² with four locations and 10 sub locations while Kirisia with five locations and 18 sub locations is the smallest division covering a total area of 1,237.70 Km². This is due to the closeness of Waso to Samburu national park, which is mostly occupied by wildlife.

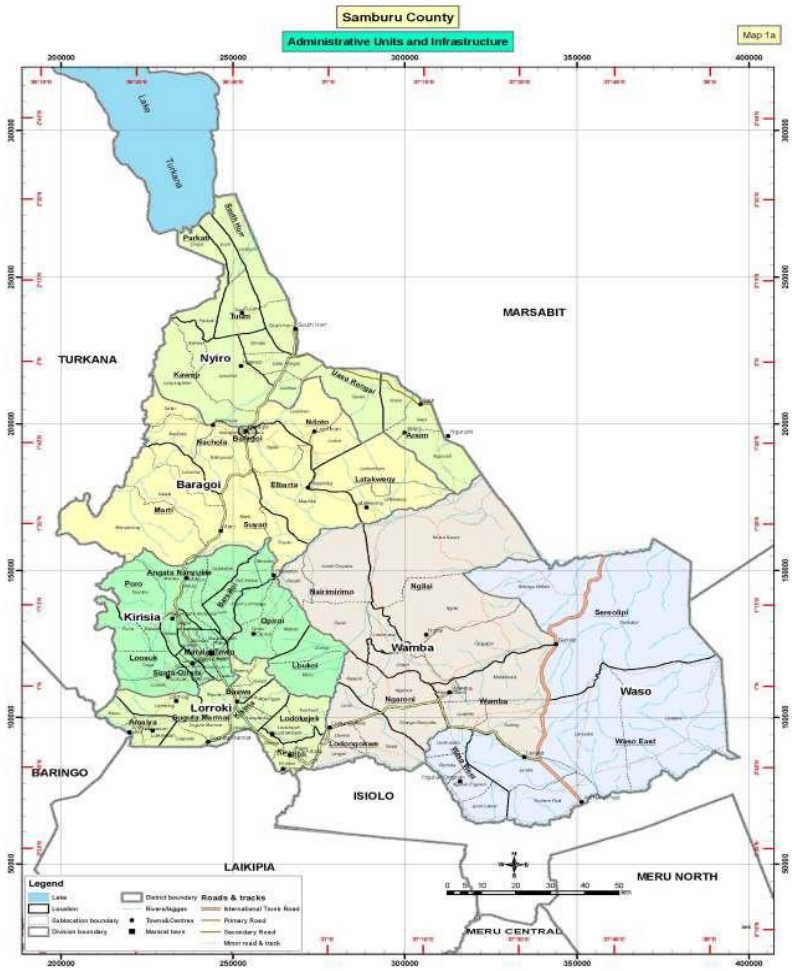

Figure 2.20: Samburu County - Administrative and Political Boundaries

2.5.4 **Geology**

The undulating topography dotted with several sinusoidal hills reflects the general geology of Samburu County. The area stands at an average altitude of 2051m a.s.l. within a steep-dipping terrain punctuated with several ant hills and flood plains both on the south eastern and north western flanks. The County lies on the eastern shoulder of the Rift Valley and can be subdivided into two major geological divisions. The eastern side covered mainly by the Mozambiquan rocks interspersed with occasional igneous outliers which occupies roughly two thirds of the county. The western side constituting one-third of the county, on the other hand, is covered by basic lava of Paleogene-Neogene volcanics of the rift valley.

The lithology may be classified into four major groups, namely, metamorphic rocks of the NeoProterozoic Mozambique Belt, igneous intrusives, Paleogene-Neogene volcanics and Quaternary volcanic and sediments. The sediment deposits were altered by tectonothermal events to form gneisses, schists, quartzites, and marbles with large areas underlain by migmatites. These events were followed by successive stages of uplift and erosion, lasting until the Paleogene when lavas flooded Mozambiquan rocks, producing basalts in the early stages and phonolites and trachytes in later stages. Recent deposits which consist of alluvium and colluvium, calcareous and lacustrine sediments, agglomeratic ash and residual soils have formed from weathering of the Mozambiquan rocks and the Paleogene volcanics with subsequent deposition on the lower regions and river valleys.

The igneous rocks are mainly granodiorites and granites but also include relatively small outcrops of pegmatites, quartz reefs, aplites and diorites. Only the major outcrops consist of foliated granites which often form inselbergs and hills, and granodiorites outcrop east of the Mathews Range. Locally, underneath the volcanics, subvolcanic deposits of probably Lower Miocene age consisting of well-rounded pebbles are fluvial erosion products of the Mozambiquan rocks.

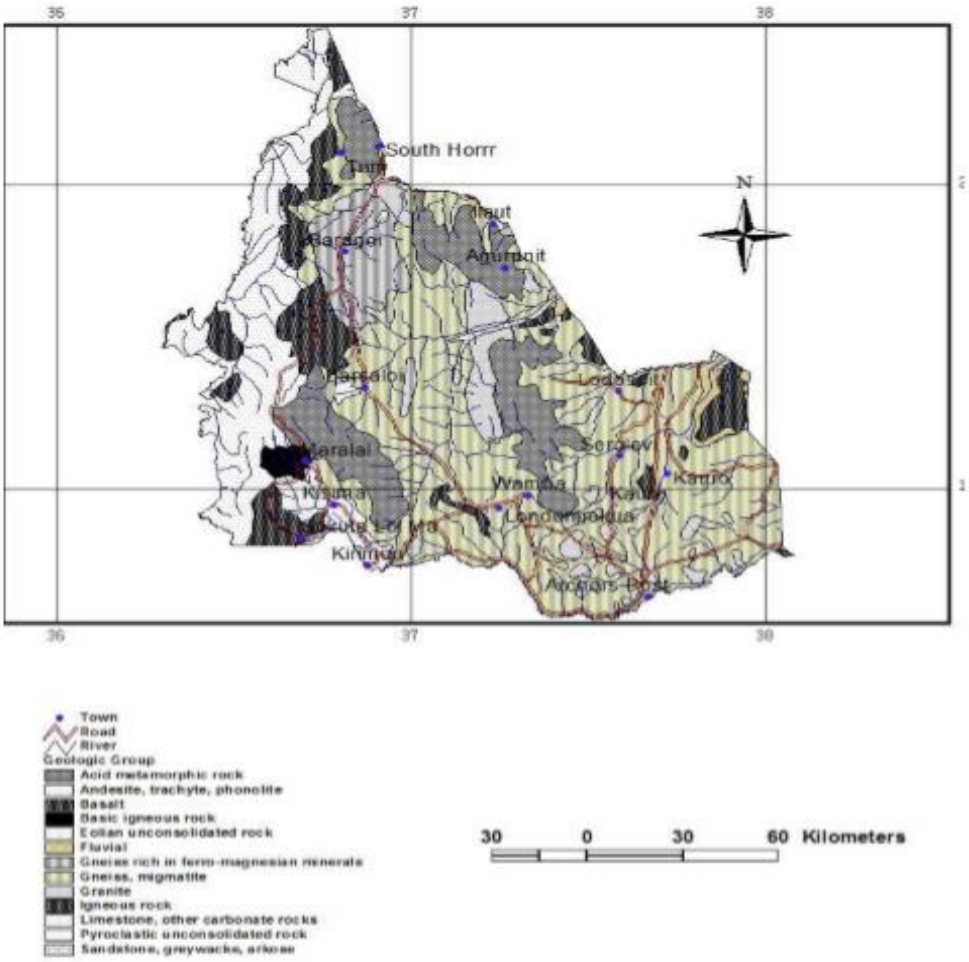

Figure 2.21: Lithology of Samburu County. The eastern part is covered mainly by gneisses and migmatites while younger volcanic and sedimentary successions cover the western part.

In the west, on the Rift Valley shoulder, the lower layers are more basaltic while the upper ones more phonolitic and trachytic. Volcanicity began in the area with the extrusion of an extensive series of basaltic pyroclasts and lavas, the Samburu basalts, followed by plateau phonolite and tuffs. Late Miocene to recent basalts and trachytes erupted over the western and northern extremities of the eastern shoulder. In the east, volcanicity began in the middle Miocene with the deposition of plateau phonolites and basalts. The Mozambiquan rocks and volcanic species have surface joints and fractures, alluding to intense forces of fracturing, faulting, minor cracking, pneumatolysis, and plate tectonics in the Precambrian orogeny and the Quaternary vulcanicity episodes.

The Quaternary sediments include alluvial infill and overspill to most water courses, calcareous deposits, Kunkar limestone, lacustrine deposits, agglomeritic ash, residual soil, and colluvium passing laterally into talus at the bases of major hills. Sinuous and braided shallow channels related to sporadic flow after the last heavy rains are marked by medium grained sands with gravel bars which top the alluvium.

2.5.5 **Topography**

The County of Samburu falls on the northern interface between highlands and lowlands. To extreme west is Suguta Valley which is bounded on both sides by fault escarpments and floored by red clays, boulders and gravel fans. In the East of Suguta Valley, the County is characterized by repeated extensive high-level plateaus which have been built by repeated floods of lava from the Rift valley. The highest parts of these plateaus are the Kirisia Hill, rising to 2000 m above sea level.

In the North of Baragoi - Tuum and South –Horr axis, the area rises to Mount Nyiro tapers northwards and falls steeply southwards. South and west of Mount Nyiro are peneplains which have been eroded to plains of lower levels ranging from 1000-1,350 m above sea level. These are noticeable at Kawap and the area between Lodungokwe and Wamba continuing eastwards and southwards. These plains are covered by red soils and sands derived from the adjacent slopes by sheet erosion. East of the central plains are the Mathew Ranges and the Ndoto mountains forming discontinuous ranges tending towards north-south of the eastern side of the county. Apart from the Lorroki plateau and the mountain ranges of Nyiro and Mathews, the rest of the County is a continuous basin which slopes northwards to Lake Turkana and east of Mathew Ranges. The high altitude of the plateau and the mountain ranges has resulted in indigenous forests which are all gazetted and preserved for rain catchments.

2.5.6 **Hydrology**

In Samburu, surface water is available in small quantities from River Ewaso Ngiro, the only major perennial river, at the southern border. High rainfall of about 700-1000 mm/year in the mountain ranges recharges springs in the lowlands. Most rivers in Samburu flow for short periods after rain. Dams and pans are common but their storage capacities have been reduced by siltation. The chemical quality of the surface water is generally good; however, bacterial contamination is common.

The river channel that would discharge into the Suyien dam has been colonized by vegetation while the forested arm of the river blocks flow into the dam. The river channels and laggas (dry river valleys) are fracture-controlled as is manifested by sudden angular changes in the channel courses. Major lineaments trending roughly north-south were observed from both the aerial photographs and LandSat imageries. A large Quaternary alluvial patch has formed south of Maralal town along the convergence of major laggas. These alluvial sediments are generally shallow and of limited extent to allow groundwater occurrence in significant quantities. Additionally, groundwater fluctuates due to short recharge periods and prolonged droughts. Although groundwater quality in laggas sediments is usually good, it is perceptible to bacteriological contamination especially in unprotected dug wells with some indication of salinity.

2.5.7 **Hydrogeology**

The Mozambiquan rocks and the young volcanics found in Samburu west of the study area are fairly fractured and hold groundwater in fractures, faults, as well as the contact zones between the volcanics and the metamorphic rocks or in the weathered zones. However, fractures and faults are of limited extent and therefore groundwater quantities

are low. The groundwater in the upper sediments receives an annual rainfall recharge through direct infiltration while the deep-seated zones may be recharged via regional flow aided by the faulted channels. In order to attain the maximum yield for optimum recharge of the groundwater, boreholes are sited near rivers or laggas where the yield is on average.

Paleogene-Neogene volcanics occur generally over large relatively continuous areas and have relatively high infiltration capacity and hydraulically interconnected fissures. Lineaments within the volcanics are more easily discerned on the basaltic rocks, while the ones on the phonolites are covered by red and loamy soils formed from weathered rocks. The recharge potential in this terrain is generally good with boreholes yielding on average 4000 ltre /hr. The water strike level is 80 m.

Table 2.16: Summary of the present yield from the boreholes

N°	Borehole	Yield (m3/day)
1	L Partuk	1080
2	Nontoto	90
3	Shabaa	38,4
4	Ledero	120
5	Nundoto	96
6	Loikas	60
7	Kirisia	1092,6
8	Total	2577

Table 2.17: A summary of the groundwater characteristics in Samburu County

Groundwater	Description	Tested Yield	Water Level		Quality
		Mean (m3/hr)	Struck (m)	Rest (m)	
Medium to High	Alluvial deposits along main laggas	0.5 - 3.0	0 - 2	0 - 2	Good
Medium	Contact zones intrusives	9	11	6	Fair
	Plateau phonolites	4	80	50	Good (TDS=500mg/l) though high fluoride
Low to medium	Pelitic basement	25	40	30	Variable but mostly bad (TDS=3000mg/l)
	Undivided basement				
	Granitic basement	1.4	24	16 (but 30% dry)	TDS=300 - 1800mg/l
	Magmatic basement				
Low	Western strip, volcanics	No data	Very deep	Deep	No data but probably acceptable
Very low	Mountain Ranges	Very low	Very low	Very deep	Good
	Inselbergs	Very low	Very low	Very deep	-
	Small plateau basalt areas	No data	Very low	Very deep	-

2.6 ISIOLO COUNTY

2.6.1 Location

Isiolo County is located almost in the centre of the country, 285 km north of Nairobi. The county is largely bound within latitudes 0^0 03' 52.77'' south and 2^0 04' 34.44'' north and longitudes 38^0 24' 33.64'' east and 38^0 59' 27.45'' east of the prime meridian.

Its capital, Isiolo Town, lies along the main highways travelling to both Moyale, Ethiopia and to Somalia (Fig. 2.22). The county is divided into several administrative units (sub-counties, locations, and sub-locations) (Table 2.18).

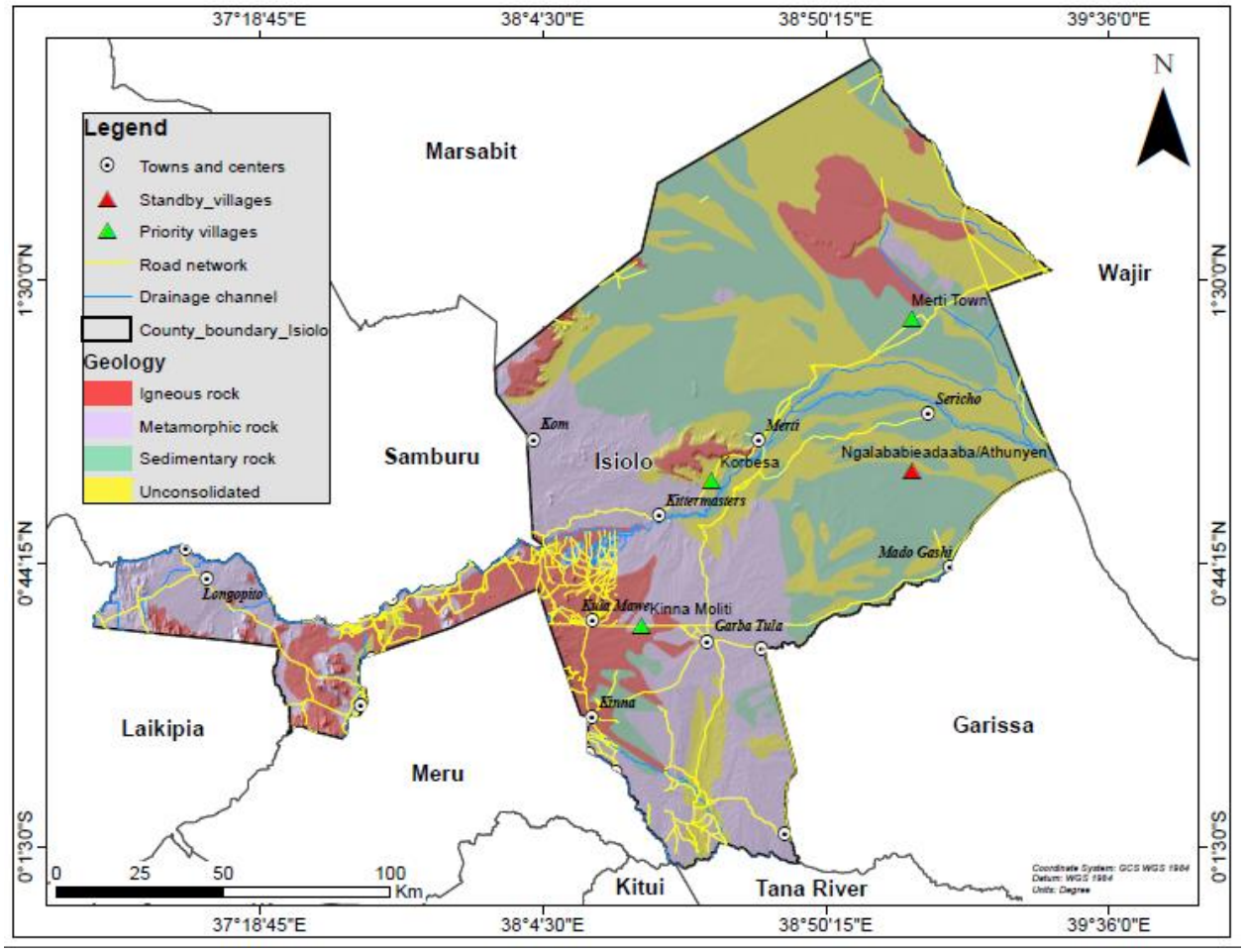

Figure 2.22: Map of the Isiolo County

2.6.2 Demography

Isiolo County is not densely populated, having an estimated 268,002 persons as per the 2019 population and housing census. The county is predominantly inhabited by the Borana (the largest portion), Somali, Meru, Turkana and Samburu. Immigrant communities from other counties form the minority. Though Islam and Christianity are practised in Isiolo County, the inhabitants are largely Muslim.

The population of the Isiolo County has the following characteristics:-

1. The population of Isiolo County is 0.37% of the Kenyan populations with 51% male and 49% female Table 2.18 and 2.19. The county has an annual population growth rate of 1.45% (1)
2. Isiolo town has the largest urban population of 32% of the county's population, followed by Merti 5%, Kinna 3% and Garbatula 3% (1)
3. The average household size is 4.5, which is 2.2% larger than the national average household size of 4.4. Table 2.18 and 2.19..
4. Population of children under 5years is 16%, 52% are between 15- 29 years of age and 5% are over 65 years (1)
5. In 2011, the national birth rate per 1,000 was 37.6 and the annual population growth rate was 2.67% (2)

Table 2.18: Population Distribution by Sex, Number of Households, Land Area, Population Density and Sub-county

Sub-county	Total	Sex			No. of households	Land Area (Sq. Km)	Density Persons per Sq. Km
		Male	Female	Intersex			
Garbatulla	99,730	54,661	45,068	1	18,661	9,902	10
Isiolo	121,066	60,414	60,947	5	29,853	2,691	45
Merti	47,206	24,435	22,768	3	9,558	12,756	4

(Source: KNBS, 2019)

Table 2.19: Population Distribution by Number of Households, Land Area, Population Density and Sub-Locations (Source: KNBS, 2019)

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
Garbatulla	Garbatulla	Boji	Boji	2,025	364	260.5	8
			Tanna	70	12	4.7	15
		Eskot	Eskot/Sikley	3,953	326	1,416.4	3
		Gafarsa	Belgesh	495	116	941.4	1
			Gafarsa	4,480	756	87	52
		Garbatulla	Garbatulla South/Kampi Samaki	14,165	2,890	935.2	15
			Garbatulla North	4,393	841	20.8	212
		Kombola	Kombola	1,618	326	65.2	25
		Malkadaka	Kuroftu Mollu	754	147	155.4	5
			Malkadaka	2,665	425	172.8	15
		Muchuro	Muchuro	1,679	295	51.7	32
	Kinna	Duse	Bibi	161	35	30.6	5
			Duse	1,412	329	314.6	4
		Kinna North	Kinna North	8,596	1,336	9.1	942
			Kubisera	418	156	412.6	1
		Kinna South	Kinna South	5,195	933	7	737
			Gubadida	727	153	27.1	27
		Kulamawe	Kulamawe	5,888	930	287.7	20
			Yaqbarsadi	549	116	52.1	11
		Madoyaka	Girisa	867	142	248	3
			Madoyaka	1,758	403	292	6
		Rapsu	Korbesa	453	103	480.6	1
			Rapsu	1,192	226	63.9	19
	Sericho	Badana	Badana	1,334	275	185.5	7
			Harr Adhi	495	76	916.7	1
		Iresa Boru	Forosa	933	152	16.5	56
			Iresa Boru	3,400	564	215.7	16

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Mogore	485	105	158.5	3
		Komor_Bulla	Komor_Bulla	932	286	365.9	3
			Modogashe North	6,437	1,473	71.7	90
		Modogashe	Burquqe/ Barkuke	6,020	1,105	685.7	9
			Modogashe South	4,477	766	37.5	119
		Sericho	Biliki	996	175	176.9	6
			Gubatu	1,624	292	76	21
			Qone	416	67	451.5	1
			Sericho	5,488	939	23.6	232
		Eldera	Eldera/ Hudun	3,176	726	183.9	17
Isiolo	Central	Burat	Burat	4,835	1,726	70.3	69
			Kilimani	4,395	943	12.5	352
			Leparua	1,739	358	125.6	14
		Central	Bulla Pesa	6,436	1,450	0.9	7,373
			Central	8,923	2,392	2.1	4,215
		Odha	Kambi Garba	3,281	666	3.3	1,009
			Kambi Odha	6,935	1,370	2.4	2,932
		Waso	Marire	8,962	3,264	0.9	10,446
			Waso	6,674	1,962	2.9	2,282
		West	Loruko	736	152	65.8	11
			West	3,149	604	297.7	11
	East	East	Kiwanjani	6,196	1,495	1.3	4,717
			Mwangaza	4,637	1,525	3.9	1,174
			Wabera	5,295	1,137	1.1	4,923
		Tullu Roba	Acacia	21,311	4,575	7.6	2,822
	Ngaremara	Attan	Attan	1,129	328	193.5	6
		Gotu	Boji Dera	216	68	425.6	1
			Gotu	740	144	2.9	255
		Nakupurat	Nakupurat	2,004	384	178.7	11

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
		Ngaremara	Manyatta North	541	95	5.9	92
			Manyatta Zebra	1,902	718	92.2	21
			Ngaremara	893	181	3.4	266
	Oldonyiro	Kipsing	Kipsing	4,646	976	288.2	16
		Lenguruma	Lenguruma	3,378	709	301.3	11
		Longopito	Longopito	2,139	495	236.6	9
			Tuale	1,648	380	100.5	16
		Oldonyiro	Oldonyiro	5,259	1,154	141	37
			Rumate	3,067	602	123.1	25
Merti	Cherab	Dadacha Basa	Alango	419	90	1,252.5	-
			Dadacha Basa	2,668	506	423.6	6
		Korbesa	Biliqi	1,143	219	99.3	12
			Korbesa	2,020	380	40	50
			Saleti	1,186	230	36	33
		Malka Galla	Dadacha Lafe	321	60	810.4	-
			Malka Galla	2,000	357	598.6	3
		Mata Arba	Bulto Bonsa	516	114	5.5	94
			Mata Arba	931	215	67.5	14
		Yamicha	Duma	356	87	1,378.8	-
			Urura/Lolkuta North/ Jira/ Noorgos/ Bukuma	15,042	2,602	3,444.2	4
			Yamicha	644	120	233.6	3
	Kom	Bisan Biliqo	Bisan Biliqo	1,776	396	38.4	46
			Biliqo Marara	540	125	786.5	1
			Kom	628	122	26.4	24
		Bulesa	Nyachis	607	145	15.4	40
			Bulesa	3,267	705	67.5	48
			Goda	847	193	299.1	3
	Merti	Merti North	Lakole	551	145	2,913.3	-

Sub - County	Division	Location	Sub location	Population 2019 census	Households	Land area Sq. Km	Density
			Merti North	7,987	1,845	162.9	49
		Merti South	Godarupa	146	42	25.3	6
			Merti South	3,611	860	31.1	116

2.6.3 **Geology**

The geology of the Isiolo County has been described in the "Geology of the Isiolo area" (Hackman et al., 1989) and earlier by J.E. Mason in 1955 Geology of the Meru-Isiolo area". In general, the geology is characterised by two major geological and lithological systems, the Pre-Cambrian Basement System and the younger Tertiary basaltic lavas.

The Basement System rocks are the oldest in the area being of Precambrian age, and underlie the entire Isiolo area. They comprise migmatites, several groups of paragneisses, and a variety of intrusives. The paragneisses have been interpreted as meta-sediments ranging from arkoses and sandstones through muddy sandstones to carbonaceous mudstones and limestones. These rocks were affected by a complex sequence of six tectonothermal episodes, which have been dated as late Proterozoic to Cambrian on the basis of radiometric ages from intrusives, which range in composition from granite and trondhjemite through syenitic orthogneiss to amphibolite and ultra-mafics.

The younger volcanic rocks found in the Isiolo area, are all associated with Mt. Kenya volcanic activity. The oldest of these rocks are the Miocene phonolites. The volcanics especially those in the south are dominated by the contemporary suites of lava and pyroclastics making up the Mt. Kenya shield and Nyambene Hills. In the Mt. Kenya area, the Ndare Forest Mugearites and Basalts form a major unit at least 200 m thick with local centres of a more trachytic composition, overlying the phonolitic rocks. Following is a succession of over 100 m of Pleistocene basalts, the Osirua Basalts, which are the most relevant volcanic rocks as far as the study area, is concerned.

The county has a combination of metamorphic rocks and other superficial rock deposits. Tertiary rocks (Olive Basalt) are found in the northern parts of the county, where oil exploration has been going on. The areas covered with tertiary marine sediments have a high potential for ground water harvesting.

The rocks of Isiolo county which covers the central part of the study area fall into two natural and distinct sub-divisions: (a) the Archaean or Basement System rocks and (b) the comparatively young Tertiary, Pleistocene and Recent extrusive rocks and subordinate sediments

The basement system

The basement system forms the floor upon which all the remaining rocks of the area rest, and consists of schists, granulites and heterogeneous gneisses of varying composition, such as are widely distributed throughout East Africa.

Although the ancient Archaean rocks of Kenya have been metamorphosed to varying degrees by regional metamorphism and granitization, so that in many cases their original identity is difficult to decipher, it is generally accepted that they were originally laid down as sedimentary deposits.

Tertiary to Recent Volcanic Activity, Erosion and Deposition.

North nearer Meru the partial succession reads: —

1. Basalts, tuffs and ashes of parasitic vents.
2. Upper olivine basalts.
3. Lower basalts, with kenyte and tuff.

The lowermost plains are basalt and olivine basalt and rest on the sub-Miocene bevel. Intercalated in this lower division near Mporiene, south-east of Meru, is a thin band of highly weathered and densely porphyritic kenyte, which indicates a minor alkaline phase. The entire division is thin, being not more than 500 ft. in thickness. The upper olivine basalts overlie the lower basalts west of the meridian passing through Kienduri, and extend to the western boundary of the area. They appear to, be much thicker than the lower basalts, but owing to the fact that they probably overlie kenytes and phonolites, which reach a thickness of 3,000 ft., further south, it would be unwise to estimate their thickness.

2.6.4 **Topography**

The Landforms and Soil types within Isiolo County is comprised twenty seven different types of land, each with its own typical set of environmental characteristics and rangeland qualities. They are grouped here as follows:

a. Landforms developed on Precambrian Basement System rocks.
b. Basalt plateaus of Plio - Pleistocene age (Merti's).
c. Basalt flows of Pleistocene - Recent age.
d. Sedimentary plains of marine origin (Plio - Pleistocene Bay sediments).
e. Piedmont plains, built up of sediments derived from Basement System rocks.
f. Older riverine sedimentary plains, to be separated in moderately well drained sands, loams, clays; and imperfectly drained clay plains.
g. Younger riverine plains and present day Ewaso Ngiro floodplains.

The southern half of the Isiolo County is largely occupied by landforms developed on gneisses of Precambrian age. They are mainly erosional plains (End - Tertiairy Peneplains) of gently undulating relief. Part of these plains (the Garba Tula area dividing Tana River and Ewaso Ngiro catchment) shows deep, strongly weathered and leached reddish sandy clay loam soils. These are known as Wayama soils in local language. In broad zones along the Ewaso Ngiro valley, and towards the Tana River, the plains are increasingly dissected, and soils become more shallow and stony, and also richer in primary weatherable minerals (Chari - soils in Boran). They are strongly calcareous over some large areas.

All Hills and Footslopes formed in Precambrian gneisses are rather limited in extent in Isiolo, and occur mainly west of Isiolo Town.

In the Central and Northern part of the Isiolo County, as well as along the northwestern border with Marsabit County, large table lands stand out in the otherwise almost flat surrounding plains ("Merti's" in Samburu language). They originate from basalt (lava) flows of Plio - Pleistocene age, deposited on the land-surface that existed by that time. The hard basalt forms a protective "cap" over the softer underlying rock. Thus it has preserved the

original surface level from being eroded to the present day level of the surrounding plains.

The extensive, flat "table" surface is covered by very deep calcareous reddish brown clays, often with scattered stones. These soils are called Malbe or Malbe-bule in Borani language. The volcanic hill-mass of the Nyambeni's in Meru County has a series of basalt flows at its base. These stretch North and North-West into Southern part of Isiolo County, covering the Basement System erosional plains. The basalt flows are of various ages, ranging from Pleistocene to Recent, consequently showing various degrees of stoniness and rockiness. The topography is mainly almost flat, but "terraced" in small, level steps. Towards the Nyambeni Hills, the topography is more sloping.

An extensive slightly undulating sedimentary area is formed by marine sediments (Bay-sediments) of Plio-Pleistocene age. These constitute part of the so called "sealing loam" plains of NE Kenya, which have a larger extent in Garissa and Wajir Counties on both sides of the Ewaso Ngiro valley. Soils are characterized by a thin, structureless topsoil that abruptly overlies a hard and massive, sodic subsoil. In upslope position soils have a thick coarse sandy surface layer; downslope soils are more clayey. In spite of unfavourable physical properties (from agricultural point of view) these Omara soils, as they are called in Borani, reportedly are regarded as "the best" areas for goats and cattle.

Piedmont plains dominate the Central-Western part of the County. These extensive very low-angle slopes are built of sediments deposited by numerous parallel ephemeral rivers. These come from the erosional plains on Basement System rocks in the West. The land almost imperceptibly slopes down towards the NE, with a very gently undulating mesorelief. Higher parts have well drained, deep and compact sandy loam and clay loam soils, partly with a sealed surface (Omara-dima in Borani). The lower parts have mostly imperfectly to poorly drained clay soils (Halbe, Omara-bor).

The higher level area exists of fine sandy loams with numerous wide, round and shallow depressions of more clayey soils. These depressions are ponded during the rains. This probably causes the area to be densely frequented during this season, judging also by the degraded aspect that the higher sandy soils offer. Sealing and wind erosion are prominent features. Most of the Northern half of the County is covered by older riverine sedimentary plains. They are the in-filled wide valley systems of both lagh Bogul and the joint Milgis/Ewaso Ngiro. Higher level, moderately well drained areas of sandy soils can be separated from lower lying, extensive flat clay plains of poorer drainage.

2.6.5 **Hydrology**

There are six perennial rivers in the county namely; Ewaso Ngiro North, Isiolo, Bisan-gurach, Bisanadi, Likiundu and Liliaba rivers. Ewaso Ngiro North River has its catchments area in the Aberdare ranges and Mount Kenya. It also serves as a boundary mark between Isiolo North and Isiolo South constituencies. Isiolo River originates from Mount Kenya and drains into Ewaso Ngiro River. Bisan- gurach and Bisanadi Rivers are found in the southern part of the county and drains into the Tana River. Likiundu and Liliaba originate from

Nyambene hills and drains into Ewaso Ngiro North River.

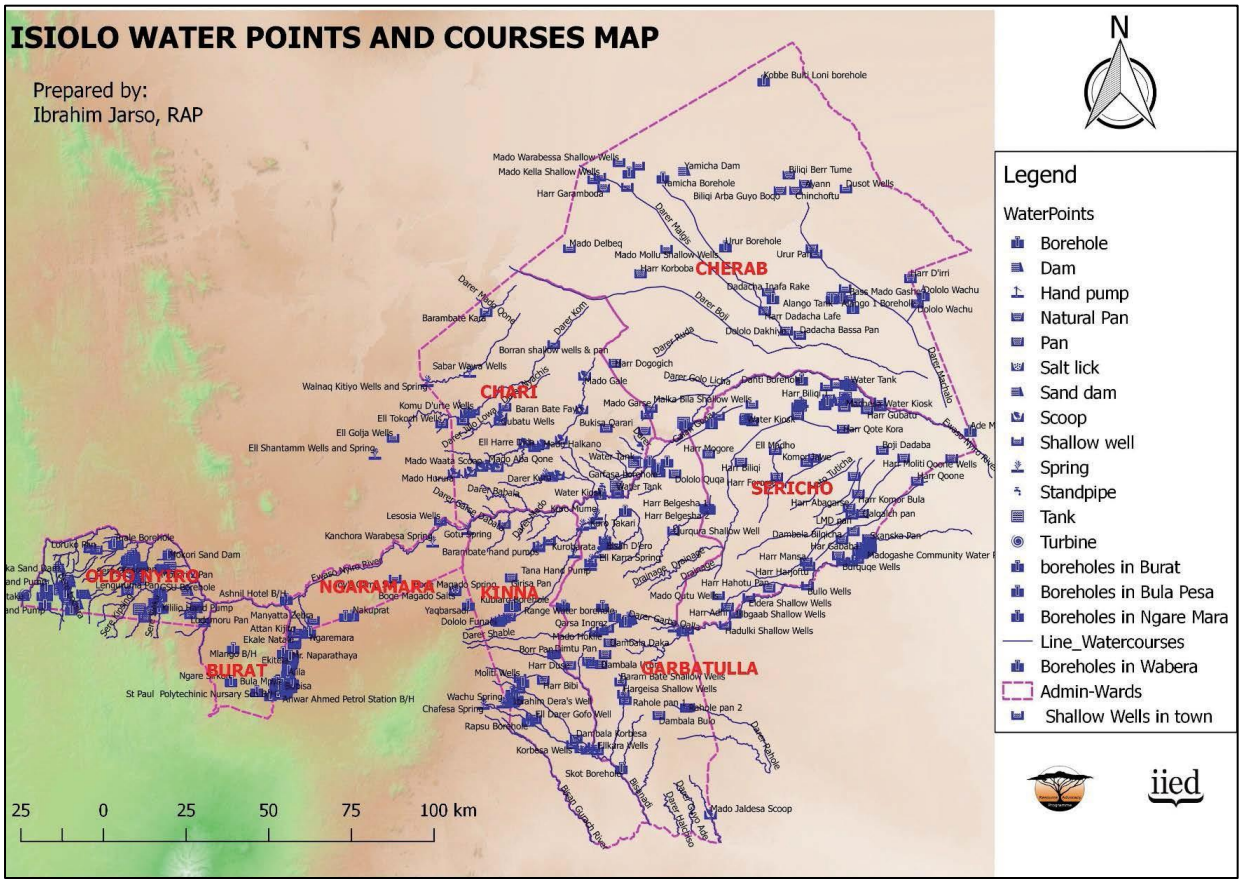

Figure 2.23: Isiolo Water Points and Courses

CHAPTER III: PROJECT APPRAISAL

3.1 MANDERA COUNTY

3.1.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Boreholes***	***Distance from The Village (km)***	***Depth m***	***Yield m^3/h***	***Water * Quality: palatability***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Omar Jillow	Omar jillow	0.2	70	15	Saline	41° 39' 45.4788" E	3° 45' 14.7636" N	414.273 376	It is only used by livestock
Qurdobow	Gofa	13	264	3	fresh	40° 36' 19.0476" E	3° 25' 12.4968" N	762.345 52	The yield is dwindling because of siltation. During our visit the community has informed us that the borehole is operational because it broke down early this year. The yield of the borehole is dwindling due high siltation.
Birikaan	Elmolay	25	290	16	Saline	40° 11' 46.0896" E	4° 02' 17.6028" N	1136.05 835	It is only used by livestock
Andarak	Elmolay	45	290	16	Saline	40° 11' 46.0896" E	4° 02' 17.6028" N	1136.05 835	It is only used by livestock, the community in Elmolay uses water pan for drinking water.
	Lulis	17	310	3	Hard	40° 20' 02.3172" E	4° 01' 39.0000" N	1092.77 3315	The borehole is solar powered and the community has requested hybridization of the borehole by installing diesel generator because the currently solar system cannot meet with the community water demand.
	Banisa	35	325	5	fresh	40° 20' 35.6460" E	3° 56' 54.9204" N	1049.56 2866	The borehole is solar powered, however the community in this centre rely on

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Boreholes***	***Distance from The Village (km)***	***Depth m***	***Yield m^3/h***	***Water * Quality: palatability***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
									harvesting system especially a Water Pan as a main source of drinking water.
Burmayo	Garse	5	260	12	fresh	40° 17' 20.5188" E	2° 58' 04.3644" N	645.338 623	Drilled and developed recently but not yet equipped and test pumping was not undertaken. The yield provided is just an estimate.
Midina	Darweed 1	30	300	30	Hard/saline	40° 13' 56.2764" E	3° 26' 04.0812" N	758.967 834	These 4 boreholes are the main water sources that supplies water to Takaba town.
	Darweed 2	30	300	5	Hard/saline	40° 13' 31.6272" E	3° 25' 17.6340" N	751.783 203	
	Darweed 3	30	300	15	Hard/saline	40° 14' 08.5596" E	3° 26' 15.9468" N	753.350 708	
	Darweed 4	30	300	10	Hard/saline	40° 13' 26.4468" E	3° 25' 05.1204" N	746.492 7	
Hardawa	Banisa	25	325	5	fresh	40° 20' 35.6460" E	3° 56' 54.9204" N	1049.56 2866	The borehole is solar powered, however the community in this centre rely on rainwater harvesting system- Water Pan as a main source of drinking water.
	Lulis	17	310	3	Hard	40° 20' 02.3172" E	4° 01' 39.0000" N	1092.77 3315	The borehole is solar powered and the community has requested hybridization of the borehole by installing diesel generator because the currently solar system cannot meet with the community water demand
Libehia	Libehia	0.5	170	10	Very saline	41° 31' 39.1764" E	3° 50' 07.3356" N	451	The village has a borehole. The water from the borehole is saline and the

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Boreholes***	***Distance from The Village (km)***	***Depth m***	***Yield m^3/h***	***Water * Quality: palatability***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
									community depends of scoop hole and shallow wells for drinking water.
Lafey	Agri BH	within the lafey town	200	8	fresh	41° 10' 54.82139" E	3° 7' 52.51242" N	420	The water quality of these borehole are fresh water and they serve the entire town. The town has water storage challenges.
	Lafey south	within the lafey town	200	14	fresh	41° 10' 10.54193" E	3° 8' 25.50001 " N	420	
	Lafey BH1	within the lafey town	165	12	fresh	41° 11' 2.67792" E	3° 9' 2.85005" N	420	
	Lafey BH2	within the lafey town	190	11	fresh	41° 11'5.5.4114" E	3° 9' 15.62364" N	420	
Towfiq	Rhamu 1	3	40	20	fresh	41° 12' 35.9172" E	3° 56' 15.0288" N	370.633 759	The boreholes are located close to the river and 6km away from Towfiq village.
	Rhamu 2	3	40	20	fresh	41° 12' 36.8532" E	3° 56' 15.3240" N	370.773 712	
Kobeturiti	Arges Awara*	40	160	10	fresh	39° 50' 48.6996" E	3° 32' 38.9904" N	899.534 668	*The borehole is newly drilled and test pumping and water quality test wasn't conducted.
	Buraqa dry borehole	27	NA	NA	NA	39° 48' 52.8084" E	3° 33' 39.1068" N	917.356 323	This borehole was recently drilled but it was dry. The reason why added this borehole is give general information of HG of that area.
* The water quality, borehole depth and yield information is as reported by county groundwater focal person									

3.1.2 **Proposed boreholes**

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
PRIORITY VILLAGES					
1	Andarak	40° 26' 45.3084" E	4° 08' 29.4936" N	1026.525391	The village is in a remote area. The main source of water is through water trucking. The village has two underground tank where they store water. The county government has recently carried out Hydrogeological survey to assess groundwater potential. The report was not yet submitted. Note: The village is close to Hardawa village. They are 6km apart and if there is a groundwater potential developing one water source can solve the water issue of both villages.
2	Birkaan	40° 06' 45.2088" E	3° 57' 24.1776" N	961.453186	The village has no permanent water source and they rely on water trucking. The nearest borehole is in Elmolay village which is approximately 13km away. The county government has recently carried out Hydrogeological Survey(HGS). The report was not yet submitted.
3	Qurdobow	40° 29' 28.9824" E	3° 20' 38.2992" N	709.169922	The village has no permanent water source. They have underground tank that they harvest with surface runoff and during the dry period they store the water that is trucked. The close borehole is
4	Burmayo	40° 16' 13.1124" E	2° 58' 48.2160" N	643.995056	The village has an old borehole that is no operational. The borehole has hard/saline water. However, the county government has recently drilled a new borehole at Garse village which is 2.5km from Burmayo. The borehole was not yet equipped but the water quality is fresh and fit for human consumption according to the county government. The yield of the borehole is 12m^3/h.

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
					Possible solution: Equipping the borehole and extending the water supply to the Burmayo village. The elevation difference between the two village is just 1m and the water can be gravitated using elevated steel tank or pumped to a storage tank at the village.
5	Midina	40° 01' 33.8340" E	"3° 37' 13.2240"" N	777.750488	The village is located 30km north of Takaba town along Takaba Gether road. The main source of water for this town is a small water pan (see the attached photo in Madina photo folder) in the north-east of the village. The village has high potential growth as it is strategically located along a main road that connect Kenya and Ethiopia. Drilling a borehole or construction of rainwater harvesting system is an ideal solution for this village.
6	Omar Jillow	41° 39' 45.4788" E	3° 45' 14.7636" N	414.273376	The village is located along Lafey Mandera road along Kenya – Somalia boarder. The village has a borehole that is mainly used by livestock. The borehole has hard water and people uses water that is trucked from Mandera. It seems the aquifer along that stretch up to Arabiya, the water quality is poor (very hard) and thorough HGS should be conducted to establish groundwater potential with good quality.
7	Komor Elle	41° 42' 41.9328" E	3° 48' 10.0584" N	412.397919	The main source of water for this village is water trucking from Mandera town and scoop hole in water ways. The village has several water storage tank.

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
STANDBY VILLAGES					
1	Libehia	41° 31' 39.1764" E	3° 50' 07.3356" N	451.428192	The village has a borehole. The water from the borehole is saline and the community depends on scoop hole and shallow wells for drinking water.
2	Lafey	41° 11' 1.98571" E	3° 8' 57.95185" N	420	The centre has 5 boreholes and all have fresh water. The boreholes can only meet 50% of ultimate design of the water supply system. The town is also facing water storage challenges.
3	Towfiq	41° 11' 46.3272" E	3° 53' 05.6832" N	445.95108	The village is located 4km from Rhamu town and 6km from Rhamu Boreholes (high yield boreholes adjacent to the river). The County government has recently drilled a borehole in the village but it was dry. *Possible solution* for this village is to connect the village to the Rhamu water supply if there is poor potential of groundwater after the HGS.
4	Hardawa	40° 23' 35.9412" E	4° 07' 01.1244" N	1031.573364	The village is close to Andarak village. They also survive with water trucking. However, the village has a small water pan and the community informed us that the pan can't retain water due high poor soil that high infiltration rate. The nearest borehole to this village is 11km in a village called Lulis which has a low yielding borehole.
5	Kobeturiti	39° 51' 04.0824" E	3° 48' 35.9568" N	947.111877	The village has no permanent water source and they rely on water trucking. The nearest borehole is in Argesa Awara village which was drilled a month ago but no yet equipped. However, there is a closer borehole that is under development at Gether village.
6	Kabo village	41.219948	3.271105	447	The village has one bore at the center town which is operational. The boreholes that were shared by Sub county water officer is as follows: yield 9.3 cubic metres and a depth of 200m. The borehole water is slightly hard

3.2 WAJIR COUNTY

3.2.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Borehole(s)***	***Distance from The Village(km)***	***Depth m***	***Yield m^3/h***	***Water * Quality (palatability)***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Guticha	Samatar Borehole	15	250	18				239.4	
Agtalahel	None								
Sita Wario	None								
Arba Kharansu	None								
Wargadud	None								
El Ben	None								
Liban center	None								
Tula tula	None								
Adadijole	Bute borehole	10							
Bute town	Bute borehole		200	7				6.77.1	Could be the same borehole described above
Fatuma Nur	None								
Adan Awale	None								
* The water quality, borehole depth and yield information is as reported by county groundwater focal person									

Name of borehole	Photo
Adadijole Borehole	
Arbakharansu Old dry Borehole	
Bute borehole	

Tulatula dry borehole		

3.2.2 **Proposed boreholes**

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
PRIORITY VILLAGES					
1	Guticha	E 39.755969	N 1.215886	239.4	The Location is in Wajir South Samatar BH is about 15km away with BH yield of 18m3/hr Depth is 250m Located about 1.12 km from the furthest end of the village.
2	Agtalahel juntion	E 40.654894	N 1.151806	156.7	The Location is in Wajir South No borehole nearby
3	Sita Wario	E 40.341269	N 1.728097	235	The location is Wajir East with no borehole nearby **Located within the village with the furthest end being about 1.22 km away.**
4	Arba Kharansu	E 40.295642	N 1.775653	240	The Location is in Wajir East and there is no borehole nearby Located within Arba Kharansu village
5	Wargadud	E 40.36075	N 2.3.9392	439	Located in Tarbaj and No boreholes nearby Located within Arba Kharansu village the furthest end being about 1.03 km away.
6	El Ben	E 40.185361	N 2.303161	471	Located in Tarbaj and No boreholes nearby Located within the village.
7	Liban center	E 39.762644	N 2.608369	468	Located in Eldas and No boreholes nearby Located within the centre
8	Tula tula	E 39.823128	N 1.893406	287	Located in Eldas and No boreholes nearby Located within the village
9	Adadijole	E 39.461178	N 3.337492	659	Located in Wajir North and No boreholes nearby The nearest borehole is 10km away (Bute borehole) with no further information Located within the village.
10	Bute town	E 39.419617	N 3.358936	677	Located in Wajir North.

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
					Bute BH with a depth 200m and Yeild=7m3/hr (could be the same borehole described in No.9 above) Located within Bute town with the furthest end being about 1.5 km away from the proposed site.
11	Fatuma Nur	E 39.549486	N 1.912525	306	Located in Wajir West with no borehole nearby Located at one end of the village with the other end being 0.61 km away
12	Adan Awale	E 39.285858	N 2.139858	338	Located in Wajir West with no borehole nearby Located within the village with the furthest end being 0.53km

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
STANDBY VILLAGES					
1	Una Salat	39.214774	1.805975	300	No remarks
2	Dadajabula	39.4	1.805975	284	No remarks
3	Omar Dagale	39.814774	1.905975	285	No remarks
4	Wajir Bor				No remarks
5	Qarsa				No remarks
6	Jijalow				No remarks
7	Baji				No remarks
8	Uthule				No remarks
9	Dambas				No remarks
10	Sarman				No remarks

3.3 GARISSA COUNTY

3.3.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Borehole(s)***	***Distance from The Village(km)***	***Depth m***	***Yield m^3/h***	***Water * Quality (palatability)***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Hara Pri School	Ishaqbini borehole		50	16		E401329	S15110	-	A new borehole at Hara Primary School complete with submersible pump, solar and piping.
Kotille	Ishaqbini borehole-Kotille		50	15	Fresh	E401050	S15826	-	A new borehole at the centre complete with submersible pump, solar and piping.
Abalatiro Pri Sch	Abalatiro Mosque				Saline	E40150	S15826	-	No remarks
Madhax Gesi	Dalsan				Saline	E400334	S11704	-	No remarks
Abaq-dheere	Abaqdera borehole			13	Fresh	E0395045	S04659	-	No remarks
Gababa pri sch	Gababa borehole				Saline	E40 30’ 4’’	S1 34’ 5’’	-	No remarks
Kulan	Kulan borehole 3		150	14	Fresh	E40° 38' 27"	N0° 13' 0.15"	108.8	No remarks
Goreale	None				Saline	E39° 43' 55.17"	N0° 2' 12.24	216.4	No remarks
Wayaana Jibril	None				Saline	E39.2075	N0.064444	176	A new borehole at the centre complete with submersible pump, solar and piping
Yusuf Haji Secondary	None					N1° 41' 48.88"	S40° 9' 24.02"	62.1	No remarks

3.3.2 **Proposed boreholes**

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
PRIORITY VILLAGES					
1	Yussuf Haji Secondary School	E 40.156672	N -1.696911	60.6	No remarks
2	Goreale	E 39 731972’	N 0.036733’	215.4	No remarks
3	Kulan	E 40.640833	N 0.216708	104.5	No remarks
4	Abalatiro Primary School	E 40.180556	N -1.973889	32	No remarks
5	Gababa Primary School	E 40.501111	N -1.580833	64.6	No remarks
6	Kotille	E 40 1050	S 1 5826	-	No remarks
7	Hara Primary School	E 40.224722	N -1.852778	56.9	No remarks
8	Madhax Gesi	E 40.059444	N -1.284444	88	No remarks
9	Abaq dheere	E 39.845833	N -0.783056	123.7	No remarks
10	Wayaana Jibril	E39.2075	0.064444	176	No remarks

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
STANDBY VILLAGES					
1	Jarirot - Garissa	39.712778	-0.561667	176.7	No remarks
2	Taqal	39.851667	-0.818333	141.7	No remarks
3	Shanta Abaq	39.731983	0.036667	216.1	No remarks
4	El dhere	38.861742	0.608131	370.9	No remarks
5	Grille Primary School	40.501111	-1.575278	60.9	No remarks
6.	Bodhai				No remarks
7.	Amuma				No remarks
8.	Jarirod Masalani				No remarks

3.4 MARSABIT COUNTY

3.4.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Borehole(s)***	***Distance from The Village(km)***	***Depth m***	***Yield m^3/h***	***Water * Quality (palatability)***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Buri Aramia	Burri Aramia	0.5				0218390	0332825	491.6	Low yield borehole
Urweno Kargi	None								No adjacent borehole
Songa	Kisoro	13.5				0236717	0395775		Small size draw pipes which according to the chairperson of borehole management committee has negatively impacted volume of supplied water. Borehole's pipeline connection has been damaged by elephants.
Dhemo	Dhemo borehole	0.2				0309274	0454640		Low yield borehole
Forole	Kumbi irresa buralle borehole	3.2				0411853	0382674		Water not piped to the village and has no storage tank.
Tullu Worabesa	Bubisa borehole	9.8			saline	0298997	0399501		Power shortfall/insufficient power; 6 more solar panels required to sufficiently power pumping system and frequent corrosion/damage to draw pipes due to high water salinity
Qoloba	Qoloba borehole	1.1			Saline	0363431	0509013		Low water yield/discharge, draw pipes damaged due to high water salinity and no pipeline connection to settlement/storage tank.

Name of borehole	Photo
Burri Aramia Borehole	
Kisoro borehole	
Dhemo borehole	

Kumbi Irresa borehole		
Bubisa borehole		
Qoloba borehole		

3.4.2 **Proposed boreholes**

S/No	*Name Village*	*Longitude*	*Latitude*	*Elevation(m)*	*Remarks*
PRIORITY VILLAGES					
1	Burri Aramia	36.46143	3.00484	491.64	This is in Laisamis Constituency. The adjacent borehole is Burri Aramia, 0.5km away with Longitude: 0218390 And Latitude: 0332825. The borehole has low yield
2	Urweno Kargi	37.0723	3.20771	390.7	This is in Laisamis Constituency. No adjacent borehole
3	Songa	36.72967	3.51202	607.1	Saku Constituency, Adjacent borehole is Kisoro which is 13.5km away with Longitude: 0236717 and Latitude: 0395775 The issues with the borehole are small size draw pipes which according to the chairperson of borehole management committee has negatively impacted volume of supplied water. Borehole's pipeline connection has been damaged by elephants
4	Dhemo	37.27968	4.10711	757.7	North Norr Constituency. There is another borehole on dhemo which is 200m away with Longitude 0309274 and Latitude 0454640. The borehole has low yield
5	Forole	38.19712	3.48272	733.9	North Horr Constituency. Kumbi Irresa Buralle borehole is 3.2 km away with Longitude: 0411853 and Latitude 0382674. The water is not piped to the village and has no storage tank either
6	Tullu Worabesa	37.12415	3.64952	558.3	North Horr Constituency. Bubisa borehole is 9.8km with Longitude: 0298997 and Latitude 0399501. The challenges are Power shortfall/insufficient power, 6 more solar panels required to sufficiently power pumping system and frequent corrosion/damage to draw pipes due to high water salinity
7	Qoloba	0364462	0508789		Moyale constituency. Adjacent Qoloba borehole is 1.1km awaya with Longitude: 0363431 and latitude: 0509013. Issues are Low water yield/discharge, draw pipes damaged due to high water salinity and No pipeline connection to settlement/storage tank

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
STANDBY VILLAGES					
1	Nturusi				No remarks

3.5 SAMBURU COUNTY

3.5.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Boreholes***	***Distance from The Village(km)***	***Depth m***	***Yield m^3/h***	***Water * Quality palatability***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Lorian	Lorian	0.2	missing	4	Good	N. 01 01.631’	E. 036 33.758’	1924	Not functional
Pura	Pura	0.4	68.6	3.6	Good	N: 01 07.932’	E: 036 32.111’	2123	No remarks
Loonkoliin	Lookkoliin	-	184	10	Good	N: 01.00907’	E: 036.61428’	1148.7	No remarks

3.5.2 Proposed boreholes

S/No	***Name Village***	***Longitude***	***Latitude***	***Elevation(m)***	***Remarks***
PRIORITY VILLAGES					
1	Keleswa	E. 036 59.473’	N. 01 54.665’	1296	No remarks
2	**Nool kera**	E: 036 32.75’	N. 01 00.351’	1888	No remarks
3	Pura	E.036º30.902'	N.0.1º06.283'	2123	No remarks

3.6 ISIOLO COUNTY

3.6.1 Existing boreholes

ADJACENT BOREHOLES IN THE PROPOSED VILLAGES									
Village Name	***Nearest Boreholes***	***Distance from The Village(km)***	***Depth m***	***Yield m^3/h***	***Water * Quality: palatability***	***GPS Location of Borehole***			
						Longitude	***Latitude***	***Altitude***	***Comments***
Kinna Moliti	Bibi Mabati borehole	5.1				0039771	0414835		Borehole has dilapidated 17km pipeline
Merti Town	Merti Quran Centre borehole	1		11		39.70308	15.98844		No pipeline connection to Merti Quran centre orphaned children centre, no storage tank and high cost of running borehole's generator power unit/system

Name of borehole	Photo
Bibi Mabati borehole	
Merti Quran centre	

3.6.2 **Proposed boreholes**

S/No	*Name Village*	*Longitude*	*Latitude*	*Elevation(m)*	*Remarks*
PRIORITY VILLAGES					
1	Kinna Moliti	0298996	0399503		Isiolo South Constituency. Bibi Mabati borehole is the adjacent borehole 5.1km away with Longitude :0039771 and Latitude 0414835, The borehole has dilapidated 17km pipeline
2	Merti Town Borehole	E 13.28016	N 19.629		Isiolo North Constituency. Merti Quran Centre borehole is the adjacent borehole 1km away with Longitude: 39.70308 and Latitude: 15.98844 with a yield of 11cm^3. The issues are No pipeline connection to Merti Quran centre orphaned children centre, No storage tank and high cost of running borehole's generator power unit/system

S/No	*Name Village*	*Longitude*	*Latitude*	*Elevation(m)*	*Remarks*
STANDBY VILLAGES					
1	Malka galla				No remarks
2	Ngalababieadaaba/ Athunyen				No remarks

CHAPTER IV: DESIGN CRITERIA & FINDINGS

4.1 BOREHOLES

4.1.1 Study Area

Groundwater exploration and development is targeted in six counties namely Marsabit, Samburu, Isiolo, Mandera, Wajir and Garissa. The pre-selected borehole site locations per county are as shown in Table 5.1

County	No. of boreholes
Marsabit	7
Samburu	3
Isiolo	2
Mandera	8
Wajir	12
Garissa	10

Table 5.1: Boreholes per County

The Location of the boreholes is provided in the **Google Map** with the following annotations:

- Green for priority boreholes,
- Yellow for standby boreholes and,
- Blue for existing boreholes.

Geologically, the areas targeted for borehole drilling are in crystalline (volcanic or metamorphic) and sedimentary rocks.

4.1.2 Successful boreholes

A successful well is the well:

- giving a sustainable yield of $\geq 3m^3/hr$,
- whose water is compliant to the health and quality standards in Kenya for Groundwater KS 05-459 (1996),

However only the yield criteria will be applied to pay for successful boreholes.

As per the expert opinion, the success rate of boreholes in the six counties is as follows:

County	Number	%
Wajir	12	95%
Garissa	10	80%
Mandera	8	95%
Marsabit	7	80%
Samburu	3	80%
Isiolo	2	60%

In order to increase the success rate of the productive boreholes, the Contractor will carry out borehole site investigations for both priority and standby selected sites. **Drilling will only be carried out for sites with high prospects. It is proposed that at least three measurements be carried out at each site.**

4.1.3 Borehole depths

The boreholes will be constructed at different depths depending on groundwater occurrence and distribution in each of the targeted areas. The borehole drill depths will be determined at the hydrogeological survey stage. The contractor is expected to hire services of a hydrogeological expert who is to carrying borehole site investigations at each of the pre-selected village and ascertain the exact location for borehole drilling as well as borehole depth.

For the purpose of the tendering process existing borehole data near a pre-selected site was evaluated from which the following tentative borehole depths have been adopted.

Table 4.2 : Borehole drill depths

Borehole depth	No. of boreholes
100	7
200	31
250	4

4.1.4 Borehole diameter, borehole casings and screens

All the 42 boreholes will be drilled at a diameter of 12”/304 mm to a depth of the six (6) metres. This section of the borehole will be installed with 12”/304 mm diameter surface casing, which will serve two purposes namely to protect the top of the borehole from erosion from returning drilling fluids or artesian flow or both and to provide the sanitary seal casing in the borehole headworks. Casing used as surface casing shall be mild steel of a specification suited to water well applications.

As from a depth of the 6 metres, all the boreholes will be drilled at a diameter of 10” (254 mm) to completion depth as will be determined during the hydrogeological survey. The borehole will be installed with 8” 203 mm plain casings and screens. The annular space between the borehole and casing/screens will be filled with gravel pack only for sections that are aquiferous. Above the upper most of gravel pack the borehole will be filled with inert backfill. In order to avert any surface pollution, a grout seal will be installed up to the top of the highest level of inert material to surface + 0.4m.

4.1.5 Borehole development and test pumping

After completion of drilling and placement of casing and screens, gravel and backfill etc the borehole shall be developed in accordance with modern borehole construction

practices, including airlift surging and possibly chemical development using a polyphosphate. It is expected that a total of 12 hours will be required. Subsequently, test pumping comprised of calibration test, 4-hour step-drawdown test followed by a constant discharge test for a period of 24 hours.

4.1.6 Water sampling and analysis

Full water chemistry analyses will be conducted on water removed from the borehole. Samples shall be collected immediately development is adjudged complete. In addition, water samples for bacteriological analysis will be collected from borehole at the end of development; these will be collected and immediately shipped to an approved laboratory to comply with KS 05-459 (1996).

4.1.7 Submersible Solar Pumps

The Contractor will select the pump based on the test pumping results (Static level and dynamic level of the water in the borehole, the flow of the borehole) as well as the height of the water tank. Based on the expert judgement, three depths (100 m, 150 m, 200m) and a flow of 15 m3/h have been selected to size the pumps to be used in this tender. Grundfos pumps or equivalent are suggested for this project. The simulations resulted in the following pumps' choice:

Type of Pump Grundfos or equivalent	Number of pumps	Maximum Yield (m)	Qmin (m3/hour)	Power of the Pump (Kw)
SP 17-12	7	100	15,93	7,5
SP 17-18	31	150	16,14	11
SP 17-23	4	200	15,14	13

The other installations done together with the submersible include include a 2" (50 mm) galvanized steel rising main, submersible cable, electrode pencils, electrode cable, a non-return valve just above the pump, a 25-32 mm dipper line, and all other items necessary for proper functioning of the pump. As an alternative to the control panel and coupled start/stop electrodes, a CU3 control unit or similar may be installed. All the Items to be installed shall be subject to confirmation and approval by the Supervising Engineer.

All items will be of high quality, and suitable to function properly in tropical conditions. Spare parts of the equipment to be supplied and installed shall as much as possible be available in Kenya.

4.2 SOLAR PANELS

The pump will only work during on PV energy and no battery storing is suggested. The minimum annual number of hours of sunshine is **1469**. The photovoltaic panels will be installed at a height of 1.60m from the ground. To acquire the best radiation intensity half of the panels will be tilted **8° to the north** while the other half, **tilted 8° to the south**. 0 on the panels shall be avoided at all the time. While designing the PV

installation and overpower is to be foreseen for the well-functioning of the pumps and to feeding the accessories as well as the inverter which will convert the current to AC:

Type of Pump Grundfos or equivalent	Power of the Pump (Kw)	Sunshine hours per year	Tilt angle / horizontal	Orientation	Peak power of the field (kWp)	Total Power (KW)	Over-power%
SP 17-12	7,5	1469	8°	0° / Nord	**6,2**	**9,1**	**22**
SP 17-18	11	1469	8°	0° / Nord	**10,2**	**15,0**	**37**
SP 17-23	13	1469	8°	0° / Nord	**12,4**	**18,2**	**40**

The Inverter shall be an advanced Solar inverter designed for use with large AC submersible pumps systems. It should be installed in an enclosure for water and heat protection. The specific features of the inverter include:

- Patented MPPT (Maximum Power Point Tracking) capability providing fast response, good stability and up to 99% efficiency.
- Supports motor soft start and gives full motor protection,
- IP65 protection guards suitable for harsh outdoor environments.

The Inverter shall offer the following control functions:

- Settable minimum and maximum frequency and open circuit voltage.
- Display of operating parameters including frequency, voltage, amperage, input power and pump speed.
- Protection against over and under voltage, over current, system overload and module over temperature.
- Fault detection with error code display.

The solar panels shall be connected among themselves as all cables of the array are connected to a junction or combiner box. The solar panels shall be:

- High module conversion efficiency superior to **19 %** by using Passivated Emmiter Rear Contact (PERC) technology,
- The modules should be **monocrystalline**,
- Low degradation and excellent performance under high temperature and low light conditions,
    - Robust aluminium frame ensures the modules to withstand wind loads up to 2400Pa and snow loads up to 5400Pa. the frame will supported by a reinforced concrete ground beam. A particular attention will be provided to the alignment of the support (horizontality) and to the tilt of the panel.
    - High reliability against extreme environmental conditions (passing salt mist, ammonia and hail tests).
    - Potential induced degradation (PID) resistance.
    - Positive power tolerance of 0 ~ +3 %.

All drawings and calculations and computer input and output shall be presented to the Consultant Engineer for approval. A set of spare parts including the followings shall be provided at each site:

a) DC Breakers
b) AC Breakers
c) Fuses

4.3 WATER TANK

It is designed that water from each borehole will pumped into an elevated rectangular steel tank. Therefore, the project has designed for 42 elevated steel tanks. The reservoir will be constructed with steel profiles. Additionally, the tank will have a liner, roof and distribution tap stands. The tank capacity will be 100m3. As stipulated, the height of the tanks is 12 m from ground level to the bottom of the tanks.

At very site a geotechnical investigation shall be carried to estimate the bearing capacity of the soil and allowable settlement and the chemical properties of the soil (sulphate & chloride contents) from this investigation the depth & type of footing of the water tank shall be decided.

4.4 WATER DISTRIBUTION SYSTEM

The water from the water tanks shall be transferred by gravity to the water taps post near to the beneficiaries. High density polyethylene pipes (HDPE) are suggested. It is designed that for each village water supply system will comprise of a main water primary truck extending over a distance of 500 metres. The secondary system will comprise of supply to the school within a distance of 250 metres as well as Kiosk for public water supply. At the end of the primary truck a cattle trough will be installed 400 metres away. Upon the instruction of the Consultant, the distribution network might be extended to the mosque and to the dispensary.

The construction of a complete Kiosk with lockable door and window will include two taps and water meter; soak pit, drainage pipe and all necessary works, furnishing of all necessary parts, masonry walls, and corrugated sheet as a roof.