



WATER RESOURCE ASSESSMENT REPORT

**FOR 271.6KM, 400KV EXTRA HIGH VOLTAGE WAJAALE-HARGEISA-BERBERA
TRANSMISSION LINE**

NOVEMBER 2024

Prepared By:



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EXECUTIVE SUMMARY

The 271.6KM, 400KV Extra High Voltage Wajaale-Hargeisa-Berbera Transmission Line project is financed by the World Bank under the Horn of Africa Regional Integration for Sustainable Energy Supply (P174175). The 271.6km Wajaale-Hargeisa-Berbera 400kV double circuit transmission line is part of the 550 km transmission line starting from Debre-Zeit to Hurso and then from Jigjiga-Tog Wajaale on the Ethiopian side into Somaliland from Tog-Wajaale to Hargeisa and terminating in Berbera.

This report presents an assessment of the existing and potential water resources that can be exploited for use for the construction the proposed High Voltage (HV) Wajaale-Hargeisa-Berbera 400kV double circuit transmission line and related facilities ('the Project') and the communities along the proposed power transmission line. The project is a 271.6 km line, starting from Wajaale (312271.34 m E 1067373.63 m N) and terminating at (510257.67 m E 1143971.30 m N) a proposed substation in Berbera.

This water resources report has been prepared by EMC Consultants Limited for Ministry of Energy and Minerals (MoEM), Somaliland (the "Proponent") as an annex to the ESIA report. EMC Consultants was appointed by Eastern Africa Power Pool (EAPP) to undertake the ESIA as an independent environmental consultancy.

Project Proponents

a) Eastern Africa Power Pool

The Eastern Africa Power Pool (EAPP) is a regional institution established in 2005 to coordinate cross-border power trade and grid interconnection among nations of the Eastern Africa region. The EAPP has thirteen (13) member states that signed the Inter-Governmental Memorandum of Understanding (IGMOU) and fourteen utilities that signed the Inter Utility Memorandum of Understanding (IUMOU). The pool countries comprise: Burundi, Djibouti, Democratic Republic of Congo (DRC), Rwanda, Egypt, Ethiopia, Kenya, Sudan, Tanzania, Uganda, Libya, South Sudan and Somalia; with indications that Eritrea may join soon. The General Secretariat of the EAPP is based in Addis Ababa, Ethiopia with a mandate to coordinate the development and functioning of the power pool. The Strategic objectives of the EAPP include:

- Securing power supply for the countries in the region.
- Optimizing energy resources in the region through regional investment schemes in power generation, transmission and distribution
- Increasing power supply and access in the region
- Reducing electricity production cost in the region by using power system interconnection and increase power exchange between countries
- Providing efficient coordination between various initiatives taken in the field of power production, transmission as well as exchange in the region
- Creating, in the framework of New Economic Partnership for African Development (NEPAD) a conducive environment for investment to facilitate integration projects financing in the fields of power generation and transmission in the region.
- Facilitating, in the long term, development of electricity market in the region.

b) Ministry of Energy and Mineral Resources, Somaliland

The vision of the Ministry of Energy and Minerals (MoEM) is to contribute to Somaliland's social and economic development through the sustainable utilisation of the country's energy, minerals, and petroleum resources for the benefit of Somaliland people by 2030. The mission of the Ministry is to establish, direct and promote the sustainable utilisation of Somaliland's energy, minerals, and petroleum resources to support the country's social and economic development through the development and implementation of policies, strategies and programs that guide, facilitate and coordinate the work of government and all other stakeholders in the energy, minerals and petroleum sectors. The mandate of the Ministry as follows:

- Exploitation of the hydroelectric and other power sources of renewable energy
- Development and implementation of the policies and strategies to develop energy power generation.
- Designing and executing regulatory standards for electricity power generation needed in urban and rural areas.
- Development, facilitation, and promotion of renewable energy and other natural resources for the use by the people of Somaliland
- Designing and execution of regulatory standards for electricity power generation needed in urban and rural areas.
- Issuing of licenses to Electricity Service Providers (ESPs) (adjusted by Presidential Decree).

c) Water Resources Assessment

Somaliland is classified as a water scarce country. In the view of this, it was necessary to carry out a water resource assessment to identify the potential water sources for the project and the compare it against the computed water demand which will inform on the viability of the project and reduce potential conflict with the local community during the project implementation phase. During the construction stage, construction teams will require water for use during construction works (concrete mixing, slab, washing vehicles) as well as for drinking by the construction workers. Although the number of construction workers are expected to vary throughout the project period, two scenarios were considered; the first scenario considered 100 workers being the peak number estimated from the ESIA report while the second scenario considered 552 people based on the correlation from a similar project that was undertaken in Djibouti. In the two scenarios, it was determined that the water demand for scenario one was 15 m³/day while the water demand for scenario 2 was 82.8 m³/day.

The ESIA report estimated that the average span between two pylons is about 400m, consequently about 680 number of pylons will be needed, each pylon will require 4 No. foot blocks resulting to a total of 2716 block for the entire project. The water demand for the construction works was estimated as 19.8 m³/day.

The ESIA report noted that the proposed project traverses 10 villages with an estimated number of 9,150 households and an average household size being estimated at about 6.2 resulting to a total population of about 56,730 people within these villages. Based on this, two scenarios were developed to determine the host population living within the project corridor. The first scenario considered a 12 km corridor, 6km from the powerline centerline in both ways this was assumed to be the furthest distance a person walking on foot can take to a water source, under this scenario it was assumed that 80% of the villages' population will be served which results to about 45,384

People. The second scenario considered a corridor of 2km wide, 1km from the power route centerline in both ways, this is the 30-minute walk distance adopted by WHO 2011 for individuals to access water points, under this scenario it was assumed that 50% of the hosts population will be within the corridor which resulted to an estimate of 28,365 People. The water demand for the local population was computed on the World Health Organization (WHO 2011) recommendation of a minimum of 50 l/c/d for basic needs. The local community aggregated water demand for the population estimate of 45,384 persons for the 12km corridor is 2,269.2m³/day, while for the total population of 28,365 persons for the 2Km corridor is 1,418.25m³/day.

The water resources in the project area included hydraulic structures such as wells, underground tanks, hillside lakes/dams and boreholes. Water resources are highly dependent on the variability of precipitation which is highly erratic within this region thus they are not permanent throughout the year. However, boreholes offer a fairly sustainable water supply sources and have been selected in the computation of the water balance analysis. The water balance was carried out by comparing the borehole water sources versus the water demand. 12 No. boreholes were mapped within the corridor that could be exploited which have a cumulative sustainable yield of at 621.6m³/day with an average yield of 51.8m³/day per borehole. It is also important to note that most of the boreholes were concentrated on the last half of the powerline transmission route.

The aggregated water demand presented four scenarios and compared against the available resources as shown in table 0-1 below

Figure 0-1: Water Balance Scenarios

	Description	Scenario 1 (m ³ /day)	Scenario 2 (m ³ /day)	Scenario 3 (m ³ /day)	Scenario 4 (m ³ /day)
A	Construction workers water demand	15	15	82.8	82.8
B	Concrete works water demand	19.8	19.8	19.8	19.8
C	Local Community Water demand	2269.2	1418.25	2269.2	1418.25
D	Total water demand	2304	1453.05	2371.8	1520.85
E	Available borehole water	621.6	621.6	621.6	621.6
F	Deficit in m³/day (E-D)	1682.4	831.45	1750.2	899.25

The following variables were used for calculating the water demand for each of the four scenarios:

- In all the scenarios water demand for concrete works is 19.8 m³/day and local community water consumption of 50l/c/d was adopted to calculate the total local community consumption.
- Scenario 1: Number of workers 100 consuming 15m³ per day, and using population estimate of 45,384 with a local community consumption of 2,269.2 m³/day and total estimated water demand of 2,304 m³/day. The water deficit under this was computed to 1682.4 m³/day.
- Scenario 2: Number of workers 100 consuming 15m³ per day, and using population estimate of 28,365 with local community consumption of 1,418.25 m³/day and total estimated water demand of 1,453.05 m³/day. The water deficit under this was computed to 831.45 m³/day.

- Scenario 3: Number of workers 552 consuming 82.8m³ per day, and using population estimate of 45,384 with a total local community consumption of 2,269.2 m³/day and total estimated water demand of 2,371.8 m³/day. The water deficit under this was computed to 1,750.2 m³/day.
- Scenario 4: Number of workers 552 consuming 82.8m³ per day, and using population estimate of 28,365 with a total local community consumption of 1,418.25 m³/day and total estimated water demand of 1,520.85 m³/day. The water deficit under this was computed to 899.25 m³/day.

It was demonstrated that the available water resources cannot meet the demand for all the scenarios considered and therefore the project will exacerbate existing water deficit if it uses the community water sources.

Considering that the project area is arid region, with scarce water resources that is greatly influenced by climate, and the water balance analysis findings it is recommended that the project invests in its own water sources, boreholes would be most suitable. The project should undertake hydrogeological studies and sites with highest potential to be given priority when establishing campsites as the highest water demand for the project is for use by the workers. Nevertheless, other interventions available that can be considered include: increasing the storage capacity of the tanks at the water points such as dams and dug wells that have been mapped along the powerline route. Additionally, this report has mapped Nine dams (potential water sources) along the corridor that can be explored for use, these will require rehabilitation measures such as installation of water intake pumps etc. or as may deem necessary which will be handed over to the host community after project.

The study of the distribution and water needs of local populations along the route made it possible to assess overall that the project will not generate any deterioration of water resources or desertification processes. However, it was recommended that particular attention to the proper management of wastewater will be required by construction of installation of septic/bioidigesters at the campsites and avoiding any environmental impact through the storage of wastewater, the storage of oils and hydrocarbons.

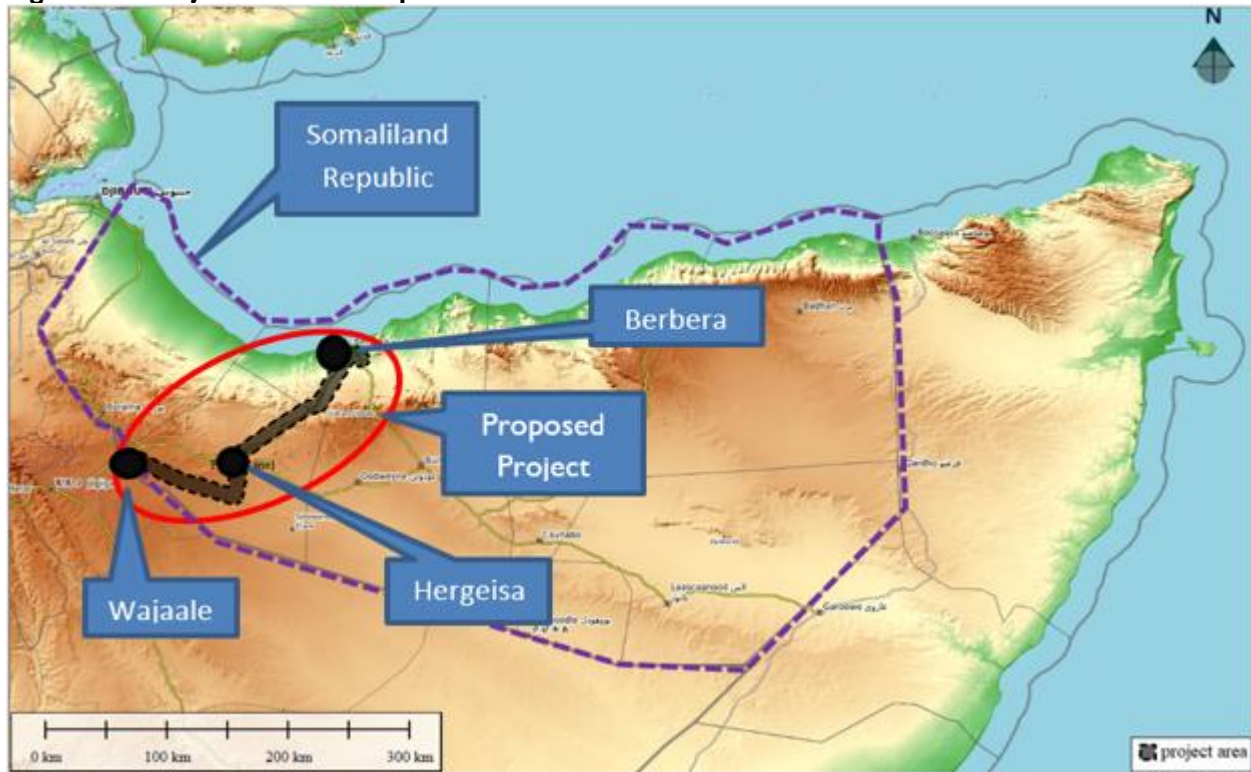
The investment in new water sources by the project will have a net benefit effect on availability of water supply. Therefore, it is recommended that the new water sources be handed over to the community after project completion.

I INTRODUCTION

I.1 Project Location

The proposed high voltage transmission line enters Somaliland at the border town of Wajaale in the South-East directions runs for 271.6km in the North-west direction passing near Hargeisa city before terminating on the outskirts of the port town of Berbera. Togo-Wajaale town is on the (312271.34m E, 1067373.63 m N) and Berbera town at (510257.67 m E, 1143971.30 m N) UTM coordinates. The demarcated project area will consist of a 12km wide corridor along the proposed transmission powerlines. This will consist of a 6km on either side of the powerline centerline. The rationale for adopting a 6km wide corridor is based on a distance covered by a person walking of foot for 30mins searching for water. Figure 1-1 refers.

Figure I-1: Project Location Map



Source: EMC Consultants

I.2 Project Objective

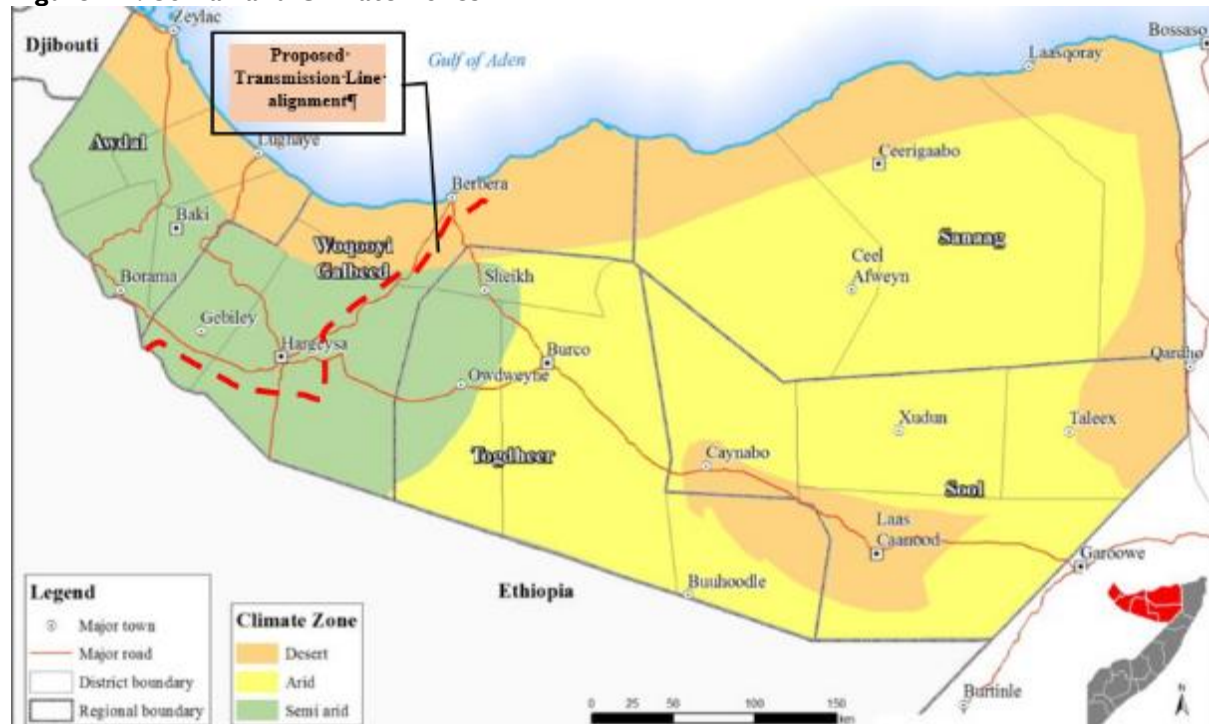
The main objective of this report is to assess the availability of the water resources within the transmission power line corridor and its adequacy to serve the needs of the workers, construction needs and the local community.

2 BIOPHYSICAL ENVIRONMENT

2.1 Climate

The Somaliland climate is classified as semi-arid to arid. The country is basically divided into three distinct climatic zones: Semi-Arid; primarily covers the western part of the country, Arid areas majorly include the eastern regions and the desert climate that covers the coastal areas, and some parts of the eastern region as illustrated in Figure 2-1.

Figure 2-1: Somaliland Climate Zones



Source: (Ullah, 2016)

2.1.1 Berbera Weather Station

Berbera features a hot arid climate (Köppen BWh). According to the weather station data, the average temperatures range between 25.2⁰C-34.4⁰C, and maximum temperatures can reach up to 41.7⁰C in the months of June-August. The climatic data for the weather station is presented in Figure 2-2.

Figure 2-2: Berbera Weather Station Climatic Data

Country	Location 26		Station	BERBERA			
Altitude	89	m.	Latitude	10.43	°N	Longitude	45.03 °E
Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m ² /day	mm/day
January	20.0	28.9	66	441	8.2	19.3	5.39
February	21.7	28.9	70	406	8.4	20.9	5.30
March	22.8	30.0	72	449	8.6	22.5	5.69
April	25.0	31.7	73	423	9.2	23.7	6.00
May	26.7	35.5	62	441	9.3	23.5	7.56
June	30.0	41.7	37	752	9.9	23.8	14.30
July	31.1	41.7	32	665	9.0	22.7	14.24
August	30.5	41.1	33	760	9.7	24.1	14.88
September	28.9	39.4	39	449	9.5	23.8	10.77
October	24.4	33.3	60	363	9.3	22.4	6.89
November	21.7	31.1	61	328	9.1	20.7	5.87
December	20.0	29.4	63	320	8.2	18.8	5.15
Average	25.2	34.4	56	483	9.0	22.2	8.50

Source: FAO

2.1.2 Hargeisa Weather Station

According to the weather station data, the average temperatures range between 15.2⁰ C – 28.1⁰C. The average humidity varies between 39-60% with average sunshine of 7.9 hours. The climatic data for the weather station is presented in Figure 2-3 below.

Figure 2-3: Hargeisa Weather Station Climatic Data

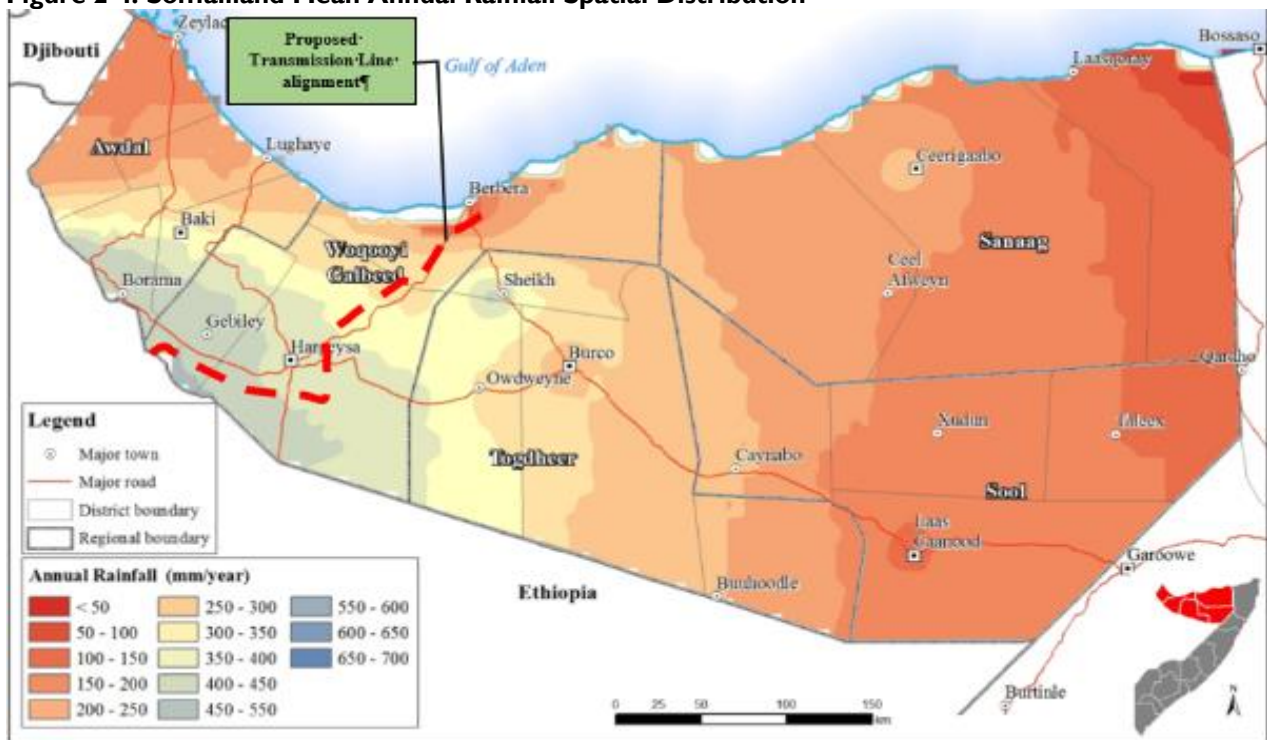
Country	Location 43		Station	HARGEISA			
Altitude	1326	m.	Latitude	9.50	°N	Longitude	44.08 °E
Month	Min Temp	Max Temp	Humidity	Wind	Sun	Rad	ETo
	°C	°C	%	km/day	hours	MJ/m ² /day	mm/day
January	11.6	24.3	54	631	8.2	19.5	5.87
February	12.7	26.6	52	596	7.7	20.0	6.52
March	15.0	28.8	48	588	8.6	22.6	7.58
April	16.6	29.3	50	596	8.0	21.9	7.60
May	17.7	30.5	47	596	7.2	20.1	7.97
June	17.7	31.0	48	873	8.2	21.3	9.25
July	17.1	29.3	52	985	7.2	19.9	8.46
August	17.1	29.3	52	968	7.1	20.1	8.43
September	17.1	30.5	51	691	8.0	21.5	8.09
October	15.0	28.2	39	562	8.5	21.5	7.99
November	13.2	26.0	56	631	8.3	19.9	6.18
December	12.1	23.8	60	657	8.2	19.1	5.36
Average	15.2	28.1	51	698	7.9	20.6	7.44

Source: FAO

2.1.3 Rainfall

Somaliland has a bimodal rainfall distribution (Gu and Deyr). The first main rainy season (Gu) occurs between April and June, when around 60 percent of rain falls, and the second rainy season (Deyr) from August to November. The months of highest rainfall within these seasons are generally from April–June and October–November. The two dry seasons in the country are Jilaal and Hagga, which occur between December - March and July–August, respectively. Rainfall is low and erratic. The amount of rainfall received annually reduces further to the north except for areas around Sheikh, Hargeisa and Borama that receive between 500 mm and 600 mm per year. The area around Ceeregaabo receives up to 400 mm annually. The northern coastline is characterized by low rains of less than 100 mm per year. The rest of Somaliland receives an annual rainfall of 200 to 300mm.

Figure 2-4: Somaliland Mean Annual Rainfall Spatial Distribution



Source: (SWALIM 2016)

	Rain	Eff rain		Rain	Eff rain
	mm	mm		mm	mm
January	2.0	2.0	January	6.0	5.9
February	11.0	10.8	February	0.0	0.0
March	25.0	24.0	March	0.0	0.0
April	85.0	73.4	April	0.0	0.0
May	65.0	58.2	May	0.0	0.0
June	33.0	31.3	June	0.0	0.0
July	39.0	36.6	July	1.0	1.0
August	55.0	50.2	August	3.0	3.0
September	65.0	58.2	September	3.0	3.0
October	29.0	27.7	October	0.0	0.0
November	8.0	7.9	November	1.0	1.0
December	1.0	1.0	December	6.0	5.9
Total	418.0	381.3	Total	20.0	19.9

Hergeisa Met. Station Rainfall Data

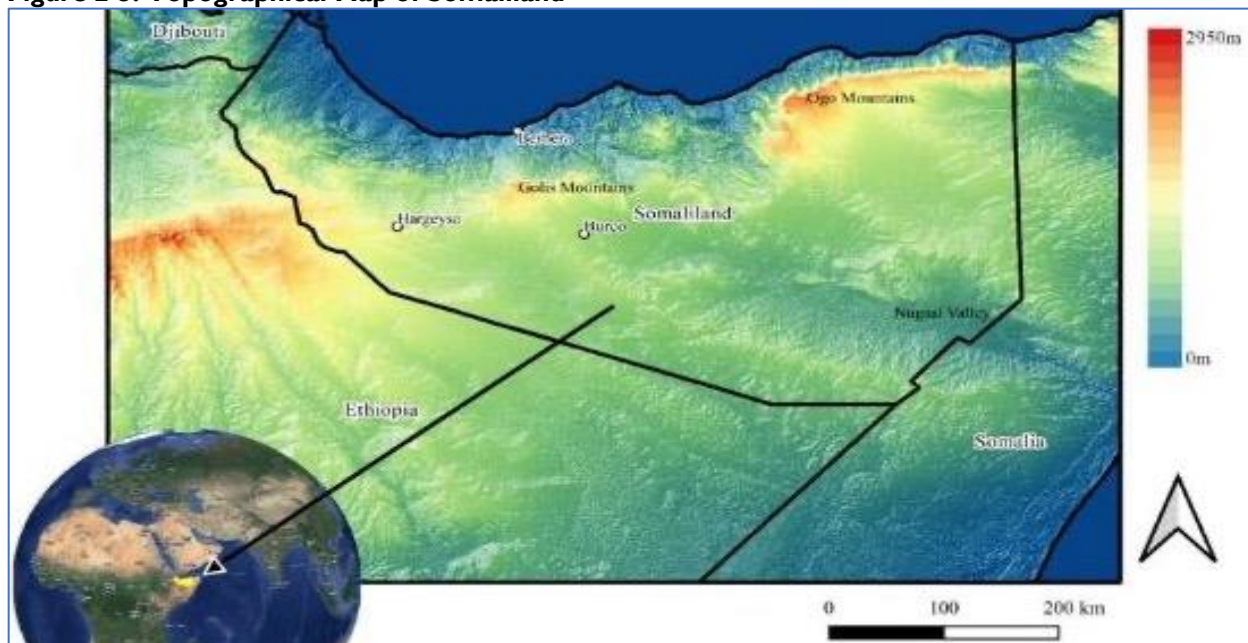
Berbera Met. Station Rainfall Data

2.1.4 Topography

Somaliland topography consists of three main landforms:

- Piedmonts and the coastal plain (Guban) southward from the Red Sea with elevations ranging from seas level to 600m.
- Hills and dissected mountains (Ogo) of rugged topography rising to more than 1,500m.
- The plateau (Haud) with large areas of gently undulating plains.

Figure 2-5: Topographical Map of Somaliland



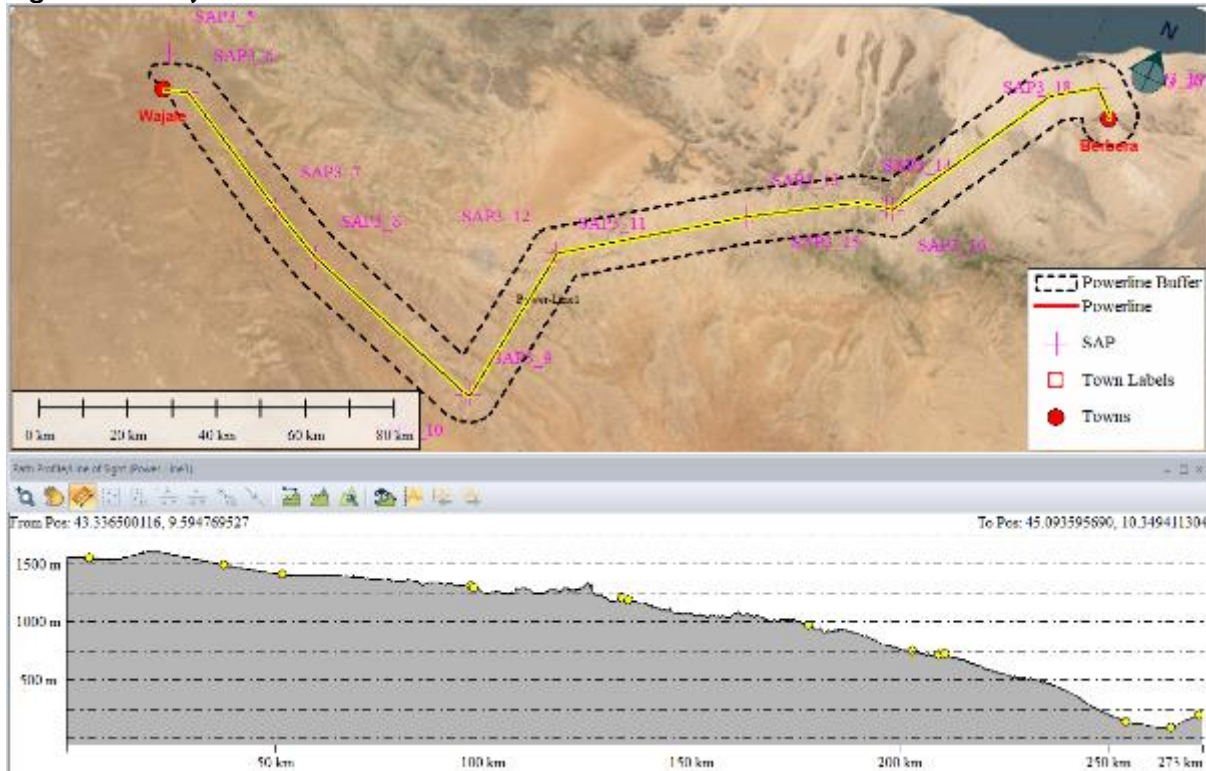
Source; Research Gate

2.1.5 Elevation Profile

The elevation profile of the transmission line from Wajaale to Berbera is generally sloping downwards starting from an altitude of about 1742m asl at Wajaale to 212m asl at Berbera. The

slope from Wajaale to Hargeisa. From SAP 3-2 to SAP3-3 the line rise up slope of 0.6% to an altitude of about 1766m asl at SAP3-3 which is the highest point the line passes through. From SAP 3-3 the line transects through a consistently downward sloping terrain until SAP3-15 at about 728 m asl then rises slightly to 721 m asl at SAP3-16. From SAP3-16 the line continues to transect a down sloping terrain until it gets to SAP3-18 which is the lowest altitude the line transects at an altitude of about 107m asl in Berbera area. From this point the line goes upslope of about 1.6% through SAP3-19 then terminate at SAP3-20 which is at about 212 m asl. Figure 2-6 overleaf refers.

Figure 2-6: Project Elevation Profile



Source: EMC Consultants

2.1.6 Drainage Networks

The surface waters of Somaliland belong to three major river basins:

- Gulf of Aden basin
- Dharoor basin
- Nugaal basin

The surface drainage closely follows the general geomorphology. Much of the area drains in a southeasterly direction towards the Indian Ocean; the extreme north discharges its runoff into the Gulf of Aden. The drainage network, which is influenced by local topography, rainfall, and geology, is dense to very dense in the northern mountains. It is very thin or virtually non-existent in large parts of the central basin. Runoff in Somaliland basins generally takes place in seasonal streams (toggas) and in addition to infiltration, it replenishes stream bed and flood plain aquifers. Runoff only occurs after heavy rainfalls in the form of spate flows, which may last from a few hours to a several days. In sandy fans and in valley bottoms in the gently rolling topography large

quantities of water are infiltrated into the aquifers. Evaporation and overland flows are also high in these plains.

There is only one perennial river along the transmission line route (Togga Baba). The smaller rivers and drainages have surface water only after periods of heavy rainfall. There are, however, many small streams called toggas (wadis) originating from the plateaus and mountains in the north that have perennial flows in some stretches and at other stretches have a complex surface-water groundwater interaction (sub-surface flow) where there is groundwater recharge. After intense rainfall, most of these small streams can carry high floods and debris. Even some river training and control structures can be destroyed as happened, for instance, on several occasions in Togga Hargeysa.

The surface runoff lasts from a few hours to a few days. The subsurface flow of toggas is often tapped by many shallow wells, being an important source of water for people and livestock in the region. Dams, ponds and dug outs (Wars) are commonly used in the valleys along the transmission line by local communities to collect storm water from small catchments. The Wars are unlined with surface areas of hundreds to thousands of m² and a depth of 2 to 3m. Berkads are major water storage infrastructure in Marodi-Jeh and Sahil regions. They vary in their capacity but are normally less than 300m³.

The main problems with berkads are related to sanitary and hygienic conditions. Along the project transmission route, the rivers crossed by the project include 1 main river Togga Baba and 5 small rivers namely Togga Maroodijeex, Togga Kodayare, Togga Dacarbudhug Caloola, Togga, Xyod-Balae Abdaal and Togga Cabaadweyne. Some angle points cross the toggas and the design is aimed at ensuring that the towers are not located at the riverbeds and instead will be re-routed. Figure 2-7 to Figure 2-9 refers.

Figure 2-7: Togga Baba River and Togga Maroodijeex



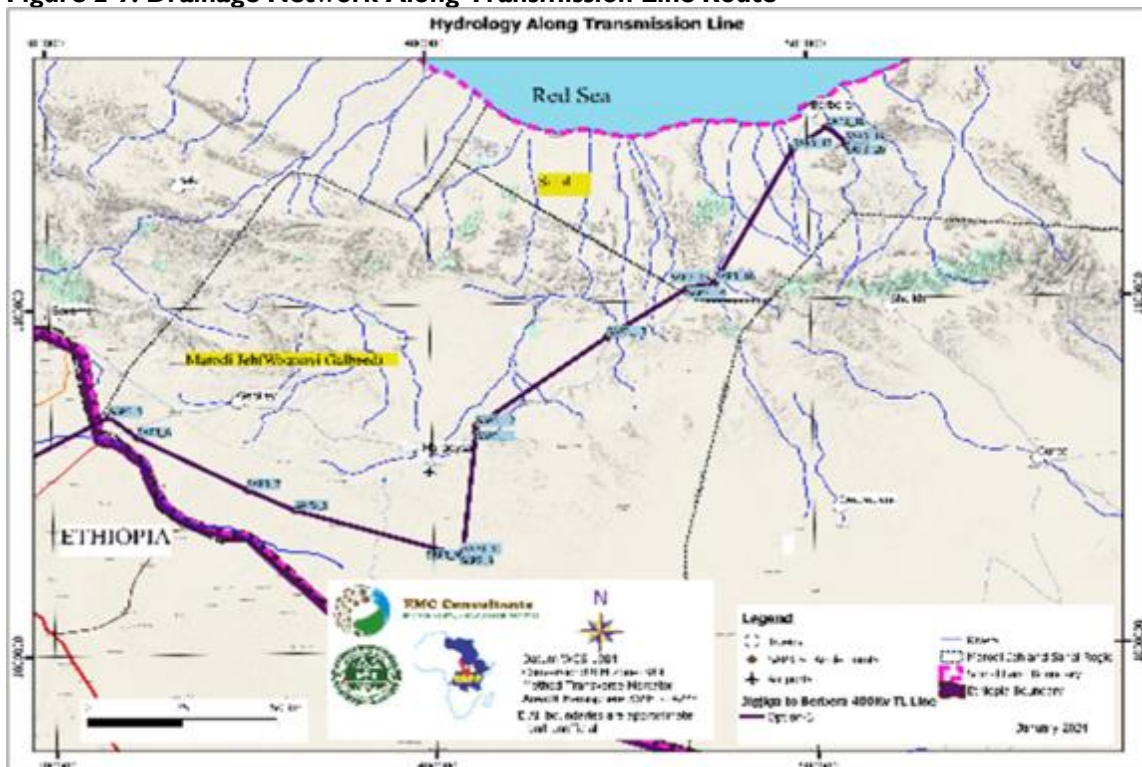
Source: EMC Consultants 2024.

Figure 2-8: Berkad in Lafta Farawayne Village and Seasonal Dry River in Lafa-ruug Village



Source: EMC Consultants 2024.

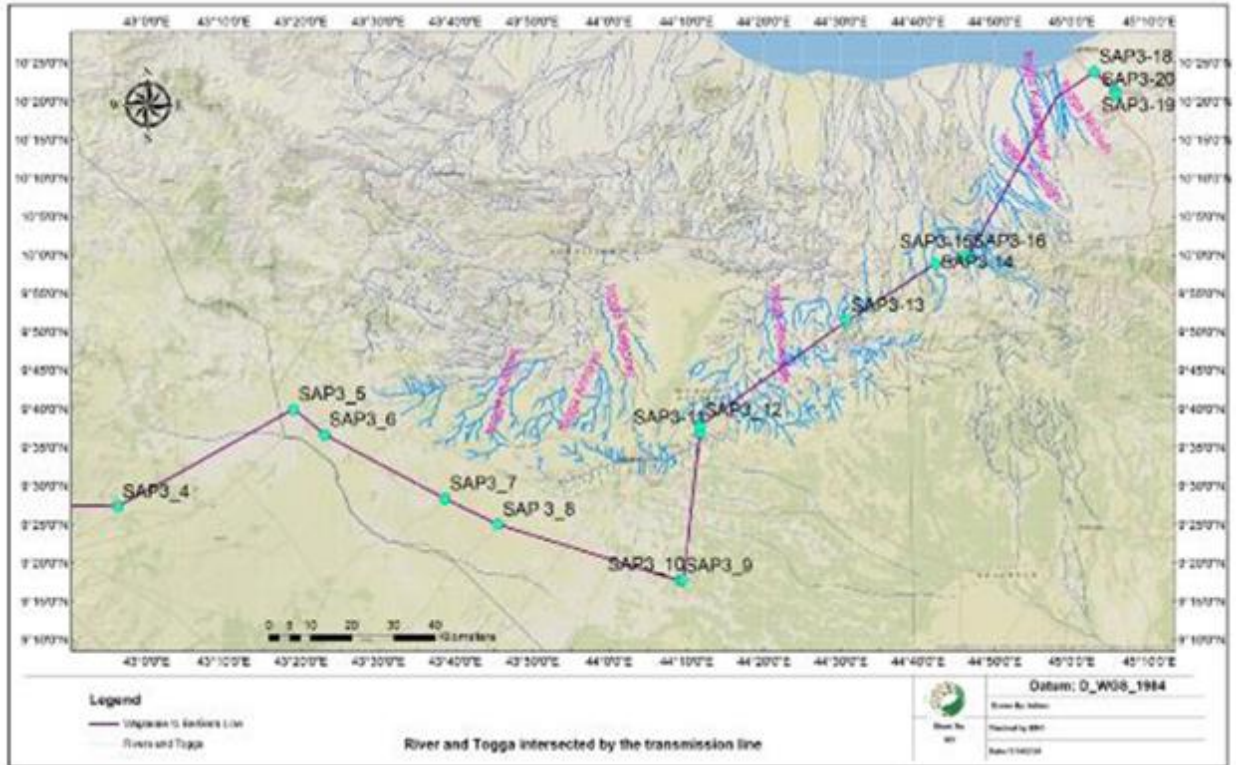
Figure 2-9: Drainage Network Along Transmission Line Route



Source: EMC Consultants 2024.

2.1.7 Flood Risk

The leg between Wajaale and Hargeisa is well drained with little risk of flooding. The leg between Hargeisa and Berbera has higher risk of flooding that should be taken into consideration during the construction period. Figure 2-10 refers



Source: EMC Consultants 2024.

3 BIOLOGICAL ENVIRONMENT

3.1 Flora

The route of the transmission line passes through three main ecological zones. According to the vegetation map of Somaliland, the most cited reference is Hemming's (1966) ecological classification. Following are the three vegetation zones and a description of the dominant species that are found in each zone:

- **Vachellia etbaica open woodland.** *V. etbaica* is found mainly on the southern fringes of the Golis range. It is a strip that widens out in the west as one approaches the Ethio-Somaliland Border and beyond. *V. etbaica* is also found on the north-facing slope of the main escarpment at somewhat lower altitudes.
- **The Golis Mountain:** The Golis Mountain range is an extension of the Ethiopian highlands that run parallel (east-west) with the Gulf of Aden. The central Golis Range, particularly the section between Hargeisa and Berbera is the lowest part in terms of elevation. For example, elevation of Dhubato Pass, just to the south of Dacar-budhuq is only 1200 metres above sea level (masl). Other important species in the area include *Balanites glabra*, *Vachellia tortilis* and *Delonix elata*.
- **Sub-Coastal and Coastal zones:** The vegetation of the coastal plain can be categorised into two main classes. Adjacent to the coast, there is a littoral zone where halophytic flora is common on vegetated beach dunes. Moving further inland, this quickly transits to an extensive vegetation type dominated by scattered, dwarf, and woody plants. This characterises across most of the sandy coastal plain as far south as Xabaalo-Tumaalo village, the nearest village to Berbera (circa 30 km south of Berbera). Dominant species in this vegetation type include *Vachellia edgeworthii* and stunted *Vachellia tortilis*. Some of the other most conspicuous species include *Balanites rotundifolia* var. *Orbicularis*, and the well-branched evergreen 'tooth-brush tree' (*Salvadora persica*). The vegetation found most commonly along seasonal water courses includes *Zizyphus hamur*, *Tamarix aphylla* and *Leptadenia pyrotechnica*. One species of vegetation in the project area and within a radius of 1-50km was evaluated as Critically Endangered (CR) and Endangered species as (EN).

3.2 Fauna

The abundance and distribution of mammals in Somaliland, particularly the larger individuals, has been heavily impacted by hunting, beginning from the colonial days. In more recent decades, insecurity, disease, droughts, and the proliferation of guns have presented an on-going threat. A recent unpublished list of mammals in Somaliland contains one hundred and six (106) terrestrial mammals. (Mazuch, 2020). The mammalian species sighted during the study along the transmission line route include Rüppell's Fox, *Hyaena hyaena*, Stripped hyaena, Common genet, Common slender mongoose, Aardvark, Rock Hyrax, Warthog, Hamadryas Baboon, Abyssinian Hare, Somalian grass rat, Crested porcupine, Geranug, Pelzeln's Gazelle, Salt's Dik-dik and Speke's gazelle.

3.3 Avifauna

Somaliland is a part of Somaliland-Masai steppe geographic region of plant endemism (savannas and shrub lands) and has 24 important bird areas. There are 2 IBA's within a radius of 10km from

the transmission line route. These 2 sites, Boorama Plains and Gacan Libaax are habitats of a number of avifauna species that are categorized as CR and EN. 5 species are classified as CR and 10 species classified as EN. The common avifauna observed along the transmission line route include *Lamprotornis suburbus*, *Lanius somalicus*, *Merops albicollis*, *Pterocles exustus*.

3.4 Protected Areas

The transmission line does not transverse any established protected area and is not within close proximity to any such ecosystem. Along the proposed project route and specifically within the project Area of Influence (AoI), there are no protected areas, parks, or critical habitats within a radius of 0-1kms. There is 1 protected area Ga'an Libah 50km away from the transmission line and the area of interest.

4 HYDROGEOLOGY

4.1 Hydrology

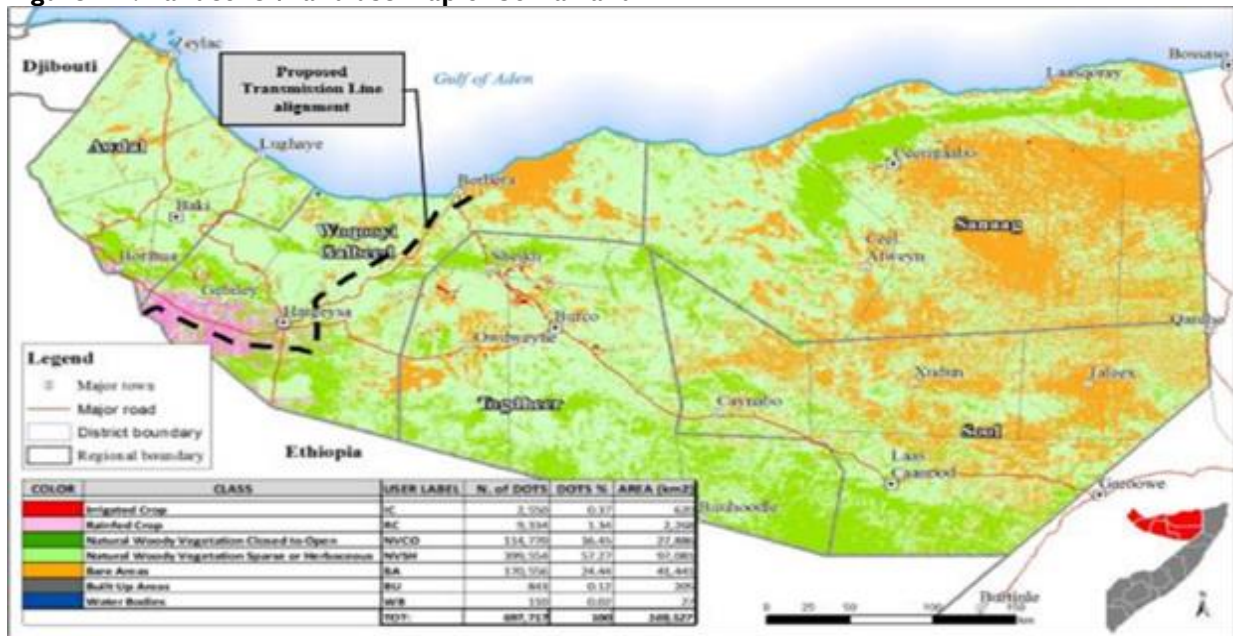
The surface waters of Somaliland belong to three major river basins: Gulf of Aden basin, Dharoor basin and Nugaal basin. The surface drainage closely follows the general geomorphology. Much of the area drains in a southeasterly direction towards the Indian Ocean; the extreme north discharges its runoff into the Gulf of Aden.

The drainage network, which is influenced by local topography, rainfall, and geology, is dense to very dense in the northern mountains. It is very thin or virtually non-existent in large parts of the central basin. Runoff in Somaliland basins generally takes place in seasonal streams (toggas) and in addition to infiltration, it replenishes stream bed and flood plain aquifers. There is only one perennial river along the transmission line route (Togga Baba). The smaller rivers and drainages have surface water only after periods of heavy rainfall. There are, however, many small streams called toggas (wadis) originating from the plateaus and mountains in the north that have perennial flows in some stretches and at other stretches have a complex surface-water groundwater interaction (subsurface flow) where there is groundwater recharge. Along the project transmission route, the rivers crossed by the project include main river Togga Baba and 5 small rivers namely Togga Maroodijeex, Togga kodayare, Togga Dacarbudhug Caloola, Togga, Xyod-Balae Abdaal and Togga Cabaadweyne.

4.2 Land Use and Land Cover

In Somaliland, the vegetation type is dominated by relatively dense stands of low thorn trees, thorn bush woods, thorn shrubs, and various species of succulent herbaceous vegetation with sparse undergrowth of rain green herbs and grasses: the thorn bush-succulent savanna, thorn tree-short grass savanna, or acacia-short grass savanna. The woody vegetation (trees) is concentrated in the hilly and mountainous area but also in the valleys. In the drier area, the open semi-desert with its widespread small xerophyte shrub vegetation and poorly developed herbaceous layer predominates. In the arid area, the trees are generally low growing, using the rainwater that percolates through the subsoil. Land cover is mainly shrubland, sparse vegetation and farmland.

Figure 4-1: Landcover/Land use Map of Somaliland

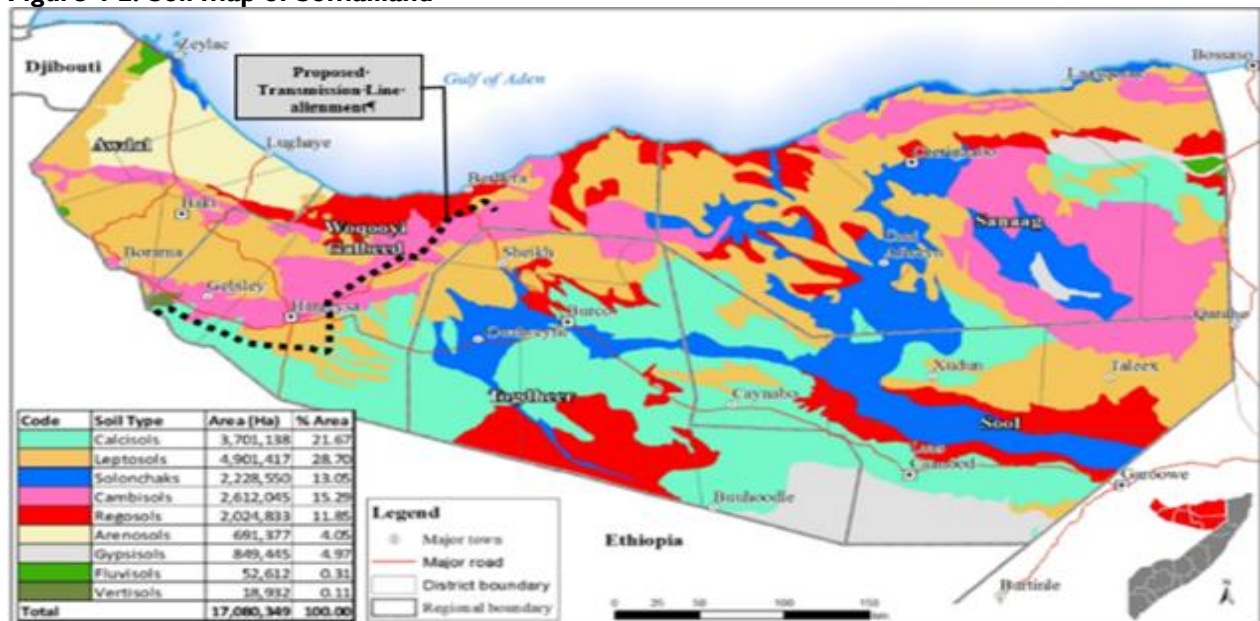


Source: (SWALIM 2016)

4.3 Soils

The soil types in Somaliland have a one-to-one relationship with the parent rock types, geomorphology, and climate elements. The soils along the coast are haplic arenosols and sandy in texture. The central, predominantly basement and mountainous areas are covered by eutric leptosols of loamy texture. Petric calcisols and calcareic cambisols are dominant over the Mesozoic sedimentary terrains of the southeast. Along the project transmission route, the dominant soil types are Leptosols, Vertisols, Cambisols and Regosols. Figure 4-2 refers.

Figure 4-2: Soil map of Somaliland

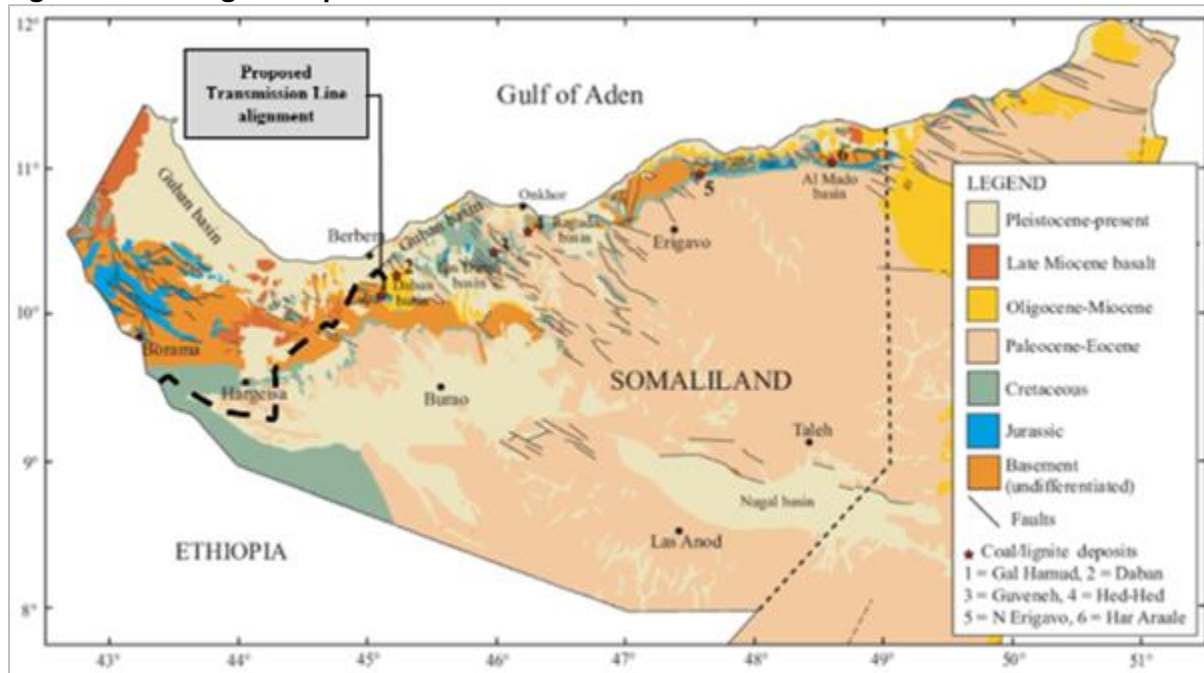


Source: (SWALIM 2016)

4.4 Geology

Somaliland has a complex geology and structural setting that make it rich in mineral resources. The country is almost all rocks of the three major rock categories. The geology of the surveyed part of Somaliland is dominantly covered by eolian and marine sediments. This unit covers areas along the coast and is dissected by radiating wadis. Mesozoic sediments, which are composed of sandstone and shale layers, are also exposed. Areas between Hargeisa and Berbera, except for the southern and northern ends, are predominantly covered by crystalline basement rocks. The northwest-southeast trending faults dissect the area and control its hydrological characteristics. Areas around Hargeisa and the Gebiley-Hargeisa stretch are covered by limestone, shale, claystone, and anhydrite rocks. Along the project route the dominant geology is sandstones, limestones, sand, silts, gravels, and biotite and/or amphibole schists. Gebiley, Hargeisa and Berbera lie within a tectonically active region characterized by the East African Rift system. Though not extensively studied or mapped as those in other regions, the broader tectonic setting of the East African Rift suggests that the three regions experience tectonic activity associated with faulting and rifting. Figure 4-3 refers.

Figure 4-3: Geological Map of Somaliland



Source; ResearchGate

5 SOCIO-ECONOMIC BASELINE

5.1 Population Distribution

a) Hargeisa City

Hargeisa city is the capital and largest city of Republic of Somaliland. It is also the regional capital of the Marodi-Jeh of Somaliland. Hargeisa was founded as a watering and trading stop between the coast and the interior by the Isaaq Sultanate. Hargeisa is situated in a valley in the Galgodon (Ogo) highlands and sits at an elevation of 1,334 m (4,377 ft). Home to rock art from the Neolithic period, the city is also a commercial hub for precious stone-cutting, construction, retail services and trading, among other activities. According to World Population Review (2024), the population Hargeisa is estimated 1.1 million.

b) Gebiley District

Gebiley is a district in the Marodi-Jeh region of Somaliland, with its capital in Gebiley. The majority of the people in the district have been settled there for the last 300 years. There are more major and minor towns in Gabiley district than anywhere else in Somaliland. In accordance with Lr. 23/2019, the district is graded under A category due to number of population and economic activities in the district. Most of the community in Gebiley and surrounding villages are farmers. It has been estimated that the broader Gebiley District has a total population of 320,430. It has been considered to be the fastest growing population district in Somaliland due to its fertile land.

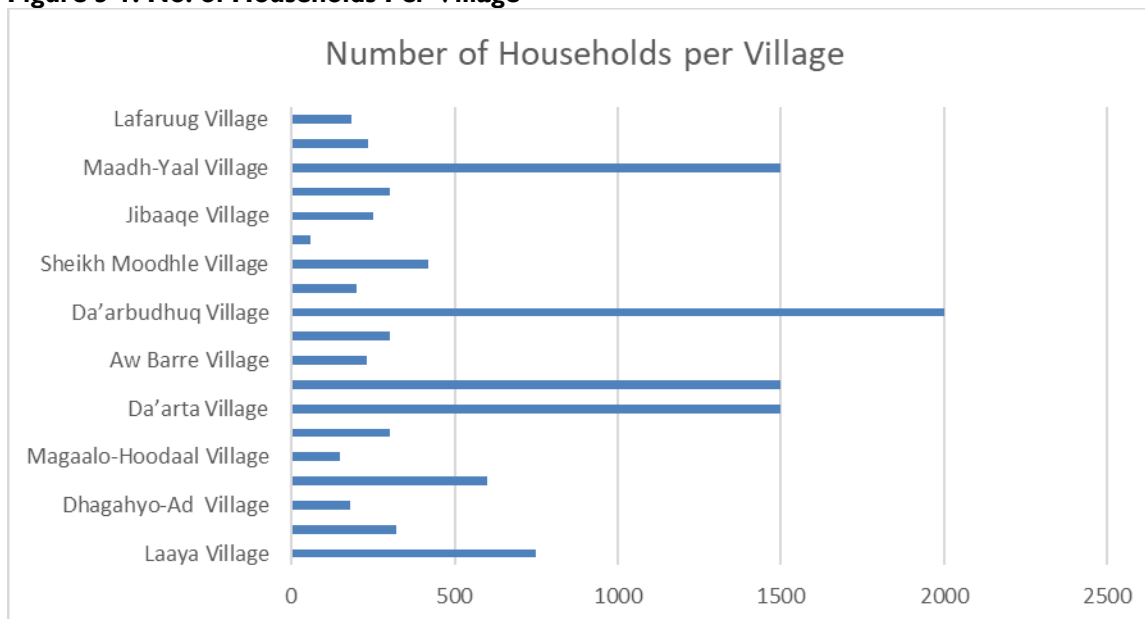
c) Berbera District

Sahil is the smallest region in Somaliland and has five districts, namely: Berbera, Sheikh, Mandera, Bulahar and Hagal Districts. Berbera and Sheikh are most populated districts, with almost half of the region's population. Berbera is the capital of the region and main port of Somaliland. The city is strategically located on the Gulf of Aden, and one of the most important entry points for goods for local use as well as those transiting to Ethiopia and federal member states of Somalia. According to Berbera District Development Framework report, the estimated population of Berbera district for 2018 is 166,622. Most of the employment comes from port related activities.

5.2 Household Size and Composition

The overwhelming majority (91.2%) are male household heads and the remaining 8.8% of the households are headed by females, categorized as single, widowed, or divorced. The average family size is 6.2 persons per household but the average figures for family size vary from as low as 5.4 in Laayo villages to as high as 7.6 in Da'arta village. Along the transmission line, the estimated household population per affected village and based on the socio-economic survey range between 50 to 2,000 households as shown in figure 5-1 overleaf.

Figure 5-1: No. of Households Per Village

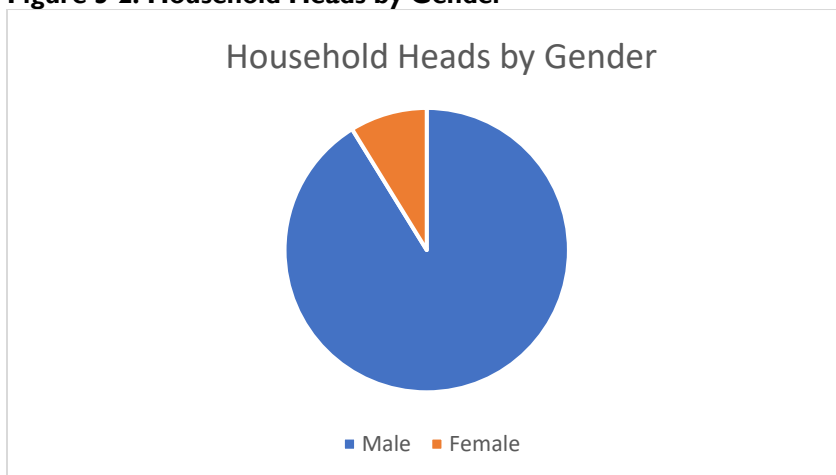


Source: EMC Consultants, 2024.

5.3 Gender

Gender and age of household heads and household members are important variables in that they inform on the general social set-up of a given society. The gender profile of the surveyed household members demonstrates that there are slightly more male than female population and it is about 91.2% and 8.8% respectively. Figure 5-2 refers.

Figure 5-2: Household Heads by Gender



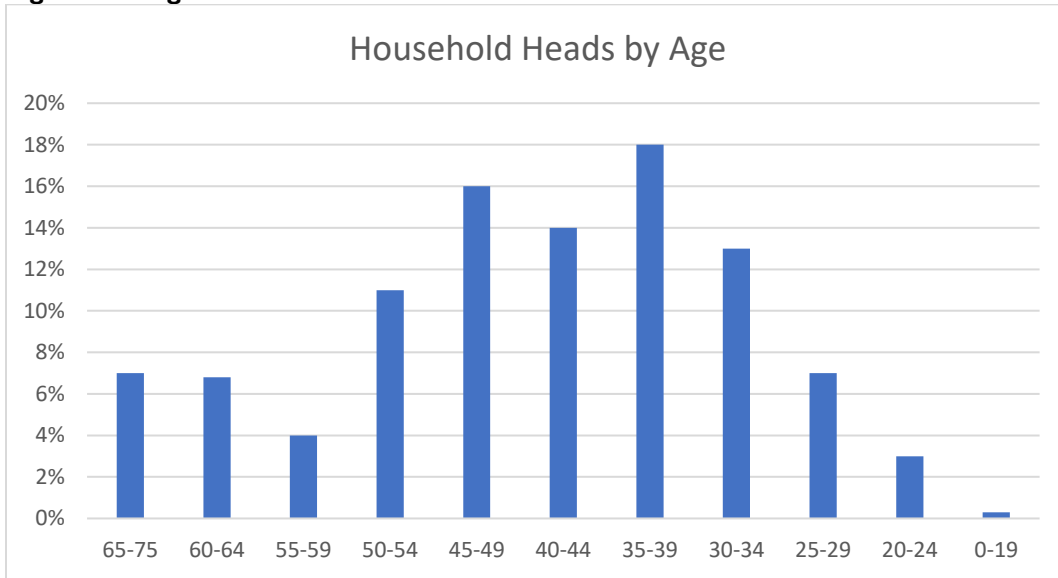
Source: EMC Consultants, 2024.

5.4 Age Structure

The age structure of the surveyed household members is dominated by youthful population. According to the survey result, about 3.3% of the household head are below 25 years old and senior household population 60 years and older constituted only 13.8% of the surveyed household

population. The average age of household heads between 40-59 years of age is 45%, while household heads below 35 years of age was 23%. Figure 5-3 refers

Figure 5-3: Age of Household Heads

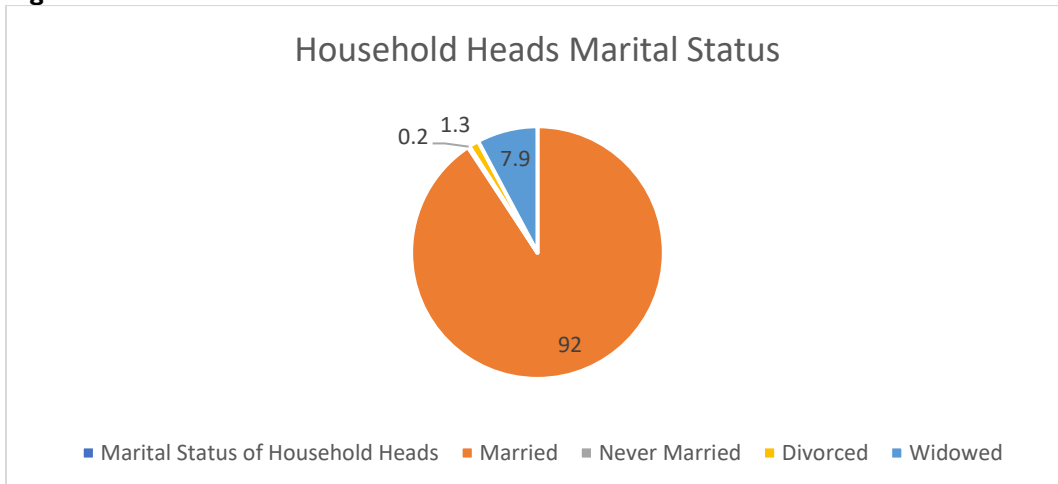


Source: EMC Consultants, 2024.

5.5 Marital Status

Majority (92%) of the household heads are married and the remaining are widows (7.9%), divorced (1.3%) and never married (0.2%). One important point to note is that widowers and divorced household heads are disproportionately higher in villages Berbera and Hargeisa as compared to villages in Gebiley district (Figure 5-4).

Figure 5-4: Marital Status of Household Heads



Source: EMC Consultants, 2024.

5.6 Land Tenure

The Constitution of Somaliland contains provisions related to land as a national property and establishes the state responsibility for the land and natural resources. Article 12 says, “The land is a public property commonly owned by the nation, and the state is responsible for it¹²”, and shall take all possible steps to explore and exploit the natural resources which are available in the nation’s land or sea. The protection and the best means of the exploitation of these natural resources shall be determined by law. Article 31 of the Constitution recognizes that every person has the right to own private property, if it is acquired lawfully, and that such property may not be expropriated except for reasons of public interests in the exchange of proper compensation. The private property ownership includes land in which Art. 2(1) of Law No. 8/1999, and 19(a) of Law No. 17 established private ownership of land with the title deed. Land tenure is closely tied to clans and Somali cultures and traditions. Since the state is weak, mistrusted and based on the clan system, it is the lineage and not the constitution that guarantees landownership rights in Somaliland.

The laws of Somaliland do not formally recognize communal land rights, but “Deegaan” implies informal recognition of clan habited areas that can be alternative to the communal land. All Somaliland people are composed of clans and sub-clans, and each is concentrated into a specific area called Deegaan. In the case of Somaliland, where the majority of the land is communal, recognizing communal land title seems the most suitable option, allowing the community to undertake its own land management, including the allocation of rights to land within its boundaries. These laws of Somaliland do not necessarily reflect the customary system. This means that they are developed regardless their consistency with the customary rules laid down by the society and existed for long time. This contributes to the existence of parallel legal regimes which potentially complicate initiatives for better land tenure. There are common types of Islamic land tenure which are also accepted either in statutory or customary law. These are:

- Mulk or milk: freehold; this is also accepted under customary law but also under the statutory laws on agricultural land ownership and urban land.
- Miri: state owned land; this can be the public land stipulated in Law No. 17
- Waqf: similar to a trust, used to create charitable endowments in perpetuity (e.g., hospitals/schools); this kind of law is also given in Law No. 17, and
- Mewat¹: “dead land”, individuals have a right to reclaim the mewat land that he turns into life, provided that there have been no previous reclaims. This practice is also recognized under Law No. 08/1999.

Along the transmission route, the land tenure in all the villages affected is freehold with all the households owning the land under customary law. However, there are some sections of agricultural land close to Wajaale which is owned by the government.

¹ Mawat (dead lands) belonging to the state and requiring state permission for cultivation and grazing rights.

6 EXISTING WATER RESOURCES

6.1 Water Sources

According to FAO-SWALIM, 2016, water resources are generally scarce in Somaliland and there is no river with perennial flows in Somaliland. Groundwater is the main source of water for the majority of the people in Somaliland to meet their water needs, groundwater from dug wells, bore holes and springs are the primary sources of water for the population in most of the country. Groundwater is harnessed by the rural and urban population to meet domestic and livestock water needs as well as for small scale irrigation. The study further indicates that a total of 1,037 water sources are found in Somaliland. More than half of the water sources are shallow wells. Dams are restricted basically to the region west and south of Hargeisa, while springs are found in the mountainous regions, particularly in Awdal, between Hargeisa and Berbera and around Erigavo. Table 6-1 refers.

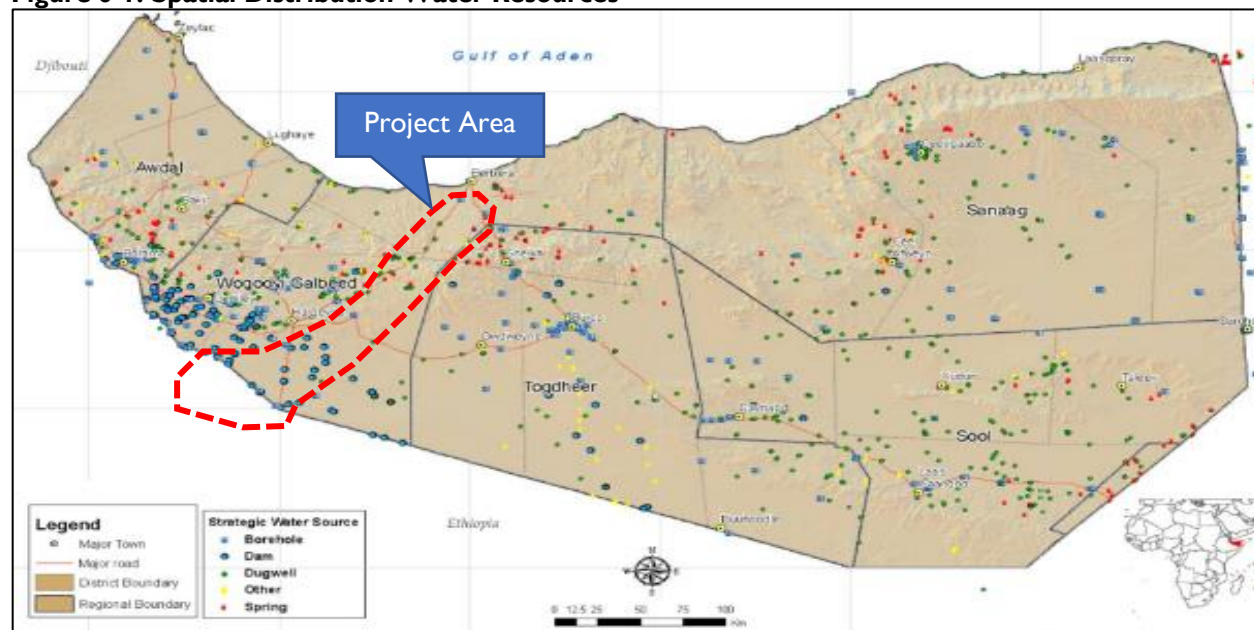
Table 6-1: Water Resources in Somaliland

Region	Dams	Boreholes	Dug wells	Springs	Others	Total
Awdal	14	25	104	37		180
Sanaag	2	32	107	30	1	172
Sool	2	18	86	3		109
Togdheer	19	40	86	20	31	196
Woqooyi Galbeed	87	43	212	34	4	380
Total	124	158	595	124	36	1,037

Source: (SWALIM 2016)

The spatial distribution of the water resources is illustrated in Figure 6-1 below.

Figure 6-1: Spatial Distribution Water Resources



Source: FAO-SWALIM

The majority of open wells, berkads (e.g. seasonal water reservoir) and some shallow boreholes in Somaliland are likely to be contaminated due to the common practice of open defecation and the absence of a system for controlling water quality. Water sources have been increasingly drying out as a result of the drought, and the scarcity of water has prompted abnormal migrations and increased the cost of potable water. The average distance to water points has increased to 50km, with some communities making a round trip of up to 125km for water. The lack of water and competition for this scarce resource is also one of the triggers for conflict in Somaliland.

6.2 Challenges Facing Water Resources

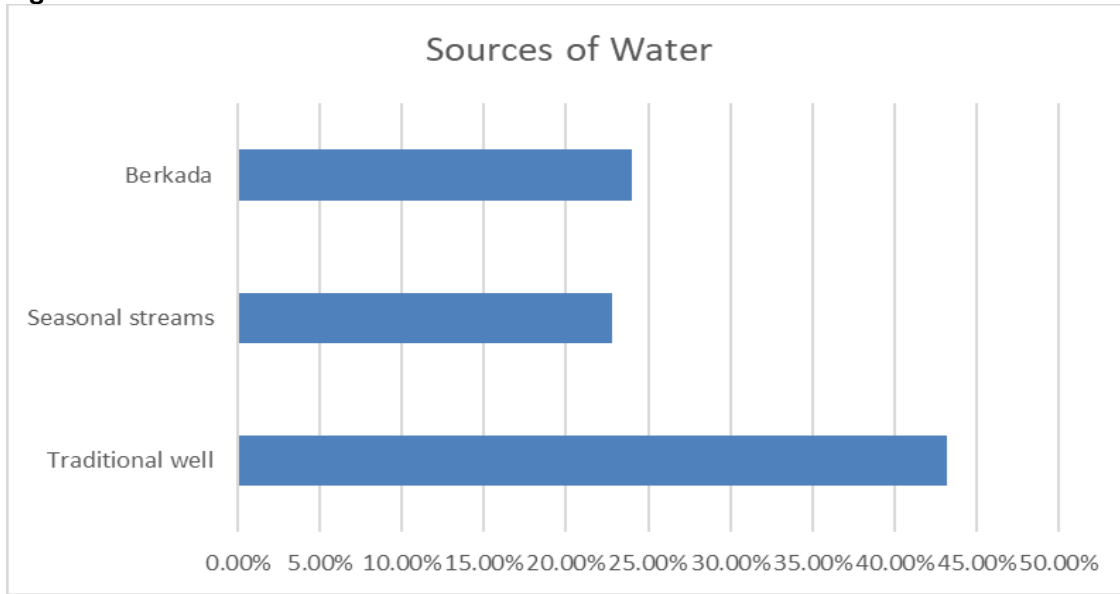
The major constraints to water resource development include:

- a) Lack of hydro geological information: groundwater data which would identify potential aquifers for new boreholes is lacking.
- b) Lack of conservation technology: the use of water efficient technologies such as drip irrigation, and water efficient appliances: faucets, showers, toilets and washing machines are lacking. Water recycling and other conservation practices and policies are also absent.
- c) Poor quality: in some parts of the country, particularly in Sool and Sanaag, water quality is so poor due to salinity that it is unsuitable for human consumption, livestock or agriculture.
- d) Climate change: Somaliland is becoming hotter and drier with changes in the seasonal and spatial distribution of precipitation. It also experiencing increasing incidence of extreme weather events such as drought.
- e) Scarcity: Somaliland has a semi-arid climate. Average annual precipitation is between 200mm and 300mm. Hence, even in normal years water is barely sufficient, and in below normal years it becomes scarce.
- f) Inadequate water storage capacity: despite substantial surface runoff generated in some of the dry rivers during the rainy season, there are no storage facilities in the form of reservoirs, and dams. Developing such facilities would require significant capital resources.
- g) Risk of floods: excessive runoff of rainwater during the wet seasons has, in the past, damaged water sources – boreholes, shallow wells, irrigation systems, flood protection structures, pumps, etc. Flooding events have led to eroding riverbanks and protection walls for intakes and pumps. Conveyance canals are often located at risk flooding plains which can cause loss of equipment and damage the irrigation systems in general.
- h) Uncontrolled exploitation of groundwater: This has led to falling water tables, abandoned wells, dried-up springs and salt-water intrusion. Opportunities for expanding irrigated cultivated lands are, therefore, limited.

6.3 Water Resources near the Corridor

The water supply situation in the villages along the transmission line is exceptionally severe. This is due to its very low rainfall. Boreholes constitute the primary source of water with 46% of the population in the villages traversed by the transmission line. 32% of the households rely on cemented water reservoirs known as Berkeds which are used to harvest water during the rainy season. 11% of households along the transmission line get their water from nearby dams, while 3% and 4% of the households get their water from seasonal rivers and springs, or wells as shown in figure 6-2. Fetching water is primarily the responsibility of women and girls (90%) with men and boys responsible only in 10% of the surveyed households. Figure 6-2 refers.

Figure 6-2: Water Sources



Source: EMC Consultants, 2024.

Figure 6-3: Borehole Under development and Fenced Water Reservoir “Berked”.



Source: EMC Consultants, 2024.

Figure 6-4: Cement and Metal Water Tanks



Source: EMC Consultants, 2024.

7 ASSESSMENT OF THE PROJECT'S WATER RESOURCES

7.1 Water Requirements

7.1.1 Estimation of the water needs for the workers

Although the number of construction workers are expected to vary throughout the project period, two scenarios were considered; the first scenario considered 100 workers being the peak number estimated from the ESIA report while the second scenario considered 552 people based on the correlates from a similar project that was undertaken in Djibouti² From the ESIA report, the total number of the workers within the construction site was estimated to be between 70-100 workers hence the adoption of the peak number. The study for the study powerline was estimated to have about 400 workers for the construction of a 197km long high voltage powerline, using the proportions, the Wajaale-Hargeisa-Berbera high voltage powerline that is 271.6km long will require about 552 people. The two scenarios above were considered in the computation of the water demand.

Using 150 l/day as the adopted per capita water consumption for each worker as a cumulative quantity for domestic use, drinking, cleaning equipment and watering the camp. The total water demand for the workers was computed to be 15 m³/day which translated to a cumulative demand of 10,800 m³ for the entire of construction (two-year) period. The breakdown of how the per capita water demand was computed is presented in table 7-1.

Table 7-1: Derivation of the per consumption

Daily Needs	Litres (Per Capita/Per person)
Domestic use	100
Drinking water	15
Kitchen	15
Cleaning the equipment	20
Watering the camp	
Total	150

Scenario 1 workers water demand – Based on 100 workers

The estimate of the water demand for the workers was computed as follows;

$$W_d = \text{population} \times \text{per capita consumption rate}$$

$$P_d = 100 \text{ people (Conservative peak population)}$$

$$W_d = 100 \times 150 \text{ l/h/d} = 15,000 \text{ l/day}$$

$$\text{say } 15 \text{ m}^3/\text{day}$$

Taking a year to comprise 360 days, The total water demand in 2 years then is;

$$W_d = 15 \text{ m}^3/\text{day} \times 720 \text{ days}$$

$$W_d = \mathbf{10,800 \text{ m}^3}$$

^{2 2} Dr. Jean Alexandre Gassani, Assessment fast resource management water for the Djibouti transmission line project

Scenario 2 workers water demand – Based on 552 people

The estimate of the water demand for the workers was computed as follows;

$$W_d = \text{population} \times \text{per capita consumption rate}$$

$$P_d = 552 \text{ people (Conservative peak population)}$$

$$W_d = 552 \times 150 \text{ l/h/d} = 82,800 \text{ l/day}$$

$$\text{say } 82.8 \text{ m}^3/\text{day}$$

Taking a year to comprise 360 days, The total water demand in 2 years then is;

$$W_d = 82.8 \text{ m}^3/\text{day} \times 720 \text{ days}$$

$$W_d = \mathbf{59,616 \text{ m}^3}$$

7.1.2 Construction Water Needs Estimation

The total water for the construction for the pylons during the two-year period was computed to be 14,259m³ as presented in table 7-2.

Table 7-2: Pylon Construction Water Demand Summary

Item	Quantity	Unit
Project duration	2	years
Linear distance of the project	271.6	km
Spacing of the pylons	400	m
No. of pylons	679	towers
Concrete volume per pylon block	20	m ³
Concrete dosage	350	kg/m ³
No. of pylon blocks (4No. blocks per pylon)	2,716	no.
Water required for 1m ³ of concrete dosed at 350kg/m ³	175	l
Vol of water for mixing per pylon block	3,500	liters
	3.5	m ³
Vol of water for mixing for 2716 pylons blocks (2716 x 3.5)	9,506	m ³
To this volume must be added the volume of water loss for cleaning the equipment and humidifying the blocks: This volume is estimated to be approximately ½ twice the total volume of mixing water.		
Volume of water loss per pylon block	1.75	m ³ /pylon block
Total volume of lost (for 2716 blocks)	4,753	m ³
Total water volume required for the construction work is estimated as (Water required for concreting + Water loss)	14,259	m ³



Photo credit: Alamy

Pylon block

The total water demand for the construction works therefore estimated as **14,259m³** for 2-year period (720 days).

$$W_d = 14,259 \text{ m}^3 / 720 \text{ days}$$

$$\text{say } 19.8 \text{ m}^3/\text{day}$$

7.1.3 Estimation of the Population & Water Needs for Local Population

Population

The project traverses ten (10) villages each with an average household size of 6.2 persons. To estimate the population of these villages, we get the product of the number of households for each village and the average household size. This are as presented in Table 7-3.

Table 7-3 : Population Estimation

Village Name	Estimated No. Of HH	Population
Lafaruug	250	1,550
Maadh-Yaal	1,500	9,300
Jibaaqe	250	1,550
Sheikh Moodhle	450	2,790
Da'arbudhuq	2,000	12,400
Aw Barre	1,500	9,300
Da'arta	1,500	9,300
Magaalo-Hoodaal	600	3,720
Dhagahyo-Ad	350	2,170
Laaya	750	4,650
Total	9,150	56,730

Source: EMC Consultants, 2024.

Assuming 80 per cent of the population are from villages that are with 12km of the project area, the population to be considered for water demand estimation is 45,384. According to SWALIM 2007 in his study on 'Rural Water Supply Assessment', the main source of income among the citizens of Somaliland is livestock. More than 60% of citizens live on rearing and selling of livestock and their products. The national economy is dependent on the exportation of livestock to the Gulf states. There are no exact figures on the number of animals exported each year from Somaliland, but it is estimated that on average 1 095 000 shoats, 6 500 camels and 73 000 oxen are exported annually through the port of Berbera. Additionally, Irrigated agriculture is practiced in all regions of Somaliland. Most farms are small in size, between 0.5–2 ha. Irrigation farms are mainly concentrated in the mountainous escarpments (northern and southern parts), along the banks of the dry riverbeds and the coastal plain in Sahil Region where water is extracted from the alluvial deposits with some aquifers and springs. For purposes of water demand estimation however, only domestic water demand for the local population shall be considered especially if only ground water is adopted as the main source of water for this project. The other water needs can however be met from the dams, springs, berkads and dug wells.

Water Demand Estimation

SWALIM 2007 further observed that Water in rural Somaliland is used for domestic consumption, watering livestock and in some cases for irrigation. The study also noted that the international water requirements are not applicable to rural communities in Somaliland, due to extreme water scarcity. The basic water requirement may be as low as 4-6 litres per day. Water use is minimal, particularly in the Jilaal season when water has to be brought by trucks from permanent water sources. The Sphere Project: Humanitarian Charter and Minimum Standards in Humanitarian Response, 2011 noted that the minimum water requirements for human survival is 7.5 l/person/day.

However, this figure was noted to be appropriate mostly for people staying on short term e.g., refugees, displaced communities or nomads. The report proposed that 15 l/c/d would be the minimum amount required to maintain health and dignity. The WHO (2011) proposed 10 l/c/d for drinking water, 20 l/c/d for cooking and drinking, 50 l/c/d for drinking, cooking and personal hygiene³. To estimate the water requirements for the local community the WHO recommended 50 l/c/d for drinking, cooking and personal hygiene has been adopted. This study further recognized that the water usage directly correlates with the distance covered to fetch water, it was noted for instance that people would take about 30 minutes to access and collect water from sources about 1km, the sphere additionally noted that people living within urban centers will require a minimum of 50 l/c/d in where there is individual connection.

To estimate the water requirements for the local community, two scenarios were considered as follows:

- a) Scenario 1 - This scenario assumed that 80% of people in villages along the powerline live within 6km of the powerline corridor on either side, at this distance, the local community can only collect water for drinking and thus the 10l/c/d was adopted as per capita water consumption.

$$\begin{aligned}
 P_d &= \text{Assuming 80\% of the population as shown in Table 7-3} \\
 &= 80\% \times 56,730 \\
 &= 45,384 \text{ People}
 \end{aligned}$$

The estimated water demand would therefore be;

Adopted Per Capita Consumption = 50 l/c/d

$$W_d = 45,384 \times 50 \text{ l/c/d} = 2,269,200 \text{ l/day}$$

$$\text{say } 2269.2 \text{ m}^3/\text{day}$$

- b) Scenario 2 - This scenario assumed that 50% of people in villages along the powerline live within 1km of the powerline corridor on either side, at this distance, the local community will be able to collect water for drinking and cooking and thus the 20 l/c/d was adopted as per capita water consumption for this scenario.

$$\begin{aligned}
 P_d &= \text{Assuming 50\% of the population as shown in Table 7-3} \\
 &= 50\% \times 56,730 \\
 &= 28,365 \text{ People}
 \end{aligned}$$

The estimated water demand would therefore be;

Adopted Per Capita Consumption = 50 l/c/d

$$W_d = 28,365 \times 50 \text{ l/c/d} = 1,418,250 \text{ l/day}$$

$$\text{say } 1418.25 \text{ m}^3/\text{day}$$

³ <https://cdn.who.int/media/docs/default-source/wash-documents/who-tn-09-how-much-water-is-needed.pdf>

7.1.4 Aggregated Water Demand

The total water demand under different scenarios were computed and added It is important to note that the settlement pattern for the local population within the project area is mostly clustered except for some sections that were noted to have permanent settlements. The Aggregated water demand for each scenario is presented in Table 7-2 below.

Figure 7-1: Aggregated Water Demand

Item	Water Demand Category	Scenario			
		1.0	2.0	3.0	4.0
1	Construction workers water demand (m ³ /day)	15.0	15.0	82.8	82.8
2	Concrete works water demand (m ³ /day)	19.8	19.8	19.8	19.8
3	Local Community Water demand (m ³ /day)	2269.2	1418.25	2269.2	1418.25
	Total (m³/day)	2304	1453.05	2371.8	1520.855

The aggregated water demand for the project area was estimated as **2304m³/day**, **1453.05m³/day**, **2371.8m³/day**, and **1,520.85 m³/day** for scenarios 1 to 4 respectively.

Note: To calculate local community water demand for scenario 1 and 3 the estimated population of 45,384 and for scenario 2 and 4 estimated population of 28,365 was used, for all the scenario consumption of 50l/c/d was used.

7.2 Mapped Water Resources Along the Powerline Corridor

The existing water resources along the transmission line corridor were mapped which included surface and ground water sources. The general observation made was that between SAP 3_5 (Wajaale town) and SAP 3_11(Hargeisa town) the predominant source of water is surface dams. According 9 dams, 3 boreholes and 1 dug well are located in this stretch. Between SAP 3_12 (Hargeisa) and SAP 3_16 (Lafa-Ruug town), the predominant source of water is the dug wells (11 number) which are shall and are constructed mostly on the dry river beds or at the river banks and between SAP 3_16 (Lafa Ruug) and SAP 3_19 (Berbera town), the predominant source of water are the high yielding boreholes (4 number).

7.2.1 Inventory of Water Points

The water resources available near the power transmission corridor are provided in Table 7-5 below.

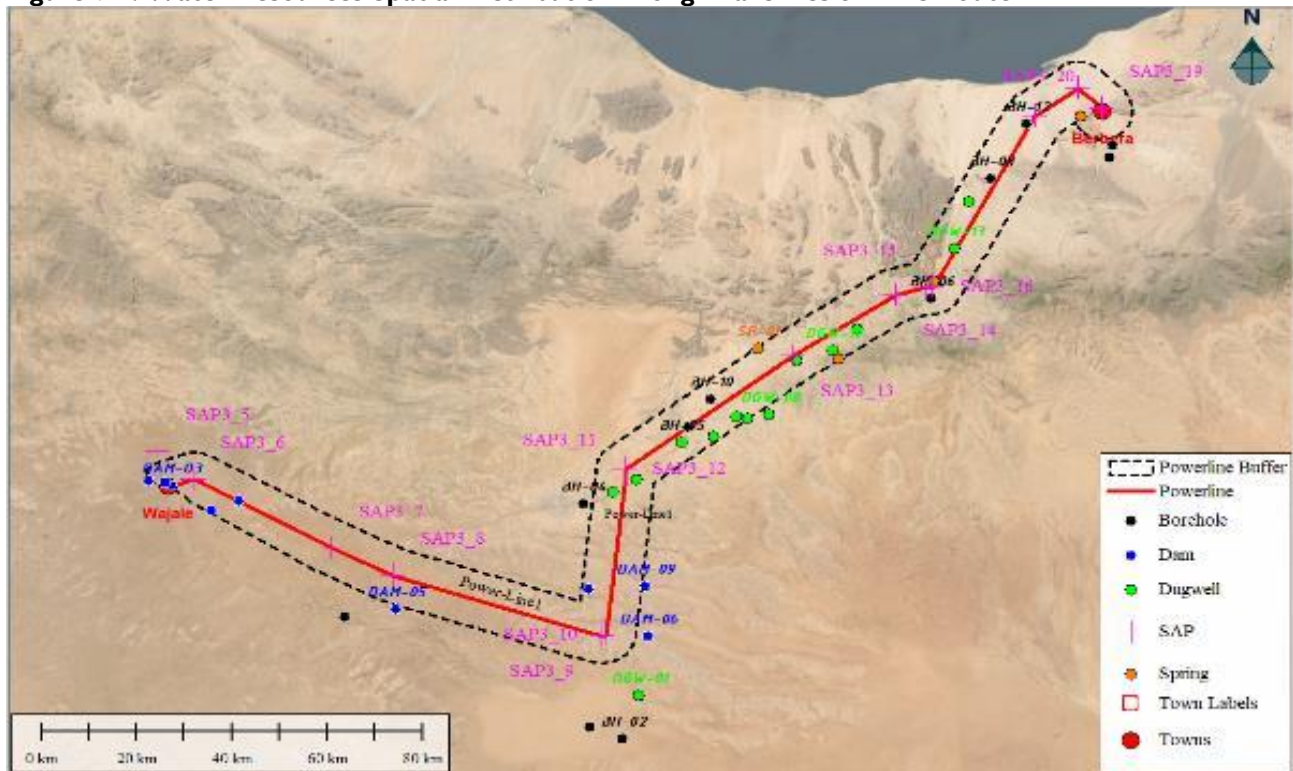
Table 7-4 : Water Resources Inventory

LONGITUDE	LATITUDE	LABEL	ITEM
43° 40' 07.3200" E	9° 19' 56.6400" N	BH-01	Borehole
44° 11' 29.4000" E	9° 05' 16.8000" N	BH-02	Borehole
44° 07' 45.8400" E	9° 06' 37.4400" N	BH-03	Borehole
44° 07' 06.6000" E	9° 33' 37.0800" N	BH-04	Borehole
44° 18' 01.8000" E	9° 41' 01.3200" N	BH-05	Borehole
44° 46' 19.9200" E	9° 58' 27.4800" N	BH-06	Borehole
44° 18' 52.2000" E	9° 42' 56.8800" N	BH-07	Borehole
44° 53' 03.8400" E	10° 12' 55.8000" N	BH-08	Borehole

45° 06' 49.3200" E	10° 16' 53.7600" N	BH-09	Borehole
44° 21' 25.9200" E	9° 46' 17.4000" N	BH-10	Borehole
45° 06' 27.7200" E	10° 15' 25.5600" N	BH-11	Borehole
44° 57' 04.0680" E	10° 19' 31.5480" N	BH-12	Borehole
43° 18' 01.0800" E	9° 36' 25.2000" N	DAM-01	Dam
43° 19' 48.7200" E	9° 36' 10.8000" N	DAM-02	Dam
43° 24' 59.0400" E	9° 32' 47.4000" N	DAM-04	Dam
43° 28' 11.2800" E	9° 33' 58.6800" N	DAM-05	Dam
43° 45' 50.4000" E	9° 20' 55.6800" N	DAM-05	Dam
44° 14' 19.6800" E	9° 17' 36.6000" N	DAM-06	Dam
44° 07' 35.7600" E	9° 23' 21.1200" N	DAM-08	Dam
44° 14' 01.3200" E	9° 23' 42.0000" N	DAM-09	Dam
43° 20' 27.2400" E	9° 35' 48.4800" N	DAM-O3	Dam
44° 13' 17.7600" E	9° 10' 30.0000" N	DGW-01	Dug Well
44° 10' 27.8400" E	9° 35' 02.7600" N	DGW-02	Dug Well
44° 13' 08.0400" E	9° 36' 29.8800" N	DGW-03	Dug Well
44° 18' 11.5200" E	9° 41' 00.9600" N	DGW-04	Dug Well
44° 21' 48.6000" E	9° 41' 47.7600" N	DGW-05	Dug Well
44° 24' 17.2800" E	9° 44' 10.6800" N	DGW-06	Dug Well
44° 25' 36.4800" E	9° 43' 59.8800" N	DGW-07	Dug Well
44° 28' 03.3600" E	9° 44' 25.0800" N	DGW-08	Dug Well
44° 31' 08.0400" E	9° 50' 51.0000" N	DGW-09	Dug Well
44° 35' 10.1040" E	9° 52' 06.8520" N	DGW-10	Dug Well
44° 37' 59.1600" E	9° 54' 42.4800" N	DGW-11	Dug Well
44° 46' 15.2400" E	10° 00' 14.4000" N	DGW-12	Dug Well
44° 49' 01.2000" E	10° 04' 27.8400" N	DGW-13	Dug Well
44° 50' 38.0400" E	10° 10' 07.6800" N	DGW-14	Dug Well
44° 26' 45.9600" E	9° 52' 22.0800" N	SP-01	Spring
44° 35' 55.3200" E	9° 51' 09.3600" N	SP-02	Spring
44° 46' 37.5600" E	10° 00' 29.8800" N	SP-03	Spring
45° 03' 10.0800" E	10° 20' 25.8000" N	SP-04	Spring

Source: (SWALIM 2016)

Figure 7-2. Water Resources Spatial Distribution Along Transmission Line Route



Source: EMC Consultants

It was not possible to determine the yield of the springs and capacity of the dams and dug wells. This is attributed to the fact that these sources of water are seasonal and may run dry during the prolonged dry spells. However, some these sources may be considered to augment boreholes sources especially between Wajale and Hargeisa where the local community obtains water predominantly through surface dams. The borehole yields, depths and capacities of that are operational within the proximity of the proposed transmission line were collected (table 7-6).

Table 7-5: Boreholes Along Transmission Line Route

Bore Hole Code	Borehole Yield (m ³ /hr)	Borehole Depth (m)	Available Storage (m ³)
BH-01	4.0	270	10
BH-02	2.5	300	10
BH-03	4.0	377	10
BH-04	5.0	280	10
BH-05	10	127	10
BH-06	5.0	36	10
BH-07	15	150	50
BH-08	9.0	70	40
BH-09	35	70	35
BH-10	2.5	42	24
BH-11	35	130	50
BH-12	2.5	70	35
Total	129.5		294

Source: (SWALIM 2016)

7.2.2 Water Resources Photo Plates



<p>Dug Well (DG 01)</p> 	<p>Dam (DM 03)</p> 
<p>Spring (SP01)</p> 	<p>Borehole (BH08)</p> 
<p>Borehole (BH 09)</p> 	<p>Borehole (BH 03)</p> 
<p>Borehole (BH 07)</p> 	<p>Borehole (BH 01)</p> 

N/B: The photo plates for the water sources presented above were obtained from <https://swims.faoswalim.org/livemap/view#>.

8 WATER BALANCE ANALYSIS

8.1 Estimation of Available Water Quantities

Based on the findings arising from these assessments of the existing water resources falling within the project area, it was possible to estimate the quantities of water available from the existing boreholes.

An estimate of the likely quantity of water available (or that can be available) needs to be made. To this end the use of existing borehole abstraction data was the first point of reference. However, long term borehole metering data for the existing boreholes was not available.

In the absence of metering data and other quantitative records, the current borehole production data was estimated from information obtained from other studies. Based on this qualitative information, the borehole production is estimated thus. Table 8-1 refers.

Table 8-1: Boreholes Along Transmission Line Corridor

Bore Hole	Borehole Yield (m ³ /hr)*	Daily Production based on discharge (m ³ /day)**
BH-01	4.0	19.2
BH-02	2.5	12.0
BH-03	4.0	19.2
BH-04	5.0	24.0
BH-05	10	48.0
BH-06	5.0	24.0
BH-07	15	72.0
BH-08	9.0	43.2
BH-09	35	168.0
BH-10	2.5	12.0
BH-11	35	168.0
BH-12	2.5	12.0
Total	129.5	621.6

*Discharge measured from boreholes at the time of test pumping

**Assumptions made include.

- a) Abstraction and operation will be done 8hr per day.
- b) Abstraction from existing boreholes is at 60% of the test yield which is the recommended sustainable abstraction from ground water resources.

The allowable sustainable abstraction capacity of the existing boreholes is therefore **621.6m³/day**. If extracted throughout the project period of 2 years, the total abstraction will be **447,552 m³**.

8.2 Water Balance

Water demand as obtained under section 7.1 of this report was compared against the estimated available water resources to determine the adequacy of the existing water sources. The water balance is as presented in Tables 8-2 overleaf.

Table 8-2: Water Balance

	Description	Scenario 1 (m ³ /day)	Scenario 2 (m ³ /day)	Scenario 3 (m ³ /day)	Scenario 4 (m ³ /day)
A	Construction workers water demand	15	15	82.8	82.8
B	Concrete works water demand	19.8	19.8	19.8	19.8
C	Local Community Water demand	2269.2	1418.25	2269.2	1418.25
D	Total water demand	2304	1453.05	2371.8	1520.85
E	Available borehole water	621.6	621.6	621.6	621.6
F	Deficit in m³/day (E-D)	1682.4	831.45	1750.2	899.25

Analysis of the water balance indicates that the available borehole sources cannot meet water demand, clearly demonstrating an existing water deficit. The project should independently source water by conducting hydrogeological surveys to locate and drill boreholes, then equip them for use. Once the project is completed, the boreholes should be handed over to the community.

9 RECOMMENDATIONS

Following the interpretation and analysis of the main results of this assessment, it is possible to formulate the following recommendations for the successful implementation of the project.

- The project should independently source water by conducting hydrogeological surveys to locate and drill boreholes, then equip them for use. Once the project is completed, the boreholes should be handed over to the community.
- The workers camp should be located near the boreholes as the highest water demand for the project is for use by the project workers to reduce on water transport costs.

9.1 Conclusions

The project area faces a water deficit, and the project should not utilize the community water sources but invest in new water sources for its use.

10 REFERENCES

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